>>next

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Home

Why Care About Pollinators?

Scientific Thinking Processes

Implementing the Curriculum

Assessment

Outline

Printable Photos

Module 1

The Who, What & Why of Pollinators

Module 2

Pollinators and Plants in Partnership

Module 3

The Other Half of the Partnership: Pollinators

Module 4

Pollinator-Friendly Habitat in Your Area

Module 5

Creating Pollinator-Friendly Habitat

Module 6

Community Service Project and Celebration

Why Care About Pollinators?

Many people think only of allergies when they hear the word pollen. But pollination — the transfer of pollen grains to fertilize the seed-producing ovaries of flowers — is an essential part of a healthy ecosystem. Pollinators play a significant role in the production of over 150 food crops in the United States — among them apples, alfalfa, almonds, blueberries, cranberries, kiwis, melons, pears, plums, and squash.

Bees, both managed honey bees and native bees, are the primary pollinators. However, more than 100,000 invertebrate species, including bees, moths, butterflies, beetles, and flies, serve as pollinators — as well as 1,035 species of vertebrates, including birds, mammals, and reptiles. In the United States, the annual benefit of managed honey bees to consumers is estimated at $14.6 billion. The services provided by native pollinators further contribute to the productivity of crops as well as to the survival and reproduction of many native plants.

However, long-term population trends for some North American pollinators are "demonstrably downward," says a new report from the National Research Council[1].

Observable decreases in wild populations of bees, butterflies, and moths are of great concern to producers of fruits, vegetables, nuts, alfalfa, and flowers. These crops depend on wild and domestic pollinators. Growers in California, Florida, Arizona, Utah, Washington, and Hawaii are especially concerned. More important is the disturbing notion of an imbalance in the natural ecosystem and biodiversity on which all food production depends. Habitat loss for pollinators by human activity poses an immediate and frequently irreversible threat. Other factors responsible for population decreases include invasive plant species, broad-spectrum pesticide use, disease, and weather.

For the most part, the general public is unaware of the decrease in pollinator populations and the implications this has for agricultural production. **The Nature's Partners: Pollinators, Plants, and You** curriculum is designed to educate young people about

- pollinators and the important role they play in providing many of the foods we eat and the

Nature's Partners is an inquiry learning-based curriculum for young people in the 3rd through the 6th grade.

>>Learn more about the curriculum.

Monarch butterfly on tithonia.

Long-term population trends for some North American pollinators are "demonstrably downward," says a new report from the National Research Council. This is of great concern to producers of fruits, vegetables, nuts, alfalfa, and flowers. These crops depend on wild and domestic pollinators.

Resources/Links

Acknowledgements

Introduction to 4-H Series

plant fiber used in our clothing and household goods, and

- ways they can help pollinators survive and flourish by protecting and creating pollinator-friendly habitat.

The *Nature's Partners* curriculum is just one step toward increasing the public's awareness and sense of responsibility that are essential to a successful conservation program for pollinators.

In this introductory curriculum we have purposely chosen to focus on just two of the many pollinators as a means for teaching basic concepts about the process and importance of pollination. **Bees** were chosen due to their primary importance among pollinators and **butterflies** were chosen because of the interesting and distinctive stages of their life cycle and their intrinsic appeal. Resource and reference materials pertaining to other pollinators are easily found on the Internet, at your local library, and by contacting the Cooperative Extension Office in your county.

[1] "Status of Pollinators in North America, " Committee on the Status of Pollinators in North America, National Research Council
View report.

Scientific Thinking Processes

Implementing the Curriculum

Begin Module 1

Honey bees on a frame in a managed hive.

Habitat loss for pollinators by human activity poses an immediate and frequently irreversible threat.

Photos by Suzanne DeJohn.

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Home

Why Care About Pollinators?

Scientific Thinking Processes

Implementing the Curriculum

Assessment

Outline

Printable Photos

Module 1

The Who, What & Why of Pollinators

Module 2

Pollinators and Plants in Partnership

Module 3

The Other Half of the Partnership: Pollinators

Module 4

Pollinator-Friendly Habitat in Your Area

Module 5

Creating Pollinator-Friendly Habitat

Module 6

Community Service Project and Celebration

Scientific Thinking Processes

Much of what we learn about science in school is delivered through readings, lectures or demonstrations. Scientists, however, create new knowledge by careful use of the scientific thinking processes outlined below.

Underlying all the curriculum activities are the basic thought processes that scientists use everyday. As leader and co-investigator, you'll be introducing and practicing these with your youth group.

a) Observing
Using all the senses of sight, smell, taste, touch, and hearing to gain information.

b) Communicating
Recording discoveries, sharing them, and listening to others who may have observed things you missed or have different ways of expressing their observations. Communication — whether oral, written, or graphic — increases everyone's awareness and gives a fuller picture of the object or phenomenon.

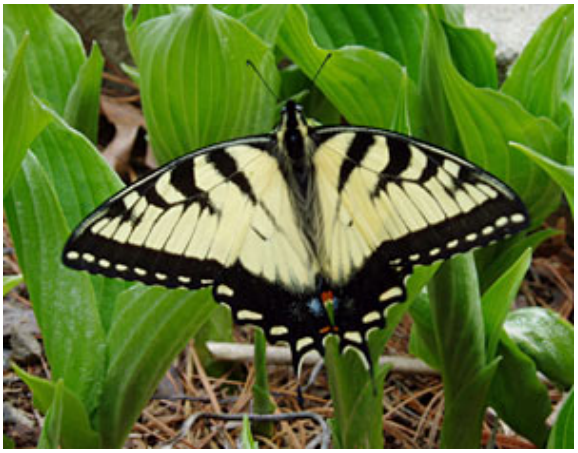
Photo by Marilyn Drabicki

c) Comparing
Observing two or more things side-by-side to find similarities and differences. Some comparisons may be sensory, such as comparing how different things feel, sound, smell, taste, look, behave, or react. Measurement is another way of comparing things: you are comparing something to a set of standardized units. You may weigh something (compare it to an ounce or a pound); measure its length (compare its length to inches or centimeters); or measure its holding capacity (compare it to the scale on a measuring cup).

The activities are designed to provide a systematic exploration of the topic using the scientific thinking processes. Since there are no "right" results, there can be no "failure."

d) Organizing
Grouping or classifying the things you are studying into categories — for example: leaves vs. twigs; red vs. green vs. blue. Another type of organization is ordering or sequencing — for example: rank the rocks from hardest to softest; twigs from longest to shortest.

e) Relating
Looking for relationships between variables involves trying out or checking your ideas in a systematic way. It is the process by which concrete and abstract ideas are woven together to test or explain phenomena. Once you have an idea about how something works (a hypothesis), you can experiment to test the hypothesis by comparing the effects of one variable on another.

f) Inferring
Inferring is the process of realizing ideas that are not directly observable. Based upon your findings in the above processes, you can begin to recognize and predict general patterns and relationships, thus forming a more comprehensive theory.

g) Applying
Applying knowledge involves using knowledge to solve problems — often in creative and inventive ways. You can take the knowledge you gained from your systematic explorations and apply it to new

Resources/Links

Acknowledgements

Introduction to 4-H Series

questions or to problems that arise in everyday life.

The activities in *Nature's Partners* are designed to provide a systematic exploration of the topic using the scientific thinking processes. Since there are no "right" results anticipated, there can be no "failure." You'll know your activities are successful when investigators come up with their own questions and together you start finding ways to answer them!

Implementing the Curriculum

Begin Module 1

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Home

Why Care About Pollinators?

Scientific Thinking Processes

Implementing the Curriculum

Assessment

Outline

Printable Photos

Module 1

The Who, What & Why of Pollinators

Module 2

Pollinators and Plants in Partnership

Module 3

The Other Half of the Partnership: Pollinators

Module 4

Pollinator-Friendly Habitat in Your Area

Module 5

Creating Pollinator-Friendly Habitat

Module 6

Community Service Project and Celebration

Implementing the Curriculum

Overview

Nature's Partners is an inquiry learning-based curriculum for young people in the 4th through the 6th grade. It is comprised of seven modules. Each module offers three or four activities designed to engage young people in active, investigative science following a learning cycle of

- exploration,
- concept introduction/development, and
- concept application.

The activities are appropriate for the formal classroom or for a nonformal education setting and can easily be adapted to fit the needs of the students and the teaching situation.

Photo by Suzanne DeJohn

The *Nature's Partners* curriculum is designed to be flexible. Although it is presented as a sequence of activities, there is no need to do them all or to do them in order.

Service Learning

The context of community is an important aspect of this program. The program will be most effective when the young people are involved in contributing to the community through a service learning project.

Adapt the Curriculum

The *Nature's Partners* curriculum is designed to be a highly adaptive and flexible resource for teachers and youth leaders. Although the curriculum is presented as a sequence of activities, there is no need to do them all or to do them in order.

Begin by reading the detailed curriculum outline to identify those modules and learning activities that fit your specific goals, situation, and needs. Each module offers a variety of activities, suggestions for further exploration, and ideas for applying the concepts developed in the activities. Activities can easily be modified for your situation.

Photo by Suzanne DeJohn

The program will be most effective when the young people are involved in contributing to the community through a service learning project.

The materials for each module are organized as follows:

Purpose: States the goals for the module.

Background: Provides information on the module topic for the benefit of the leaders. This is not intended to be read to participants.

Activities: Each activity provides an easy-to-follow plan for implementation and is divided into sections:

- **Participants will:** Statement of what the participants will do and learn.

Resources/Links

Acknowledgements

Introduction to 4-H Series

- **Materials needed:** Lists materials you will need for the activity.
- **Getting Ready:** Reminders of things that need to be done before the activity.
- **Action:** Provides guidelines for the three stages of the activity: Exploration, Concept Introduction/Development, and Concept Application.
- **Going Further:** Additional ways participants can apply or share the concepts they have learned during a module. Not all Modules have this section.

Optional/Alternate Activities: Other ways to accomplish the goals and objectives of the module are sometimes suggested.

Supplementary Resources: Materials that provide information helpful in carrying out the activities included in that module.

Activity Sheets: Printed materials for the participants to use in the activities.

Engage the Community

Community members and organizations that are knowledgeable and interested in such topics as ecology, plants and/or animals native to the region, beekeeping, gardening, and environmental conservation can be great resources for your program. You will probably find such people or organizations very willing to help by sharing their expertise with the children. See Resources/Links for suggestions on how to locate such individuals or groups.

It is also worthwhile to give some thought to possible service projects and community awareness projects that the group may wish to undertake. Your community may have some unique needs and opportunities for service.

Participant Supplies

If possible, each participant should have a copy of the *Pollinator Field Journal*. If it is not possible to order one journal per student, at least have a few copies on hand to use as references. It would also be helpful if each participant had a folder with pockets for organizing the work sheets that accompany many of the activities and for storing their field journal.

Available from the Gardening with Kids Store.

Module 1

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Home

Why Care About Pollinators?

Scientific Thinking Processes

Implementing the Curriculum

Assessment

Outline

Printable Photos

Module 1

The Who, What & Why of Pollinators

Module 2

Pollinators and Plants in Partnership

Module 3

The Other Half of the Partnership: Pollinators

Module 4

Pollinator-Friendly Habitat in Your Area

Module 5

Creating Pollinator-Friendly Habitat

Module 6

Community Service Project and Celebration

Assessment

Without measurable evidence of changes in the knowledge, attitudes, and behavior of the participants after completing an activity, we can only say we "think" changes have occurred in these areas.

As the Nature's Partners experience is completed, it is important to have evidence of gains in knowledge and understanding of:

- the fundamentals of plant reproduction;
- the unique nature of the primary pollinators: bees;
- the role pollinators play in maintaining the ecosystem and productivity of agriculture; and
- actions necessary to protect and encourage the growth of pollinator populations.

Changes in Attitudes & Behaviors

Besides factual knowledge, we are also interested in the attitudes and behaviors that result from participating in the activities of this curriculum:

- How have participant's perspectives changed about:

  — the nature of bees?
  — the importance of bees to the availability of foods and fibers?
  — the use of pesticides?
  — the development of lands?
  — the need to take an active role in protecting pollinators?

- What changes will they make or activities will they participate in to:

  — make their environment more pollinator-friendly?
  — educate others about the importance of protecting pollinators?

We propose **assessing** changes in **knowledge**, **attitudes**, and **behaviors** both in pre-assessment and post-assessment projects:

1. Pre-Assessment

- To determine gains in factual knowledge, the group will participate in a **pre-assessment activity**, in which they will brainstorm and fill in a wall-sized chart, "What Do We Know About Plants?" to establish a base-line of knowledge.
- Near the end of the Nature's Partners experience, this activity will be repeated and new knowledge will be added to the chart, or an additional chart may be used for recording the participants' input.
- Pre-Assessment Activity

2. Post-Assessment

- An **open discussion** using the following topics will be used as talking points can give insight to how participants' perspectives have changed:

  — attitudes about bees,

Resources/Links

Acknowledgements

Introduction to 4-H Series

— use of pesticides,
— development of lands,
— need to protect pollinators,

Someone will write down the ideas expressed on a large paper pad that all the participants can see. These group notes will be reviewed by evaluators.

- **Activity sheets and Field Observation Journals** will also serve as a record of gains in knowledge and understanding. These can be collected and reviewed by leaders and evaluators.
- A group **photo journal** of the group service project, and any other activities undertaken as a group or as individuals, will contain annotations from the participants and will provide important evidence of attitudinal and behavioral changes that have taken place because of involvement in the *Nature's Partners* experience.
- Post-Assessment Activity

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Home

Why Care About Pollinators?

Scientific Thinking Processes

Implementing the Curriculum

Assessment

Outline

Printable Photos

Module 1

The Who, What & Why of Pollinators

Module 2

Pollinators and Plants in Partnership

Module 3

The Other Half of the Partnership: Pollinators

Module 4

Pollinator-Friendly Habitat in Your Area

Module 5

Creating Pollinator-Friendly Habitat

Module 6

Community Service Project and Celebration

Table of Contents

Home

Why Care About Pollinators?

Scientific Thinking Processes

Implementing the Curriculum

Assessment

Outline

Printable Photos

Note: * Indicates activities that participants can do as independent projects or with their family. Time should be planned in future sessions for reports on the outcomes of these activities.

Module 1: The Who, What & Why of Pollinators

Background

Pre-assessment Activity What kids know and think right now about plants and flowers and the animals and insects around

Activity A Discovering the Partnership between Plants and Insects

Activity B Why Pollination and How it Works

Activity C Without Pollinators: What We Would Do "Without"

Going Further Introduction of the Field Journal.

Reproducibles PDF files to print and photocopy

Module 2: Pollinators and Plants in Partnership

Background

Activity A Understanding Flower Structure & Plant Reproduction

Activity B Designing a Flower

Activity C* Creating a Reference Catalog of Flowers: Identifying and Preserving Flowers

Activity D* A Rainbow of Choices: How Flowers Use Color to Attract Pollinators

Module 3: The Other Half of the Partnership: Pollinators

Background

Resources/Links

Acknowledgements

Introduction to 4-H Series

Activity A The Anatomy of Bees, Butterflies, & Moths

Activity B Designing a Pollinator

Activity C Pollinator Real Estate

Activity D* Look Who's In the Neighborhood!

Activity E* Sugar Rush: How sweet does nectar need to be?

Module 4: Pollinator-Friendly Habitat in Your Area

Background

Activity A "Who Am I" Game: Reviewing Characteristics of Bees & Butterflies

Activity B Native Pollinators and Their Habitat: A Guided Field Trip

Module 5: Creating Pollinator-Friendly Habitat

Background

Activity A Welcome Home: Plants & Landscaping for Pollinators

Activity B Is Your Neighborhood Pollinator-Friendly?

Module 6: Community Service Project and Celebration

Background

Activity A Planning a Community Service Project

Work Sessions

Celebration of Project Celebrate and share learning and accomplishments with family and friends through displays, skits, activities and refreshments.

Post-Curriculum Assessment

Resources/Links

Acknowledgements

Introduction to 4-H Series

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Home

Why Care About Pollinators?

Scientific Thinking Processes

Implementing the Curriculum

Assessment

Outline

Printable Photos

Module 1

The Who, What & Why of Pollinators

Module 2

Pollinators and Plants in Partnership

Module 3

The Other Half of the Partnership: Pollinators

Module 4

Pollinator-Friendly Habitat in Your Area

Module 5

Creating Pollinator-Friendly Habitat

Module 6

Community Service Project and Celebration

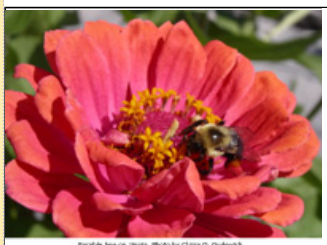
Resources/Links

Acknowledgements

Introduction to 4-H Series

Print these photos to inspire your students!

Click on an image to open up an 8.5 x 11" version for printing. Opens a new browser window; note that some images are large and may take a few moments to open.



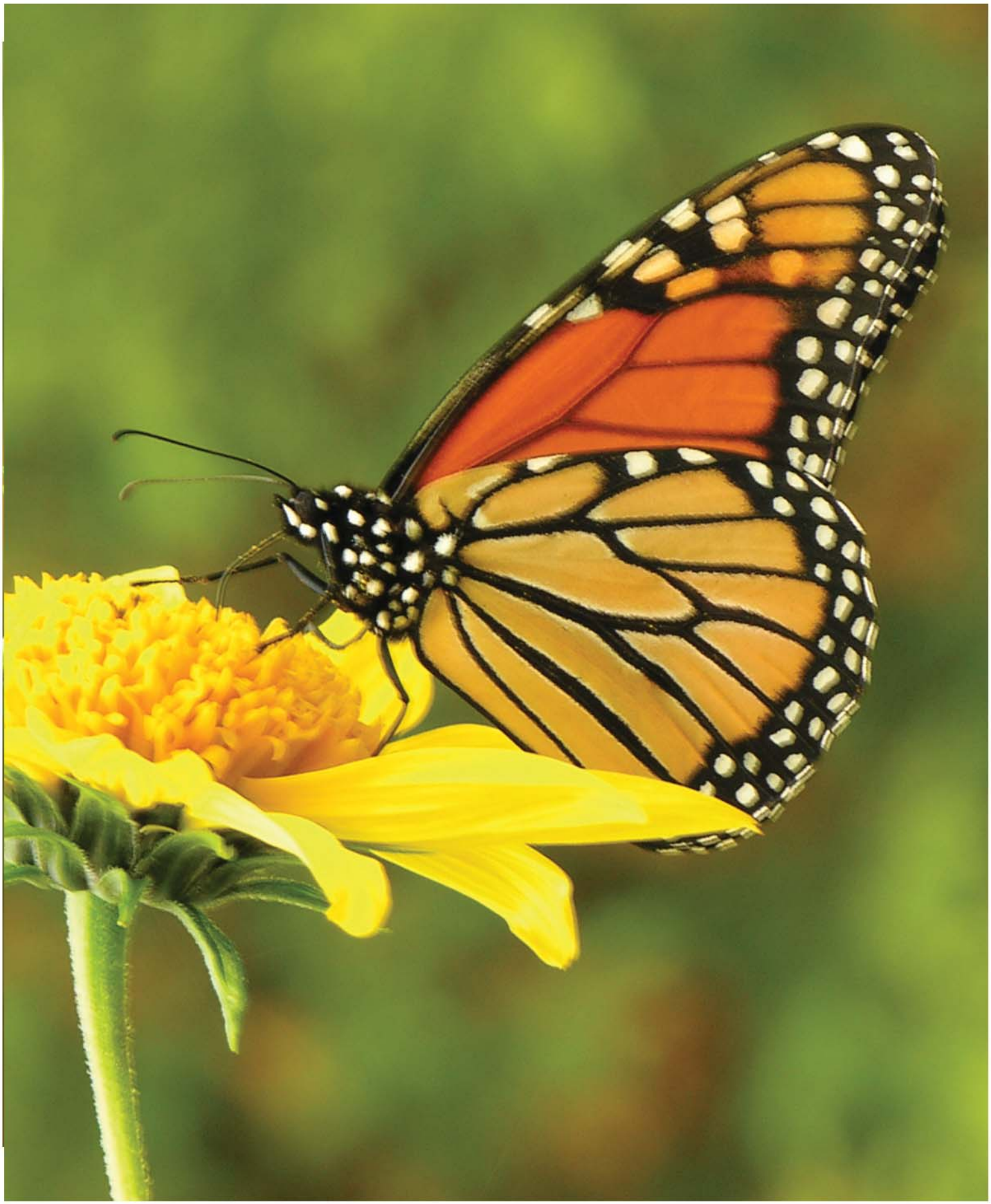
Bumble bee on zinnia. Photo by Claire O. Gudewich

Bananaquit, a very important pollinator from South Florida to Venezuela.

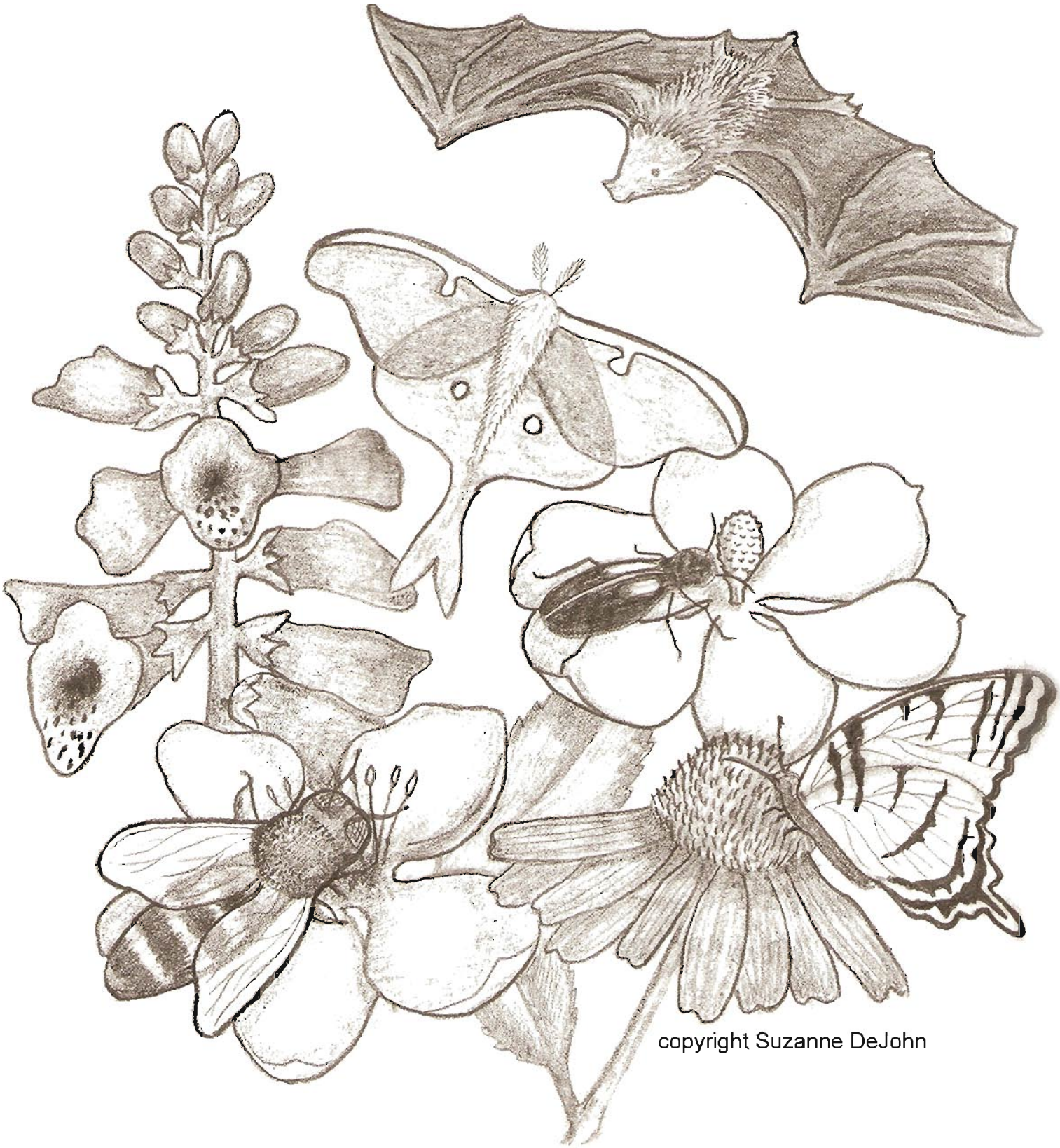
Photo by Leopoldo Miranda-Castro, USFWS

Bee on composite flower (possibly *Arnica montana*, leopard's bane).

