Forensic Entomology
INTRODUCTION

It has been said that humans and insects are the two most successful creatures on Earth. Insects have been around much longer—they were here about 350 million years before humans entered the picture, which was only about 100,000 years ago! A

Humans attempt to manage their environment, which allows us to manipulate our success as a species. Insects, on the other hand, do not have the powers of higher thought or the use of tools, as far as we know. What insects do have is the ability to adapt to a variety of habitats and lifestyles because of their small size, fast rate of reproduction, hard exoskeleton, and often the ability to fly. These traits have made insects the dominant group of animals on Earth (both on land and in fresh water).

Insects' unique abilities also make them a very useful tool in the world of forensics. Forensics is a hot topic, with many movies and popular television shows (such as "CSI") introducing youth to the tools, processes, and critical thinking skills needed to solve various crimes. Indeed, the growing presence of forensic entomology focuses on the information that insects provide investigators about the time, location, and criminal negligence within a wide variety of criminal cases—everything from food contamination to murder.

Using This Curriculum

This curriculum has been designed as a tool for teaching youth (grades 6–8) about the contributions that insects make to the world of forensics. This three-week series of lesson activities is designed for use in informal educational settings such as after-school programs, summer day camps, 4-H clubs. However, this package also includes the Next Generation Sunshine State Standards for teachers within formal classroom settings who may wish to incorporate these activities into their current lesson plans.

Acknowledgements:

This work was partially funded by a grant from the USDA-SCRISSouthern Region Pest Management Center to Russell Mizell, professor, and Erika Andersen, graduate student, Entomology and Nematology, University of Florida.
In order to capture the full content of this package, it is recommended that the nine lessons be followed in chronological order. Supplemental Lesson 1 and 2 can also be added for enrichment of the materials, but are not necessary to the forensic science content. Brief descriptions of each lesson are provided on page 4. The first page of each lesson provides several key pieces of information, in addition to the MAIN IDEA and OBJECTIVES. Each lesson also contains a SIDEBAR which outlines the following:

- Subject area emphasis
- Time required
- Science and life skills built
- Materials needed for the lesson
- Applicable Sunshine State Standards

The first page of each lesson also contains BACKGROUND INFORMATION for the content within the lesson. This is where key vocabulary for the lesson is identified and defined. Background topics include these items:

- What is forensic entomology?
- What is the history of forensic entomology?
- Forensically important insects
- Understanding metamorphosis
- Understanding the collection process
- Understanding sampling
- Understanding the connection between insects and forensic entomology

Directions for the corresponding lesson including advanced preparation needs, a materials list, any specific notes about the lesson, and suggested dialogue for use with the youth. The Let’s Begin section contains the actual activity. This section is followed by Let’s Reflect and Let’s Apply with questions for use following completion of the activity. If you would like to continue the exploration of this subject matter, activity options have been included in the Extension Activities endnote. Each lesson contains any handouts that may be needed for any given activity.
Experiential Learning

The five steps of the experiential learning model are used extensively in 4-H Youth Development to teach and reinforce life skills. The sequential steps of the model help youth identify what they have learned from an experience or activity and then how to apply that learning to other experiences or situations. Within this model, the “teacher/leader” must be very clear which skill or concept has been targeted, and then provide the experience and processing time which have been designed to support that learning goal. This learning process engages learners in all phases of the activity, resulting in the ability to apply this learning to new situations. Experiences lead to learning if the participant understands what happened, sees patterns of observations, generalizes from those observations, and understands how to use the generalization again in a new situation.

We begin the process with an Experience. The experience should be concrete, and can be either an individual or group experience. The key here is that youth are “doing something.” Within this project book, the “do” section is denoted by the heading Let’s Begin.

Once the experience is completed, the youth then begin to reflect on what they learned within the activity. This includes sharing their experiences and processing themes, problems, or issues were brought out by the activity. Within this project book, this is found in the Let’s Reflect section.

Share. Allow the participant(s) to discuss the experience. Some common sharing questions include:
- What did you do?
- What happened?
- How did it feel to…?
- What was most difficult?
- What was easiest?

Process. Discuss how recurring themes, problems, and issues are brought out by the exercise. Address specific problems and issues that the group discovers from the exercise or individual’s recall from personal experiences. Some common processing questions include:
- Did problems/issues seem to occur over and over? What were they?
- What similar experiences have you had?

Once youth have reflected on the activity, it is time to create links between that new knowledge and their lives. This includes generalizing principles that apply to “real life” and understanding how that knowledge can then be used in their daily lives. Within this project book, this is found in the Let’s Apply section.

Generalize. Find general trends or common truths in the experience. Draw out and identify the principles that are important and that apply to “real life,” not just the activity. Focus on the key messages. Some common generalizing questions include:
- What did you learn about yourself through this activity?
- What did you learn about the life skill (i.e., making decisions)?
- How did you go about making your decision?
- How do the major themes or ideas relate to real life and not just the activity?

Apply. Concentrate on how the new learning can be applied to everyday situations. Discuss how issues raised by the activity can be useful in the future. Describe how more effective behaviors can grow out of what is learned. Some common questions here may include:
- How can you apply what you learned (making decisions) to a new situation?
- How can issues raised by this activity be used in the future?
- How will you act differently in the future as a result of this activity?

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<td>LA.8.5.2.4 The student will research, organize, and effectively deliver speeches to entertain, inform, and persuade.</td>
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<td>LA.(5, 6, 7).4.2.1 The student will write a variety of informational/expository forms, e.g., summaries, a procedures, instructions, experiments, rubrics, how to manuals, assembly instructions.</td>
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*As of 01/01/10 Florida Department of Education*
Main Idea
This lesson provides an introduction to the world of forensics through the introduction of basic vocabulary.

Objectives
Youth will be able to:

1. Practice observational skills by recording observations of a staged scene.
2. Communicate findings with group members.
3. Compare findings with other groups.
4. Use the skill of inference to solve a problem in a small group.

Background Information

What is Forensic Entomology?
Forensics is a hot topic, and many youth have seen forensic entomology practiced in movies and on popular television shows (such as “CSI”) as a way to solve crimes such as murder cases. Even for those who are not aware of the current trend, a murder case is something that consistently piques the interest of youth.

Forensic entomology can be used in many areas to aid investigations. It is commonly broken down into three general areas:

1. **Medicolegal** - deals with necrophagous (or carrion) feeding insects that typically infest human (and other animal) remains. This may involve murder victims—insects can be used to pinpoint exactly when the victim was killed, and therefore eliminate or accuse suspects.

2. **Stored produce pests** - insects are commonly found in food (prepared or stored). A forensic entomologist may serve as an expert witness during both criminal and civil proceedings involving food contamination.
3. **Urban** - deals with insects that affect man and his immediate environment. The damage caused by insects feeding on flesh can cause marks and wounds on the skin that may be mistaken as abuse. Insects can also show signs of neglect and abuse, particularly in children and the elderly. There are published cases documenting parents intentionally using wasps and bees to sting their children as a form of punishment, and entomological evidence has been used to prove neglect and lack of proper care for wounds existing on the elderly. Insects are also known to cause car and aircraft accidents. Stings of bees and wasps may be responsible for a large number of single-occupancy car accidents that lack a definitive cause. Insects also have been responsible for causing aircraft crashes through obstructed equipment, such as fuel lines, causing engine failure. Urban pests are of great economic importance and a forensic entomologist may become involved in civil proceedings over monetary damages.

**Vocabulary**

- **Post-Mortem Interval (PMI)** - time elapsed between death and the discovery of a body
- **Pupate** - to turn into a pupa
- **Forensics** - of, relating to, or used in courts of law or public debate or argument
- **Forensic Entomology** - using insects to solve crimes

**Understanding the CONNECTION between insects and forensic entomology**

Chronology is the science of locating historical events in time. Events that happened in the past occurred in a sequence over time. To fully understand what happened in the past, people in the present attempt to reconstruct how the events unfolded by developing a time line of the sequence of the events. Understanding the chronology of a crime is very important to an investigator trying to uncover what really happened and when.

The Post-Mortem Interval (PMI) is the time elapsed “chronology” between death and discovery and medical examination of a body. The knowledge of forensic entomology can help determine the PMI, if the evidence is properly collected, preserved, and analyzed. After 48–72 hours, forensic entomology is often the only method for determining the PMI. Blowflies are the first visitors to a corpse, followed by beetles and other insects. Knowing which insects are present, and which life stage they are in (maggot vs. adult, for example), can determine how long ago a death took place.

If a body is soft, it is likely that the death occurred less than three or more than 36 hours ago (>3 or <36 hours PMI). If it is stiff, the PMI is most likely between 3–36 hours PMI. If there are flies around the body, the PMI is 3 or more hours. If there are maggots (fly larvae) on the body, the PMI is between 3–5 days. Body stiffness and presence of insects can be greatly affected by the time of year (day length, temperature, humidity, presence of certain insects), location (sun vs. shade, body placed in bag or freezer), or other factors.
Defining the PMI Stages

The “Fresh” stage: The process of decay begins with blow flies (family: Calliphoridae) and flesh flies (family: Sarcophagidae) finding the body. They can arrive within 10 minutes of death! They lay their eggs, from which maggots hatch, and begin to feed on the tissues. (Flesh flies actually lay newly hatched maggots and not eggs). Beetles and predatory wasps may arrive to feed on the maggots (not on the corpse). Depending on weather conditions, it represents days 1–3 PMI.