Photo by Suzanne DeJohn, National Gardening Association



Monarch butterfly on composite flower (possibly coreopsis).
Photo by Suzanne DeJohn, National Gardening Association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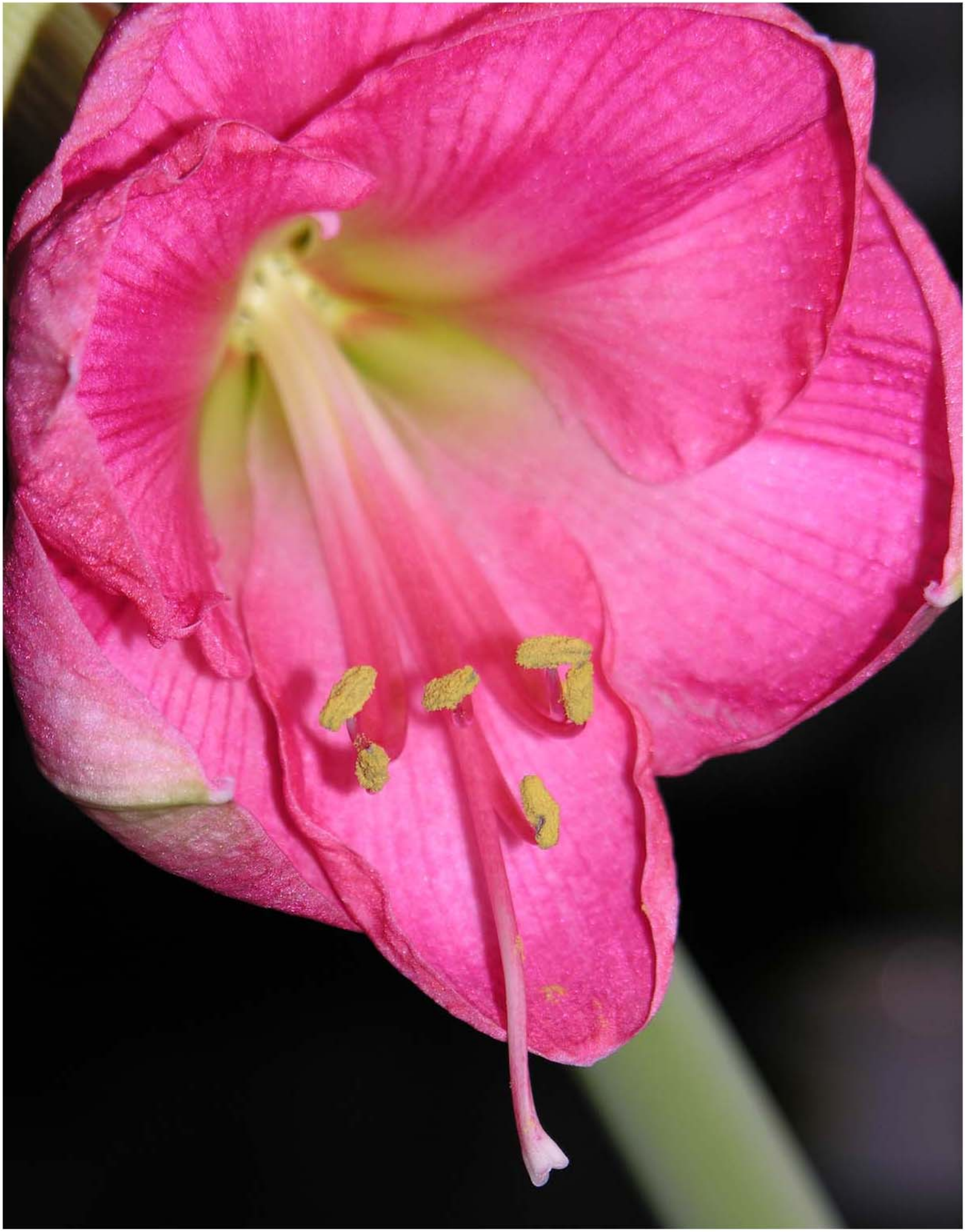


Amaryllis. Photo by Suzanne DeJohn, National Gardening Association

Honey bee. Photo by Leopoldo Miranda-Castro, USFWS

female ruby-throated hummingbird
copyright Steve Hillebrand

Our Future Flies on the Wings of POLLINATORS

THE GREAT POLLINATOR PARTNERSHIP EXHIBIT • U.S. Botanic Garden • May 29, 2004 - October 11, 2004 • The North American Pollinator Protection Campaign

Printer-Friendly View | Normal View

Home

Why Care About Pollinators?

Scientific Thinking Processes

Implementing the Curriculum

Assessment

Outline

Printable Photos

Module 1

The Who, What & Why of Pollinators

Module 2

Pollinators and Plants in Partnership

Module 3

The Other Half of the Partnership: Pollinators

Module 4

Pollinator-Friendly Habitat in Your Area

Module 5

Creating Pollinator-Friendly Habitat

Module 6

Community Service Project and Celebration

Module 1

The Who, What & Why of Pollinators

Purpose:

- To understand the interdependence of certain plants and the insects that pollinate them
- To understand the process of pollination
- To become aware of how people depend on pollinators for food

Background

(Note: Background material is designed to provide helpful information to educators. It is not intended to be shared directly with participants.)

Pollination is central to successful reproduction in most plants. Simply stated, it is the transfer of pollen grains from the stamen of one flower to the stigma of the same or another flower. Some plants are self-pollinated or wind-pollinated, but most depend on insects, birds, bats, and other organisms — collectively referred to as pollinators — to transport the pollen for them.

The coevolution of pollinators and the pollination process is one of nature's unique solutions to the dilemma of sexual reproduction among stationary plant organisms. Plants have developed scents, colors, and shapes that make them attractive to pollinators who, in turn, have developed physical characteristics that allow them to gather and transport pollen as they seek food. See the **Flower Courtship** supplement.

The relationships between flowering plants and their pollinators have evolved since the early Cretaceous period, some 140 million years ago. These relationships are usually mutually beneficial to both parties.

Photo by Nan Vance.

Module 1

- Background
- Pre-assessment Activity (25-30 min)
- Activity A (30-45 min) Discovering the Partnership between Plants and Insects
- Activity B (25-30 min) Why Pollination and How it Works
- Activity C (10-15 min) Without Pollinators: What We Would Do "Without"
- Optional/Alternate Activities
- Flower Courtship Supplement
- Putting Food on our Tables Supplement

Resources/Links

Acknowledgements

Introduction to 4-H Series

Pollinators assist in the reproduction of plants by transporting pollen. (Flowers that are not pollinated are not able to produce fruits and seeds.) In return, flowering plants produce nectar, a highly nutritious, sugar-based substance and a critical source of food for pollinators.

Pollinators are essential to the survival of over ninety percent of the 250,000 flowering plants species on the planet today.

Pollinators may be generalists, such as bees, that make visits to many different types of flowering plants. Or they may be specialists, such as yucca moths, that pollinate only one type of plant.

Blueberries beginning to ripen.
Photo by Suzanne DeJohn/NGA.

Whether specialists or generalists, pollinators are responsible for

--bringing us an estimated 1 out of every 3rd bite of food,
--assisting 90% of the world's flowering plants to reproduce, and
--providing an indispensable food source for countless other animals,

as well as providing beauty and educational opportunities to gardens, fields and farms.
The availability of pollinators is as important as important as moisture, sunlight, and soil fertility to the reproductive success of the world's flowering plants.

Pollination is also vital to the well-being of humans. The most obvious example of our link to pollination is agriculture. Pollination, by managed honey bees and wild pollinators, is a key factor in the productivity of the seed, fruit, and fiber crops that we depend upon. Almost all fruit and grain crops require successful pollination in order to produce the harvested crop.

While it is true that some very important agricultural crops, such as rice, corn, and wheat, are self- or wind-pollinated, the majority requires the services of pollinators. Over 150 food crops in the United States — among them apples, alfalfa, almonds, blueberries, cranberries, kiwis, melons, pears, plums, and squash, depend on pollinators. Thirty percent of the food we eat is dependent upon pollinators for production. See the **Putting Food on our Tables** supplement.

next >>

Printer-Friendly View | Normal View

Home

Why Care About Pollinators?

Scientific Thinking Processes

Implementing the Curriculum

Assessment

Outline

Printable Photos

Module 1
The Who, What & Why of Pollinators

Module 2
Pollinators and Plants in Partnership

Module 3
The Other Half of the Partnership: Pollinators

Module 4
Pollinator-Friendly Habitat in Your Area

Module 5
Creating Pollinator-Friendly Habitat

Module 6
Community Service Project and Celebration

Resources/Links

Acknowledgements

Introduction to 4-H Series

Module 1

Pre-Assessment Activity

The purpose of this activity is to determine what kids think right now about the relationship between flowering plants and insects or other animals, and to begin stimulating their curiosity. It is NOT important that their observations about plants and insects are correct.

Familiar fruits and vegetables.
Photo by Suzanne DeJohn/NGA.

> Spark participants' curiosity by catching live butterflies and placing them in the refrigerator for one half to one hour. This will make them sluggish and therefore easy to look at close up. As the butterflies warm they will seemingly come back to life, delighting the children.

Participants will:

- **Review / explore** what they already know about plants and insects and the interaction between them. This provides information that will be helpful in determining how much the participants learn during their experiences in the pollinator project.

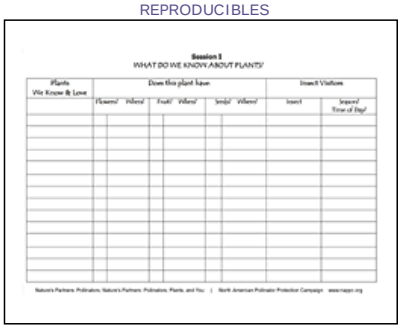
Materials Needed:

- Printed chart or large sheet of butcher paper for chart
- Felt-tipped markers
- Masking tape
- Fresh flowers in a vase

Getting Ready

Prepare a large version of the **What Do We Know About Plants? chart** on paper. It does not need to be drawn perfectly. It is just to help organize the participants' answers and be a record of what they know and think at this point in their experience. It will be used in later activities so rolling rather than folding for storage will be helpful.

REPRODUCIBLES


Session 1
WHAT DO WE KNOW ABOUT PLANTS?

Plants We Know & Love	Does this plant have:						Insect Visitors	
	Flowers?	Yellow?	Fruit?	Yellow?	Seeds?	Yellow?	Insect	Insects' Time of Day?

Nature's Partners: Pollinators, Nature's Partners: Pollinators, Plants, and You. | North American Pollinator Protection Campaign www.nappc.org

>>What Do We Know About Plants? Chart

Suggested Groupings

Whole group participation

Action
(Communicating, sorting, categorizing)

1. **Tape chart to wall.**

2. **Introduce session**: *"We are going to be talking about how plants and certain insects depend on each other and why it is important to us."*

3. **Participants brainstorm** about all the plants they can name. Write the plant names on the chart. Here are some examples of prompt questions to begin the activity:

   — What kinds of plants to you see around you? (in your yard, your neighborhood, at school)?

   — Do you have vegetable gardens or fruit trees in your yard or neighborhood? What are some of the plants in these gardens?

4. **Identify characteristics** of the plants listed, placing a "yes," "no," or "?" in the appropriate column:

   — Which of these plants have flowers?

   — Do the flowers all bloom at the same time or at different times?

   — Which of these plants produce fruit? At what time of year?

   — Which of these plants have seeds? Where do we find the seeds?

5. **Identify insects** that are frequently found near the plants that have been listed and answer the following:

— *In what ways do you think these plants might be helpful to insects? Why do you think that?*

— *What kinds of insects have you noticed around the plants?*

— *Which insects pay a lot of attention to flowers?*

— *What time of the day do the insects have an interest in the flowers?*

— *Why do you think these insects are so interested in the flowers?*

6. **Congratulate participants** on all they know. Transition to next activity with the statement,

   "As we learn more about how plants and insects depend on each other, we will find answers to some of the things we were not sure about, and perhaps learn new things that will cause us to change our some of our ideas about plants and insects."

   You could add some questions to assess their attitude towards insects such as bees:

   — *What do you feel when you see a bee?*

   — *What do you think bees are good for?*

   — *What do you feel when you see a butterfly?*

   — *What do you think butterflies are good for?*

Bumble bee on tithonia. Photo by Suzanne DeJohn/NGA.

<< previous next >>

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Printer-Friendly View | Normal View

Home

Why Care About Pollinators?

Scientific Thinking Processes

Implementing the Curriculum

Assessment

Outline

Printable Photos

Module 1

The Who, What & Why of Pollinators

Module 2

Pollinators and Plants in Partnership

Module 3

The Other Half of the Partnership: Pollinators

Module 4

Pollinator-Friendly Habitat in Your Area

Module 5

Creating Pollinator-Friendly Habitat

Module 6

Community Service Project and Celebration

Module 1

Activity A: Discovering the Partnership Between Plants and Insects

There are two ways that the objectives of this activity can be accomplished. The option you choose will depend on the resources you have available. When possible, Option 1, which includes outdoor field observation, is recommended. However, Option 2 may be your best choice if the season, poor weather, lack of a suitable observation area, or lack of adults to provide adequate supervision, make it unproductive or impractical to do outdoor observations. Whichever option is chosen, helping children learn by looking and observing is essential to making this a worthwhile experience.

Participants will:

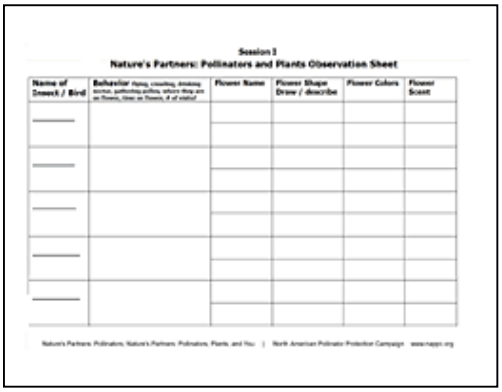
- Observe interaction between plants and insects.
- Learn about the role each plays.
- Become familiar with the terms pollen, pollination and pollinator.

Materials Needed

Option 1:

- **Nature's Helpers: Pollinators and Plants Observation Sheet** & pencils, 1 per participant
- **BEE Courteous, Bee Safe** Handout
- Enlarged copy of **Nature's Partners: Pollinators & Plants Group Observation Record,** tape, & markers
- Depending on the size & age of the group, adult volunteers to accompany participants during the field observation
- Poster on pollination (optional): Download pdf or order a full-sized poster

REPRODUCIBLES


Session I
Nature's Partners: Pollinators and Plants Observation Sheet

Name of Insect / Bird	Behavior	Flower Name	Flower Shape Draw / describe	Flower Colors	Flower Scent

>>Nature's Helpers: Pollinators and Plants Observation Sheet

Option 2:

- ***Bees and Butterflies* video** (available from Discover School Teacher's Store) or similar video
- VHS player and monitor
- **Nature's Helpers: Pollinators and Plants Observation Sheet** & pencils, 1 per participant
- Enlarged copy of **Nature's Partners: Pollinators & Plants Group Observation Record,** tape, & markers
- Poster on pollination (need to locate or develop)

Getting Ready

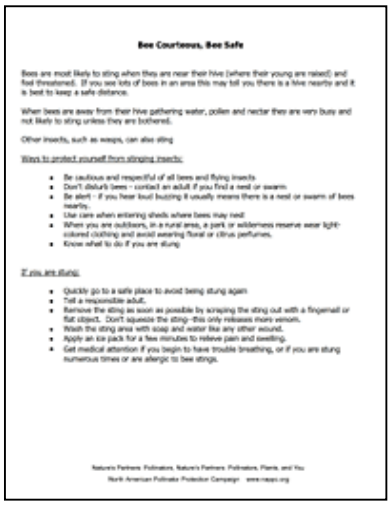
Resources/Links

Acknowledgements

Introduction to 4-H Series

Option 1:

- Select suitable area for field observation, preferably one with flowering plants.
- Decide on method for structuring field observation. See suggestions below.
- Make a copy of **Nature's Helpers: Pollinators and Plants Observation Sheet** and **BEE Courteous, Bee Safe** for each participant.
- Make enlarged version of **Nature's Partners: Pollinators & Plants Group Observation Record** to use during the group discussion after the observation activity to summarize the children's observations.
- Review the questions you'll pose to participants during the Exploration to encourage careful observation and decide on method for structuring field observation.
- Invite parents or other adults to accompany group as needed.



Bee Courteous, Bee Safe

Bees are most likely to sting when they are near their hive (where their young are raised) and feel threatened. If you see lots of bees in an area this may tell you there is a hive nearby and it is best to keep a safe distance.

When bees are away from their hive gathering water, pollen and nectar they are very busy and not likely to sting unless they are bothered.

Other insects, such as wasps, can also sting

Ways to protect yourself from stinging insects:

- Be cautious and respectful of all bees and flying insects
- Don't disturb bees - contact an adult if you find a nest or swarm
- Be alert - if you hear loud buzzing it usually means there is a nest or swarm of bees nearby.
- Use care when entering sheds where bees may nest
- When you are outdoors, in a rural area, a park or wilderness reserve wear light-colored clothing and avoid wearing floral or citrus perfumes.
- Know what to do if you are stung

If you are stung:

- Quickly go to a safe place to avoid being stung again
- Tell a responsible adult.
- Remove the sting as soon as possible by scraping the sting out with a fingernail or flat object. Don't squeeze the sting--this only releases more venom.
- Wash the sting area with soap and water like any other wound.
- Apply an ice pack for a few minutes to relieve pain and swelling.
- Get medical attention if you begin to have trouble breathing, or if you are stung numerous times or are allergic to bee stings.

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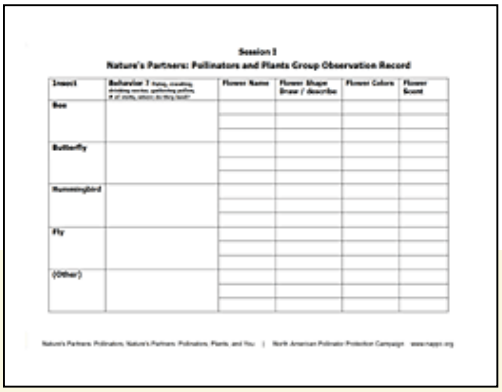
>>BEE Courteous, Bee Safe



Session 1

Nature's Partners: Pollinators and Plants Group Observation Record

Insect	Behavior 1 flying, crawling, drinking nectar, gathering pollen, # of visits, where do they land?	Flower Name	Flower Shape Draw / describe	Flower Colors	Flower Scent
Bee					
Butterfly					
Hummingbird					
Fly					
(Other)					

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>>Nature's Partners: Pollinators & Plants Group Observation Record

Suggestions for structuring field observations:

1. Each individual or team chooses a limited area to carefully observe (a 5' x 5' square, for example) for 5 to10 minutes, rather than running around from place to place.

2. Construct an "observation guide" by cutting a 2" x 2" square in the center of an index card. By holding the card a distance of two feet from their face they will be able to "frame" an area for observation.

3. The first team member observes just one insect and reports its activities at 10 second intervals or as new actions occur (i.e., flying, landing on a flower — describe flower color, shape, scent in detail, as well as insect crawling, movement of legs, etc.) The second team member records the reported activities. After 2 to3 minutes, team members switch roles.

Option 2:

Arrange for VHS play and monitor and preview ***Bees and Butterflies*** video. Make a copy of **Nature's Helpers: Pollinators and Plants Observation Sheet** and **BEE Courteous, Bee Safe** for each participant. Make enlarged version of the Observation Sheet. Review the questions you'll pose to participants during the Exploration to encourage careful observation.

Exploration

1. Prepare the participants to be good observers by discussing what types of things they should be watching for. Let them make suggestions. Ask the following questions to bring out ideas:

What types of creatures are in, on, or around the plants & flowers?

What do you see the insects doing?
— do they spend more time on the flower or flying around?
— what part of the flower seems most interesting?
— where do they spend most of their time on the flower?
— how long to they usually stay on the flower?

Does one type of insect only visit one kind of flower or do they visit different kinds of flowers?

Do they visit a flower only once or do they return to the same flower several times?

What do you think attracts the insects to the flowers?

What do you think attracts an insect to certain flowers more than others?
— what color is the flower?
— What is it's shape--flat, petals forming a "cup" shape, clusters of small flowers?
— What size is the flower?
— How would you describe the scent of the flower?

What do you think the insects get from the plants?

What might the flowers & plants get from the insects?

2. **Option 1**

Distribute Observation Sheets. Before starting the activity, give instructions on conducting their observations and using the Observation Sheet. Review the BEE Courtesy handout.

Take participants go to a suitable outdoor location for 20 minutes where they can record the insect activity they observe. Participants can work individually or in teams of two.

Option 2

Participants watch the *Bees and Butterflies* video and record on their Observation sheets the insect activity they observe.

Photo by Marilyn Drabicki

Concept Introduction/Development

1. Have individuals or groups share their findings and record them on the enlarged version of the Observation Sheet.

2. Reflect on their observations using the questions posed earlier during the Exploration.

3. Introduce and discuss the concept of pollination using the questions:

How is the insect benefiting by its visits to the flowers?

What do you think the flowers and plants get from the insects?

4. Lead participants in developing definitions for the terms, pollen, pollination, and pollinator. Record the definitions on large paper. Prompt questions could include:

Who are the pollinators?

Can a flower reproduce without an insect pollinator?

What would happen if there were no pollinators?

How does the weather affect pollination?

What is the insect doing when it visits many different flowers?

Concept Application

Lead participants to reflect on their observations and develop and record several predictions about their observations.

What prediction can we make about which flowers a bee (or other pollinator) will choose?

How would you describe the behavior of a bee (or other pollinator) around a particular flower?

***How** do you think plants and pollinators are partners?*

***Why** do you think plants and pollinators are partners?*

Be sure to include a general statement about pollination (transfer of pollen from one part of a flower to another part or from one flower to another so that plants can reproduce) and pollinators (who are they — bees, butterflies, hummingbirds, bats, beetles).

<< previous next >>

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Home

Why Care About Pollinators?

Scientific Thinking Processes

Implementing the Curriculum

Assessment

Outline

Printable Photos

Module 1

The Who, What & Why of Pollinators

Module 2

Pollinators and Plants in Partnership

Module 3

The Other Half of the Partnership: Pollinators

Module 4

Pollinator-Friendly Habitat in Your Area

Module 5

Creating Pollinator-Friendly Habitat

Module 6

Community Service Project and Celebration

Resources/Links

Module 1

Activity B: Why Pollination and How it Works

Participants will:

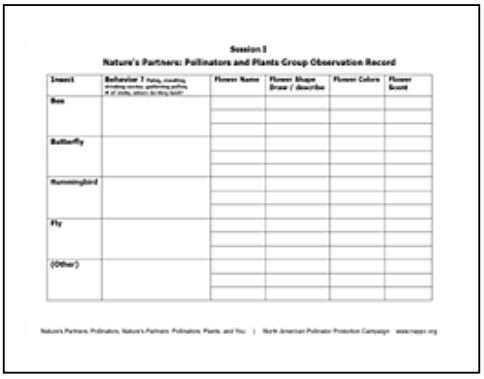
- Learn more about pollination by reflecting on the Observation Sheet they generated in Activity A.
- Participate in a game that demonstrates the pollination process.

Materials Needed

- Fruit and "vegetable" snacks — apples, pears, zucchini, cucumber, etc. (Zucchini and cucumbers are, botanically speaking, fruits.)
- Tomato, pepper, or squash plant with flowers (optional)
- Napkins
- Nature's Partners: Pollinators & Plants Group Observation Record created in Activity A
- Pollination activity:

  3 pipe cleaners/participant
  1 8oz. foam or paper cup/participant
  Talcum powder
  Colored chalk, 2 or 3 pieces crushed to powder ***or*** several colors of Jello powder
  Transparent tape, 3-4 rolls
  Nails, 5 or 6

REPRODUCIBLES


Session 1
Nature's Partners: Pollinators and Plants Group Observation Record

Insect	Behavior ? Flying, crawling, drinking nectar, gathering pollen, # of visits, where do they land?	Flower Name	Flower Shape Draw / describe	Flower Colors	Flower Scent
Bee					
Butterfly					
Hummingbird					
Fly					
(Other)					

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>>Nature's Partners: Pollinator and Plants Group Observation Record

Getting Ready

- Put up the Pollinators & Plants Group Observation Record created in Activity A where you can refer to it
- Cut fruits and vegetables and arrange for serving.
- Have pollination activity supplies set up where participants can easily use them.
- Obtain flowering vegetable plant if season is appropriate.

Suggested grouping

Whole group

Reflection and Review

Ask group to look at the Pollinators & Plants Group Observation Record they created and to share any new questions or ideas about their observations.

Exploration

1. Invite participants to sample fruits and vegetables that depend on pollinators.

2. While they are eating their snacks, review the concepts on pollination introduced at the end of Activity A.

Acknowledgements

Introduction to 4-H Series

Honey bee on apple blossom.
Photo by Suzanne DeJohn/NGA.