The “Bloating” stage: Next, house flies (family: Muscidae) join the other flies and their maggots form feeding masses that help liquefy the tissue. At this point, there are a lot of maggots feeding on the body and the competition (as well as number of predators that come to eat on the maggots) increases. Depending on weather conditions, it represents days 2–6 PMI.

The “Decay” stage: This is when the decay of a body really starts to smell bad. By the end of this stage, most maggots have finished development and begin to leave the body to find a place to pupate in the soil. The corpse becomes devoid of all flesh, except cartilage, bone, and skin. Depending on weather conditions, it represents days 5–11 PMI.

“Post-decay” stage: Beetles come to feed on the remains. Depending on weather conditions, it represents days 10–25 or more PMI.

Recommended Resources

- Forensic Insect Identification Cards (By Castner and Byrd) - Available from Feline Press, P.O. Box 357219, Gainesville, FL 32635; 352-371-6439; or http://www.FelinePress.com.
  This article contains scenarios of 4 Murder investigations. Youth solve with the materials provided in (and indicated by) the article. Helpful background information and tables are provided. An adaptation of this article and activity can be found at http://ipm.ncsu.edu/4-H/CSIfinal.pdf.

Activity 1

Advanced Preparation—You will need to prepare the insect jars for this activity over the course of the two weeks immediately prior to performing this activity. Every four days (Day 1, 5, 9, and 13), place approximately 1/2 pound of chicken livers inside a new container. Place these open containers outside (in the same general location) for 30 minutes in order to attract insects to the meat. Be sure to place the containers in a location where raccoons and other animals cannot access the meat.
After 30 minutes, return the container to the indoors and cover. The cover should allow for some ventilation, but not access by other insects. At the conclusion of the two weeks, you will have four distinct containers with different stages of insect attraction, growth, and decomposition of meat. In no particular order, label each numerically.

**Note to the Leader**
As a contingency plan for problems that may arise with time of year, weather, or other issues, the forensic experiment can be conducted outdoors prior to the lesson date and then labeled and frozen until use. This approach might also be taken to supplement the conduction of the experiment by the students, or to add other special scientific or "diabolical" treatments to the experiment. Then, relate the changes to how a criminal might try to counteract the normal forensic data and mislead an investigator. Discuss how an investigator might use his knowledge and the data to discover and interpret these diabolical schemes.

Some ideas for special treatments:
- Add ethyl alcohol (or other preservative) to the jar and compare what happens to this treatment versus the untreated jars.
- Subject a jar to higher or lower temperatures for a day or so indoors before freezing to compare the effects on insect growth and survival.

**During the Activity:**
**Outside:** If you gained permission from school administration regarding setting up the crime scene on school grounds, take the four jars and hang them from a tree somewhere on school property. Be sure this place is in a location where other youth in the school would not normally travel, and where wild animals will not bother the scene.

**Inside:** If permission was not granted, simply bring the four jars to the classroom or meeting area where youth will be able to observe the differences between the jars.

Let's Begin

Begin today’s activity by taking youth to the location of the jars (either outside or inside). Divide youth into four groups (hopefully between 3–5 youth per group). Each group should start at a different jar. Ask them to use their senses (what they see, smell, hear) to describe what is going on in the jar. However, do not allow them to touch the jar. Have youth record their observations in the appropriate place on their handout.

After five minutes, have them rotate to the next jar. Have them observe what is going on in the second jar (just as they did in the first). Repeat the process until they have observed each of the four jars.

Once youth have made their observation at the final jar, have them gently pour the contents out onto a sheet of wax paper. Youth will now have the opportunity to inspect the insects that are in the sample. Using the tweezers and insect collecting vials, have youth collect and count the insects from that jar. Ask them to be as descriptive as possible as they collect and count these insects. Encourage them to figure out at least one way to categorize or sort the insects as they are collecting them.

**NOTE:** Leader may want to use a camera (instant or digital) to record evidence and require youth to make a collage or add to their “files.”
Let's Reflect

- After you observed the first jar, what did you expect to see in the other jars?
- Which jar would you say had the most insect activity? The least?
- Describe the differences between the four jars.
- Describe anything that surprised you while you were doing this activity.
- What would you say was the most difficult part of this activity?
- How did you and your group decide how to collect, categorize, and count the insects from your final jar?

Let's Apply

These jars were all placed outside in order to attract insects. Each one was placed in the same location, but at different times. One was put outside on Day 1, another was put out on Day 3, another on Day 5, and the last on Day 7.

- Based on your observations, which jar do you think was from Day 1? Why do you think that is?
- Which one do you think was from Day 5? How do you know this is not from Day 3?
- How do you think these jars might be different if they had all been placed in different locations?
- There are many occasions where you have to work in teams or groups. Sometimes groups have problems. Did your group have any problems working as a team? How did you work through those problems to finish the task?

Extension Activities

Youth may want to try this same activity at home over a longer period to see more distinct differences between the jars. They can elect to change other variables (location, time of day, wrapping the meat in cloth, etc). Have them record their findings and report back to the group. Be sure they include what variable they chose to change, what they observed, and what they might conclude from those observations.
## Insect Investigation...

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Archival copy: for current recommendations see [http://edis.ifas.ufl.edu](http://edis.ifas.ufl.edu) or your local extension office.
Now, for A Closer Look...

Which was your final jar?

What I Saw:

What I Smelled:

What I Heard:

Possible Categories:

Insect Count from this Jar:

What "PMI Stage" would you guess for the meat from this Jar? (Use Handout 1.2)

How did you reach your conclusion?
Did You Know...

The Post-Mortem Interval (PMI) is the time elapsed between death and discovery and medical examination of a body. The knowledge of forensic entomology can help determine the PMI, if the evidence is properly collected, preserved, and analyzed. After 48–72 hours, forensic entomology is often the only method for determining the PMI. Blowflies are the first visitors to a corpse, followed by beetles and other insects. Knowing which insects are present, and which life stage they are in (maggot vs. adult, for example) can determine how long ago a death took place.

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The “Decay” stage: This is when the decay of a body really starts to smell bad. By the end of this stage, most maggots have finished development and begin to leave the body to find a place to pupate in the soil. The corpse becomes devoid of all flesh, except cartilage, bone, and skin. Depending on weather conditions, it represents days 5–11 PMI.

“Post-decay” stage: Beetles come to feed on the remains. Depending on weather conditions, it represents days 10–25 or more PMI.
Main Idea
This lesson provides the story of the very first recorded use of insects as a forensic tool.

Objectives
Youth should be able to:
1. Use the skill of inference to solve a problem in a small group.
2. Communicate with group members to solve a murder case.
3. Cooperate in a small group to solve a problem.
4. Practice accurate note-taking from a case read aloud.
5. Demonstrate that a change in one or more variables can alter the outcome of an investigation.

Background Information

What is the HISTORY of forensic entomology?
Forensic entomology was first documented in China in 1235. A.D. in a book entitled The Washing Away of Wrongs: Forensic Medicine in Thirteenth Century China (University of Michigan, Ann Arbor, MI). See the case covered in this lesson for more information.

In 1668, Francesco Redi (1668) studied rotting meat that was either exposed or protected from flies. From his analysis of blowfly infestations, he refuted the hypothesis of the spontaneity of generation "of life. Up to that time, it was generally believed that maggots were produced from rotten meat. In reality, they are hatched from eggs, which are laid on a rotting carcass by flies.

French scientists Bergeret, Brouadel, A. A. Kovavitch, and Megnin introduced forensic entomology into Europe during the 19th century. French forensic entomology did not reach the United States until 1898. When Dr. Murray Motter examined the stages of decomposition and insect succession in a buried human remains. Not until 1903 was forensic entomology visited in the United States. Dr. J. W. Payne conducted a decomposition research with pig carcasses and his work was still highly regarded today. During the 1980's, forensic entomology exploded in the U.S. As more and more scientists have examined insects that colonize a cadaver. The University of Tennessee has a long-term research program focusing on the factors affecting decomposition of the body.
Activity 2

Instructor Reads:

Many of the skills that you just practiced are important in crime scene investigations and entomology.

**Science of Forensic Entomology**

Does anyone know what forensic entomology means? You can give the youth hints such as “What does ‘forensic’ mean?” “What is entomology?” “Have you seen the TV show CSI before?” It may be helpful to make a concept map or list of the responses on a board or overhead projector.

**Let’s Begin**

Divide youth into groups of 2–4. These will be their brainstorming groups. Each youth will need a piece of paper and a pencil/pen. Then read the following:

I am going to tell you a story of the first forensic entomology case ever recorded. Your groups will help you determine the best plan of action based on the evidence provided. When I ask you to stop and discuss or brainstorm the case, expect each group member to participate in the discussion. As a group, reading the case, please write down anything that stands out as important information. At the end of the activity, each group will share their information with members of your group.

“In 1235, a crime occurred in a village in China. The crime? **Murder.** The weapon? **A sickle,** a rounded tool made of wood and metal, used for harvesting rice. The villagers called on the local death investigator to solve the crime.”

**Brainstorm** with your group. How do you think the death investigator could have solved the crime? Give youth 5” 10 minutes to complete their group’s response. Allow each group to share.

“**After some fruitless questioning,** the investigator asked all the villagers about the sickles available. They were all next to each other, and somehow before anyone knew.”

**How do you think the death investigator could have solved the crime?** Give youth 5 minutes to come up with a new theory.

“**There are probably many ways to solve this case,** but the way it really happened was this—at first, at a moment, flies were attracted to one of the sickles.”

**Why do you think this happened?** Allow 5 minutes of small group discussion time. Then have small groups share answers with larger group.

After the youth have shared their answers, tell them that the flies were probably attracted to the sickle because of the odor coming from the invisible remains of tissue and blood adhering to the leaves. The victims had been washed down a river. Confronted with such evidence, the sickle’s owner broke down and confessed to the murder. This case is documented in *The Washing Away of Wrongs,* a book written in 1235 A.D. by Sung Tzu, a Chinese ‘death investigator.’

Handout 2.1 provides a copy of the story for each youth to keep.
Let's Reflect

- Did other people in your group have the same ideas as you, or did they bring new ideas to the group? Another words, how did you use cooperation to come up with ways to solve the case?
- Why was communication important to your group's efforts to solve this case? Would you have been able to share your thinking without successful communication? If you had been able to communicate with the murderer, suspects, or witnesses in this case, how would good communication skills have helped you?
- What does it mean to infer something? How is an inference different than an observation?
- What is an inference that you made in this case today? (What a youth would have done if they were an investigator based on the evidence provided.)

Let's Apply

- In a murder case today, do you think experts are all called from the same area of expertise, or are many different people with different talents chosen? For example, would you need a team of five fingerprint experts for this case, or would you need a diverse group of experts?
- In a murder case today, why would communication be so important?
- Describe a time when you had to make an inference about something.
- Describe a time when you had to solve a problem or mystery. What types of skills did you need to solve that problem or mystery?
- What do you think are some of the skills a forensic entomologist needs to solve mysteries?

EXTENSION ACTIVITIES

Have youth act out this entomology case (not the murder, but the proceedings after the murder).

Possible Roles: investigator, judge, suspects with sickles, flies, and villagers.
Props: magnifying glasses, plastic swords (sickles), gavel, rice picker hats, fly costumes.

Reenact the scene by smearing several identical utensils (forks or spoons) with a bloody piece of meat. Then clean the utensils and place on a piece of cardboard. Ask youth to identify which one they think is the “guilty” utensil. Place the utensils outside and allow nature to tell which utensil committed the crime.
**Setting:** Rice Field in China

**Year:** 1235

**The crime:** Murder (stabbing) of a farmer

**The weapon:** Sickle—a rounded tool made of wood and metal, used for harvesting rice

**Investigator:** Sung Tzu documented in 'The Washing Away of Wrongs'

**The case:** The local magistrate (judge) suspected that a sickle had been used, but no one confessed to the crime. The day after the murder, the investigator ordered all workers to lay down their working tools (sickles) on the floor in front of them. Invisible traces of blood drew blow flies to a single sickle, even though its owner had wiped it clean. Confronted with such evidence, the sickle’s owner confessed to the murder.
Main Idea

This lesson provides an overview of the most important tools of the trade for forensic entomologists—INSECTS. Topics include a discussion of important insects to the field of forensics.

Objectives

Youth will be able to:
1. Identify insects that are important to the field of forensics.
2. Determine the stage of PMI based on the insects present.

Background Information

Forensically Important INSECTS

Flies: Often the first insects to arrive at the scene. Some of the more forensically important members of this group include blowflies (can smell death up to ten miles away), flesh flies (often lay eggs in open wounds of mammals), cheese flies (do not take up residence in a corpse until three to six months after death), as well as others.

Beetles: Generally found on the scene when decomposition is more advanced. Some of the more forensically important members of this group include rove beetles (common only during later stages of decomposition), hister beetles (among the first beetles to arrive at a corpse), and skin/hide beetles (important in the final stages of decomposition because they are the only beetle with the enzymes necessary for breaking down dried skin, hair, tendons, and keratin), as well as others.

Moths: Closely related to butterflies, moths are important in the final stages of decomposition.

Mites, Wasps, Ants, and Bees: Found at the scene, but often because they are feeding on fly eggs and larva. This can lead to incorrect PMI estimates.
Activity 3

Advanced Preparation: You will need to make game boards and cards. Sets for each small group. You may want to make a multiple copies of the cards. Sets are red and yellow. For each group, have plenty of cards. A continued play. The 11x17 game board and cards are available at http://florida4h.org/projects/forensics.shtml.

A

Read the following:

A You have now heard the story of a forensic entomology case ever recorded. An ATP lawyer was asking a question: Was he the one who did it? He wanted to answer the question and was looking for a yes or no answer. However, many other insects can also help investigators solve mysteries of their own.

A Today, an order to solve a mystery using forensic entomology. It is important to have several pieces of evidence. What do you think are some important pieces of evidence might be? Answers may include type of insect, stage of life, location. Forensic entomologists may need to know several insects. A what type of insect is an, where the insect is usually found, and a lot more. Let's begin with the basics: what is an insect? And what are some of the insects that help autopsies?

Let's Begin

Carcass Crazy Board Game

The object of the game is for youth to learn about some of the important insects in forensics as they travel across a board. To win the game, youth must arrive at each carcass at the end.

A

Read the following instructions for youth:

A Separate into small groups (between 4-5 youth per group). Each group receives one game board, one Alice, game pieces, and 40 playing cards. You can add these numbers or larger groups or if you have limited resources. Simply add youth to a team and work as a team.

A The first youth rolls the Alice. The youth moves that number of spaces and then draws a card from the corresponding pile.

A If you land on an insect square, draw a card and then read the card aloud.

A If you land on a yellow square, give a person an AFTL. You may draw a card and give a person an insect. A that person then asks you a question on an insect. If you get a right, you can roll again. A not, you have to wait until your next turn.

A Be sure to remind youth to pay attention as everyone reads the cards. Alice helps contain the answers. A needed to complete the questions on the yellow cards. The person with the most of the first person to then repeat his process. Whoever gets 3 or 4 carcasses at the end of the board first is the winner!

NOTE: Leader may want to use a camera (instant or digital) to record evidence and require youth to make a collage or add to their “files.”
Let's Reflect

- What are some of the insects that are important to the field of forensics?
- You have learned that certain insects arrive at different times over the course of decomposition. Construct a timeline or chronology of insect arrivals.
- Which are the first to arrive on the scene?
- Which arrive towards the end of decomposition?
- Why is it important to be able to identify which insects are found on a corpse?
- How can the counts of insects at a crime scene be affected by the environment?

Let's Apply

- Our insect timeline provides a way to know what to look for. What are some other ways that a scientist might use a timeline to discover what is going on?
- Forensic science uses a lot of critical thinking and problem-solving skills to solve a case. In what areas of your life are you able to use critical thinking and problem-solving skills?
- How do you think scientists are able to look at something critically and objectively, and avoid emotional bias?
- Why would avoiding emotional or other types of bias be important when trying to solve a case?

Extension Activities

- Have youth create their own game to educate others about some aspect of forensic entomology.
- Have youth research additional insects or other environmental factors that are important to practitioners in the field of forensics.
<table>
<thead>
<tr>
<th><strong>Blowflies</strong></th>
<th><strong>Skin/hide beetles</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Are often the first insects at a crime scene because they can smell death up to ten miles away.</td>
<td>Are important in the final stages of decomposition because they are the only beetle with the enzymes necessary for breaking down dried skin, hair, tendons, and keratin.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Flesh flies</strong></th>
<th><strong>Hister beetles</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Arrive early at a crime scene and often lay their eggs in open wounds on mammals.</td>
<td>Are among the first beetles to arrive at a corpse.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Cheese flies</strong></th>
<th><strong>Moths</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Tell a lot about the timing of an old crime scene because they do not take up residence in a corpse until 3 to 6 months after death.</td>
<td>Are closely related to butterflies and are important in the final stages of decomposition.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Rove beetles</strong></th>
<th><strong>Mites</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Are common only during the later stages of decomposition.</td>
<td>Can be found at any time on a crime scene. Some are feeding on the corpse, while others are feeding on fly eggs and larva. This can lead to incorrect PMI estimates.</td>
</tr>
</tbody>
</table>
Wasps and bees can be found at any time on the scene. Some are feeding on the corpse, while others are feeding on fly eggs and larva. This can lead to incorrect PMI estimates.

Wild or domesticated animals can interfere with the crime scene by moving the corpse or consuming parts of it.

Temperature and climate can affect the amount of insect activity at a crime scene. Production of blow fly eggs will be lower at lower temperatures.

Limited access to the corpse affects which insects are able to be found. If the corpse is submerged, then evidence of terrestrial (land) insects should be minimal.

Clothing or coverings affects how quickly a corpse decomposes, thereby changing how many insects may be found at a given time. A tightly wrapped corpse will decompose at a slower rate and have less evidence of insect activity.