You have identified how the insects benefit from the plants. What is the name of the food they get from flowers? (nectar)

How do plants benefit from the insects? (Insects help pollinate plants.)

Why is pollination important to fruit and vegetable production? (Only pollinated plants can develop fruits and produce seeds that will grow more plants.)

Concept Development

3. Show participants the tomato, pepper, or squash plant with flowers. Ask,

What has to happen to these flowers if the plant is going to produce a fruit (tomato or whatever is appropriate)?

4. Clarify and further define the terms pollen, pollination, pollinator.

What would happen if the flowers were not pollinated? (Plants would not bear fruit and produce seeds for reproduction.)

Where do we get most of our fruits and vegetables? (Stores --> farms and orchards)

Where are the farms and orchards located?

Why should we be concerned about the protection of crop pollinators everywhere?

What if pollination didn't happen? (Wouldn't have fruits and vegetables like we are eating now.)

Concept Application

1. Explain to the participants that they are going to construct a model of an insect and then investigate how it will pollinate a flower.

2. Have participants each make an insect by bending one pipe cleaner into an insect shape, then twisting a second pipe cleaner around its center. Note: Insect shape should be small enough to fit easily into the bottom of the paper cup flower.

Make pipe cleaner insects.

3. Have participants make a flower:

- Poke a hole in the bottom of a cup using a nail.
- Wrap tape, sticky side out, around the top of the remaining pipe cleaner. Insert non-taped end of the pipe cleqaner through hole in bottom of cup to form the flower pistil. Tape pipe cleaner in place on bottom of cup.
- Carefully sprinkle a teaspoon of talcum and 1 color of chalk powder or jello powder in the bottom of the cup, trying not to get any on the tape on the pipe cleaner.

Wrap tape sticky side out on one end of pipe cleaner and insert other end through bottom of cup.

4. Have the students fly their insects in and out of their flower cup and the cups of other students — allow them to touch the powder and taped pipe cleaner.

What happened to the taped pipe cleaner?

Are there different colors on the pipe cleaner?

5. Inferring and communicating:

What did we use to simulate the flower's pollen?

What happened to the pipe cleaner insect?

What happened to the "pollen?"

How do you think this relates to real flowers?

(Inside the flower is a pistil that is sticky like the tape. The pollen sticks to the pistil and is used to fertilize the ovaries in the flower.)

Why do you think pollination is important to us?

(Without pollination the plant cannot develop seeds — reproduce — or produce fruits and we would not have many of the foods we enjoy.)

<< previous next >>

Use tape to secure pipe cleaner and to cover hole.

Sprinkled colored powder in cup, taking care not to get it on tape.

Photos by Suzanne DeJohn/NGA

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Home

Why Care About Pollinators?

Scientific Thinking Processes

Implementing the Curriculum

Assessment

Outline

Printable Photos

Module 1

The Who, What & Why of Pollinators

Module 2

Pollinators and Plants in Partnership

Module 3

The Other Half of the Partnership: Pollinators

Module 4

Pollinator-Friendly Habitat in Your Area

Module 5

Creating Pollinator-Friendly Habitat

Module 6

Community Service Project and Celebration

Module 1

Activity C: Without Pollinators — What We Would Do Without

Participants will:

- Explore how we are dependent on pollinators for many of the foods we eat.

Materials needed:

- A grocery bag or large picnic basket filled with a variety of food — some that don't need pollination and many that do depend on pollination.
- **Putting Food on Our Tables** sheet, 1/participant
- **Melon Flowers and Fruits**, 1/participant
- **Bee-Free Fiesta** sheet, 1/participant
- Menus from restaurants, optional
- Pollinator Field Journal, 1/participant (may be purchased from the Gardening with Kids Store)

REPRODUCIBLES

Putting Food on Our Tables

A Sampling of Crops Dependent Upon or Benefited By Insect Pollination

Fruits and Nuts:

Apple, Apricot, Crabapple, Cashew, Fig, Pomegranate, Blackberry, Chestnut, Coconut, Oil Palm, Date, Papaya, Strawberry, Blueberry, Macadamia, Cacao, Olive, Cherry, Passion fruit, Raspberry, Cranberry, Grape, Peach, Nectarine, Pear, Plum, Kiwi, Cranberry, Grapes

Vegetables:

Artichoke, Broccoli, Celery, Eggplant, Pumpkin, Turnip, Asparagus, Brussels Sprouts, Chicory, Leek, Squash, Watermelon, Balsam Pear, Cauliflower, Cucumber, Green Pepper, Rutabaga, White Gourd, Beet, Carrot, Chiva, Parsnip, Tomato, Radish

Others:

Coffee, Black Pepper, Sesame, Dill, Mustard, Nutmeg, Parsley, Sunflower, Fennel, Lavender, Vanilla, Guava

Source: A.E. McGregor, "Insect Pollination of Cultivated Crop Plants," USDA, 1976 http://gsrs.ibrem.ars.usda.gov/Book/index.html

Nature's Partners: Pollinators, Plants, and You
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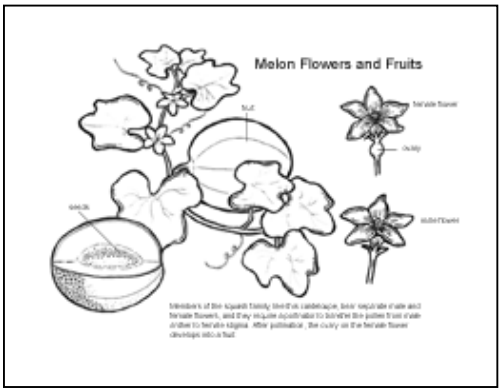
>>Putting Food on Our Tables



>>Melon Flowers and Fruits

Suggested Grouping

Whole group

Getting Ready

Collect about 25 to 30 food items from your refrigerator and pantry and place in grocery bag or picnic basket. Make a copy of the **Putting Food on Our Tables, Melon Flowers and Fruits,** and **Bee-Free Fiesta** sheets for each participant.

Exploration

1. Gather students around a table or sit in a circle on the floor so everyone can see the foods that you will be showing them. Review the concept of pollination and fruit development with the Melon Flowers and Fruits handout. Explain that you want to see how good they are at identifying which foods depend on pollinators and which foods do not

2. Take foods out of the bag or basket one at a time and have the children say "pollinator" or "no pollinator," then place the foods in two separate piles. If the children are not correct, help them think about where the food really comes from and then place it in the appropriate group. Let them refer to the Putting Food on Our Tables sheet if necessary.

3. By the time you have identified all the foods you should have one group of foods that do not require

Resources/Links

Acknowledgements

Introduction to 4-H Series

pollination (usually this group will be smaller and not very colorful), and one group of foods that do require pollination (usually a large selection of colorful foods including lots of fresh fruits and vegetables). Discuss what it would be like to be without all the foods that depend on pollination — how unenjoyable and unhealthy our diet would be.

Concept Application

1. Ask the participants to imagine a world without bee-pollinated plants: the "Bee-Free Zone." Explain that they are going to attend a Bee-Free Fiesta in the Bee-Free Zone and that hamburgers and hot dogs are on the menu.

2. Hand out the Bee-Free Fiesta sheet. (This can also be used as a take-home activity.) Ask the participants to pretend they have chosen a hamburger or hot dog from the grill. Remind them that this is the Bee-Free Fiesta and that the foods listed on the **Putting Food on our Tables** sheet won't be available. Have the participants check the items on the list that they could not have at the Bee-Free Fiesta.

3. After they have eliminated the pollinator dependent items from the list, they can now choose what they will have with their hamburger or hot dog. Have them describe the meal that would remain.

4. Draw conclusions and develop statements about the need for pollinators in our environment.

Bee-Free Fiesta

A wonderful meal is planned:

Menu
Chips and Salsa
Tortillas
Fajitas made of
Chicken, Red & Green Bell Peppers, Onions
Refried Beans
Rice
Guacamole
Lemonade

But if all animal pollinators were to become extinct which of the foods on our menu would be eliminated?

Hint: Some of the more common foods that we enjoy from animal-pollinated plants include tomatoes, onions, avocados, beans, green peppers, chili peppers, lemons, limes, and oranges, berries, vanilla, sugar, almonds, watermelons and apples

>>Bee-Free Fiesta sheet

Available from the Gardening with Kids Store.

Going Further

1. Introduce the Field Journal. Ask,

> *How would you find out if pollinators are doing well in our area or if they are having a hard time surviving?*
>
> *How often do you notice bees, butterflies, and hummingbirds in your neighborhood?*
>
> *Handout field journals and challenge participants to do "What's Buzzing in My Garden?" on page 5. (Ask participants to write their names on their journals.)*

2. Participants can also take home the "insect" and "flower" they made during the pollination activity and the Bee-Free Fiesta sheet to share with their family.

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Wagner, Lisa. Cultivating Inquirers: The Plant-Pollinator Connection. National Gardening Association web site: http://www.kidsgardening.com/themes/pollinator5.asp (Dr. Wagner is Education Coordinator for the South Carolina Botanical Gardens and affiliated with Clemson University.)

Small squash fruit developing behind pollinated flower.

Melons require pollinators, too. Photos by Sabin Gratz/NGA.

Without pollination, there would be no pumpkins or squash. Photos by Suzanne DeJohn/NGA.

<< previous next >>

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Home

Why Care About Pollinators?

Scientific Thinking Processes

Implementing the Curriculum

Assessment

Outline

Printable Photos

Module 1

The Who, What & Why of Pollinators

Module 2

Pollinators and Plants in Partnership

Module 3

The Other Half of the Partnership: Pollinators

Module 4

Pollinator-Friendly Habitat in Your Area

Module 5

Creating Pollinator-Friendly Habitat

Module 6

Community Service Project and Celebration

Module 1

Optional/Alternate Activities

These fruits all depend on pollinators.
Photo by Suzanne DeJohn/NGA.

1. As a group, visit a supermarket and identify foods that depend on pollination for production.
2. Accompany a parent to the grocery store and/or make a list of all the foods your family buys on the next trip to the grocery store that depend on pollination.
3. Do a survey of plants in the neighborhood that have flowers sometime during the year.
4. Make a list of the plants and find out when they usually flower.
5. Design a "comic strip" showing the process of pollination.
6. Visit various Internet sites that have information about pollinators. The list below is just a sampling.

   Coevolution Institute http://www.coevolution.org

   National Gardening Association's Kids Gardening Web site http://www.kidsgardening.com

   Butterfly World http://www.butterflyworld.com

   The Science Spot http://www.sciencespot.net

   Xerces Society http://www.xerces.org

   Monarch Watch http://www.monarchwatch.org

   The Insects Homepage http://www.earthlife.net/insects/six.html

   Alien Empire http://www.pbs.org/wnet/nature/alienempire

   Enature http://enature.com

   Ecology Society of America http://www.esa.org

<< previous Module 2 >>

Printer-Friendly View | Normal View

Printer-Friendly View | Normal View

Home

Why Care About Pollinators?

Scientific Thinking Processes

Implementing the Curriculum

Assessment

Outline

Printable Photos

Module 1

The Who, What & Why of Pollinators

Module 2

Pollinators and Plants in Partnership

Module 3

The Other Half of the Partnership: Pollinators

Module 4

Pollinator-Friendly Habitat in Your Area

Module 5

Creating Pollinator-Friendly Habitat

Module 6

Community Service

Module 1

Flower Courtship: Alluring Advertisers

Author: Eve Pranis, National Gardening Association

Many announce their presence with bold and vibrant hues, while others remain modest and drab. Some are simple and open in form, but others feature tricky entries or convoluted mazes. They have long inspired humans with their beauty and fragrances, and we've bestowed them with symbolic meanings.

Myths and symbolism aside, the real job of flowers is to ensure that plants produce offspring. Animals can roam about and seek mates with whom to reproduce, but imagine the challenge for a plant, rooted firmly to the ground, to achieve this same end.

Over millions of years, flowers have evolved a remarkable range of strategies to guarantee that male pollen is transferred to female flower parts so fertilization and seed production can occur. Relying on wind to move pollen, as grasses and many trees do, is the oldest method of ensuring pollination. But a more efficient — and fantastic — means is by luring unsuspecting animal partners to inadvertently make the transfer as they search for food. In this indispensable partnership, flowers and pollinators are utterly dependent on one another for survival. So, in turn, are we.

Welcoming Pollinating Partners

To compete for the attention of pollinators, flowers have evolved ingenious methods to entice hungry bees, birds, moths, butterflies, and beetles to inadvertently act as pollen-carrying liaisons between blooms that would otherwise never touch. Their main offerings? Sugar-filled nectar and protein- and vitamin-rich pollen.

The amazing diversity of flowers results from their unique adaptations to lure a range of pollinators. Every aspect of a flower, from the designs on its petals to the timing of its blooming, is vital to the process. As your students observe flowers and pollinators in indoor and outdoor settings, invite them to consider and investigate how this unsurpassed advertising lays the groundwork for pollination. This section describes some of the more apparent features used to draw in customers.

Colors/Patterns

Since most pollinators fly, flower color sends a bold signal to potential partners passing by. Different pollinators may see the same colors differently, and some can't see certain colors at all, but they may be drawn by other characteristics, such as scent. The colors that humans see are not necessarily what bees or beetles see. Regardless of how it is perceived, color is a primary means by which flowers grab attention. Many flowers, such as foxgloves and irises, also feature stripes, spots, or other markings that guide pollinators toward food. (Some of these nectar guides are invisible to humans but quite apparent to hungry bees!) Some, such as Gaillardia (blanket flowers) have concentric rings, providing a target focused on the nutritious nectar "bull's eye." Lilies have ridged petals that similarly guide their guests. Have your students look at a delphinium blossom. Don't those tufts of hairs in the center look like a bee who has already found the flower appealing?

As your students observe who visits which flowers, see what they can uncover about the relationships between flower colors and patterns and the visitors who frequent them. If students notice that some flowers change color over time, invite them to conjecture why. (Color changes can be a way of preventing pollinators from wasting energy on an already-fertilized flower so the other flowers on the plant have a better chance of being visited.) Students in the South can discover that bluebonnets lure bees with a white or yellow spot, which turns red (a color bees can't distinguish) after pollination.

Project and Celebration

Resources/Links

Acknowledgements

Introduction to 4-H Series

Scents

Aromatic blooms signal food to roving bees, butterflies, moths, wasps, and some flies. Certain orchids actually emit an odor evocative of female insects to arouse the males to visit! Other flowers, such as skunk cabbages, smell like rotting flesh to attract insects such as carrion-eating flies or certain beetles looking to lay eggs. Flowers that appeal to a wide range of pollinators often have light aromas, which accommodate a variety of taste buds. Others, such as those that bloom at night, have strong, distinct scents that attract moths and bats in the dark. Many flowers typically pollinated by hummingbirds, such as nasturtiums, don't need to be fragrant because their pollination partners have little sense of smell. Consider inviting students, blindfolded, to try to distinguish among different flower smells. Tough? Honeybees can tease out hundreds of aromas!<

Shapes

Flowers' shapes are important for protecting pollen, attracting or precluding certain pollinators, or ensuring that pollen is picked up and transferred. For instance, butterflies tend to prefer flat, open surfaces with views (e.g., zinnias), while certain bees seem to like those with special petals that serve as landing platforms (e.g., delphiniums). Open, bowl-shaped flowers (e.g., poppies) can be easily seen by and offer warm access to short-tongued insects. The shallow blossoms of milkweeds, phlox, mints, and similar flowers also appeal to short-tongued insects such as honeybees and wasps. The nectar in tubular flowers, such as bee balm, is available to beaks and tongues with a long reach. Drooping, bell-shaped flowers protect their sexual parts from weather and offer food and shelter for honeybees and bumblebees, who can feed while hanging. Some flowers, such as snapdragons, have hinged petals or other mechanisms, to conceal their sexual parts and nectar. They are closed to all but selected pollinators (in this case, certain bees) who have the dexterity, strength, and tenacity to open the flower. What can your students discover or infer about flower shapes and their relationships to different pollinators?

Numbers

Many of what we call flowers are actually groups of tens or hundreds of tiny flowers in a cluster or along a stem. Imagine what the advantages of this arrangement might be for the flowers or pollinators. The large display of tiny flowers signals loudly to passing pollinators, saving them time and energy. Many such plants bloom and supply food for a long time, keeping pollinators coming back as the flowers open in sequence.

One of the largest families of plants, the Composites, has flowers so tightly packed that they look like one bloom. This family, which includes familiar sunflowers, daisies, and zinnias, has showy outside ray flowers that are exclusively for advertising and hundreds of plain inside disc flowers, ready to be fertilized. These ubiquitous flowers offer up loads of nectar over long periods to hundreds of long- and short-tongued insects. But if they fail to get pollinated, many can take care of business themselves!

Challenge your students to try to find flowers that grow in groups, imagine how the grouping might improve chances of pollination, and use hand lenses to explore these tiny miracles. Consider displays of flower clusters in a clover, dill, or Queen Anne's lace. Or observe plants with flowering spikes, such as loosestrifes or liatrises, over time as they bloom from the bottom up or top down, in sequence.

Pollinator Preferences

Bees — Yellow, blue, purple flowers; there are hundreds of types of bees that come in a variety of sizes and have a range of flower preferences;

Butterflies — Red, orange, yellow, pink, blue; they need to land before feeding, so like flat-topped clusters (e.g., zinnias, calendulas, butterfly weeds) in a sunny location;

Moths — Light-colored flowers that open at dusk (e.g., evening primroses);

Beetles — White or dull-colored, fragrant flowers since they can't see colors (e.g., potatoes, roses);

Bats — Large, light-colored, night-blooming flowers with strong fruity odor (e.g., many cactus flowers); bats don't see well, but have a keen sense of smell;

Flies — Green, white, cream flowers; many like simple bowl-shaped flowers or clusters;

Carrion-eating flies — Maroon, brown flowers with foul odors (e.g., wild ginger);;

Hummingbirds — Red, orange, purple/red tubular flowers with lots of nectar, since they live exclusively on flowers (e.g., sages, fuschias, honeysuckles, nasturtiums, columbines, jewelweeds, bee balms); no landing areas needed since they hover while feeding;

Ants — Although ants like pollen and nectar, they aren't good pollinators, so many flowers have sticky hairs or other mechanisms to keep them out.

Evolutionary Excellence

Just how much energy should a flower expend to get pollinated? The oldest method, using wind to transfer pollen, requires little investment in producing flowers, but is not very efficient, since little pollen hits the right destination. Over millions of years, many flowers and pollinators have "co-evolved" to develop more complex relationships. Imagine how this might have happened. A pollinator that is capable of detecting certain colors or scents, or possessing structures that best fit certain flowers, passes these advantages on to its offspring. Over many generations, these traits become well established. Flowers, meanwhile, also evolve with characteristics suiting a variety of — or particular — pollinators. Some non-choosy flowers, such as daisies, play host to nearly any pollinator. Others, such as monkshoods, are adapted to be pollinated by just one pollinator (bumblebees). In tropical areas, it's common to find flowers and pollinators exclusively dependent on one another. Although these types of relationships require a lot of energy investment from the plant, they are very efficient.

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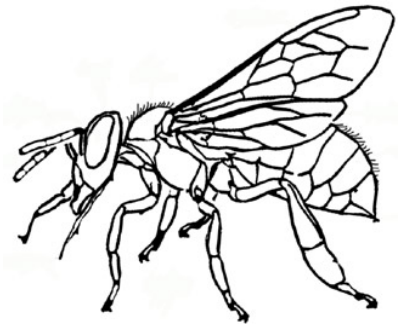
Putting Food on Our Tables



A Sampling of Crops Dependent Upon or Benefited By Insect Pollination

Fruits and Nuts:

Apple	**Chestnut**	**Macadamia**	**Peach**
Apricot	**Coconut**	**Cacao**	**Nectarine**
Crabapple	**Oil Palm**	**Olive**	**Pear**
Cashew	**Date**	**Cherry**	**Plum**
Fig	**Papaya**	**Passion fruit**	**Kiwi**
Pomegranate	**Strawberry**	**Raspberry**	**Cranberry**
Blackberry	**Blueberry**	**Gooseberry**	**Grapes**

Vegetables:

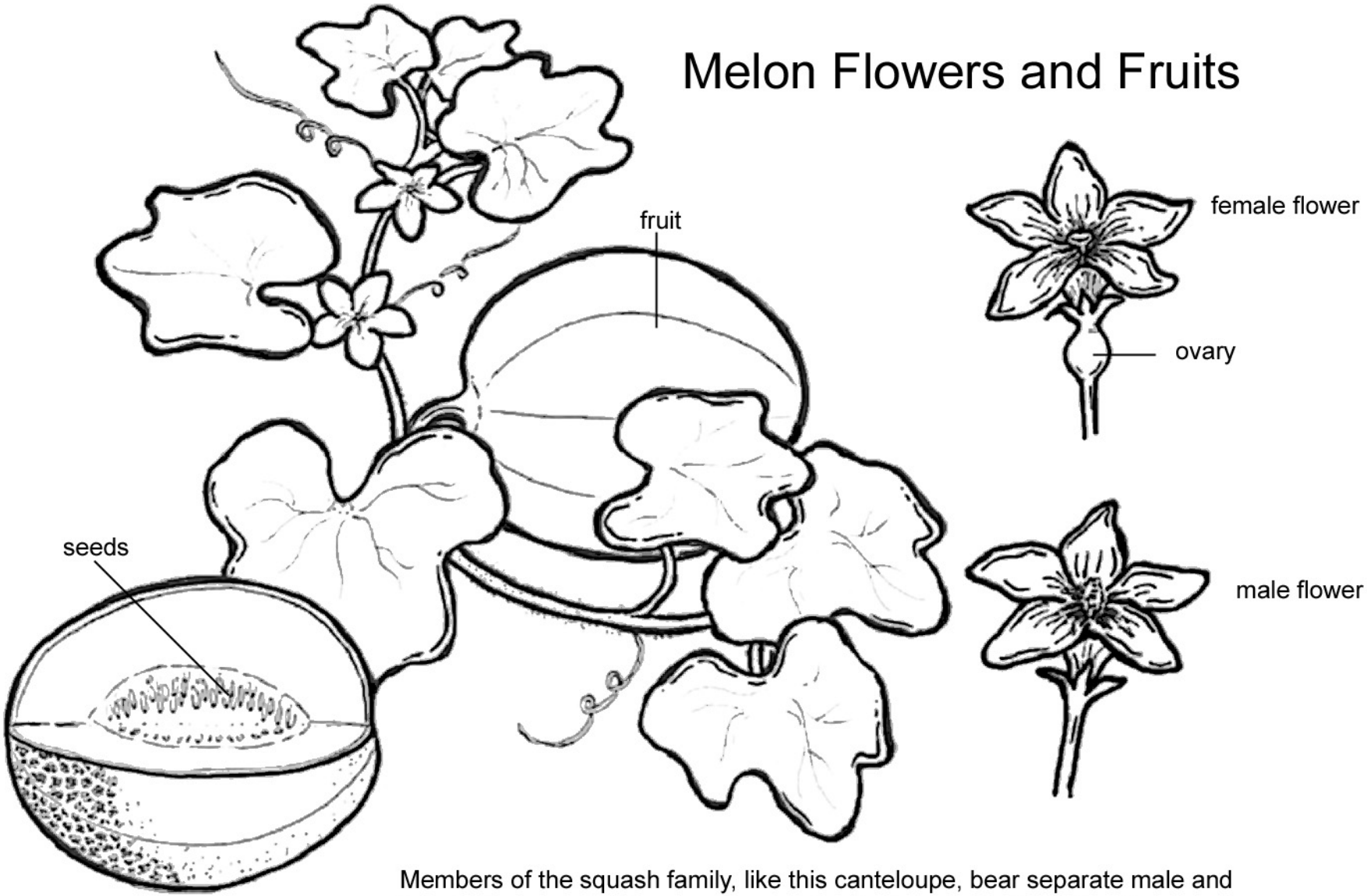
Artichoke	**Asparagus**	**Balsam Pear**	**Beet**
Broccoli	**Brussels Sprouts**	**Cauliflower**	**Carrot**
Celery	**Chicory**	**Cucumber**	**Chive**
Eggplant	**Leek**	**Green Pepper**	**Parsnip**
Pumpkin	**Squash**	**Rutabaga**	**Tomato**
Turnip	**Watermelon**	**White Gourd**	**Radish**

Others:

Coffee	**Dill**	**Parsley**	**Lavendar**
Black Pepper	**Mustard**	**Sunflower**	**Vanilla**
Sesame	**Nutmeg**	**Fennel**	**Guava**

Source: S.E. McGregor, "Insect Pollination of Cultivated Crop Plants." USDA, 1976
http://gears.tucson.ars.ag.gov/book/index.html

Melon Flowers and Fruits



Members of the squash family, like this canteloupe, bear separate male and female flowers, and they require a pollinator to transfer the pollen from male anther to female stigma. After pollination, the ovary on the female flower develops into a fruit.