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Archival copy: for current recommendations see http://edis.ifas.ufl.edu or your local extension office.
### YELLOW CARDS

<table>
<thead>
<tr>
<th>Which insects are often the first at a crime scene because they can smell death up to ten miles away?</th>
<th>Which beetles are important in the final stages of decomposition because they have enzymes necessary for breaking down dried skin, hair, tendons, and keratin?</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Answer:</strong> Blowflies</td>
<td><strong>Answer:</strong> Skin/hide beetles</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Which insects arrive early at a crime scene and often lay their eggs in open wounds on mammals?</th>
<th>Which beetles are among the first insects to arrive at a corpse?</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Answer:</strong> Flesh flies</td>
<td><strong>Answer:</strong> Hister beetles</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Which insects tell a lot about the chronology of a crime scene because they do not take up residence in a corpse until 3 to 6 months after death?</th>
<th>Which insects are closely related to the butterfly and are important in the final stages of decomposition?</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Answer:</strong> Cheese flies</td>
<td><strong>Answer:</strong> Moths</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Which beetle is common only during later stages of decomposition?</th>
<th>Name one insect that can be found at any time on the scene with some feeding on the corpse, while others are feeding on fly eggs and larva.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Answer:</strong> Rove beetles</td>
<td><strong>Answer:</strong> Mites, wasps, or bees</td>
</tr>
</tbody>
</table>

Archival copy: for current recommendations see [http://edis.ifas.ufl.edu](http://edis.ifas.ufl.edu) or your local extension office.
<table>
<thead>
<tr>
<th><strong>Name three insects that can cause forensic entomologists to determine incorrect PMI estimates.</strong></th>
<th><strong>Why is constructing a timeline or a chronology of crime scene events important and useful?</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Answer:</strong> Mites, wasps, and bees.</td>
<td><strong>Answer:</strong> To better understand how the events of a crime unfolded.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Explain how temperature and climate can affect the amount of insect activity at a crime scene.</strong></th>
<th><strong>Explain how limited access to the corpse affects the ability of insects to find a corpse.</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Answer:</strong> How temperatures often reduce the production of blowfly eggs.</td>
<td><strong>Answer:</strong> If the corpse is submerged, then evidence of terrestrial (land) insects should be minimal.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Explain how clothing or coverings affects how quickly a corpse decomposes.</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Answer:</strong> A tightly wrapped corpse will decompose at a slower rate and have less evidence of insect activity.</td>
<td></td>
</tr>
</tbody>
</table>
You’ve Won Carcass Crazy!

Available at the project website: www.florida4h.org/projects/forensics.shtml

Archival copy: for current recommendations see http://edis.ifas.ufl.edu or your local extension office.
Tools of the Trade: METAMORPHOSIS

Grade Levels: 6—8
Subjects: Science
Setting: Indoor/Outdoor

Time Needed: 50 minutes

Science Skills: Communication
Classification

Life Skills: Problem solving
Communication

Materials Needed:
Foldables
For each youth...
• Handout 4.1 (both sides copied double sided)
• Books about insects or internet access for researching insect metamorphosis
• Miscellaneous materials for creating an educational activity
• Scissors
• Pencils
• Crayons or colored pencils

Just For Fun
For each youth...
• Handout 4.2 (double-sided)

Main Idea
This lesson continues the insect overview with a discussion of the processes they go through as they grow from egg to adult.

Objectives
Youth will be able to:
1. Differentiate between incomplete and complete insect development.
2. Illustrate the life stages of each type of development.
3. Give an insect example for each type of development.

Understanding METAMORPHOSIS

Metamorphosis
The term “metamorphosis” literally means “change” and refers to the way that most insects grow, develop, and change forms. There are two types of metamorphosis, incomplete and complete, although some insects do not have a metamorphosis at all. A

In incomplete metamorphosis, the insect goes through three life stages: the egg, the juvenile stage, and the adult stage. A juvenile insect with this type of metamorphosis are called nymphs. A nymphs are typically small versions of the adult but lack wings. They often eat the same food as the adult. As they grow, they molt, or shed, their exoskeletons and replace them with a larger one. Grasshoppers, true bugs, and dragonflies are all examples of insects with an incomplete metamorphosis. These types of insects are called hemimetabolous (hemi = partial, metabolous = changing) insects because they only go through a partial change.”
Vocabulary

Almost 90% of insect species have **complete metamorphosis**, or four stages: egg, larva, pupa, adult. Incomplete metamorphosis has three stages: egg, larva, adult. There are also **holometabolous** life cycles. These insects go through a complete change from adult to larva to pupa to adult.

A

Why complete metamorphosis? A

One common question that people ask when they talk about insects is, "What are those things doing?" There are many insects with very complicated life cycles. All insects have a metamorphosis, which means they go through a complete change. Some insects have a larva stage, while others do not. Some insects have a pupa stage, while others do not. Some insects have both a larva and a pupa stage, while others have neither.

A

Another advantage is that these insects are better prepared to survive the winter. They have a pupal stage, which allows them to survive the cold. Unlike adults, pupae do not have a mouthpart. The pupae often burrow into the ground over the winter and emerge in the spring as adults. Some insects actually must experience a freeze as a pupa before they are able to emerge.

These Background Basics are excerpts from ABCs of Entomology, Florida 4-H. For more information on this in-depth entomology curriculum, visit the project website at [http://florida4h.org/projects/entomology_group.shtml](http://florida4h.org/projects/entomology_group.shtml).
Activity 4

Let's Begin

Let’s Get Living

A

To reinforce knowledge of both development processes, youth will create educational tools for use in teaching others about the details of metamorphosis and the importance of insect life stages in forensic entomology.

A

Have youth begin this activity by getting into pairs. Have each pair choose three important life stages of an insect they have studied and make an initial guess at the stages of metamorphosis and the importance of those stages in forensic entomology.

A

Once they have made their decisions, have the pairs use books or the Internet to research the information about the insects, as well as the importance of those insects to the world of forensic entomology and any other facts they may want to include within their project.

A

Have youth use the facts they discover as an aid to help answer questions about the back of their project. They can then use the rubric questions and the back of their project to help them determine if their project will accomplish all the necessary goals.

NOTE: Leader may want to use a camera (instant or digital) to record evidence and require youth to make a collage or add to their “files.”

Materials for Activity A

Let’s Get Living

For each youth...

• Handout 4.1a (both sides copied, A double-sided)

• Books about insects or the Internet for researching insect metamorphosis

• Miscellaneous materials for creating an educational activity

• Scissors

• Pencils

• Crayons or colored pencils

A

Just for Fun

For each youth...

• Handout 4.2 (double-sided)

Activity 4- Page 28
Let's Reflect

- What is the difference between complete metamorphosis and incomplete metamorphosis?
- What is one example of an insect that goes through complete metamorphosis?
- Have you ever been able to actually see an insect at each of the stages of its life? Tell us what you saw or experienced.
- What educational tool did you choose to create? Why did you choose that one?
- What did you think was the hardest part of the project? How did you overcome those difficulties?
- What changes would you make now that the project is complete and you've seen what others have created?
- This activity asked you to be part of a team. Why do you think it is important to know how to be part of a team?
- What skills do you think are important for you to use when you are on a team?
- Think about your life. If you had been an insect, what type of metamorphosis would you have gone through? Why did you choose that one?

Let's Apply

- This activity asked you to be part of a team. Why do you think it is important to know how to be part of a team?
- What skills do you think are important for you to use when you are on a team?
- Think about your life. If you had been an insect, what type of metamorphosis would you have gone through? Why did you choose that one?

EXTENSION ACTIVITIES

Allow youth to experience first hand the stages of metamorphosis. You can either have youth capture caterpillars or you may choose to order a butterfly kit (which often comes with butterflies in the larval stage). Have them keep a record of their observations. An easy method to obtain insect eggs is to use the porch light or a blacklight to attract insects at night. Female moths that come to the lights can be captured and placed in a brown paper bag. If they have eggs they will lay them inside the bag. Make sure to identify the moth collected so that the host plant they feed on can be determined and also used to raise the larvae.

Have youth create a skill station using either the information from the Life Stages Activity or from the Insect or Non-Insect Activity.
# Handout 4.1

## My Insect Information

### Insect #1:

**Type of Metamorphosis:**
- [ ] Complete
- [ ] Incomplete

**How are the stages of metamorphosis for this insect important to forensic entomology?**

[ ]

**Other interesting details/facts about this insect:**


### Insect #2:

**Type of Metamorphosis:**
- [ ] Complete
- [ ] Incomplete

**How are the stages of metamorphosis for this insect important to forensic entomology?**

[ ]

**Other interesting details/facts about this insect:**

[ ]
Insect #3: A

Type of Metamorphosis: □ Complete □ Incomplete

How are the stages of metamorphosis for this insect important to forensic entomology?

Other interesting details/facts about this insect:

Rubric Questions

Determine whether your project is ready to use by asking these questions. Place a check mark (✓) next to any question you can answer yes to!

- Did we include information about ALL THREE insects?
- Does our project help others learn about the stages of metamorphosis AND how these insects are important to forensic entomology?
- Is our project fun and interactive? Would we enjoy using this to learn about metamorphosis and the importance of these insects to the world of forensic entomology?
- Is our project educational? Did we use resources that were reliable and accurate sources of information?

Archival copy: for current recommendations see http://edis.ifas.ufl.edu or your local extension office.
IF I WERE AN INSECT, I WOULD BE ...

START HERE

When are you usually more active? During the...
- DAY
  - Diurnal Insects
    - How do you prefer to work on an assignment?
      - By myself
        - Non-social Insects
          - Much different
            - Are you a vegetarian?
              - No
                - Lape of nicknames?
                  - No
                    - Firefly
                  - Yes
                    - Butterfly
                - Yes
                  - Lady Beetle
              - No
                - Which would you rather eat?
                  - Meat
                    - Did you like to swim when you were little?
                      - Yes
                        - Ant
                      - No
                        - Grasshopper
                  - Vegetables
                    - Juice
                  - Whatever is in the fridge
            - Very similar
              - Are you a vegetarian?
                - No
                  - Firefly
                - Yes
                  - Butterfly
            - Much different
              - Are you a vegetarian?
                - No
                  - Firefly
                - Yes
                  - Butterfly
        - Social Insects
          - With a group
            - Me
              - Juice
            - Beer
          - Whatever is in the fridge
    - Cockroach
      - When you were a baby, how did your looks compare to now?
        - Very similar
          - Are you a vegetarian?
            - Yes
              - Firefly
            - No
              - Butterfly
        - Much different
          - Are you a vegetarian?
            - Yes
              - Firefly
            - No
              - Butterfly
      - Much different
        - Are you a vegetarian?
          - Yes
            - Firefly
          - No
            - Butterfly
      - Very similar
        - Are you a vegetarian?
          - Yes
            - Firefly
          - No
            - Butterfly

NOCTURNAL INSECTS

Do you play musical instrument(s)?
- Yes
  - Cricket
    - Much different
      - Are you a vegetarian?
        - Yes
          - Firefly
        - No
          - Butterfly
    - Very similar
      - Are you a vegetarian?
        - Yes
          - Firefly
        - No
          - Butterfly
  - Much different
    - Are you a vegetarian?
      - Yes
        - Firefly
      - No
        - Butterfly
    - Very similar
      - Are you a vegetarian?
        - Yes
          - Firefly
        - No
          - Butterfly

DIURNAL INSECTS

When you were a baby, how did your looks compare to now?
SO, WHICH INSECT WERE YOU?

**ANT** - Most active during day (diurnal), works with other members of community to achieve a common goal (social), will eat most anything

**BEE** - Most active during day (diurnal), works with other members of community to achieve a common goal (social), eats pollen and nectar

**BUTTERFLY** - Most active during day (diurnal), a vegetarian, drinks nectar, young looks completely different than adult (holometabolous: think caterpillar vs. butterfly)

**CRICKET** - Most active during night (nocturnal), a makes a music by rubbing hind legs against wing

**COCKROACH** - Most active during night (nocturnal), young looks similar to adult (hemimetabolous)

**DRAGONFLY** - Most active during day (diurnal), aquatic nymph (baby), young looks similar to adult (hemimetabolous)

**FIREFLY** - Most active during night (nocturnal), eats other insects, snails, etc. (carnivorous), young looks very different from adult (holometabolous). Fireflies have many nicknames: they are actually beetles and not flies at all, and are called lightning beetles, lightning bugs, or blinkie-wallahs.

**GRASSHOPPER** - Most active during day (diurnal), a vegetarian, mostly eats...you guessed it—grass!, young looks similar to adult (hemimetabolous)

**LACEWING** - Most active during night (nocturnal), carnivorous, young looks very different from adult (holometabolous)

**LADY BEETLE** - Most active during day (diurnal), carnivorous, young looks very different from adult (holometabolous)

**MOTH** - Most active during night (nocturnal), a vegetarian, young looks very different from adult (holometabolous)

**PRAYING MANTIS** - Most active during day (diurnal), and a nymph, young looks similar to adult (hemimetabolous)

Forensic Entomology, Handout 4.2—page
Main Idea
This lesson introduces youth to the ten basic rules for insect collection as well as the basic tools of the forensic entomologist.

Objectives
Youth will be able to:
1. Discuss the Ten Basic Rules of insect collection.
2. Explain the use for each of the basic tools used by entomologists in the collection of insects.

Understanding the COLLECTION PROCESS

Insect Collections
At a crime scene, forensic entomologists begin their processing of the scene by collecting adult insects in the area. The most common methods use nets, although sticky traps placed near the corpse can be used as well. By collecting adult insects, forensic entomologists are able to determine what species may be on the corpse in larval form.

The next step is to collect larvae in order to determine PMI. Orifices on the body (eyes, ears, nose, anus, and mouth) as well as any open wounds are good places to look for eggs and larvae. Larvae of each species have unique migration patterns when they migrate away from their original food source. So, it is important for the forensic entomologist to not only collect larvae from around the body itself, but also underneath.

Overall, a forensic entomologist collects two samples from around the corpse. The first set of insects are used for immediate observation. These are preserved using boiling water and "kill jars," or ethyl acetate. The second set is allowed to remain alive in order to grow for larval or pupal identification. Both of these methods help provide a positive identification for the insect genus and species. With all these details, it is easy to see why one of the most important parts of a forensic entomologist’s job is documentation.

Background Information
Background Information (continued)

The Ten Basic Rules of Insect Collection

Mark Benecke, a forensic biologist, developed the following basic guidelines for arthropod collection:

1. Take very good close-up photographs of all locations from a variety of angles.

2. Photograph without flash. Maggots will flash out, "which a means they become just white a nothing," especially an image.

3. A metric and an analog scale should always be used in every photograph. This helps investigators indicate the relative size or a scale of the contents. A loan may be sufficient if a ruler is not available.

4. Collect a spoonful of insects from at least three different sites on the corpse and around the crime scene. An arborist can help label the samples.

5. Put half of the insects in 80% ethanol. Cheap ethanol 

6. At least should be a made to kill the animals with a hot water ("tea water") before placing them in an airtight container with ethanol.

7. If possible, put half of the insects alive in a refrigerator (not a freezer). Put fabric or aops of their apon lid containers. An arborist can breathe. Maturing might become an issue. So forward the animals. An arborist can store them in a freezer.

8. Label excessively: a location, exact time, date, initials.

9. If questions arise during collection, a forensic entomologist should be called.

10. Determination (i.e., identification of the arthropod species) must be performed by an experienced entomologist using keys that can be applied to the local fauna. However, for many regions of the world, appropriate keys are not yet available. Some forensic entomologists determine third instar larvae of known maggot species by the characteristics of the maggot's mouth parts.

Tools of the Trade

Forensic entomologists use a variety of tools to determine post-mortem intervals:

- Net
- Sticky traps
- Vials/kill jars
- Preservation chemicals (such as ethanol)
- Ethyl alcohol and acetone
- Latex gloves
- Forceps
- Live specimen containers
- Shovel
- Thermometers
- Labels (adhesive)
- Small paint brushes
- Foil
- Vermiculite and a scoop
- Graphite/pencil
- Hand towel
- Camera
- Ruler
- Paper towels
- Sifting screen
- Death acetone form

These background basics are taken from Forensic Entomology: Arthropods and Corpses, B. A. Mark Benecke, available as an entirety in PDF on the project website.

Activity 5 - Page 35
Activity 5

Read the following:

A You have learned about which insects forensic entomologists find most helpful as well as the stages insects go through as they change from eggs to adults. A

A Now, when forensic entomologists arrive at a crime scene, they are able to put all that knowledge to work. They collect the specimens that will help them solve the crime. This lesson is going to take us through the ten basic rules for insect collection. While also examining some of the other common tools forensic entomologists use in his process. A

A A A

Let's Begin

A There are three projects you can allow youth to complete for this activity. Depending on the resources and time available to you, you may resource and time are not a problem, you could also allow youth to complete both. It's a Snap and Caught You! A

A A A

It's a Snap

This activity teaches youth to capture insect evidence using an important tool— the camera. The camera captures that precise moment in time in order to allow forensic scientists to have an opportunity to examine those specific details later. A

A Have youth read a verbatim handout 5.1, focusing on items 1–3. A

1. Take very good close-up photographs of all locations from where animals are collected. The state of insect-aided decomposition can severely change within days, even under cool conditions, and even when the body is stored in a cooling apparatus. Also, bites of mites should be documented on living persons (e.g., possible offenders). A

2. Photograph without a flash. Maggots will “flash out,” which means they become “just white nothings,” especially on digital photographs. A

3. A metric and an inch scale should always be used on every picture. A

A Now, separate youth into four groups. Then, using the directions within handout 5.1 (items 1–3), have each group take a photograph of the insect evidence for their assigned jar. Be sure to encourage youth to share the photographs. A

A Once each group has completed taking their pictures, allow them to download the images onto a CD or a thumb drive in order to create a digital presentation (either at home, or during another meeting). Provide each group with a time at the end of the activity to share their presentations. A

NOTE: Leader may want to use a camera (instant or digital) to record evidence and require youth to make a collage or add to their “files.”
Caught Ya!

This activity teaches youth how to capture insect evidence using other forensic tools. These tools have been used by entomologists for many years. To collect insects, they wish to study.

A Day 1A

Have youth read over the Handout 5.1, focusing on items 4-8. A

4. Collect one spoon full of insects from at least three different sites of the corpse and the crime scene in three different, clearly labeled jars.

5. Put half of the insects in 98% ethanol. Cheap ethanol (i.e., methylated spirit for camping purposes) can be used without any problems. Neither isopropyl alcohol (“hand cleaning alcohol”) nor formalin should be used! Killed insects can be stored frozen with or without ethanol.

6. Attempts should be made to kill the animals with hot water (“tea water”) before placing them in ethanol.

7. If possible, put half of the insects alive in a refrigerator (not a freezer). Put fabric on top of their open-lid containers so the insects can breathe. Maturing might become an issue, so forward the animals to a biologist within 1 or 2 days. Keep white larvae separate from brownish larvae and separate larvae from adults if possible.