Printer-Friendly View | Normal View

Home

Why Care About Pollinators?

Scientific Thinking Processes

Implementing the Curriculum

Assessment

Outline

Printable Photos

Module 1

The Who, What & Why of Pollinators

Module 2

Pollinators and Plants in Partnership

Module 3

The Other Half of the Partnership: Pollinators

Module 4

Pollinator-Friendly Habitat in Your Area

Module 5

Creating Pollinator-Friendly Habitat

Module 6

Community Service

Session I

Reproducibles

Pollinators and Plants Observation Sheet

What Do We Know About Plants?

Pollinators and Plants Group Observations Record

Pollinators and Plants Observation Sheet (blank left column)

Bee Courteous, Bee Safe

Bee-Free Fiesta

Bee-Free Barbeque
This activity page is available at *Smithsonian in the Classroom Plants and Animals: Partners in Pollination* November/December 1997

<< previous Session II >>

Session I

Nature's Partners: Pollinators and Plants Observation Sheet

Insect	Behavior (flying, crawling, drinking nectar, gathering pollen, # of visits, etc.)	Flower Name	Flower Shape (draw flower)	Flower Color	Flower Scent
Bee					
Butterfly					
Hummingbird					
Fly					
(Other)					

Nature's Partners: Pollinators and Plants Observation Sheet

Name of Insect / Bird	**Behavior** **flying, crawling, drinking nectar, gathering pollen, where they are on flower, time on flower, # of visits?**	**Flower Name**	**Flower Shape Draw / describe**	**Flower Colors**	**Flower Scent**
_____					
_____					
_____					
_____					
_____					

WHAT DO WE KNOW ABOUT PLANTS?

Plants We Know & Love	Does this plant have:						Insect Visitors	
	Flowers?	When?	Fruit?	When?	Seeds?	Where?	Insect	Season? Time of Day?

BEE Courteous, Bee Safe

Bees are most likely to sting when they are near their hive (where their young are raised) and feel threatened. If you see lots of bees in an area this may tell you there is a hive nearby and it is best to keep a safe distance.

When bees are away from their hive gathering water, pollen and nectar they are very busy and not likely to sting unless they are bothered.

Other insects, such as wasps, can also sting

Ways to protect yourself from stinging insects:

- Be cautious and respectful of all bees and flying insects.
- Don't disturb bees -- contact an adult if you find a nest or swarm.
- Be alert -- if you hear loud buzzing it usually means there is a nest or swarm of bees nearby.
- Use care when entering sheds where bees may nest.
- When you are outdoors, in a rural area, a park, or wilderness reserve wear light-colored clothing and avoid wearing floral or citrus perfumes.
- Know what to do if you are stung.

If you are stung:

- Quickly go to a safe place to avoid being stung again.
- Tell a responsible adult.
- Remove the sting as soon as possible by scraping the sting out with a fingernail or flat object. Don't squeeze the sting -- this only releases more venom.
- Wash the sting area with soap and water like any other wound.
- Apply an ice pack for a few minutes to relieve pain and swelling.
- Get medical attention if you begin to have trouble breathing, or if you are stung numerous times or are allergic to bee stings.

Bee-Free Fiesta

A wonderful meal is planned:

Menu

Chips and Salsa
Tortillas
Fajitas made of
Chicken, Red & Green Bell Peppers, Onions
Refried Beans
Rice
Guacamole
Lemonade

But if all animal pollinators were to become extinct which of the foods on our menu would be eliminated?

_____ _____ _____

_____ _____ _____

_____ _____ _____

_____ _____ _____

Hint: Some of the more common foods that we enjoy from animal-pollinated plants include tomatoes, onions, avocados, beans, green peppers, chili peppers, lemons, limes, and oranges, berries, vanilla, sugar, almonds, watermelons and apples.

Home

Why Care About Pollinators?

Scientific Thinking Processes

Implementing the Curriculum

Assessment

Outline

Printable Photos

Module 1

The Who, What & Why of Pollinators

Module 2

Pollinators and Plants in Partnership

Module 3

The Other Half of the Partnership: Pollinators

Module 4

Pollinator-Friendly Habitat in Your Area

Module 5

Creating Pollinator-Friendly Habitat

Module 6

Community Service Project and Celebration

Module 2

Pollinators and Plants in Partnership

Purpose:

- To understand the anatomy of flowers that make them attractive to pollinators.
- To understand plant reproduction and the role of pollination.

Background

Some flowers announce their presence with bold and vibrant hues, while others remain modest and drab. Some are simple and open in form, but others feature tricky entries or convoluted mazes.

Flowers have long inspired humans with their beauty and fragrances, and we've bestowed them with symbolic meanings. Myths and symbolism aside, the real job of flowers is to ensure that plants produce off-spring.

Animals can roam about and seek mates with whom to reproduce, but imagine the challenge for a plant, rooted firmly to the ground, to achieve the same end. Over millions of years, flowers have evolved a remarkable range of strategies to guarantee that male pollen is transferred to female flower parts so fertilization and seed production can occur.

Relying on wind to move pollen, as grasses and many trees do, is the oldest method of ensuring pollination. But a more efficient — and fantastic — means is by luring unsuspecting animal partners to inadvertently make the transfer as they search for food.

Insects — especially beetles, ants, flies, bees and wasps, butterflies, and moths — are the predominant animal pollinators. They have physical characteristics that make them extremely efficient in locating flowers and transferring pollen from one flower to another.

(From "The Secret Life of Flowers," Growing Ideas: A Journal of Garden-Based Learning, National Gardening Association 10 (3) September 1999.)

Module 2

- Background
- Activity A (30-35 min) Understanding Flower Structure & Plant Reproduction
- Activity B (20-30 min) Designing a Flower
- Activity C (Part I, 30 min, Part 2, 30 min) Creating a Reference Catalog of Flowers: Identifying and Preserving Flowers
- Activity D (Part 1, 20-30 min, Part 2, 20-30 min) A Rainbow of Choices: How Flowers Use Color to Attract Pollinators

Insect wiggling its way into snapdragon flower.

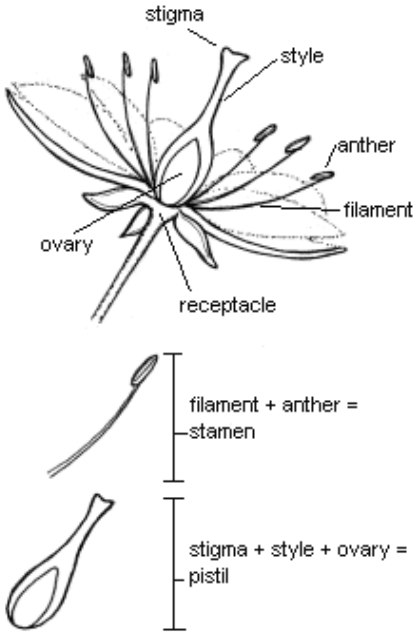
Resources/Links

Acknowledgements

Introduction to 4-H Series

Of course, animals don't do the work of pollination for nothing, so plants offer rewards. Animals use flowers as sources of food for themselves and their offspring. First of all, animal-pollinated flowers produce nectar, a sugar-based substance that also contains vitamins, amino acids, and other nutrients. The amount of nectar a flower typically produces relates to the needs of its pollinators. Second, pollen itself is a good source of protein for many animals. Finally, a few plants reward their pollinators with fatty oils, resin or wax.

Over millions of years, flowers have evolved a remarkable range of strategies to guarantee that male pollen is transferred to female flower parts.



It's easy to identify the different parts of the flower on lilies (top) and amaryllis. Illustrations and photos by Suzanne DeJohn/NGA.

The typical flower contains the necessary parts for enticing pollinators and producing seeds. The center of a flower usually contains the female, pollen-receiving **pistil**. The **stigma** at its tip is often sticky, feathery, folded, or otherwise designed to trap pollen. When they're ready to accept pollen, stigmas ready themselves for the transfer. They may be pushed upward by the long **style** that supports them, lean toward the male parts, or become stickier.

At the base of the pistil, the generally hidden **ovary** protects **ovules** (eggs), which become seeds when fertilized. The male parts, or **stamens**, typically surround the pistil. They may be quite long, to maximize exposure to wind and pollinators; hidden inside the flowers, to force pollinators to touch the stigmas on their way in or out; or able to lengthen and shorten over time, as needed.

The stamen is made up of the **filament** that supports the **anther** which produces and releases huge quantities of pollen.

Animal-pollinated plants have large, irregular pollen grains with lots of tiny hooks, spines, and craters on the surface. A rough texture and sticky surface ensure that the pollen will stick to a visiting animal's hair, scales, feathers, or appendages and then stay there until the animal visits another flower. At the next flower the pollen will be rubbed off onto the strategically placed stigma.

The pollen descends down the style of the sigma and fertilizes an ovule, leading to seed production. Once fertilized, the ovary wall takes in moisture and swells, becoming the fruit, which surrounds and protects the developing seeds.

The **petals**, which are typically the most noticeable parts of flowers, are designed to attract and provide platforms for insects, bats, birds, and other roving pollinators. The base of many petals contains **nectaries**, which produce the nectar. Since this food treasure is typically tucked deeply in the flowers, pollinators are coaxed into touching the flower's reproductive organs, and thus transferring pollen, in their search for nourishment. (From "Digging into Flowers: Pollen, Petals, Pistils, & Other Parts," *Growing Ideas: A Journal of Garden-Based Learning*, National Gardening Association 10 (3) September 1999)

In this indispensable partnership, flowers and pollinators are utterly dependent on one another for survival. And in turn, we depend on this process for much of the food we enjoy.

References

Digging into Flowers from *Growing Ideas: A Journal of Garden-Based Learning*

Parts of the Flower, Information sheet 9. Africanized Honey Bees on the Move, Africanized Honey Bee Education Project, University of Arizona

Pollination: The Art and Science of Floral Sexuality by Nancy C Pratt and Alan M. Peter, ZooGoer, July/August 1995.

"The Secret Life of Flowers," *Growing Ideas: A Journal of Garden-Based Learning*, National Gardening Association 10 (3) September 1999.

next >>

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Home

Why Care About Pollinators?

Scientific Thinking Processes

Implementing the Curriculum

Assessment

Outline

Printable Photos

Module 1

The Who, What & Why of Pollinators

Module 2

Pollinators and Plants in Partnership

Module 3

The Other Half of the Partnership: Pollinators

Module 4

Pollinator-Friendly Habitat in Your Area

Module 5

Creating Pollinator-Friendly Habitat

Module 6

Community Service Project and Celebration

Module 2

Activity A: Understanding Flower Structure & Plant Reproduction

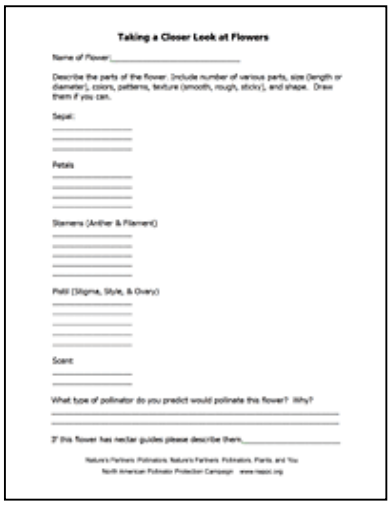
Participants will:

- Examine several varieties of flowers observing their scent, color, & conformation.
- Dissect and identify parts of the flowers using the flower identification sheet.
- Review the characteristics of flowers listed on the Field Observation Chart created by the group in Session I.

Materials Needed:

- A variety of fresh flowers
- Small sharp scissors
- **Flowers Poster** (showing flower structure and function, available from Edugraphics.net, #GS520-BB)
- **Taking a Closer Look at Flowers** record sheet, 1 for each type of flower
- **Flower Anatomy Sheet**, 1/participant
- **Design Your Own Flower** activity sheet, 1/participant
- Felt markers
- **Group Observation Record** of pollinators and plants generated by group during Session I
- Books with detailed drawings of number of different kinds of flowers (optional)

REPRODUCIBLES


Taking a Closer Look at Flowers

Name of Flower:_____

Describe the parts of the flower. Include number of various parts, size (length or diameter), colors, patterns, texture (smooth, rough, sticky), and shape. Draw them if you can.

Sepal:

Petals

Stamens (Anther & Filament)

Pistil (Stigma, Style, & Ovary)

Scent:

What type of pollinator do you predict would pollinate this flower? Why?

If this flower has nectar guides please describe them._____

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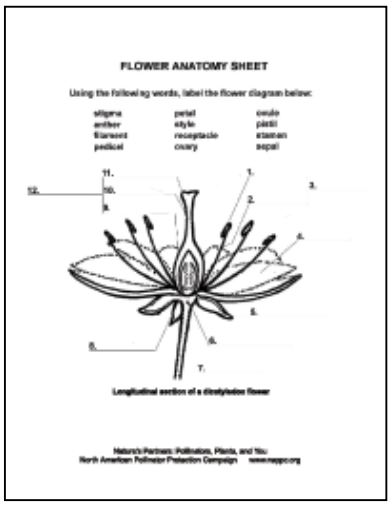
>>Taking a Closer Look at Flowers


FLOWER ANATOMY SHEET

Using the following words, label the flower diagram below:

stigma	petal	ovule
anther	style	pistil
filament	receptacle	stamen
pedicel	ovary	sepal

Longitudinal section of a dicotyledon flower

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>>Flower Anatomy

Getting Ready

- Carefully read background material.
- Check local library for botany books (optional).
- Obtain a variety of fresh flowers — may ask participants to bring flowers.
- Make copies of activity sheets: **Flower Anatomy**, **Design Your Own Flower**, and **Taking a Closer Look at Flowers**
- Display **Group Observation Record** of pollinators and plants generated by group during Session I

Suggested Groupings

Participants can work as individuals or groups of 2 or 3.

Exploration

Science Process: Observing, Learning, Recording

1. Give each participant a copy of the Flower Anatomy sheet.

Resources/Links

Acknowledgements

Introduction to 4-H Series

2. Spread fresh flowers out on a table, or place individual flowers in plastic cups. Place one Taking a Closer Look at Flowers sheet labeled with the name of the flower with each sample for recording observations.

3. As a group examine the flowers and discuss:

   What parts of the flower are visible?

   How are flowers different?

   How are they similar?

   Encourage participants to notice and compare flower characteristics such as shape, petals (color, patterns, texture, and number), scent, and whether the flower is composite (composted of many small flowers) or simple.

Design Your Own Flower

>>Design Your Own Flower

4. Divide group into teams of 2 or 3 participants to examine one flower and record their observations on the Taking a Closer Look at Flowers sheet.

Concept Development

1. A. Have each group dissect their flower, carefully laying out the different parts and comparing the real flower with the Flower Anatomy sheet. If necessary, help them identify the basic flower structures.

   B. Have each participant fill out a Taking a Closer Look at Flowers sheet to reinforce/review the basic structure of a flower.

2. A. As a whole group or in small groups, look at each dissected flower and the accompanying Taking a Closer Look at Flowers sheets.

   B. Discuss as a group the features they have identified, i.e., floral color, form, reward, scent, and structure.

3. Discuss the basic process of pollination using the Flower Structure and Function poster. Depending on the age of your group, focus on the cross-section of the flower and the development of the pollen grain, pollinating agents, and types of pollination.

4. Have them predict what type of pollinator could be expected to pollinate each of the flower types. Encourage the participants to think about the size and configuration of each flower and the characteristics of a potential pollinator:

- *What size would the pollinator be? Would they need to be large and strong to get to the pollen and nectar? Would a small pollinator have a better chance at getting to the nectar?*

- *What would be the best type of "equipment" for reaching the nectar? (Beak, proboscis — long or short)*

- *Would the pollinator need to land on the flower or hover around the flower?*

Concept Application

1. In small groups brainstorm the question, *If you were a pollinator what would your flower partner look, smell and taste like?*

   Have participants make a sketch and describe their flower on the Design Your Own Flower sheet.

   Encourage lots of creativity and fun in this activity; their flowers might have pizza slice petals, a candy bar pistil, a favorite drink could be the nectar, etc.

2. Discuss other examples in nature where a plant or animal might do something special to attract a partner. Examples include the showy tail feathers of male peacocks and turkeys, and the bright colors of birds and fish.

3. What about humans? Do we do things to attract partners? If so, what types of things do we do?

<< previous next >>

Flowers vary in shape, size, color, and form.
Top: honeysuckle flower.
Bottom: honey bee on thyme flowers.
Photos by Suzanne DeJohn/NGA.

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Home

Why Care About Pollinators?

Scientific Thinking Processes

Implementing the Curriculum

Assessment

Outline

Printable Photos

Module 1

The Who, What & Why of Pollinators

Module 2

Pollinators and Plants in Partnership

Module 3

The Other Half of the Partnership: Pollinators

Module 4

Pollinator-Friendly Habitat in Your Area

Module 5

Creating Pollinator-Friendly Habitat

Module 6

Community Service Project and Celebration

Module 2

Activity B: Designing a Flower

Participants will:

- Review basics of flower structure and function.
- Design a flower, giving attention to shape, size, color, and scent as well as applying what they have learned about the structure of flowers.

Materials needed

Note: Start collecting materials well in advance of this module. Ask participants to bring in items that can be included in the collection of creative materials. These materials will also be used in Module 3, Activity B.

Large variety of materials such as:

foil	wax paper	craft paper	construction paper
pipe cleaners	juice containers	oatmeal boxes	egg cartons
plastic containers	beads	buttons	string/yarn
glitter	balloons	fabric scraps	magazines
	felt	Styrofoam & bubble packing material	

Basic supplies

- Scissors (1 pair/participant), white craft glue, tape, stapler, brads, colored markers, crayons, acrylic craft paints or poster paint & brushes (optional)
- Protective covering for work areas (newspaper or disposable plastic tablecloths).
- Display board, sky blue and green construction paper to cover it, pushpins or other method for attaching flowers.

Getting Ready

- Arrange to hold this activity where there is plenty of workspace — several large tables would be ideal.
- Cover tables
- Place basic equipment (scissors, glue, etc.) on tables.
- Place craft materials in a central location so all

Resources/Links

Acknowledgements

Introduction to 4-H Series

participants can see what is available.

Tibouchina, osteospermum, and allium flowers.
Photos by Suzanne DeJohn/NGA

Grouping

Individuals or teams of 2.

Review/Concept Development

1. As a group, have participants briefly review what they have learned in Activity A about the structure of a flower and the function of the parts of the flower.

   This is a good time to correct any misconceptions that may have occurred by asking, *Does everyone agree with that idea?* or *Does anyone have a different understanding about* _____?" from time to time.

Concept Application

1. Possibly start with a question: "*Have you ever thought how much fun it would be to work on movies like the Harry Potter series, the Lord of the Rings trilogy, or the Star Wars series where you could invent creatures that no one has ever seen before?"*

   You are going to be creators and inventors of new creatures — new pollinators and the flowers they would prefer. You have learned a lot about pollinators, such as bees and butterflies and how flowers are designed to attract them. Today we'll start by inventing flowers.

2. Challenge the participants to create a flower with the craft materials you have assembled. Remind them that they will be creating a pollinator partner soon, so they can keep that in mind as they design their flower.

3. Display the completed flowers on a bulletin board covered with construction paper. Leave space around each flower for the pollinator partner that the participants will create in Module 3.

<< previous next >>

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Home

Why Care About Pollinators?

Scientific Thinking Processes

Implementing the Curriculum

Assessment

Outline

Printable Photos

Module 1

The Who, What & Why of Pollinators

Module 2

Pollinators and Plants in Partnership

Module 3

The Other Half of the Partnership: Pollinators

Module 4

Pollinator-Friendly Habitat in Your Area

Module 5

Creating Pollinator-Friendly Habitat

Module 6

Community Service Project and Celebration

Resources/Links

Module 2

Activity C: Creating a Reference Catalog of Flowers — Identifying and Preserving Flowers

You can preserve flowers by pressing them.

This activity is ideal for spring when wild flowers are in bloom. If public or private gardens are used for collecting flowers, obtaining permission in advance of this activity is important.

If this activity is done as a group during the session the cataloging process needs to be planned for a later session when the flower specimens are dry. It can also be used as a "Going Further" take-home activity.

Participants will:

- Collect, identify, and learn to preserve flowers that are attractive to pollinators.
- Create reference catalog of pressed flowers.

Materials needed:

- 3-4 books, large and heavy enough to apply even pressure to flowers
- Newspaper, newsprint, or facial tissue
- 3-ring notebook
- Plain white paper
- Clear plastic page protectors
- Plastic (zip-lock) food storage bags for collecting plants
- Paper grocery bag, 1/group
- Plant Identification Forms
- Ballpoint pens, 1/group
- Clear tape
- Several pair of scissors
- *Sunset Garden Book* or other good flower reference book or field guide
- Other plant identification reference books

REPRODUCIBLES

Plant Identification Form

>>Plant Identification Form

Getting Ready

- Assemble materials needed.
- Have sample plant cutting and a card filled out so you can demonstrate each step as you explain how to collect the plant samples.
- Become familiar with the area where the participants will be collecting samples. Try to learn the common names of the plants and flowers in the area so you can guide them in identifying their samples. If you wish, have someone knowledgeable about plants join you on this activity as a resource person.

Suggested Grouping

Acknowledgements

Introduction to 4-H Series

Teams of 3

Exploration

Gathering plant specimens:

1. Introduce activity by discussing:

   Why is cataloging samples of flowers useful and important?

   What other types of items do scientists collect and catalog?

2. Divide participants into teams of 3. Give directions for the activity:

a. Each person in your team has a specific responsibility:

- 1 person will cut samples of flowers (needs scissors)
- 1 person will record the information about the flowers (needs record forms & pen)
- 1 person will be responsible for placing the specimen in a plastic bag along with the information card and bringing it back (needs plastic food storage bags and larger grocery bag)

b. Make the following guidelines clear:

- Be careful that a bee is not visiting the plant when you cut the sample.
- Do not to trample plants in order to get your sample.
- Cut only one sample of each type of flower.
- Include some plant stem and leaves when you cut your samples.

c. Record the following information on the form provided:

Date:_____
Time: _____
Location:_____
Name of Plant*:
_____
Description of plant (flower color, leaf shape, height, many or few plants)
_____
_____
_____
Pollinator: _____
Team members: _____
*will need to look this up when finished collecting samples

d. Place the form in the bag with the plant specimen, make sure the bag is closed, and place it carefully in your large sack.

e. When you have 3-5 samples, then you will be ready to identify your flowers and preserve them.

Identifying and preserving the flowers:

Leader should go through the following steps to demonstrate what the teams are to do.

1. Using reference books and help from your leaders, try to identify your flower samples and enter the common and Latin names of the plant on the identification form.

2. Prepare the flowers for drying:

a. Depending on the size of the flower and the thickness of the stem, leave about 3" of stem attached to the flower.

b. Prepare the flowers for pressing by arranging each flower with its stem and leaves on a piece of newspaper or facial tissue. Place another piece of paper over them.

c. Starting near the back of a large book, put the prepared flowers with the drying papers in a large book.

d. After you have closed the book, place additional weight on top of it. The weight can be another book of about the same size.

e. Do not disturb the pressing process for about a week. Then gently open the book to the first layer to see how the drying process is progressing. If the material is still not thoroughly dry, close the book and wait a few more days.

Pressing flowers.
Photos by Suzanne DeJohn/NGA

Concept Application/Development (about 1 week later)

Cataloging the flower specimens:

1. When the flowers are dry, attach them to an 8.5 x 11 sheet of white paper or card stock with a very small amount of glue. Attach the information form to the paper.

2. Slip the sample into a plastic sheet protector and arrange them on tables or tape them on a wall so everyone can see them.

3. As a group, reflect on their experience and what they have learned so far through collecting and preserving the flower specimens.

How are the samples similar? Different?

How do flowers vary in their suitability for preserving by pressing?

Are there other methods that would have been more suitable for certain flowers?

In what ways can this collection of pressed flower samples be used?

4. Place samples in a binder or a file folder and store in a dark, dry place.

5. These samples can be a reference resource for later activities and used for bulletin board displays about pollinators and the plants that are important to them.

Going Further

Encourage participants to continue to collect and press samples from plants in their yards and neighborhood and add them to the collection.

<< previous next >>

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Home

Why Care About Pollinators?

Scientific Thinking Processes

Implementing the Curriculum

Assessment

Outline

Printable Photos

Module 1

The Who, What & Why of Pollinators

Module 2

Pollinators and Plants in Partnership

Module 3

The Other Half of the Partnership: Pollinators

Module 4

Pollinator-Friendly Habitat in Your Area

Module 5

Creating Pollinator-Friendly Habitat

Module 6

Community Service Project and Celebration

Module 2

Activity D: A Rainbow of Choices — Determining Color Preferences of Insects

This activity will be most successful in attracting honey bees if done in the fall when nectar is scarce.

Fly on aster. (Yes, this is a fly, not a bee.) Photo by Suzanne DeJohn/NGA.

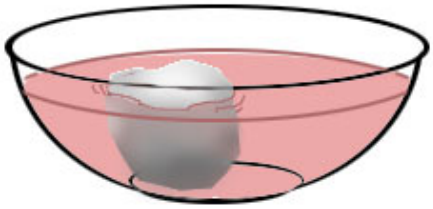
If this activity is done as a group, discussion and reflection on the participants' observations needs to be planned for a later session. It can also be used as a "Going Further" take-home activity.

Participants will:

- Conduct an experiment to discover the influence color may have on an insect's attraction to a food source.
- Observe and record information.
- Think critically about their observations.
- Develop hypotheses about the food preferences of insects.

Note on Safety: Yellow jackets and wasps may also be attracted to the containers of sugar water and children should observe from a safe distance. A boundary marker could be placed around the experiment area. The guidelines on the "BEE Courteous, Bee Safe" handout should be reviewed.

Materials needed:



Rocks should be large enough to provide a dry landing place for pollinators.

- Clear plastic shallow bowls or petri dishes (same number as paper colors)*
- Mesh with 1 mm size holes or several small rocks
- Water, spring or filtered
- Sugar
- Measuring cups and spoons
- A variety of colored papers*
- Large paper pad and markers
- **Science Experiment Record Sheet**
- Group Observation Record created in from Module 1, Activity A

*colored bowls or food coloring can be used instead of colored construction paper

REPRODUCIBLES

Getting ready:

- Assemble materials
- Make copies of Science Experiment Record Sheet, 1/ participant

Resources/Links

Acknowledgements

Introduction to 4-H Series

Suggested groupings

Whole group

Action Part I

Review:

As a group, make predications about which colors are most preferred by certain insects according to their observations on the Group Observation Record from Module 1, Activity A. Record the predications on a large sheet of paper.

Science Experiment Record Sheet

Name of Experiment: _____

What I hope to learn: _____

Description: _____

Observation Record:

Date	Time of Day	Weather	What I Observed

Date	Time of Day	Weather	What I Observed

Date	Time of Day	Weather	What I Observed

Date	Time of Day	Weather	What I Observed

Summary of Observations: _____

Predications? _____

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>>Science Experiment Record Sheet

Exploration & Concept Introduction:

1. Introduce activity: "*To test your predications we can do an experiment using color.*"

2. Prepare experiment.

- Place a dish on each sheet of colored paper or use colored dishes or food coloring in the sugar solution.
- Label dishes: 1,2,3, etc.
- Make a sugar solution of 2 parts water and 1 part sugar.
- Place an equal amount in each dish.
- Completely cover the top of each dish with a square of mesh to provide a landing platform; alternatively, place a small rock in each container to provide a dry landing spot.
- Place the dishes outside in a sunny location next to some plants.

3. Distribute a Science Experiment Record Sheet to each participant and explain what to do:

Two times a week for the next 3 weeks, quietly watch the dishes and record what you see, answering the questions on your Science Experiment Record Sheet.

--Which dish attracts the most insects?

--What types of insects are attracted to the different dishes?

Be sure to fill in the time of your observation, how long you observed and the weather conditions (cloudy, sunny, raining, windy, calm, cool, warm, really hot).

Action Part II (1-2 weeks later)

Review

Read the predictions made at the beginning of this activity.

Butterfly on cantaloupe. Photo by Suzanne DeJohn/NGA.

Concept development & application:

4. As a group compare observations and answer the following questions. Record answers on a large sheet of paper.

- *What types of insects are attracted to each color? Are they flying or crawling insects? Are they pollinators?*
- *Which color attracted the most insects? Can you identify these insects? Why do you think this color attracts the most insects?*

- *Why do you think certain insects are attracted to certain colors?*

Have participants develop statements about their conclusions.

Going further:

Now try new combinations to attract the greatest variety of types of pollinators. Mix and match different colored dishes and amounts of sugar water to find the combination that attracts the most pollinators. Artificial flowers or flowers made of construction paper sprinkled with the sugar water can also be used. Create a chart and record your observations.

Adapted from *Vanishing Pollinators*, a publication of the Smithsonian National Zoological Park and the National Fish and Wildlife Foundation.

<< previous Module 3

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Taking a Closer Look at Flowers

Name of Flower:_____

Describe the parts of the flower. Include number of various parts, size (length or diameter), colors, patterns, texture (smooth, rough, sticky), and shape. Draw them if you can.

Sepal:

_____
_____
_____

Petals

_____
_____
_____
_____

Stamens (Anther & Filament)

_____
_____
_____
_____
_____

Pistil (Stigma, Style, & Ovary)

_____
_____
_____
_____
_____

Scent

_____
_____

What type of pollinator do you predict would pollinate this flower? Why?

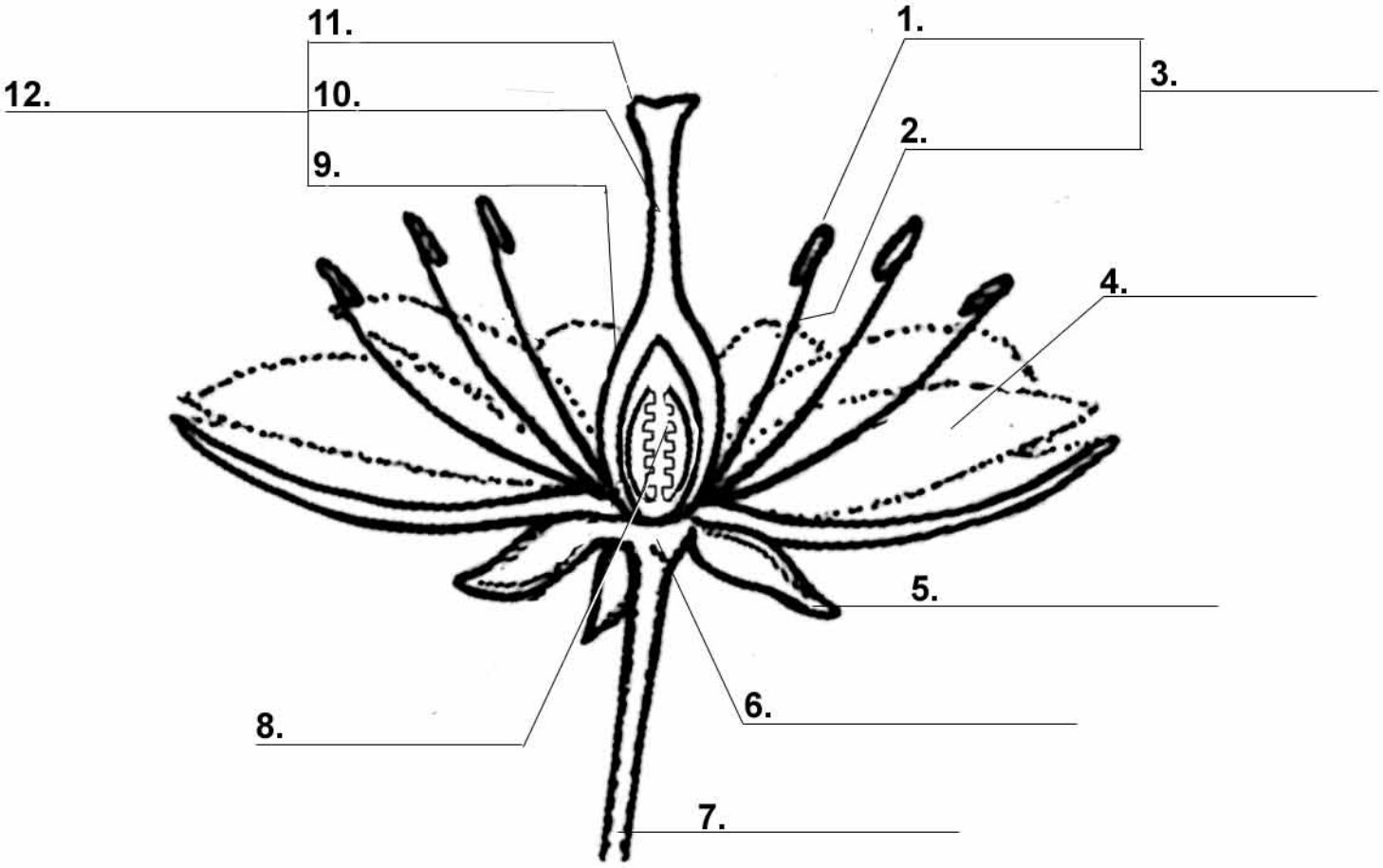
_____
_____

If this flower has nectar guides please describe them._____

FLOWER ANATOMY SHEET

Using the following words, label the flower diagram below:

stigma	petal	ovule
anther	style	pistil
filament	receptacle	stamen
pedicel	ovary	sepal



Longitudinal section of a dicotyledon flower

Design Your Own Flower

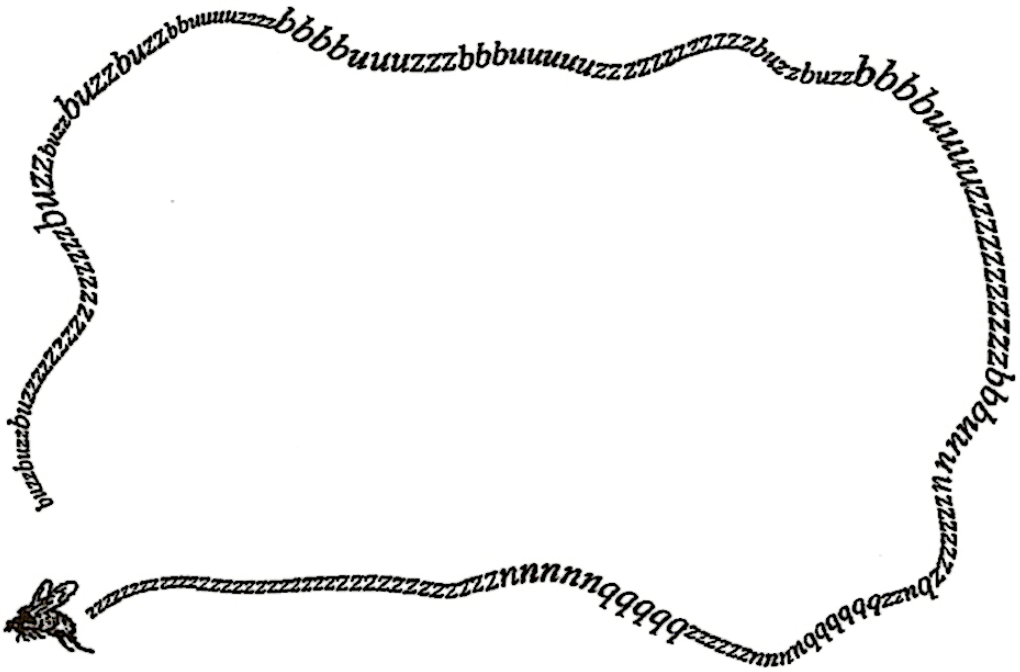
Fill out your preferences and give them to your partner:

Your favorite color: _____

Your favorite shape: _____

A smell you like: _____

Your favorite snack: _____



Imagine you are a flower adapting to your partner's preferences. In the area above, draw a "designer" flower to suit these preferences. Then, describe why the flower you created would appeal to your partner:

_____

_____

_____

_____

Adapted from Smithsonian in the Classroom *Plants and Animals: Partners in Pollination*

Date:_____

Time: _____

Location:_____

Name of Plant: _____

Description of plant (flower color, leaf shape, height, many or few plants)

_____

_____

_____

Pollinator: _____

Team members: _____

Date:_____

Time: _____

Location:_____

Name of Plant: _____

Description of plant (flower color, leaf shape, height, many or few plants)

_____

_____

_____

Pollinator: _____

Team members: _____

Date:_____

Time: _____

Location:_____

Name of Plant: _____

Description of plant (flower color, leaf shape, height, many or few plants)

_____

_____

_____

Pollinator: _____

Team members: _____

Science Experiment Record Sheet

Name of Experiment: _____

What I hope to learn:_____

Description:_____

_____

_____

Observation Record:

Date	Time of Day	Weather	What I Observed

Date	Time of Day	Weather	What I Observed

Date	Time of Day	Weather	What I Observed

Date	Time of Day	Weather	What I Observed

Summary of Observations:_____

_____

_____

_____

Predications? _____

_____

_____

_____

Home

Why Care About Pollinators?

Scientific Thinking Processes

Implementing the Curriculum

Assessment

Outline

Printable Photos

Module 1

The Who, What & Why of Pollinators

Module 2

Pollinators and Plants in Partnership

Module 3

The Other Half of the Partnership: Pollinators

Module 4

Pollinator-Friendly Habitat in Your Area

Module 5

Creating Pollinator-Friendly Habitat

Module 6

Community Service Project and Celebration

Module 3

The Other Half of the Partnership: Pollinators

Purpose:

- To understand the characteristics of pollinators that make them uniquely suited to the task of pollination

Module 3

- Background
- Activity A (25-35 min) The Anatomy of Bees, Butterflies, & Moths
- Activity B (25-45 min) Designing a Pollinator
- Activity C (40-50 min) Pollinator Real Estate
- Activity D-1 (10-15 min set-up) Look Who's in the Neighborhood!

Background

In various parts of the world bats and certain birds, such as hummingbirds, sunbirds, sugarbirds, honeycreepers, and brush-tongued parrots, serve as pollinators to certain plants. For example, many species of bats live in tropical areas where they pollinate fruit-bearing plants such as the banana tree. However, insects — especially beetles, ants, flies, bees and wasps, butterflies and moths — are the predominant animal pollinators.

The study of the life cycle and habits of each of these insects is fascinating in and of itself. However, the focus of this curriculum is on the role of pollinator carried out by these insects within the ecosystem. We have further narrowed our focus to those North American pollinators that are most important to the foods we eat and delight us with their beauty: managed and native bees and butterflies and moths. These insects have physical characteristics that make them extremely efficient in locating flowers and transferring pollen from one flower to another.

For example, The **antennae** of bees are very sensitive to touch and odor stimuli. Bees can differentiate between hundreds of different aromas. Honey bees also rely on their sense of vision to locate flowers. Using 2 **compound eyes** that detect color, shape and movement and three **simple eyes** that detect light, they see colors in the spectrum ranging from ultraviolet to orange, but do not see red.

Flower fly. Photo by Andy Neill.

Many flowers have shiny patches of ultraviolet on their petals called bee guides or nectar guides. Like airport runway lights, these ultraviolet regions guide the bees to the nectar.

The **proboscis** of the honey bee is a long, slender, hairy, tube-like tongue that acts as a food canal to bring the liquid food (nectar, honey, and water) to the mouth. It allows the bee to access nectar in the flower that it could not otherwise reach. When in use, the tongue moves rapidly back and forth while the flexible tip performs a lapping motion.

Bees have lots of little hairs on their body. Even

Resources/Links

Acknowledgements

Introduction to 4-H Series

their eyes have hairs. Pollen sticks to the hairs while the bees are visiting the flowers. A furry little bee wiggling around inside the flower picks up a lot of pollen. After getting pollen on their body hairs, the bees may move some of it to a special area on their hind legs called **pollen baskets**. Foraging bees returning to the hive often have bright yellow or greenish balls of pollen hanging from these pollen baskets.

Honey bees.

Butterflies and moths are classified together in the order *Lepidoptera*[1] due to the fact that every part of their body, from their wings to their feet, is covered by thousands of delicate scales — scales that can collect pollen. Butterflies and moths usually differ in four ways:

1. Most butterflies fly only during the day, while most moths fly at dusk or at night.

2. Generally, butterflies fold their wings straight up over their bodies and moths spread their wings flat when resting.

3. The antennae of butterflies have bare knobs at the ends; the antennae of most moths are either hair-like or plume-like and end in a point.

4. Most moths have a plump body when compared to the thinner body of butterflies.

Honey bee with full pollen baskets.
Photo by Suzanne DeJohn/NGA.

In one respect, butterflies have a Dr. Jekyl/Mr Hyde character. During each of the 4 stages of development (egg, larva, pupa, adult) the insect looks and lives in a new way. In the larva stage, as a caterpillar, its voracious appetite makes it very destructive of crops. Caterpillars of different kinds of butterflies look quite different but the colors and markings of the caterpillar do not resemble the adult butterfly they become. In the adult stage butterflies are harmless and are helpful in pollinating flowers.

The antennae of butterflies and moths are used to smell and may also be used for hearing, according to some experts. A butterfly tastes with its feet. The sweet taste of flower causes the insect to uncoil its probiscis, which it uses to suck up nectar and other liquids. Butterflies also have large compound eyes on the sides of their head that detect movement and the color patterns of flowers and other butterflies. Certain butterflies, such as the monarch butterfly, are migratory and may go through a different stage of development at different points along its migratory route.

[1] The name *Lepidoptera* comes from two Greek words, *lepidos* (meaning scale) and *pteron* (meaning wing).

Newly emerged atlas moth.

References

Honey Bees & Pollination, Lesson 2.4, Africanized Honey Bees on the Move, Africanized Honey Bee Education Project, University of Arizona

Pollinators & Their Preferred Flowers, Information sheet 23, Africanized Honey Bees on the Move, Africanized Honey Bee Education Project, University of Arizona

Pollination: The Art and Science of Floral Sexuality by Nancy C Pratt and Alan M. Peter, ZooGoer, July/August 1995.

>> next

Luna moth. Photos by Suzanne DeJohn/NGA.

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Printer-Friendly View | Normal View

Home

Why Care About Pollinators?

Scientific Thinking Processes

Implementing the Curriculum

Assessment

Outline

Printable Photos

Module 1

The Who, What & Why of Pollinators

Module 2

Pollinators and Plants in Partnership

Module 3

The Other Half of the Partnership: Pollinators

Module 4

Pollinator-Friendly Habitat in Your Area

Module 5

Creating Pollinator-Friendly Habitat

Module 6

Community Service Project and Celebration

Module 3

Activity A: The Anatomy of Bees, Butterflies, & Moths

Participants will

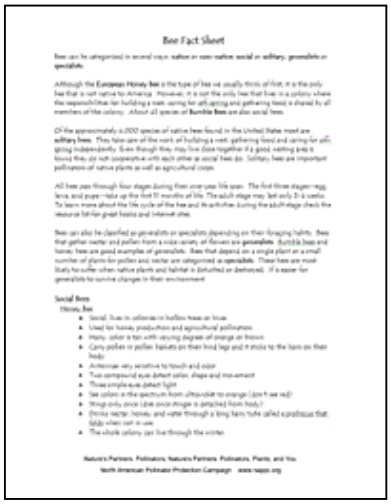
- Examine bee and butterfly specimens, identify body parts and learn how they are involved in the process of pollination.

Materials needed

- Several specimens each of bees and butterflies (mounted specimins available from Carolina Biological Supply: Honey Bee, item# 30-8004; Buttefly Families mount, item# 26-2754).
- Or collect and mount your own: How to Mount a Butterfly, Preparing Insects for Mounting

- Magnifying glasses, 1/participant
- **Anatomy of a Honey Bee** activity sheet, 1/participant
- **Anatomy of a Butterfly/Moth** activity sheet, 1/participant
- Clue cards for "What Am I?" game
- **Bee Fact Sheets**
- **Butterfly & Moth Fact Sheet**
- Books on bees & butterflies from library (optional)
- Computer with Internet connection (optional)

REPRODUCIBLES



>>Bee Fact Sheet (2 pages)

>>Butterfly & Moth Fact Sheet

Getting Ready

- Review background information on bees & butterflies.
- Make copies of Bee & Butterfly/Moth Fact Sheets
- Make copies of Anatomy of a Honey Bee
- Place specimens in a well-lighted area with plenty of room for participants to examine them.

Suggested Grouping

Divide group into teams of two.

Action:

Review

Discuss briefly the concepts of flower characteristics designed to attract pollinators.

Exploration

1. Give each participant a copy of the Bee & Butterfly Anatomy activity sheet and a magnifying glass. Encourage participants to closely examine the specimens and compare them to the activity sheet diagrams.

Resources/Links

Acknowledgements

Introduction to 4-H Series

Concept Development

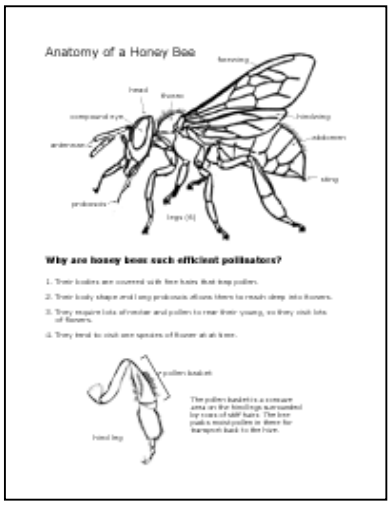
2. Discuss as a group the function of the different body parts, especially those related to locating flowers, gathering nectar, and collecting and distributing pollen.

3. Introduce fact sheets on bees and butterflies that includes facts about their life cycles, habitat, activities, needs, etc.

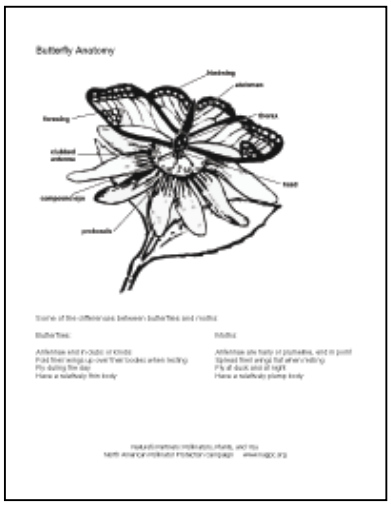
Concept Application

4. Play "**Who Am I?**" game (similar to "What Am I?") where children guess which pollinator is being described by clues given.
>>Instructions and links to reproducibles.

<< previous next >>



>>Anatomy of a Honey Bee



>>Butterfly Anatomy

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Home

Why Care About Pollinators?

Scientific Thinking Processes

Implementing the Curriculum

Assessment

Outline

Printable Photos

Module 1
The Who, What & Why of Pollinators

Module 2
Pollinators and Plants in Partnership

Module 3
The Other Half of the Partnership: Pollinators

Module 4
Pollinator-Friendly Habitat in Your Area

Module 5
Creating Pollinator-Friendly Habitat

Module 6
Community Service Project and Celebration

Module 3

Activity B: Designing a Pollinator

Participants will:

- Further explore and apply concepts related to insect adaptation and service in maintaining an ecological system by:
  1. Designing a pollinator.
  2. Creating a fact sheet about the pollinator including information about life cycle, habitat, lifestyle, what and how it eats, reproduces, carries pollen, etc.

Materials needed:

Note: Start collecting materials well in advance of this session. Ask participants to bring in items that can be included in the collection of creative materials.

foil	wax paper	craft paper	construction paper
pipe cleaners	juice containers	oatmeal boxes	egg cartons
plastic containers	beads	buttons	string/yarn
glitter	balloons	fabric scraps	magazines
	felt	Styrofoam & bubble packing material	

Basic supplies

- Scissors (1 pair/participant), white craft glue, tape, stapler, brads, colored markers, crayons, acrylic craft paints or poster paint & brushes (optional)
- Protective covering for work areas (newspaper or disposable plastic tablecloths)
- Display board, sky blue and green craft paper to cover it, pushpins or other method for attaching pollinators, 3" x 5" cards for pollinator identification label
- Bee Fact Sheet (2 pages), Butterfly & Moth Fact Sheet

Getting ready:

REPRODUCIBLES

- Arrange to hold this activity where there is plenty of workspace — several large tables would be ideal.
- Cover tables.
- Place basic equipment (scissors, glue, etc.) on tables.
- Place resource materials in a central location so all participants can see what is available.

Grouping

Individual or teams of 2

Action

Review

Resources/Links

Acknowledgements

Introduction to 4-H Series

Discuss briefly some of the general characteristics that make an insect an efficient pollinator.

Concept Application
Remind participants about the flowers they created in Module 2, Activity B. Tell them,

"Today you are going to be creating new pollinators. You have learned a lot about pollinators, such as bees and butterflies. You'll be applying that knowledge as you invent a pollinator for the flower you've created.

Pretend you are designing a pollinator that we might find on some imaginary planet. What would it look like? What unique characteristics would it have that would make it a partner to the flower you already created?] Thin about how the pollinator would move, how they would see, how and what they would eat.

As you design your pollinator think about how and where they would live, their life cycle, whether they are active during the day or only at night, etc. and write a fact sheet about it."

Bee balm (Monarda) has unusual flowers.
Photo by Suzanne DeJohn/NGA.

Designing a Pollinator

As you create your new pollinator and its favorite flower, think about their sizes and shapes and where the pollen is located on the flower.