8. Label excessively: location, exact time, date, initials.

Items 4-8 are only a small part of what goes into doing a proper insect collection. In order to learn what it takes, ask youth to separate into small groups of three or four youth and then visit the website at www.entnemdept.ufl.edu/bug_club/ent’events/collection101.shtml. A Once at the website, ask each group to research one of the following sections:

A Where do you Collect?
A How do you Kill your insects?
A How do you preserve/pin your insects?
A How do you label your insects?
A

Have each group share their findings before the end of the meeting.

A Day 2A

With their new knowledge about treating an insect collection, have youth begin their own hunt for insects using any of the tools you have provided for them. Remind them to use the practices that they learned from A Handout 5.1 and the Florida A’H Bug Club when collecting and preserving their insects. Have youth share their findings at the end of the meeting.

NOTE: Leader may want to use a camera (Polaroid or digital) to record evidence and require youth to make a collage or add to their “files.”
Let's Reflect

- What types of insects did you find on your hunt?
- What was the hardest one to capture? Why do you think it was the hardest?
- Which insect was the easiest to capture?
- What tools were you using? Would it have made a difference if you had been using a different tool?
- What would you say is the most important rule in creating an insect collection?
- What would you do differently next time?
- Often we are asked to follow a particular set of directions in order to do something. In this case, collecting and preserving insects has a very particular process. Why is it important to follow these directions?
- How would choosing to not follow directions change a scientist's ability to do his or her job?
- How can choosing to not follow directions limit your ability to do what someone has suggested you do?

Let's Apply

- Often we are asked to follow a particular set of directions in order to do something. In this case, collecting and preserving insects has a very particular process. Why is it important to follow these directions?
- How would choosing to not follow directions change a scientist's ability to do his or her job?
- How can choosing to not follow directions limit your ability to do what someone has suggested you do?

**EXTENSION ACTIVITIES**

Youth who are interested in doing more insect collections can participate in the Florida 4-H Insect Collection Contest. Use the link below to find out more information about this annual event.

http://www.entnemdept.ufl.edu/bug_club/ent-events/collection-contest.shtml
**Handout 5**

**The Ten Basic Rules of Insect Collection**

Mark Benecke, a forensic biologist, developed the following basic guidelines for arthropod collection:

1. **A** Take every good close-up photograph of all locations from a where an insect is collected. The state of an insect aided decomposition. An anciently change within days, even under a cool environment. Also, bites of insects should be documented on living persons (e.g., possible offenders).

2. **A** Photograph without a flash. Maggots will flash away, which means they become a thought. "(especially in digital A photographs."

3. **A** A metric and an inch scale should be always be used in every A picture. This helps investigators indicate the relative size or a scale of the contents. A coin may suffice in a ruler. A foot (available.)

4. **A** Collect one spoon of insects from at least three different A sites on the corpse and around the area. Insects are collected in a clear, labeled jar.

5. **A** Put half of the insects in 98% ethanol. Cheap ethanol (i.e., a methanol spirit) for camping purposes) can be used. Without any problems. Neither isopropyl alcohol ("hand cleaning A alcohol") nor formalin should be used. Killed insects can be a stored frozen with or without ethanol.

6. **A** Attempts should be made to kill the animals with a hot water ("tea water") before placing them in ethanol.

7. **A** If possible, put half of the insects alive in a refrigerator (not AA freezer). Put a fabric over the top of the insect. Keep it cool. Insects can breathe. Maturing might become an issue. Forward a the animals a biologist within 3-4 days. Keep white larvae separate. From brownish larvae and separate larvae from adults if possible.

8. **A** Label excessively. A location, exact time, date, initials.

9. **A** If questions arise during collection, a forensic entomologist should be called.

10. **A** Determination (i.e., identification) of the arthropod species must be performed by an experienced arthropod entomologist using keys that can be applied to the local fauna. However, for many regions of the world, appropriate keys are not yet available. Some forensic entomologists determine a third instar A larva of a known maggot species by the characteristics of the maggot's mouth parts.

**Tools**

- Net
- Sticky traps
- Vials of formaldehyde
- Preservation chemicals
- Ethanol
- Latex gloves
- Forceps
- Live specimen containers
- Shovel
- Thermometers
- Labels (adhesive)
- Small paintbrushes
- Foil
- Vermiculite
- Ruler
- Graphite pencil
- Hand towel
- Camera
- Shovel
- Latex gloves
- Sticky traps
- Sifting screens
- Mortar and pestle
- Death scene form

**Arthropods**

These background basics were taken from Forensic Entomology: Arthropods and Corpses by Mark Benecke, available at his entire project website: a.

**Forensic Entomology, Handout 5**
Main Idea
This lesson provides an introduction on estimating population sizes using the quadrant sampling method.

Objectives
Youth will be able to:
1. Estimate the number of caterpillars on the page.
2. Measure a 5 cm x 5 cm square using a ruler.
3. Measure the length and width to find the area of a rectangle.
4. Find the difference between his/her estimate and the class average, before and after sampling.
5. Describe two reasons why population estimates may have differed among youth.
6. Explain two scenarios where scientists might use quadrant sampling.

Understanding SAMPLING
Organisms and things “accrue differently at different times.” Often, a scientist or experimenter does not have the time and resources necessary to account for every member of a population of interest. Therefore, a sample of a type and number, usually greater than one, is taken. The sample(s) serve as a representative estimate of the true population number. From these sample counts, the average population number and the average values are calculated. These new values are termed statistics and statisticians analyze and interpret statistical principles underlying statistics. One special type of sampling is called “sequential sampling.” It was invented during World War II to reduce the number of manufacturing errors in the making of weapons and ammunition.

Background Information

Activity 6 - Page 40
Often, the purpose of sampling a population of organisms is to determine their numbers and space. A basic way we want to estimate certain values about a population, termed parameters such as the average value or a mean, and the variation or variance among the samples. The variance actually is a measurement of how much a sample value differs among itselfselves. This is known as a “distribution.” And we can think of the distribution as a value for the mean surrounded by the values that are less and greater than the mean in which make up all the sample values. Since there will be a sample value that are repeated, the distribution actually represents the frequency of each of the sample values. A normal distribution is always less than the mean and the variance and the values closest to the mean will occur with the greatest frequency. Other distributions of counts also occur and are have different relationships between the mean and variance. One is a distribution as a known as the Poisson distribution (mean and variance are equal) and another is the negative binomial (variance is greater than the mean). As the distribution of the sample frequencies is known, it is easier to choose the appropriate A statistical analysis for advanced study, you might search the Web for these distributions to find out how they are graphically depicted.

A By sampling a population, hypotheses about the population can be tested. There are many sampling methods available, and the method used depends on the question being asked. An exercise you will do is to introduce a few methods of sampling and asked to apply them to different types of a population. Another word, you will use your sample data to pose hypotheses about the populations you are studying, and then make inferences about your results.

A Two Types of Sampling
The first method referred to as quadrant sampling. Quadrant sampling uses a small plot to sample a population in a larger area.

A The second, which is often used for estimating animal populations, is known as mark-recapture sampling (or capture-recapture sampling). For example, a biologist might set live traps for a certain kind of a beetle. Once collected, each beetle could be marked with a fingernail polish and then be released back to the wild. After a certain amount of time, the beetle then be recaptured. Another sample of beetles is caught. Some of the beetles that were captured may be new ones; however, some before, but some of them may be marked individuals from the first trapping.

### Activity 6

**Advanced Preparation**
- This activity fits well with the themes of population density and a population. Sampling methods. It may be helpful for students to be introduced to the idea of population sampling and purposes behind a sampling before completing this activity.
- Make copies of the activity handouts for each student (or pair of students) and place the caterpillar field on a separate sheet of paper. Attach them to the back of the sheet.
- Be sure there are scissors, index cards, and a metric ruler for each group.

**Materials for Activity**
- 

**For Each Group...**
- Metric Ruler
- Pair of Scissors
- Pencil
- Index Card

**For Each Youth...**
- Handouts 6.1, 6.2

**NOTE:** Leader may want to use a camera (instant or digital) to record evidence and require youth to make a collage or add to their “files.”
Read the following:

So far, you have seen many tools of the trade forensic entomologists use when trying to solve a case. Now, think back to our first activity where you observed the various insects that had collected on a ‘corpse’. One of the tasks you were asked to do was to count the number of insects you saw on your ‘corpse’. How easy or difficult was that to do? Now imagine if that was an entire animal or human corpse. That would be a lot of counting.

Sometimes it is good enough to estimate the number rather than counting each and every one. Remember, some of those insects can lay over 500 eggs each! In order to get an estimate as accurate as possible, scientists often make samples.

Let's Begin

Read the following:

Here are some terms you will need to know as we talk about samples.

- **Population**: the total number of individuals occupying an area or making up a whole
- **Population Density**: usually expressed in terms of items or organisms per unit area. An example of this would be 2300 dogs per 1 square mile.
- **Population Sampling**: selecting a number of study subjects from a defined population in order to approximate a picture that represents the whole

Now, distribute Handout 6.1 and Handout 6.2, rulers, index cards. Have youth work individually or in pairs. Have youth complete all steps on worksheet to estimate the number of caterpillars in Farmer Melanie’s field.

After youth complete steps 1–10 on the worksheet, compile all the student data on an overhead projector or on the blackboard. Find the mean of all youth’s estimates to get one class estimate.