Describe your new pollinator:

Its life cycle

Habitat

Lifestyle

How it eats

How it carries pollen

Other features

>>Designing a Pollinator

1. Allow participants to work freely. Use casual questions to encourage attention to detail as you walk around observing their projects. Some young people may be hesitant at first — give them time to "warm-up" to the activity. If they continue to have a hard time getting started, suggest they work with a partner if they are not already doing so.
2. Some participants will finish more quickly than others. Have them prepare the display board or help in some other way.
3. Mount pollinators on the display board along with the flowers they created. Have each creator write the name of their pollinator & flower and their own name on a 3 x 5 card.
4. Before sharing as a group, have participants help clean up — putting away supplies, cleaning off tables, and sweeping as necessary.
5. As a group, let each person tell about their creations. Remind the group that this is a time to enjoy and celebrate everyone's creativity and imagination (no negative comments allowed).

Going further:

1. Observe, collect, and record information in their Field Journal about insect pollinators and hummingbirds, pages 6-11.
2. Share the Bee Fact Sheet and Butterfly & Moth Fact Sheet and "**Who Am I?**" game with their families. >>Instructions and links to reproducibles for game.
3. Visit PBS Online site Alien Empire and explore information and activities related to bees.
4. Encourage students to explore the Internet and library for interesting information about pollinators in their area in preparation for Module 4.

Home

Why Care About Pollinators?

Scientific Thinking Processes

Implementing the Curriculum

Assessment

Outline

Printable Photos

Module 1

The Who, What & Why of Pollinators

Module 2

Pollinators and Plants in Partnership

Module 3

The Other Half of the Partnership: Pollinators

Module 4

Pollinator-Friendly Habitat in Your Area

Module 5

Creating Pollinator-Friendly Habitat

Module 6

Community Service Project and Celebration

Module 3

Activity C: Pollinator Real Estate

Participants will:

- Learn about the nesting habits of various pollinators.
- Practice observation skills.

Materials & Equipment needed:

- Empty flowerpot
- 2 blocks of a soft wood, such as pine, 4" x 4" x 8" (Do not use pressure-treated wood!)
- Drill and bits from 1/8 to 3/4" in diameter
- Hollow plant stems such as bamboo in varying lengths; bamboo poles can be purchased at nurseries.
- Science Experiment Record Sheets

REPRODUCIBLES

>>Science Experiment Record Sheet

Getting ready:

- This activity can be done as a group or used as a take-home activity.
- Assemble materials and equipment.
- Scout around for a location near some trees and bushes that is in sunlight and won't be disturbed by pets and other kids.
- For more information on building nesting sites, visit Xerces Society's Nests for Native Bees.

Grouping

Whole group or individual take-home activity

Action:

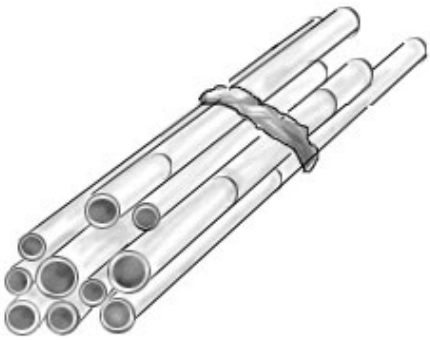
1. If the group was able to go on a field trip and learn about the habitat of various pollinators ask them to recall some of the things they learned about pollinator nesting habits. If the group was not able to have the field experience, give a brief overview of the nesting habits of various bees and other pollinators.

2. Explain that the group is going to provide three types of nests in order to discover first-hand where pollinators like to live. Describe each type of nest:

   a. pile of hollow plant stems, such as bamboo, in varying lengths

   b. an upside-down, empty flower pot that has holes on the bottom so insects can enter and leave

   c. a pollinator condo made from wood. Drill 6 to 10, 6-



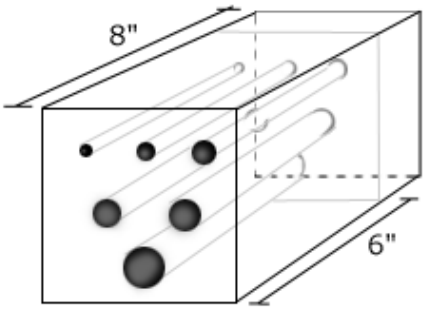
Resources/Links

Acknowledgements

Introduction to 4-H Series

inch-deep holes of 1/8 to 3/4-inch diameter on one side of the board. Be sure the holes don't go completely through the wood. (An adult should do the actual drilling.)

Hollow pieces of stems or bamboo, cut to varying lengths and bound together.



Pollinator "condo" — holes should not extend all the way through the board.

3. With the group, locate the site for the experiment and decide where to put each type of nest. Divide into three groups, each group setting up one of the experimental nests. Condos should be placed facing the sun.
4. Have groups check their section once a week and record what animals have made these houses their homes. The nesting sites should not be disturbed. They can use their field journals to record their observations each week either by writing or drawing pictures.
5. Encourage group members to research the nesting habits of native bees and other pollinators important to the area by using the library or the Internet.
6. After a few weeks hold a group discussion where the participants can share the results of their observations and answer the following questions:

   a. *What type of animals did each house attract? Are any of these animals pollinators?*

   b. *Why do you think a certain type of animal decided to live in a certain type of house?*

   c. *How many bees or wasps are living in your condos?*

   d. *How could you make these homes even more attractive and suitable for their animal inhabitants?*
7. Challenge students to watch for possible nesting areas in their yard or neighborhood and record their observations in their field journal.

Adapted from *Vanishing Pollinators*, a publication of the Smithsonian National Zoological Park and the National Fish and Wildlife Foundation

<< previous next >>

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Printer-Friendly View | Normal View

Home

Why Care About Pollinators?

Scientific Thinking Processes

Implementing the Curriculum

Assessment

Outline

Printable Photos

Module 1

The Who, What & Why of Pollinators

Module 2

Pollinators and Plants in Partnership

Module 3

The Other Half of the Partnership: Pollinators

Module 4

Pollinator-Friendly Habitat in Your Area

Module 5

Creating Pollinator-Friendly Habitat

Module 6

Community Service Project and Celebration

Module 3

Activity D: Look Who's in the Neighborhood!

Participants will:

- Conduct an experiment to discover the variety of insects that are in the area and the colors they are attracted to using the "Pan Trap" method.
- Observe and record information.
- Analyze information and draw conclusions about the types of insects in their neighborhood.

Materials needed:

- Plastic bowls, 3 red, 3 blue, 3 white, and 3 yellow
- Water
- Liquid dishwashing detergent
- **Science Experiment Record Sheets**, 1/participant

REPRODUCIBLES

Science Experiment Record Sheet

Name of Experiment: _____

What I hope to learn: _____

Description: _____

Observation Record:

Date	Time of Day	Weather	What I Observed

Date	Time of Day	Weather	What I Observed

Date	Time of Day	Weather	What I Observed

Date	Time of Day	Weather	What I Observed

Summary of Observations: _____

Predictions? _____

Nature's Partners: Pollinators, Plants, and You
North American Pollinator Protection Campaign www.nappc.org

>>Science Experiment Record Sheet

Getting ready:

- Assemble materials.
- Locate area near flowers or foliage where bowls can be placed.
- Make copies of Science Experiment Record Sheets

Suggested grouping:

Whole group for setting up the experiment
Individuals for observation

Action:

Review

Briefly discuss the role of color in attracting insects to flowers.

How do insects see colors differently?

What colors are attractive to bees, butterflies, moths, beetles, etc.?

Exploration and Concept Introduction:

1. There are a various ways of trapping insects and taking a sample of the population of insects in an area. One simple way is to make "Pan Traps."
2. To make a Pan Trap simply partially fill different colored bowls with water and place them about 3 feet apart near flowers or foliage.
3. After the bowls are in place add 2-3 drops of liquid dishwashing detergent to the water in each bowl. Do not mix or stir. The detergent "traps" the insects that are attracted to the bowls.
4. At regular intervals over a period of several days observe the types of insects that are trapped and record the information on the Science Experiment Record Sheets.

Resources/Links

Acknowledgements

Introduction to 4-H Series

Concept Development:

5. Discuss their observations:

- *Which colors attracted which types of insects?*
- *Which types of insects were caught during the day?*
- *Which types of insects were caught in the evening or during the night?*
- *Which of the trapped insects are pollinators?*
- *How many of each type of insect were trapped?*

Concept Application:

6. As a group develop prediction statements about the insect, particularly the insect pollinators, that can be found in the area.

<< previous next >>

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Home

Why Care About Pollinators?

Scientific Thinking Processes

Implementing the Curriculum

Assessment

Outline

Printable Photos

Module 1

The Who, What & Why of Pollinators

Module 2

Pollinators and Plants in Partnership

Module 3

The Other Half of the Partnership: Pollinators

Module 4

Pollinator-Friendly Habitat in Your Area

Module 5

Creating Pollinator-Friendly Habitat

Module 6

Community Service Project and Celebration

Module 3

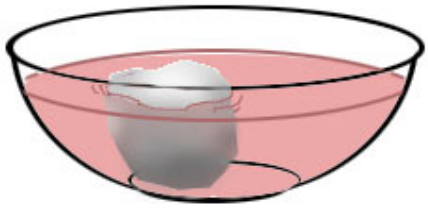
Activity E: Sugar Rush: How Sweet Does Nectar Need to Be?

Participants will:

- Conduct an experiment to discover which insects are attracted to a light, medium, or heavy sugar solution.
- Observe and record information.
- Think critically about their observations.
- Develop hypotheses about the food preferences of insects.

Materials needed:

- 3 clear plastic bowls, either clear or of the same color
- Mesh with 1 mm size holes or several small rocks
- If bowls are clear, food coloring in one color attractive to bees
- Water, spring or filtered
- Sugar
- Measuring cups and spoons
- Group Observation Record Sheet created in Module 1
- Large paper pad and markers
- Science Experiment Record Sheet



Rocks should be large enough to provide a dry landing place for pollinators.

Getting ready:

- Assemble materials
- Display Group Observation Record Sheet
- Make copies of Science Experiment Record Sheets, 1/ participant

REPRODUCIBLES

Science Experiment Record Sheet

Name of Experiment: _____

What I hope to learn: _____

Description: _____

Observation Record:

Date	Time of Day	Weather	What I Observed

Date	Time of Day	Weather	What I Observed

Date	Time of Day	Weather	What I Observed

Date	Time of Day	Weather	What I Observed

Summary of Observations: _____

Predictions? _____

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North American Pollinator Protection Campaign www.nappc.org

>>Science Experiment Record Sheet

Suggested groupings:

Whole group for steps 1 and 2
Break into 3 groups for step 3

Action:

Review

Briefly discuss the primary reason insects are attracted to flowers.

How do insects know that nectar is available in a flower?

How do flowers signal that nectar is no longer available?

Exploration & Concept Introduction:

1. Introduce activity: *Have you ever wondered why insects prefer the nectar from some flowers more than other flowers? What might be some possible reasons?* Discuss and record all answers.

Resources/Links

Acknowledgements

Introduction to 4-H Series

2. *We can gather information that will help us answer these questions by doing an experiment.*

3. Prepare experiment. Label dishes 1, 2, and 3 and prepare sugar solutions:

   — In dish 1 make a sugar solution of 1 part sugar/2 parts water;
   — dish 2, 1 part sugar/3 parts water;
   — dish 3, 1 part sugar/4 parts water.

   Stir to dissolve.

   Place the dishes outside next to some plants in full sun.

4. Distribute a Science Experiment Record Sheet to each participant and explain what to do:

   Two times a week for the next 3 weeks, quietly watch the dishes and record what you see, answering the questions on your observation sheet:

   — which dish attracts the most insects?
   — what types of insects are attracted to Dish 1, Dish 2, and Dish 3?

   Be sure to fill in the time of your observation, how long you observed and the weather conditions (cloudy, sunny, raining, windy, calm, cool, warm, really hot).

Concept development:

5. As a group compare observations and answer the following questions. Record answers on a large sheet of paper.

   — Which dish attracted the most insects?
   — How much dissolved sugar was in this dish?
   — Why do you think this dish is so attractive?
   — What types of insects does each dish attract?
   — Why are certain types of insects attracted to a certain dish?
   — Is there any sugar water left in any of the dishes?

Have participants develop statements about their conclusions
Compare their conclusions with their original suppositions from step 1.

Adapted from *Vanishing Pollinators,* a publication of the Smithsonian National Zoological Park and the National Fish and Wildlife Foundation.

<< previous Module 4>>

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Bee Fact Sheet

Bees can be categorized in several ways: **native** or **non-native**, **social** or **solitary**, **generalists** or **specialists**.

Although the **European Honey Bee** is the type of bee we usually think of first, it is the only bee that is not native to America. However, it is not the only bee that lives in a colony where the responsibilities for building a nest, caring for off-spring, and gathering food is shared by all members of the colony. About 45 species of **Bumble Bees** are also social bees.

Of the approximately 4,000 species of native bees found in the United States most are **solitary bees.** They take care of the work of building a nest, gathering food, and caring for offspring independently. Even though they may live close together if a good nesting area is found they do not cooperative with each other as social bees do. Solitary bees are important pollinators of native plants as well as agricultural crops.

All bees pass through four stages during their one-year life span. The first three stages -- egg, larva, and pupa -- take up the first 11 months of life. The adult stage may last only 3 or 4 weeks. To learn more about the life cycle of the bee and its activities during the adult stage check the resource list for great books and Internet sites.

Bees can also be classified as generalists or specialists depending on their foraging habits. Bees that gather nectar and pollen from a wide variety of flowers are **generalists**. Bumble bees and honey bees are good examples of generalists. Bees that depend on a single plant or a small number of plants for pollen and nectar are categorized as **specialists**. These bees are most likely to suffer when native plants and habitat is disturbed or destroyed. It is easier for generalists to survive changes in their environment

Social Bees

Honey Bee

- Social, lives in colonies in hollow trees or hives
- Used for honey production and agricultural pollination
- Hairy, color is tan with varying degrees of orange or brown
- Carries pollen in pollen baskets on their hind legs and it sticks to the hairs on their bodies
- Antennae very sensitive to touch and odor
- Two compound eyes detect color, shape and movement
- Three simple eyes detect light
- Sees colors in the spectrum from ultraviolet to orange (don't see red)
- Stings only once (dies once stinger is detached from body)
- Drinks nectar, honey, and water through a long hairy tube called a probiscus that folds when not in use
- The whole colony can live through the winter

Bumble Bees

- Only social bee native to North America
- Make nests close to or in the ground; likes abandoned rodent holes
- Large and very furry

- Yellow and black
- Wings are clear with black veins
- Slow and unsteady when flying
- Because of its size and strength it can collect nectar and pollen from hard-to-get-into flowers such as snapdragons
- Can sting more than once
- Generalist feeders; often the first bee active in early spring and the last active in the fall
- Only the queen survives through the winter

Examples of Solitary Bees

Leafcutter bee

- Cuts neat circles in leaves and uses the pieces to line their nests
- Builds nest in hollow twigs or other openings about the diameter of a pencil
- Usually will not sting unless trapped
- Helps pollinate alfalfa

Carpenter bees

- Hairy
- Females are bluish-black in color and can sting
- Males are blond or tan in color and can't sting
- Over 1 inch long and as wide as your thumb
- Nests in wood such as dead tree trunks, firewood, or exposed wood on structures
- Nest consists of a tunnel bout 10 inches long
- Female gathers nectar and pollen which she rolls into a ball. She pushes the ball to the back of the tunnel, where she lays an egg and seals it in a chamber about 1 inch long. She repeats this process until the tunnel is filled with chambers of growing bees.

Alkali Bees

- Pollinate alfalfa better than honey bees

Butterfly & Moth Fact Sheet

Insects that have certain basic structures that are the same are classified into large groups or orders. Butterflies and moths are members of the order Lepidoptera. There are about 10,000 species of Lepidoptera in North America and 120,000 species worldwide. In Greek *leidos* means scale and *ptera* means wings. The scales on the upper and under side of the wings provide the distinctive patterns and colors.

In general, butterflies are thought of as bright and colorful and moths as gray, brown, and white, but this is not always true. Butterflies and moths usually differ in four ways: 1) the time of day when they are active, 2) how they hold their wings when resting, 3) the shape of their body, and 4) the shape of the antennae.

Although moths and butterflies have many natural enemies, man is their number one enemy. They have no defense against the destruction of natural habitat and the use of herbicides. For moths, floodlights at malls, intersections, and athletic fields are also very destructive. Creating a butterfly garden and rearing butterflies and moths from eggs for release are two ways we can help protect and conserve them.

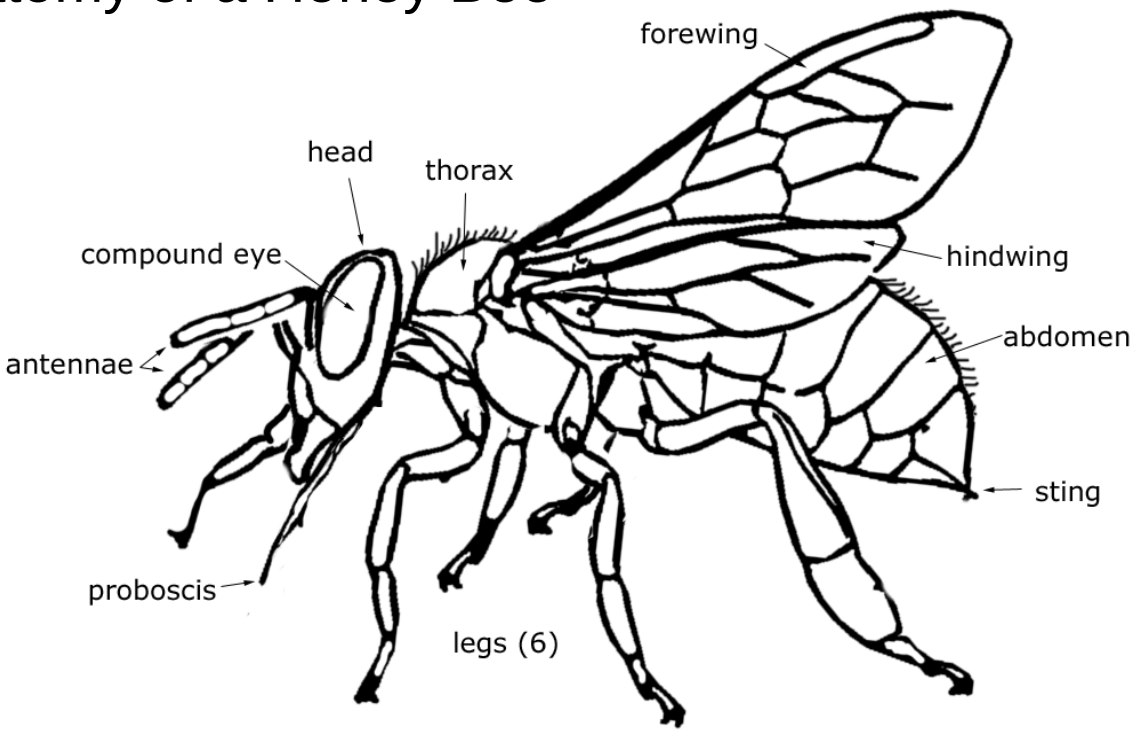
<u>Butterflies</u>

- Every part of their thin body and wings are covered with scales.
- Fly only during the day when it is warm.
- Fold their wings straight up over their bodies when resting.
- Antennae have bare knobs at the end and are used for smell and also for hearing, according to some experts.
- Pass through 4 stages of development -- egg, larva or caterpillar, pupa or chrysalis, adult.
- As caterpillars they can be destructive to flower gardens and crops because of their huge appetite.
- In the adult stage they are harmless and beautiful.
- They use their probiscis -- a long, tube-like tongue that can be uncoiled -- for drinking nectar.
- Two large compound eyes detect color and movement.
- Some are migratory and travel great distances.

<u>Moths</u>

- Fly only at dusk and at night.
- Every part of their body is covered with scales.
- Have a plump body.
- Spread their wings flat when resting.
- Antennae are either hairy or plume-like and end in a point.
- Attracted to light or white flowers that are open at night.

Anatomy of a Honey Bee



Why are honey bees such efficient pollinators?

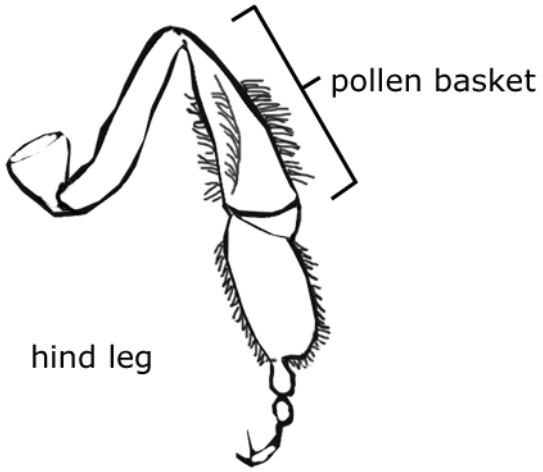
1. Their bodies are covered with fine hairs that trap pollen.

2. Their body shape and long proboscis allows them to reach deep into flowers.

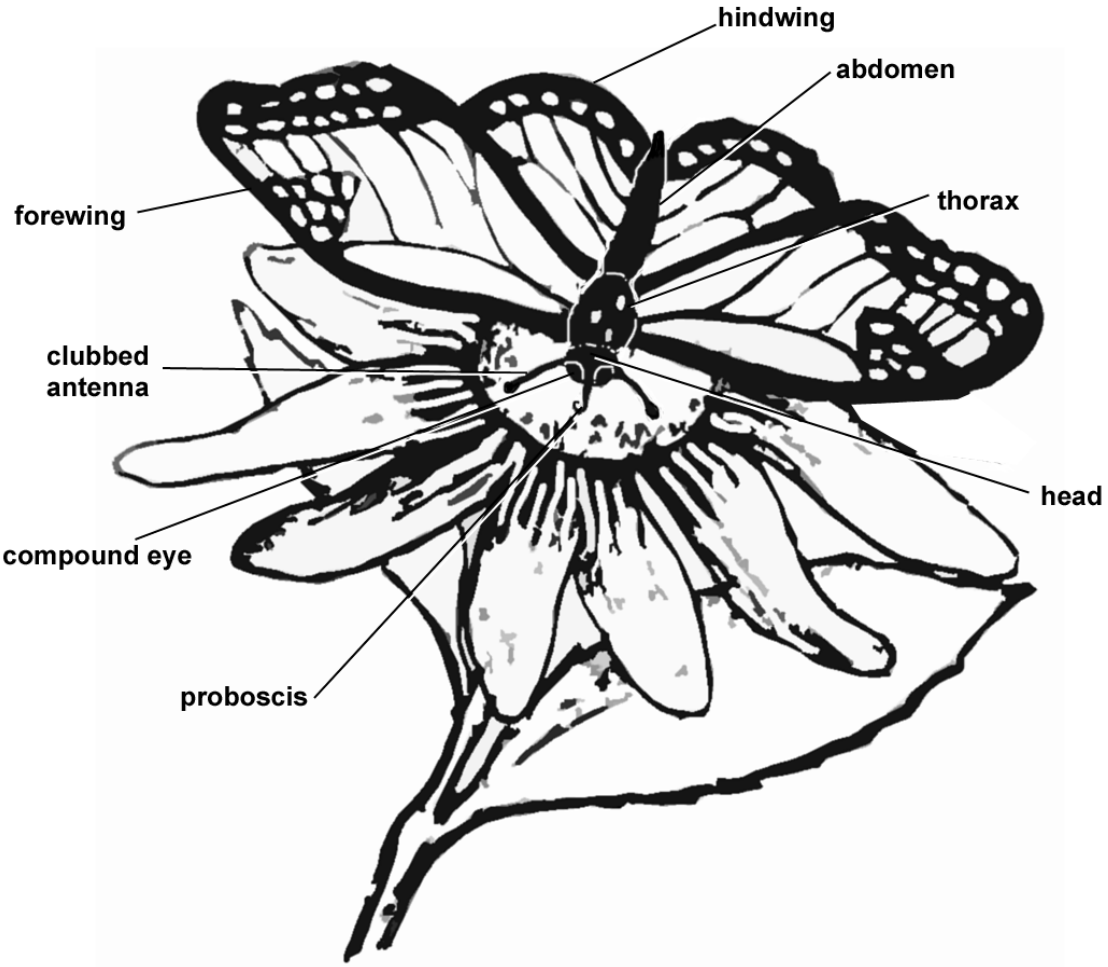
3. They require lots of nectar and pollen to rear their young, so they visit lots of flowers.

4. They tend to visit one species of flower at at time.

The pollen basket is a concave area on the hind legs surrounded by rows of stiff hairs. The bee packs moist pollen in there for transport back to the hive.



Butterfly Anatomy



Some of the differences between butterflies and moths:

Butterflies:

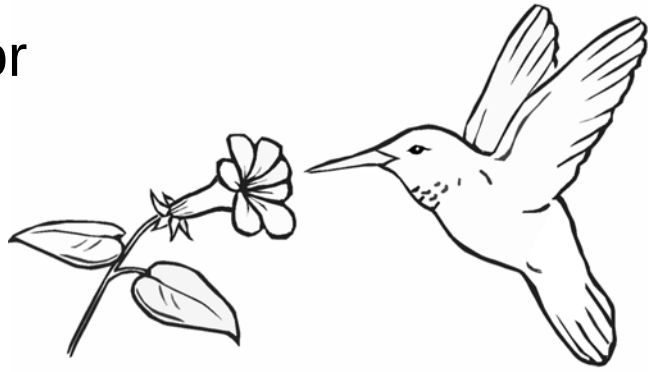
Antennae end in clubs or knobs
Fold their wings up over their bodies when resting
Fly during the day
Have a relatively thin body

Moths:

Antennae are hairy or plumelike, end in point
Spread their wings flat when resting
Fly at dusk and at night
Have a relatively plump body

Designing a Pollinator

As you create your new pollinator and its favorite flower, think about their sizes and shapes and where the pollen is located on the flower.



Note how the shape of this hummingbird's beak and head is a perfect match to this trumpet-shaped flower.

Describe your new pollinator:

Its life cycle (For example, a butterfly goes through 4 life stages.)

Habitat (Does it live in the woods? Near an ocean? Near the ground? In the treetops?)

Lifestyle (When does it fly and feed?)

How it eats

How it carries pollen

Other features

Science Experiment Record Sheet

Name of Experiment: _____

What I hope to learn:_____

Description:_____

_____

_____

Observation Record:

Date	Time of Day	Weather	What I Observed

Date	Time of Day	Weather	What I Observed

Date	Time of Day	Weather	What I Observed

Date	Time of Day	Weather	What I Observed

Summary of Observations:_____

_____

_____

_____

Predications? _____

_____

_____

_____

Resources/Links

Acknowledgements

Introduction to 4-H Series

Decline in the Pollinator Population

Four reasons for the alarming decline in the pollinator population are:

Monarch butterfly larvae feed only on milkweed plants. Photos by Suzanne DeJohn/NGA.

1. Habitat loss and fragmentation. Habitat loss and fragmentation affect pollinators in two ways:

- Pollinators have basic food requirements. The availability of a variety of native plants is important because not all pollinators can access the nectar found in introduced flowers. Pollinators also depend on the availability of various flowering plants throughout a season. Habitat loss can negatively affect the timing and amount of food availability, thereby increasing competition for those limited resources.
- Loss of habitat can also disrupt the nesting requirements of certain pollinators. For example many species of bees nest in underground burrows and in hollowed-out logs. Decreases in suitable nesting areas can be attributed to natural disasters, such as fire, drought, or floods, and to the development of land for human use.

While habitat loss can seriously impact all pollinator organisms, increased fragmentation of habitats is particularly troublesome for those pollinators that travel great distances. Fragmentation of habitat increases the distance between suitable food and shelter sites along migratory routes, thereby disrupting the journey. Migratory pollinators, such as the monarch butterfly and the rufous hummingbird, travel thousands of miles each year as the season change. These trips require high levels of energy, making consistent food resources all along the way critical to survival. Some scientists believe that if fragmentation continues at its current rate, many migratory corridors will soon be closed.

2. Agricultural and grazing practices. Modern agricultural practices have made farms an increasingly poor habitat for wild pollinators. Single-crop farming has led to the elimination of fencing between smaller fields. Such fencing created buffer strips where native flowering plants could grow, providing suitable habitat for the native pollinator population. Removal of these buffer strips has a destabilizing effect on native pollinator habitat. At the same time, the use of hybrid crop seeds that require increased pollination make the farmer more dependent on costly managed honey bee colonies.

Use of land for grazing can result in diminished pollinator food resources and destruction of underground nests and potential nesting sites. Ironically, grazing animals are dependent on insect-pollinated legumes, such as alfalfa and clover, for forage.

3. Pesticides. Agricultural and residential use of broad-spectrum pesticides poses another major threat to all pollinators. Insecticides affect bees and other insect pollinators directly through unintentional poisonings, and herbicides affect them indirectly through destruction of insect forage and other wildflowers important in maintaining some insect populations.

4. Introduced species. Introduced species of plants and animals can have a serious effect on their new ecological system. Introduced pollinators can increase competition for floral resources, disrupt the reproduction of native plant species and facilitate the spread of invasive plants. Despite the negative impact they may have, some non-native pollinators also can be beneficial, the honey bee being an example. (From Ecological Society of America's *Pollinator Tool Kit: Pollinators in Decline*; see references below.)

Home

Why Care About Pollinators?

Scientific Thinking Processes

Implementing the Curriculum

Assessment

Outline

Printable Photos

Module 1

The Who, What & Why of Pollinators

Module 2

Pollinators and Plants in Partnership

Module 3

The Other Half of the Partnership: Pollinators

Module 4

Pollinator-Friendly Habitat in Your Area

Module 5

Creating Pollinator-Friendly Habitat

Module 6

Community Service Project and Celebration

Module 4

Pollinator Friendly Habitat in Your Area

Purpose:

- To understand the habitat requirements of native pollinators.
- To become familiar with native pollinators and the native and introduced plants they pollinate.
- To learn the areas in the community that are suitable habitat for pollinators and what is being done to preserve or improve them.
- To consider ways to raise public awareness of the importance of pollinators and the need to protect their environment.
- To learn how to conduct a survey or a census.

Module 4

- Background
- Activity A (time varies with size & age of group) "Who Am I" Game: Reviewing Characteristics of Bees & Butterflies (25-30 min)
- Activity B (1-2 hours) Native Pollinators and Their Habitat: A Guided Field Trip

Background:

Importance of Pollinator-Friendly Habitat

Pollinators, like other animals, require food, shelter and water, space, a place to reproduce, and materials for nesting in order to survive and flourish. These needs are usually met for native pollinators when the natural environment is not disturbed.

Pollinators play an important role in maintaining the balance and biodiversity necessary for a healthy ecosystem. There has been a global decline in biodiversity due to habitat loss, introduced species, pollution, population growth, and the overconsumption of resources. By applying sound ecological principles to our use of land and water, we can help to reverse this loss of biodiversity while making a healthier environment for all, including the animals that provide the essential eco-service of pollination. (From *Saving Pollinators*; see reference list at bottom of page.)

Black swallowtail larva feed on dill-family plants. Photo by Suzanne DeJohn/NGA.

The following community services or organizations may be able to direct you to local groups or individuals that are knowledgeable about native plants and pollinators:

- Cooperative Extension Service (See listing in County Government pages in phone book.)
- Reference librarian at local library
- Local chapter of your state's native plant society (Do an Internet search by entering your state's name followed by "Native Plant Society.")
- Local plant nurseries
- The botany or biology department at your local high school or college
- U.S. Fish and Wildlife Service

References:

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>> next

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Home

Why Care About Pollinators?

Scientific Thinking Processes

Implementing the Curriculum

Assessment

Outline

Printable Photos

Module 1

The Who, What & Why of Pollinators

Module 2

Pollinators and Plants in Partnership

Module 3

The Other Half of the Partnership: Pollinators

Module 4

Pollinator-Friendly Habitat in Your Area

Module 5

Creating Pollinator-Friendly Habitat

Module 6

Community Service Project and Celebration

Module 4

Activity A: Who Am I Game

Note: This activity can be used at various times. At this time it serves to bring the participants together in preparation for the field trip and review information about basic needs of bees and butterflies.

Participants will:

- Review information about bees and butterflies from Modules 2 and 3.

Materials needed:

- **"Who Am I"** reproducibles

>>Who Am I Game (15 pages)

Getting ready:

Make a copy of the "Who Am I" game card sheets (preferably on cardstock) and cut into cards. Review rules of the games and be prepared to explain them to the group.

Suggested Grouping:

Full group or if over 14 participants may choose to form two groups

Action:

1. Introduce game and explain rules of play.
2. Play game.

<< previous next >>

Home

Why Care About Pollinators?

Scientific Thinking Processes

Implementing the Curriculum

Assessment

Outline

Printable Photos

Module 1

The Who, What & Why of Pollinators

Module 2

Pollinators and Plants in Partnership

Module 3

The Other Half of the Partnership: Pollinators

Module 4

Pollinator-Friendly Habitat in Your Area

Module 5

Creating Pollinator-Friendly Habitat

Module 6

Community Service Project and Celebration

Module 4

Activity B: Pollinators and Their Habitat — A Guided Field Trip

Participants will:

- Participate in a guided exploration of the natural environment in their area. If undeveloped land, such as a nature preserve or regional park, is not reasonably accessible, a city park or garden area would also be suitable.
- Record observation in field journal and take photos of native pollinators & native plants in their area.
- Learn about possible threats to the pollinator populations in their area.
- Discuss possible projects and begin to develop a plan to raise public awareness of pollinators.

Teaching Resources

Try to find a person knowledgeable about the local environment and pollinators. A Cooperative Extension specialist/County Agent in entomology, environmental protection, or other related field, a member of the Master Gardeners' group, or other local organizations or societies involved with native plants or the environment would be appropriate. Local nursery people may also be very good resources. See suggestions for locating local resources in Background section.

Review these lesson goals and steps with the person who will be conducting this field observation experience; see below for suggestions. Either give a copy of the guidelines or this lesson plan to the person and discuss it with them so that 1) he/she understands what your expectations are and 2) you have a clear understanding of the kind of information and experience he/she will be able to offer the young people.

Materials/Help Needed:

- Field Journal
- Cameras and film (depending on group, participants could bring their own cameras or you could supply several disposable cameras)
- Small first aid kit
- Volunteers to help transport participants and accompany the group on the field experience
- Participants should be dressed appropriately and carry water (good shoes for hiking/walking, hat, sunscreen, etc.)

Getting ready:

- Arrange for a knowledgeable person from the community to lead the field trip and meet ahead of time with him/her.
- Arrange for parents or other volunteers to provide transportation and accompany the group during the activity.
- Purchase several disposable cameras, if necessary.

Grouping:

Group may be divided into smaller groups for transportation and supervision purposes.

Resources/Links

Acknowledgements

Introduction to 4-H Series

Action:

Exploration/Concept Development

1. Encourage members of the group to keep the following questions in mind as they participate in the field trip:

- What are some pollinators native to the area?
- Are they solitary or social? Where do they make their nests?
- Where can they most likely be found?
- What is the geography and vegetation like?
- What are the native plants they prefer?
- Are different plants necessary at various stages of the life cycle of native bees & butterflies?
- What are the sources of water and shelter?
- Are there threats to native pollinators and managed bees and their habitat?

2. Explore an area or areas of the community, guided by the resource person. Learn about the native and introduced pollinators in the area, their habitat requirements, native and introduced plants that support pollinators, threats to their survival, etc.

3. Have participants take photos of optimum habitat, native plants & pollinators, and places where habitat has been destroyed or is threatened.

Concept Development

4. At the end of the field trip discuss observations and impressions

- Refer to questions above.

Concept Application

5. Direct discussion towards what is needed in the community and what the group can do.

- Is there a need to raise public awareness of pollinators in the community?
- If so, what are some ways to educate people in the community about the importance of pollinators and the need to provide a pollinator-friendly environment?

Brainstorm ideas. Here are some examples:

- Create a display with the photos from the field trip of native plants, optimum habitat, and areas that are threatened along with a handout on ways to create pollinator-friendly landscaping. (Module 5 addresses creating pollinator-friendly landscaping.)
- Start a "BEE-Friendly to Pollinators" campaign through a local supermarket or farmers market. Create and supply a handout to be distributed to customers.

6. Record brainstorming ideas so they can be used as a basis for further discussion and planning at the next session.

Note: If cameras were provided collect them so pictures can be developed by the next time you meet.

Alternate Activities:

If a field trip is not possible:

- Invite guest presenter(s) to come to talk to the group about native pollinators and plants and their status in your area.
- Have students do informational interviews either in person or by telephone with people involved

in ecology and/or the natural resources of the area.

- Have participants do research on the Internet to learn more about threats to native pollinator habitat, as well as on creating a pollinator friendly environment.
- Encourage participants to visit appropriate places with their families.

Guidelines for Field Trip

The young people that you will be leading have been learning about the importance of pollinators to the ecosystem and to agriculture and the production of many foods we enjoy.

The purpose of this field trip is to:

- Become familiar with native pollinators and the native and introduced plants they pollinate
- Understand the habitat requirements of native pollinators
- Have first hand experience with an area in the community that is suitable habitat for pollinators and learn what is being done to preserve it and what may need to be done to improve other areas.

It is our hope that they will be able to observe native pollinators in natural areas that provide the type of habitat they need to survive and flourish as well as areas that have been disturbed and need to be restored.

By the conclusion of the trip the students should have time to reflect on their experience and share their impressions.

They should be able to answer the following questions:

- What are some pollinators native to the area?
- Are they solitary or social? Where do they make their nests?
- Where can they most likely be found?
- What is the geography and vegetation like?
- What are the native plants they pollinate?
- Are different plants necessary at various stages of the life cycle of native bees & butterflies?
- What are the sources of water and shelter?
- Are there threats to native pollinators and their habitat in your area?

<< previous Module 5 >>

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Nature's Partners "WHO AM I" Game

Preparation of Game Cards and Tags:

- Pages 5-10, "Facts About Pollinators" cards. Copy on 8 1/2" x 11" card stock, cut in half, and laminate if possible.

- Pages 11-15, Pollinator Name Tags. Copy on 8 1/2" x 11" card stock, cut in uniform sizes, laminate, punch holes and attach string so sign can be worn around the neck.

Directions for Playing:

- Each player receives a set of "Facts About Pollinators" cards.

- A pollinator name-tag is worn on the back of each player so that they do not see it.

- Each player tries to determine what is on their name-tag by asking other players questions. The cards are to help them answer questions as well as ask questions to try to determine their "identity."

- Questions can only be answered "Yes" or "No."

- Once a player has guessed his "identity" he/she can turn the name tag to the front. A small simple prize can be awarded as players guess their "identity" if desired.

- Even though a player has learned their "identity" he/she may still continue playing by answering questions from other players.

List of Pollinators & Other Insects

- Note: Several of the insects included in the list are not pollinators but may be easily mistaken for pollinators. If desired, they can be eliminated from the game.

Flower Fly

- Looks like a social bee or wasp
- Antennae are short with a bristle on the end
- Has only one pair of wings
- Cannot sting or bite
- Hairy
- Considered a significant pollinator

Yellow Jacket

- Often mistaken for bees
- Sometimes called meat bees
- A social wasp
- A real pest at picnics
- Carnivorous, eats insects, meat
- Nests are made of paper and are usually in underground cavities
- Hairless, no brushes or pollen baskets
- Not usually considered a pollinator

Honey Bee

- Social, lives in colonies in hollow trees or hives
- Used for honey production and agricultural pollination
- Hairy, color is tan with varying degrees of orange or brown
- Carry pollen in pollen baskets on their hind legs and it sticks to the hairs on their body
- Antennae very sensitive to touch and odor
- Two compound eyes detect color, shape and movement
- Three simple eyes detect light
- See colors in the spectrum from ultraviolet to orange (don't see red)
- Stings only once (dies once stinger is detached from body)
- Drinks nectar, honey, and water through a long hairy tube called a probiscus
- The whole colony can live through the winter

Bumble Bee

- Only social bee native to North America
- Make nests close to or in the ground. Likes abandoned rodent holes.
- Large and very furry
- Yellow and black
- Wings are clear with black veins
- Slow and unsteady when flying.
- Can collect nectar and pollen from hard to get into flowers such as snapdragons
- Can sting more than once
- Only the queen survives through the winter

Butterflies

- Every part of their thin body is covered with scales
- Fly only during the day when it is warm
- Fold their wings straight up over their bodies when resting
- Antennae have bare knobs at the end and are used for smell and also for hearing according to some experts
- Pass through 4 stages of development--egg, larva, pupa, adult
- In the larva stage they are recognized as caterpillars and can be destructive to flower gardens and crops because of their huge appetite.
- In the adult stage they are harmless and beautiful.
- A long tube that can be uncoiled for drinking nectar is called the probiscis
- Two large compound eyes detect color and movement
- Some are migratory and travel great distances

Moths

- Fly only at dusk and at night
- Every part of their body is covered with scales
- Have a plump body
- spread their wings flat when resting
- Antennae are either hairy or plumy and end in a point
- Attracted to light or white flowers that are open at night

Leafcutter Bee

- A solitary bee
- Cuts neat circles in leaves and uses the pieces to line their nests
- Builds nest in hollow twigs or other openings about the diameter of a pencil
- Usually will not sting unless trapped
- Help pollinate alfalfa

Carpenter Bee

- Solitary
- Hairy
- Females are bluish-black in color and can sting
- Males are blond or tan in color and can't sting
- Over 1 inch long and as wide as your thumb
- Nest in wood such s dead tree trunks, firewood or exposed wood on structures
- Nest consists of a tunnel bout 10 inches long
- Female gathers nectar and pollen which is rolled into a ball that she pushes to the back of the tunnel where she lays an egg and seals it in a chamber about 1 inch long. This process is repeated until the tunnel is filled with chambers of growing bees

Alkali Bees

- Solitary
- Pollinate alfalfa better than honey bees

Paper wasps

- Black and yellow stripes on abdomen
- No hair on body
- Can't carry pollen
- Eats insects and spiders
- Builds nest out of "paper"

Hummingbirds

- Important for pollinating flowers and eating insects
- Bright red, orange and pink flowers are more visible to them than other colors
- Red, tubular-shaped flowers are ideal
- Fragrance is not important
- Have the largest brain, heart, energy output, and breast muscles in proportion to body size of any bird.
- They feed 5 to 8 times/hour consuming half their weight in sugar each day.
- Nests are usually 1.5 inches in outer diameter and used year after year
- Eggs are 1/2 the size of a jelly bean and hatch in 14 to 21 days

Bats

- Bats, like moths, do their foraging at night and are also attracted to white flowers.
- Pollen clings to their forehead as they reach into the flower with their long snout and bristly tongue to reach the nectar.
- The Saguaro and Agape cactus depend on bats for pollination
- They are responsible for pollinating bananas, cashews, peaches, avocados, mangos and other tropical fruits and vegetables
- There are nearly 1,000 species of bats
- They are generally divided into two groups; mega and micro bats
- Megabats live mostly in tropical parts of Australia, Asia, Africa, and the Pacific and eat fruit, nectar, or pollen.

Beetles

- They are clumsy when they fly and can't smell or see colors very well.
- They are attracted to flowers that are white or green and either have a very strong scent or none at all.
- The flowers they visit must produce a lot of pollen so there is enough for food as well as pollination.
- They usually pollinate flowers with large openings where there is plenty of room to land.

Flower Fly

- **Looks like a social bee or wasp**
- **Antennae are short with a bristle on the end**
- **Has only one pair of wings**
- **Cannot sting or bite**
- **Hairy**
- **Considered a significant pollinator**

Yellow Jacket

- **Often mistaken for bees**
- **Sometimes called meat bees**
- **A social wasp**
- **A real pest at picnics**
- **Carnivorous, eats insects, meat**
- **Nests are made of paper and are usually in underground cavities**
- **Hairless, no brushes or pollen baskets**
- **Not usually considered a pollinator**

Honey Bee

- **Social, lives in colonies in hollow trees or hives**
- **Used for honey production and agricultural pollination**
- **Hairy, color is tan with varying degrees of orange or brown**

- **Carry pollen in pollen baskets on their hind legs and it sticks to the hairs on their body**
- **Antennae very sensitive to touch and odor**
- **Two compound eyes detect color, shape and movement**
- **Three simple eyes detect light**
- **See colors in the spectrum from ultraviolet to orange (don't see red)**
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- **Drinks nectar, honey, and water through a long hairy tube called a probiscus**
- **The whole colony can live through the winter**

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- **Only social bee native to North America**
- **Make nests close to or in the ground. Likes abandoned rodent holes.**
- **Large and very furry**
- **Yellow and black**
- **Wings are clear with black veins**
- **Slow and unsteady when flying.**
- **Can collect nectar and pollen from hard to get into flowers such as snapdragons**
- **Can sting more than once**
- **Only the queen survives through the winter**

Butterflies

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- **Fly only during the day when it is warm**
- **Fold their wings straight up over their bodies when resting**
- **Antennae have bare knobs at the end and are used for smell and also for hearing according to some experts**
- **Have a thin body**
- **Pass through 4 stages of development--egg, larva, pupa, adult**
- **In the larva stage they are recognized as caterpillars and can be destructive to flower gardens and crops because of their huge appetite.**
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- **Attracted to light or white flowers that are open at night**

Leafcutter bee

- **A solitary bee**
- **Cuts neat circles in leaves and uses the pieces to line their nests**
- **Builds nest in hollow twigs or other openings about the diameter of a pencil**
- **Usually will not sting unless trapped**
- **Help pollinate alfalfa**

Carpenter bees

- **Solitary**
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- **Females are bluish-black in color and can sting**
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- **Over 1 inch long and as wide as your thumb**
- **Nest in wood such s dead tree trunks, firewood or exposed wood on structures and consists of a tunnel bout 10 inches long**
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Hummingbirds

- **Important for pollinating flowers and eating insects**
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- **Red, tubular-shaped flowers are ideal**
- **Fragrance is not important**
- **Have the largest brain, heart, energy output, and breast muscles in proportion to body size of any bird.**
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- **Nests are usually 1.5 inches in outer diameter and used year after year**
- **Eggs are 1/2 the size of a jelly bean and hatch in 14 to 21 days**

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- **They usually pollinate flowers with large openings where there is plenty of room to land.**

Paper wasps

- **Black and yellow stripes on abdomen**
- **No hair on body**
- **Can't carry pollen**
- **Eats insects and spiders**
- **Builds nest out of "paper"**

Alkali Bees

- **Solitary, habits similar to Carpenter and Leafcutter Bees**
- **Pollinate alfalfa better than honey bees**

Flower Fly

Yellow Jacket

Honey Bee

Bumble Bee

Butterfly

Moth

Beetle

Hummingbird

Carpenter Bee

Leafcutter Bee

Alkali Bee

Paper Wasp

Bat

Home

Why Care About Pollinators?

Scientific Thinking Processes

Implementing the Curriculum

Assessment

Outline

Printable Photos

Module 1

The Who, What & Why of Pollinators

Module 2

Pollinators and Plants in Partnership

Module 3

The Other Half of the Partnership: Pollinators

Module 4

Pollinator-Friendly Habitat in Your Area

Module 5

Creating Pollinator-Friendly Habitat

Module 6

Community Service Project and Celebration

Module 5

Creating Pollinator-Friendly Habitat

Module 5

- Background
- Activity A (60-90 min) Welcome Home: Plants & Landscaping for Pollinators
- Activity B (45-60 min) Is Your Neighborhood Pollinator-Friendly?

Purpose:

- To learn more about the characteristics of pollinator-friendly gardens and landscaping
- To assess the availability of pollinator habitat in a limited area or neighborhood
- To develop a plan for improving or creating a pollinator-friendly habitat

Background:

Attention to certain basic principles for residential and public landscaping can create pollinator-friendly gardens. These include:

- Using local native plants
- Choosing plants with a diversity of colors
- Choosing flowers of different shapes and sizes
- Selecting plants with varying heights, growth habits, and flowering times
- Including plants that provide food for butterfly larva as well as plants that provide nectar and pollen-producing flowers for pollinators

For details please refer to the Xerces Society's *Plants for Native Bees* .

References:

Greenmap System, Kids' Greenmaps Activity Guide, http://www.greenmap.com/ymaps/activity.html

Shepard, M. Plants for Native Bees: Backyard Conservation Series #1, Xerces Society, Portland, Oregon, http://www.xerces.org

next >>

Home

Why Care About Pollinators?

Scientific Thinking Processes

Implementing the Curriculum

Assessment

Outline

Printable Photos

Module 1

The Who, What & Why of Pollinators

Module 2

Pollinators and Plants in Partnership

Module 3

The Other Half of the Partnership: Pollinators

Module 4

Pollinator-Friendly Habitat in Your Area

Module 5

Creating Pollinator-Friendly Habitat

Module 6

Community Service Project and Celebration

Module 5

Activity A: Welcome Home: Plants & Landscaping for Pollinators

Participants will:

- Learn characteristics of pollinator-friendly gardens and landscaping through a presentation/ demonstration by a member of the community knowledgeable in gardening ecology

Community Resource Person

Invite a person who is knowledgeable about planning gardens and landscape using native plants. Local nurseries often have staff whose expertise is landscaping with native plants. The Master Gardeners group would also be a good resource for a guest presenter. Be sure to explain to the presenter exactly what their presentation should address — planning gardens and landscapes with plants, both native and introduced, that will provide a suitable habitat for native pollinators.