Finally, youth should next complete the Population Questions 1–4.

**Answer Key:**

for *Caterpillar Chaos!*

- Measurements below were made from the inside of the BOLD BLACK LINE.
- Width = 18.1 cm
- Length = 18.7 cm
- There are 280 caterpillars in the field.

**NOTE**: Leader may want to use a camera (Polaroid or digital) to record evidence and require youth to make a collage or add to their “files.”
Let's Reflect

- Did every group come up with the same average? Give two reasons why you think this is the case.
- How far was the class estimate from your estimate before sampling? (Hint: Subtract to find an answer) After sampling?
- Why do you think a scientist would use quadrant studies to measure populations of organisms? Too difficult to count each organism, convenient if animals or plants are spread evenly over an area.
- Can there be too many of a certain type of plant or animal in a certain area? Give two examples to support your answer.
- Would you have been able to complete this sampling activity if you had not been able to measure using the metric system? Justify your answer.
- Why would record-keeping be important to a farmer who is trying to manage pests in his/her crop? (Think of farming on a year-to-year basis, for example).

Let's Apply

- Give two or more scenarios where using a quadrant would help to estimate a population. Your examples can be for sampling insects as well as other animals or plants.
- When do you use the skill of measurement in your life?
- When do you use the skill of prediction (estimation) in your life?
- When is keeping records important in your life?

Extension Activities

Have youth research other methods scientists and other researchers use to sample the population that they are interested in studying.
**Too Many Caterpillars!**

**Instructions:** Please follow each step carefully and in order.

1. Measure the length and width of Farmer Melanie's field (Handout 6.2) in centimeters. \[ A \text{ m} \times A \text{ m} = A \text{ m}^2 \text{ (total area; record as } G \text{ below)} \]

2. Estimate the number of caterpillars in the field. Your estimate: \[ A \]

3. Cut out a 5 cm by 5 cm square from an index card. This is your quadrant.

4. Lay your copy of Farmer Melanie's field on a flat surface.

5. Drop your paper quadrant onto the field and trace around it with a pencil or pen. If your quadrant lands off the field, try again until it lands fully on the field.

6. Count the number of caterpillars in your square (this is \[ A \]). If there is a part of a caterpillar within the square, round up to "1" if it is more than \( \frac{1}{2} \) and down to "0" if it is less than \( \frac{1}{2} \).

7. Repeat steps 4 and 5 four more times. Record your data in the table below.

8. Find the mean (average) of your five samples by adding them together and dividing by five (number of trials). \[ F \]

9. Multiply the average of your five samples by the area of the field (\( FA \)). This is your total number of caterpillars in the field.\[ F \times G \]

<table>
<thead>
<tr>
<th>Caterpillars per quadrant</th>
<th>( A )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trial 1A</td>
<td>A.A</td>
</tr>
<tr>
<td>Trial 2A</td>
<td>B.A</td>
</tr>
<tr>
<td>Trial 3A</td>
<td>C.A</td>
</tr>
<tr>
<td>Trial 4A</td>
<td>D.A</td>
</tr>
<tr>
<td>Trial 5A</td>
<td>E.A</td>
</tr>
<tr>
<td>Average of 5 trials</td>
<td>F.A</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Area of field</th>
<th>G.A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total number of caterpillars in field</td>
<td>H.A</td>
</tr>
<tr>
<td>Average of class data (to be worked on board)</td>
<td>I.A</td>
</tr>
</tbody>
</table>
Follow the directions found on your “Too Many Caterpillars” worksheet.
Taking an Insect Census:
MARK-RECAPTURE

Grade Levels: 6—8
Subjects: Science, Mathematics
Setting: Indoor
Time Needed: 50 minutes
Science Skills: Population sampling, Prediction
Life Skills: Critical thinking, Keeping records
Materials Needed: Mark-Recapture
For each small group...
- Approximately 4 dozen mealworms*
- Permanent marker (black, blue or purple)
- 2 plastic boxes
- Wheat flour or germ

*Missing the mealworms? You can use approximately 1/2 pound of dried beans (pinto, kidney, etc.) instead of the 4 dozen mealworms.

For each youth...
- Handout 7

Sunshine State Standards:
SC.(5,6,7).N.1.1
MA.4.G.3.3
MA.7.S.6.1

Main Idea
This lesson provides an introduction to estimating population sizes using the mark-recapture sampling method.

Objectives
Youth will be able to:
1. Estimate the number of mealworms or beans in a box.
2. Use an algebraic expression to calculate a population estimate.
3. Calculate which of two estimates deviates least from an actual population.
4. Modify a sampling method in two ways to increase accuracy.
5. Identify one reason why a scientist would use the mark-recapture method.
6. Contrast one animal mark-recapture would work well for with another animal it may not work well for.

Understanding SAMPLING
What is sampling? Organisms and things occur differently in time and space. Often, we would like to know how many there are of something and what their pattern of occurrence might be. For example, we might like to know what the differences are in the average height between boys and girls. Usually, a scientist or any other experimenter does not have the time or the resources necessary to account for every member of a population of interest. Therefore, a sample of some type and number, usually greater than one, is taken. The sample(s) will serve as a representative estimate of the true population number. From these sample counts, a sense of the average value and the variation in the values are calculated. These new values are termed statistics, and statisticians analyze and interpret the numerical data.

A Sampling theory is strongly rooted in the mathematical principles underlying statistics. One special type of sampling, called sequential sampling, was invented during World War II to reduce the number of manufacturing errors in the making of weapons and ammunition.
Often, the purpose of sampling a population of organisms is to determine their numbers. To do this, we estimate certain values about the population, termed parameters. These parameters could be the average value or the mean, and the variation or variance among the samples. The variance as actually defined represents the frequency of each value of the population. The distribution is often called “normal.” The distribution of a population is always less than the mean, and the values of the closest value to the mean will occur with the greatest frequency. Other distributions of counts also occur. Sometimes the distribution is known, and in that case you may choose a statistical analysis to test the hypothetical hypotheses about the populations you are studying, and then make inferences about your results.

A

Two Types of Sampling

The first method is referred to as quadrant sampling. Quadrant sampling uses a small plot to sample a population in a larger area. 

A

The second, which is often used for estimating animal populations, is known as mark-recapture sampling (or capture-recapture sampling). For example, a biologist might set live traps for a certain kind of beetle. Once collected, each beetle could be marked with a tab of fingernail polish and then released back to the wild. After a certain amount of time, say a week, the traps are reset and another sample of beetles is caught. Some of the beetles in this second group will be new ones, never seen before, but some of them may still be marked individuals from the first trapping.

### Activity 7

#### Preparation
- Set up a plastic box with lid containing a大约有100只甲虫和一些小麦。用面粉和小麦进行实验。
- Divide students into groups of 3 or 4. A
- Make sure each group has a permanent marker, a extra plastic box, and a copy of the handout for each student.
- Place 4 equidistant spots on the board (shown below).

#### Materials for Activity:
- 4 screen boxes
- 12 large mealworms* A
- Permanent marker (black, blue, or purple) A
- 2 plastic boxes A
- Wheat flour and germ A

*Missing: 1 mealworm A

You can use an approximately 1/2 pound A

of dried beans the pint, kidney, etc.) A

instead of the 12 mealworms.

A

For each youth... A
- Handout / A

**NOTE:** Leader may want to use a camera (instant or digital) to record evidence and require students to make a collage or add to their “files.”
Let's Begin

These instructions apply to either specimen choice (mealworms or beans). The worksheet (Handout A 7) is also applicable to either choice.

A

\[
\begin{align*}
N & = n \\
M & = m
\end{align*}
\]

A

1. Have students follow instructions on worksheet. Each student should make an estimate of how many animals (mealworms or beans) they think are in their group’s box. NO COUNTING!

2. Each student can be given a different job, such as Handler, Marker, Recorder.

3. The Handler begins by picking up a handful of the animals from the box. The Marker will then color the specimens with a marker and then release them back into the population. Gently placing them back into the container and stirring them around. The Recorder should write down the number of specimens from that handful. Once they are marked (M), A

4. The Handler (the same student who picked a handful of the animals) picks up another handful of the animals. The Recorder should write down this number as an A.

5. Within an A, there should be some specimens that are marked. The Recorder counts the previously marked animals and records his or her number as an A.

6. Simply knowing these three numbers (M, A, and an) is not enough to make a calculated estimate of the total number of animals in an A box (N). A

Multiply A by M and divide by an N.

7. Finally, remove the specimens and count them. Place them into the other box to help keep track.

8. Students should answer questions 8–11 on their worksheet individually.
Let's Reflect

- Was your estimate closer when you predicted the number of specimens at the beginning, or after marking and recapturing (on a worksheet)? Why do you think this was the case?

- Could you have gotten your estimate closer to the actual number of specimens in the box? Why do you think this was the case?

- Why do you think a scientist would use the mark-recapture method instead of counting all the individuals in a population?

- Compare one insect type (or another animal) that mark-recapture would work well for another type (or another animal) that may not work well for (on a worksheet). Why is this?

- Why would record-keeping be important to make mark-recapture sampling as accurate as possible?

- Why might a scientist have to think critically to plan exactly how to sample a population?

- What are some similarities between the quadrant and mark/recapture methods? Some differences?

Let's Apply

- When have you had to use the skill of prediction before?