Materials needed:

- Field Journals for making notes
- Cameras & film
- Large sheet of butcher paper, markers, and tape

Getting Ready:

- Invite presenter to meet with group.
- Arrange transportation for participants to nursery or site as necessary.

Action

Exploration & Concept Development:

1. The presentation may take place at a nursery, a garden site, or at the usual meeting location. Ideally the presenter would keep the formal presentation short and then:

   a. Accompany the group on a walking tour of an area (possibly the one they will be mapping and help identify possible sites for improvement) or

   b. Lead a guided tour of a garden or landscaped area that is based on the garden planning principles that have been discussed.

2. Participants make notes in field journals and take photos of suitable plants and/or landscaping.

Concept Application:

3. As a group, create a checklist of important elements they would include designing a garden or landscape project to attract pollinators.

<< previous next >>

Home

Why Care About Pollinators?

Scientific Thinking Processes

Implementing the Curriculum

Assessment

Outline

Printable Photos

Module 1

The Who, What & Why of Pollinators

Module 2

Pollinators and Plants in Partnership

Module 3

The Other Half of the Partnership: Pollinators

Module 4

Pollinator-Friendly Habitat in Your Area

Module 5

Creating Pollinator-Friendly Habitat

Module 6

Community Service Project and Celebration

Module 5

Activity B: Is Your Neighborhood Pollinator Friendly?

Participants will

- Survey their neighborhood or any defined area and create a map indicating pollinator-friendly locations and locations that have the potential to become an attractive habitat for pollinators

Materials needed:

- Enlarged map of the area to be surveyed, 1/participant
- Colored markers
- Cameras
- Checklist of important garden elements generated in Activity A

Getting Ready:

- Enlarge map of area to be surveyed and make copies for each participant
- Display checklist
- Invite adult volunteers to accompany group

Grouping:

Whole group or two or three smaller groups, depending on the number of participants

Action:

Exploration & Concept Development:

1. Depending on the size of the area to be surveyed, go as a whole group or divide the area into sections and assign a small group to each section.

2. Give participants copies of area map and instructions about the colors or symbols they will use to mark the map for locations that are:

a) pollinator-friendly

b) can be improved with minor transformations

c) need major changes

d) show evidence of practices that may be a threat to pollinators.

Set a time limit for the survey that is reasonable but will keep the participants focused on the task. Participants may wish to take pictures of the various sites they identify.

3. Return to meeting place and as a group transfer the markings to a larger map that the whole group can see.

Concept Application:

Resources/Links

Acknowledgements

Introduction to 4-H Series

4. Group members share and reflect upon their observations.

5. As a group, identify a site they might wish to improve. Guide the group in selecting a site that fits the resources of the group.

6. Draw a large map of the site and list the improvements that need to be made.

<< previous Module 6 >>

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Home

Why Care About Pollinators?

Scientific Thinking Processes

Implementing the Curriculum

Assessment

Outline

Printable Photos

Module 1

The Who, What & Why of Pollinators

Module 2

Pollinators and Plants in Partnership

Module 3

The Other Half of the Partnership: Pollinators

Module 4

Pollinator-Friendly Habitat in Your Area

Module 5

Creating Pollinator-Friendly Habitat

Module 6

Community Service Project and Celebration

Module 6

Community Service Project

Purpose & Background:

A community service project should be the culminating activity of the Nature's Partner's experience. This service project should provide an opportunity for the youth to put into practice many of the concepts they have learned over the past weeks. Most importantly, it should be conceived and developed by the participants. There are numerous possibilities:

- Build on the project tackled in the previous module, by adding additional gardens and/or establishing nesting sites for native bees.
- Use the photos from the field trip to create a public display and information sheet about optimum habitat for pollinators, native plants and pollinator friendly gardening, as well as endangered natural habitat, to increase public awareness of the importance of pollinators and how to protect them.
- Start a Bee-friendly to Pollinators campaign through a local supermarket or farmers market by creating signs to indicate which produce and food products depend on pollinators and preparing a handout or brochure on ways to create pollinator-friendly landscaping.
- Demonstrate how to plant a pollinator-friendly garden using native plants.
- Present activities from the curriculum in schools, camps, or after school programs.
- Create skit to share with others.
- Have an information booth at a farmers market, community day, county fair, nursery, science fair or other suitable locations/events.
- Create a story book to share with others.

People and businesses in the community can be recruited to share their expertise, donate supplies and materials, or provide a site for a display or demonstration. The group may want to do more than one type of project. If so, make sure they do not take on more than they can successfully accomplish and that you can support. Involving the parents and families of the participants as well as other interested individuals would be ideal.

Module 6

- Background
- Activity A (60 min) Planning a Community Service Project
- Work Sessions (time depends on plan/# of participants)
- Celebration of Project (time varies with group & plans)
- Post-Curriculum Assessment (time varies with group & plans)

next >>

Home

Why Care About Pollinators?

Scientific Thinking Processes

Implementing the Curriculum

Assessment

Outline

Printable Photos

Module 1

The Who, What & Why of Pollinators

Module 2

Pollinators and Plants in Partnership

Module 3

The Other Half of the Partnership: Pollinators

Module 4

Pollinator-Friendly Habitat in Your Area

Module 5

Creating Pollinator-Friendly Habitat

Module 6

Community Service Project and Celebration

Module 6

Activity A: Planning a Community Service Project

Participants will:

- Develop a plan for a community service project or projects

Materials Needed:

- Large paper pad
- Felt tip markers
- Masking tape

Good things to have on hand:

- Maps created in Module 5
- Local phone book for contact information on people and businesses

Grouping:

Whole group for initial decision making and planning
Sub groups may be formed to develop plans or prepare various aspects of the project

Action:

Exploration:

1. Brainstorm ideas for the service project. Write down all ideas on large paper and tape to wall so all the ideas are on display

2. As a group discuss the ideas. Add changes or revisions to ideas listed.

3. Ask the group to select 3 or 4 of the ideas they think are most promising

4. Discuss the pro's and con's of these project possibilities and make a final selection.

Project Development:

5. As a group write a detailed description of the project, including:

- what they hope to accomplish by doing this project
- when it will be done
- where it will take place
- equipment and materials needed
- people, organizations or businesses that could help

6. At this point, the group could break into committees or subgroups to work on various aspects of the project. Set a time when they will report back to the group.

Resources/Links

Acknowledgements

Introduction to 4-H Series

7. Bring the whole group together. Committees share their ideas and ask for suggestions from the group.

8. Decide on "Next Steps"

The following example is a brief outline of an action plan for creating a pollinator-friendly garden or improving a site they have identified through in Module 5, mapping their neighborhood or an area of the community.

Planning for a Pollinator-Friendly Garden Service Project

Materials needed:

- Large sheet of butcher paper, markers
- Large map, list of suggested improvements from Activity B, Module 5
- Camera

Getting Ready:

- Tape up butcher paper and large map and list of suggested improvements

Grouping:
Whole group

Action:
1. Display large map of site and list of proposed improvements. Compare it with the checklist for a pollinator-friendly garden or landscape project.

2. Develop plans for making improvements. Sketch in the desired improvements on the large site map. Make lists of equipment and materials needed, determine how and where they can be obtained, assign responsibilities, and set a date and time to carry out the plan.

3. An additional meeting or phone calls may be necessary to make sure equipment and materials have been obtained and/or address problems.

Note: This service project will probably need to take place on a Saturday and/or divided into several sessions.

Going Further:
This map could be used as the focal point for creating a display about creating and/or improving residential and public landscaping to attract pollinators. Pictures taken during survey of the area, checklist of desirable landscaping features, and proposed plans for improvement of selected site could be included.

<< previous next >>

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Home

Why Care About Pollinators?

Scientific Thinking Processes

Implementing the Curriculum

Assessment

Outline

Printable Photos

Module 1

The Who, What & Why of Pollinators

Module 2

Pollinators and Plants in Partnership

Module 3

The Other Half of the Partnership: Pollinators

Module 4

Pollinator-Friendly Habitat in Your Area

Module 5

Creating Pollinator-Friendly Habitat

Module 6

Community Service Project and Celebration

Module 6

Work Session(s): Community Service in Action

Purpose:

The activities of this session put into action the ideas and decisions generated by the students in the previous session. Although some adult guidance may be needed, the project should primarily reflect the thinking and decisions of the participants.

For example: A demonstration garden can help educate the community about how to protect native habitat, to use native plants in landscaping, and to minimize the use of pesticides.

Participants will:

- Work towards a goal as a group in a cooperative and friendly manner
- Take responsibility for assignments
- Experience the enjoyment of accomplishment from working hard on a project
- Feel satisfaction as they contribute and serve the community
- Develop a deeper commitment to protecting and improving the environment for all

Materials Needed:

- See list of equipment and materials generated during planning session
- Camera

Getting Ready:

- Follow-up with group members who have accepted responsibility for various aspects of the project either through a short meeting or phone call.
- Depending on the size and nature of the project, invite several parents to be on hand in case assistance is needed.
- Contact the local newspaper to let them know about the project.

Grouping:

Whole group

Action:

Carry out plans developed in planning session. Be sure to take pictures at various stages of the project.

<< previous next >>

Home

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Scientific Thinking Processes

Implementing the Curriculum

Assessment

Outline

Printable Photos

Module 1

The Who, What & Why of Pollinators

Module 2

Pollinators and Plants in Partnership

Module 3

The Other Half of the Partnership: Pollinators

Module 4

Pollinator-Friendly Habitat in Your Area

Module 5

Creating Pollinator-Friendly Habitat

Module 6

Community Service Project and Celebration

Module 6

Celebration of Project

Purpose:

- Celebrate and share learning and accomplishments with family and friends.

Participants will:

- Share knowledge with others through displays and activities
- Feel positive about what they have learned and accomplished
- Gain experience in planning and organizing an event

Activity:

This activity should be planned and carried out primarily by the participants.
Things that it might include are:

- nvitations for parents and family
- Displays of
  -- Field Observation Chart that was begun in Session I
  -- Pollinators and flowers designed and created by students
  -- Green map project
  -- Photos from field trips and other sessions
  -- Field journals
- Refreshments or a meal featuring foods which are dependent on pollinators such as
  -- Orange juice or a fruit juice punch
  -- Nuts, plain or prepared in various ways or in baked goods
  -- Vegetables and dip
  -- Stir-fried vegetables with rice
  -- Fruit tray or fruit salad
  -- Apple pie
  -- Chocolate fondue with fruits for dipping
  -- Banana splits with fruit and chocolate toppings and nuts
- Games and Skits
- Guided tour of community service project site.

<< previous next >>

Home

Why Care About Pollinators?

Scientific Thinking Processes

Implementing the Curriculum

Assessment

Outline

Printable Photos

Module 1

The Who, What & Why of Pollinators

Module 2

Pollinators and Plants in Partnership

Module 3

The Other Half of the Partnership: Pollinators

Module 4

Pollinator-Friendly Habitat in Your Area

Module 5

Creating Pollinator-Friendly Habitat

Module 6

Community Service Project and Celebration

Module 6

Post-Curriculum Assessment

Determining what students have learned about plants, their pollinators and what they can do to help maintain a balanced ecosystem.

At this point in the *Nature's Partners* experience, it is important to have evidence of gains in knowledge and understanding of:

- the fundamentals of plant reproduction;
- the unique nature of the primary pollinators: bees;
- the role pollinators play in maintaining the ecosystem and the productivity of agriculture; and
- what needs to be done to protect and encourage the growth of pollinators in your area.

Besides factual **knowledge**, we are also interested in the **attitudes** and **behaviors** that result from participating in the activities of this curriculum:

- How have participant's perspectives changed about:
  — the nature of bees?
  — the importance of bees to the availability of foods and fibers
  — the use of pesticides?
  — the development of lands?
  — the need to take an active role in protecting pollinators?

- What **changes** will they make or activities will they participate in to:
  — make their environment more pollinator-friendly?
  — educate others about the importance of protecting pollinators?

Materials Needed:

- "What Do We Know About Plants?" chart developed in Session I
- "What Do We Know About Plants and Pollinators" chart
- Large paper pad
- Felt-tipped markers
- Masking tape

Getting Ready:

- Tape both charts to a wall
- Arrange a seating area that is informal and comfortable

Grouping:

Whole group

Action (Communicating, Organizing, Synthesizing, Recording):

1. To determine gains in factual knowledge, revisit the "What Do We Know About Plants?" that was developed during the pre-assessment in the first session. Use a felt tipped marker of a different

Resources/Links

Acknowledgements

Introduction to 4-H Series

color to write in additional information suggested by the participants on the pre-assessment chart. Use the new chart to record additional input from the participants.

2. Hold an **open discussion** to see if and how their attitudes may have changed. Use the items mentioned above (attitude about bees, use of pesticides, development of lands, need to protect pollinators) as talking points. Have someone write down ideas on a large paper pad that all the participants can see. These notes can be reviewed by evaluators.

<< previous

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Printer-Friendly View | Normal View

Home

Why Care About Pollinators?

Scientific Thinking Processes

Implementing the Curriculum

Assessment

Outline

Printable Photos

Module 1

The Who, What & Why of Pollinators

Module 2

Pollinators and Plants in Partnership

Module 3

The Other Half of the Partnership: Pollinators

Module 4

Pollinator-Friendly Habitat in Your Area

Module 5

Creating Pollinator-Friendly Habitat

Module 6

Community Service

Resources

Internet Sites

Each Internet site has many links to other excellent sites. There is an abundance of excellent information on the web. Use keywords: Pollinator, Bee, or Butterfly.

Alien Empire http://www.pbs.org/wnet/nature/alienempire
--has a great interactive page on the anatomy of the bee and a page of interactive puzzles

American Field Guide http://www.pbs.org/americanfieldguide
--choose Animals --> Insects; shows video clips from "The Forgotten Pollinator"

Butterfly World http://www.butterflyworld.com

Butterfly Conservation Initiative http://www.butterflyrecovery.org/education/

Coevolution Institute http://www.coevolution.org
Pollinator Gardens and Habitat Program/Curriculum and Activities http://pollinator.org/Resources/CoE%20Gardens%20Curriculum.pdf

Ecology Society of America http://www.esa.org
--good background on the field of ecology

National Wildlife Federation
--Build a Bee House http://www.nwf.org/backyard/beehouse.cfm
-- What You Can Do About the Pollination Crisis http://www.nwf.org/nationalwildlife/article.cfm?issueID=16&articleID=677

Enchanted Learning http://www.enchantedlearning.com

National Gardening Association Kids Gardening http://www.kidsgardening.org

Logan Bee Lab, Utah State University http://www.loganbeelab.usu.edu

Monarch Watch http://www.monarchwatch.org

National Honey Board http://www.honey.com

North American Pollinator Protection Campaign http://www.nappc.org

Pollinator Partnership http://www.pollinator.org

Pollination Adaptations http://plantphys.info/Plants_Human/pollenadapt.html
--this site is a must for understanding how bees see flowers and how the characteristics of flowers are designed to attract bees

Smithsonian Institute http://www.smithsonianeducation.org/educators/lesson_plans/partners_in_pollination/index.html

The Insects Homepage http://www.earthlife.net/insects/six.html

Project and Celebration

Resources/Links

Acknowledgements

Introduction to 4-H Series

The Science Spot http://www.sciencespot.net
--Jr. High School level

The University of Arizona Africanized Honey Bee Education Project http://ag.arizona.edu/pubs/insects/ahb

Xerces Society http://www.xerces.org
--excellent source of information about gardening, building bee nests, also a great resource list

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Books for Youth

The books listed are only a small sampling of the many books available on bees, butterflies and moths, and other pollinators. Check your local library for these and other books.

Western Butterflies: A Sunset Junior Book J595.78
Arthur C. Smith
Lane Book Company, Menlo Park, CA 1961
--good basic information

Collecting Cocoons J 595.78
Lois J. Hussey & Catherine Pessino
Thomas Y. Crowell Company, NY 1953
--not flashy, good ideas for specific interest, good B&W illustrations

Butterflies and Moths: A Guide to the More Common American Species
Robert T. Michell & Herbert S. Zim
Golden Press, NY 1991
--Good field handbook

The Life & Times of the Honey Bee
Charles Micucci
Houghton Mifflin Company, Boston/NY, 1995
--Wonderful, appealing illustrations & interesting broad treatment--highly recommended

Creepy, Crawly Caterpillars
Margery Facklam
Little, Brown & Company, Boston, NY, Toronto, London 1995
--Wonderful illustrations and information on the larva stage--links to But. or Moth

Amazing Butterflies & Moths, Eyewitness Juniors, 9
John Still
Alfred A. Knopf, NY, `1991
--Wonderful photos, interesting facts

A Closer Look at Butterflies & Moths
Denny Robson
Gloucester Press, NY Toronto, 1986
--Good illustrations and basic information

Monarch Magic, Butterfly Activities & Nature Discoveries
A Williamson Good Times Book, by Lynn M Rosenblatt
Williamson Publishing Company, Charlotte, Vermont 1998
--Excellent all round book for illustrations, information, and esp. activities

Butterfly Story
Anca Hariton (lives in Richmond, CA and works for an architectural firm) also did very nice watercolor illustrations

Dutton Children's Books, NY1995
--More story-like, for younger children, not a lot of text, very basic

The Butterfly Book: A Kid's guide to attracting, raising and keeping butterflies
Kersten Hamilton
John Muir Publications, Santa Fe, New Mexico, 1997
--Excellent, relates butterflies to zones in US,

Caterpillarology
Michael Elsohn Ross
Carolrhoda Books, Inc., Minneapolis, 1997
--Excellent, good photographs, lots of activities
--Author teaches at Yosemite, studies conservation of natural resources at Berkeley

Butterfly & Moth Eyewitness books
Paul Whalley
Alfred A. Knopf, NY, 1988
--Large format, beautiful photos and illustrations, good info

4-H Hummingbird Observation Project
Ken R. Churches and Jennifer Mitchell
Cooperative Extension University of California
Division of Agriculture and natural Resources
Order from ANR Publications http://anrcatalog.ucdavis.edu
--Beautiful color photos and excellent information about hummingbirds and how to feed them

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Organizations and Agencies

Cooperative Extension Service (See listing in County Government pages of your local phone book or go to http://anr.ucdavis.edu.)

California Native Plant Society (http://www.cnps.org lists local chapters.)

Reference Librarian at local library

Local Independent Plant Nurseries (Often have expertise in native plants.)

Botany or Biology Departments (Local high school or college)

U.S. Forest Service (See listing in Federal Government pages of your local phone)

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Home

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Scientific Thinking Processes

Implementing the Curriculum

Assessment

Outline

Printable Photos

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The Who, What & Why of Pollinators

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Pollinators and Plants in Partnership

Module 3

The Other Half of the Partnership: Pollinators

Module 4

Pollinator-Friendly Habitat in Your Area

Module 5

Creating Pollinator-Friendly Habitat

Module 6

Community Service Project and Celebration

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Printer-Friendly View | Normal View

Home

Why Care About Pollinators?

Scientific Thinking Processes

Implementing the Curriculum

Assessment

Outline

Printable Photos

Module 1

The Who, What & Why of Pollinators

Module 2

Pollinators and Plants in Partnership

Module 3

The Other Half of the Partnership: Pollinators

Module 4

Pollinator-Friendly Habitat in Your Area

Module 5

Creating Pollinator-Friendly Habitat

Module 6

Community Service Project and Celebration

Resources/Links

Introduction to 4-H Series

By Richard Ponzio, Ph.D, 4-H Youth Development Specialist, University of California

What makes 4-H Science Experiences and Resources for Informal Education Settings 4-H SERIES different from other science activities. There are few if any new science activities. The difference is in how they are used. The science learning available to youth participating in SERIES is significantly different because SERIES includes five important context dimensions. The science processes imbedded in the learning experience; the value of cross-age instruction; use of the learning cycle in each activity; and the value of an apprentice structure where youth are involved in community-based service learning projects.

Scientific Thinking Processes. Virtually all science instruction in schools is content oriented and delivered through readings, lectures or demonstrations. Adding the scientific thinking processes to the content and using those processes to find, frame, and develop solutions to science-based community service projects provides a fresh avenue for the development of critical thinking skills. Further, SERIES scientific thinking processes adapted form the California State Science Framework (1993), and implemented in an authentic science inquiry of the students' own design match well with the science benchmarks (1993) and national science standards (1996). In SERIES materials the processes have been organized in a unique project-based way that other curriculum organization schemes lack. SERIES reflects knowledge from two research fields: developmental psychology (matching stages of development to the thinking need to complete each activity); and cognitive science (providing particular kinds of learning experiences that related to specific science concepts.) Great care has been taken to ensure that the processes build in each other, each subsequent one inclusive of the prior one. Thus, content will build in the same manner towards the advanced concepts that participants use to develop and reinforce their academic understanding of science as they carry out their community service projects.

Cross-Age Teaching. Current research emphasizes the value of social interactions for improving learning. The current national trend toward cooperative learning is an example of this value. SERIES builds in opportunities for younger learners to solve problems, record data, make inferences, and so on. The modeling that older youngsters provide is more effective than the modeling provided by an adult in a teaching role for several reasons including age differences, time for personal, more individualized contact, and status (Ponzio, et al; 2000). With less age and status difference two-way interactions begin faster and seem to generate more enthusiasm and learning opportunities.

The Learning Cycle. The instructional model used in presenting the inquiry based activities is an adaptation of the Learning Cycle (Karplus and others, 1977); Lawson, and others, 1989; and Marek & Cavallo, 1997). This instructional format has been found effective in working with youth to develop reasoning abilities in science. Researchers have found it to be particularly effective when used in combination with other instructional interventions such as inquiry labs, peer-led discussions and Socratic teaching methods (Guzzetti and others, 1993). Activities based on the Learning Cycle involve three distinct phases:

EXPLORATION - Youth are given materials or engaged in an experience and are encouraged to explore,

Acknowledgements

Introduction to 4-H Series

manipulate and observe. This is often a rather playful part of the program, and the youth learn through their own actions with little guidance or expectation of specific accomplishments. As a leader, you are not looking for particular answers. Your role is to be a co-investigator - you may explore also and even enrich

their observations with your own.

Photos by Suzanne DeJohn

CONCEPT INTRODUCTION - In this phase, you encourage the youth to discuss their observations and discoveries that they made during the Exploration phase, These findings should be made by the youth. In your role as a facilitator, you can help them describe their discoveries - 'the bee visited many flowers of one kind' and develop questions--"What was the bee getting from the flowers?" "Was the flower benefiting from the bee's visit?"-- that will lead to understanding of their observations. This phase also provides an opportunity for them to discuss the significance of their findings, develop hypotheses, begin to outline ways they can test those hypotheses, and learn new terms related to the concept.

CONCEPT APPLICATION - In this phase, youth again have a chance to manipulate the materials. They may test the hypotheses they developed during the first two phases, refine a technique, or explore something in more depth. Ideally, theories and experiments should be developed solely by the youth investigators. (Ponzio, 1994)

Apprentice Structure. Another form of learning through social interactions is the apprentice structure of SERIES. This allows the novice to work side by side with the expert to learn the craft, the processes and the knowledge development aspects of " sciencing." The adult volunteers serve as "coaches" for the teen leaders, and the teen leaders serve as "personal instructors" for the younger participants.

Community-Based Academic Service Learning. An assumption in SERIES is that we are not focusing on just providing youth with more information about science, but rather our emphasis is upon developing scientific thinking skills and decision-making through the community-based application of what is being learned. The problem identification, design and application activities provide increased relevance and connection between what is being learned and "the world" by focusing on high intrinsic interest topics chose by the participants themselves. The academic service learning dimensions of SERIES units fit well with the suggestions of Robert Reich, former US Secretary of Labor for experiences necessary for youth to be able to be better prepared to participate effectively in the emerging global economic Reich, 1983, 1991a, 1991b, 1994). The authentic learning opportunities provided participants in community-based projects are described by McKenna and Ward (I 999) and in Howard Gardner's book The Unschooled Mind (1991).

In his seminal book, *A Place Called School*, based on a study of the nation's schools, John Goodiad noted that science instruction found in most schools was just another reading lesson. The goal of SERIES is to encourage the youngsters to begin to use the processes and approaches of science in his or her personal decision making as a citizen in our society. Content is carefully chose and related to the processes so that participants develop a clearer understanding of how science related to their lives every day. SERIES carries science beyond the 4-H meeting, camp project or other group experience by incorporating a community-based academic service-learning component related to science literacy in each of the units of study. After experiencing the content and processes related to the unit, the participants take their new knowledge into their community. Through direct interaction they reinforce and enlarge upon their own knowledge and skill base while contributing, in the spirit of 4-H, new knowledge and direct service to their community.