- What could you do to predict the examples you have above more accurately?

- Why is keeping records important to make mark-recapture sampling as accurate as possible?

- Have you ever had to guess the number of something? How did you go about doing it? Would the mark-recapture method have helped you make that guess?

- Scientists have to think critically (solve a problem by looking at it from many angles). Think of a time when someone you know had to think critically to help them solve a problem.
1. Estimate the number of animals you think are in the box: 

2. Now pick up a handful and count them. This is your first trapping sample, M.

   \[ M = \underline{\text{______}} \]

3. Mark these specimens by placing a visible dot on their backs with your permanent marker. Release them back into the population after they have been marked.

4. Shake the box and (without looking) pick up another handful. This is your second trapping sample, n.

   \[ n = \underline{\text{______}} \]

5. Some specimens in your second trapping sample were probably already marked. Count how many were already marked; this number equals m.

   \[ m = \underline{\text{______}} \]

6. Use the mark-recapture equation to calculate your population estimate, N.

Show your work here:

\[ N = \frac{n (M)}{m} \]

\[ N = \underline{\text{______}} \]

Population Estimate
7. Now, count the actual number of animals in your box: **_____**

8. Which was closer to the actual number of animals in your box — the estimate using sampling, or your initial estimate? **_____**

9. What are two ways you could increase the accuracy of your estimate (when using the sampling method)? **_____**

10. What is one reason a scientist would use the mark-recapture method instead of counting all the individuals in a population? **_____**

11. Can you think of one type of animal that the mark-recapture method of sampling might work well for? One that it would not work well for? Why did you choose these animals? **_____**
Main Idea
This four-day lesson may stand alone or can be integrated into a unit on forensics, black bears, entomology, or science process skills. Permission from school administration should be granted before setting up the crime scene on school grounds.

Objectives
Youth will be able to:
1. Practice observation skills by recording observations of a mock crime scene.
2. Determine a Post Mortem Interval by making inferences about their observations.
3. Identify insects found at the crime scene.
4. Communicate findings with group members.
5. Compare identifications and findings with other groups.
6. Determine which suspect committed a crime by making an inference.
7. Determine what evidence is necessary to accuse a suspect of killing an animal.

Background Information

Understanding the CONNECTION between insects and forensic entomology

The Post-Mortem Interval (PMI) is the time elapsed between death and discovery and medical examination of a body. The knowledge of forensic entomology can help determine the PMI, if the evidence is properly collected, preserved, and analyzed. After 48–72 hours, forensic entomology is often the only method for determining the APMI. Blowflies are the first visitors to a corpse, followed by beetles and other insects. Knowing which insects are present and which stage they are in (maggots, adult, for example) can help determine how long ago a death took place. 

Sunshine State Standards:
SC.6.N.1.4
SC.(5,6,7).N.1.1
If a body is soft, it is likely that the death occurred less than three or more than 36 hours ago (>3 or <36 hours). If a body is stiff, the PMI is most likely between three and 36 hours. If there are flies around the body, the PMI is between three and 36 hours. If there are maggots (fly larvae) on the body, the PMI is 3 or more days. If there are maggots, the PMI is 3 – 5 days. Body stiffness and insect presence can be greatly affected by the time of year (day length, temperature, humidity, presence of certain insects), location (sun vs. shade, body placed in bag or freezer), or other factors.

**Defining the PMI Stages**

*Fresh* stage: The process of decay begins with blow flies (family: Calliphoridae) and flesh flies (family: Sarcophagidae) finding the body. They can arrive within 10 minutes of death! They lay their eggs, from which maggots hatch, and begin to feed on the tissues. Beetle larvae may also arrive to feed on the maggots (not on the corpse). Depending on weather conditions, it represents days 1 – 3 PMI.

*The Bloating* stage: Next, house flies (family: Muscidae) join the other flies and their maggots. A feeding mass helps liquefy the tissues. At this point, there are a lot of maggots feeding on the body and the competition (as well as number of predators that come to eat on the maggots) increases. Depending on weather conditions, it represents days 2 – 6 PMI.

*The Decay* stage: This is when the decay of a body really starts to smell bad. By the end of this stage, most maggots have finished development and begin to leave the body. They seek a place to pupate in the soil. The corpse becomes devoid of all flesh, except cartilage, bone, and skin. Depending on weather conditions, it represents days 5 – 11 PMI.

*Post-decay* stage: Beetles come to feed on the remains. Depending on weather conditions, it represents days 10 – 25 or more PMI.
Activity 8

Preparation:

- On Day One, the leader (with the facility/administrator's permission) will set up the room for the morning before school. Be sure to place the crime scene, against where a young animal (or chicken) was attacked. A hammer and a shovel will be present. If a girl or boy chooses a group, they will be responsible for hammering up the ground area approximately two to three feet in diameter. The area should be cleaned up by the crime scene. On the ground, within the crime scene, place two to three yards of thick, fake fur (or fake fur, and a bag of sand). And dump fake chicken if it is present. Spread the fake chicken if it is present. At the end of the school day, a group is expected to hammer up the scene and make every attempt to clean up properly.

- Also, determine how you will form groups of threes. Each group will choose a group number or group name. Each group member will have a roll (illustrator, scribe, crime scene manager), and each number within a group may also want a position.

Materials for Activity A

Black Bear Mystery

For each small group...

- Fresh chicken is available at most grocers and in the meat department. A faux bear (at most fabric stores)
- Faux black fur (yards are available at most fabric store)
- Camera (or camera for each group of three)
- Transparency film
- Thermometer

A

For each youth:

- Copies of Case & Suspects page A, observations page A, and questions page A
- Pencil and colored pencils
- Clipboard
- Thin wooden stick/stake for a test to allow stiff and flexible A

Day 1

In morning
Teacher sets up
crime scene

During class
Scripted crime story

For tomorrow
Notes/research

Day 2

During class
To schoolyard for observations

Share findings with small group

Day 3

During class
To schoolyard for observations

Follow-up identifications

Day 4

During class
Follow-up class discussion

Schedule Overview

Day 1

In morning
- Teacher sets up
  crime scene

During class
- Scripted crime story

For tomorrow
- Notes/research

Day 2

During class
- To schoolyard for observations

Share findings with small group

Day 3

During class
- To schoolyard for observations

Follow-up identifications

Day 4

During class
- Follow-up class discussion

NOTE: Leader may want to use a camera (instant or digital) to record evidence and require students to make a collage or add to their “files.”
Day 1A

Read this script to youth:

Yesterday morning, a phone call from the director of the Florida Fish and Wildlife Conservation Commission (FWCC) indicated that a bear had been killed in the Ocala National Forest. The FWCC is asking for your help in determining how long ago the bear was killed. The lead investigator is an arrestworthy offender who has illegally shot the bear. The remains of the bear are being brought to your site for your analysis (later today/tomorrow).

Ask students:

What are some ways you can tell how long ago the bear was killed?

They may not have any ideas, but allow them to guess based on their prior knowledge.

Read a sheet (via overhead transparency, if possible) to students.

Have students get out a piece of paper and a pencil. Ask a short set of notes to record their ideas (or provide them with the one included). Students should write down the phrase “Postmortem Interval (PMI).” Ask students what they think this means—break this down into words: “Post” (after), “mortem” (death), “interval” (elapsed time).

Review the important ways to tell how long ago something died:

A

Is the body stiff or soft or stiff after a time?

Stiff = between three and six hours

Soft = less than three or more than six hours

A

What types of insects were present around the body and are they adults?

1. Under specified environmental conditions, it is possible to predict within a few hours the exact order of the insects that will appear on a carcass/corpse, when they are adults. A

2. Flies and beetles are the most important “key witnesses.” Insects are forensic entomology—they are the first to arrive at a scene.

3. Depending on how much time you have and how detailed you’d like to make your notes, go through the stages of decay (Fresh through Post decay) with students.

Day 1A

Yesterday morning, a phone call from the director of the Florida Fish and Wildlife Commission (FWCC) indicated that a bear had been killed in the Ocala National Forest. The FWCC is asking for your help in determining how long ago the bear was killed. The lead investigator is an arrestworthy offender who has illegally shot the bear. The remains of the bear have been brought to your site for your analysis (later today/tomorrow). There are three suspects in this case, which have been profiled on a handout. You will receive a momentary call to determine if they are legal hunting license holders.

NOTE: Leaders may want to use a camera (instant or digital) to record evidence and require youth to make a collage or add to their “files.”
At this point, divide the students into groups of three. Assign each group a role of Illustrator, Scribe, and Crime Scene Manager within each group. Pass out the observation form, clipboard, and items listed for each role accordingly.

**Illustrator:** Sketches all aspects of the crime scene with colored pencils. Include drawings of any insects (or other animals) that are at the crime scene. The drawing should be so descriptive such that someone who hadn’t seen the crime scene could imagine it in detail.

**Scribe:** Maintains a written log of all observations. Include written, detailed descriptions of any insects (or other animals) that are at the crime scene. The writing should be so descriptive that someone who had not seen the crime scene could imagine it in detail.

**Crime Scene Manager:** Makes sure Scribe and Illustrator have all materials and are on-task and that no group member crosses crime scene tape or touches the evidence. Also should assist scribe or illustrator upon request. If camera is available, photograph scene and group members examining scene. Each group member must fill out an observation form.

A

**You will be observing the remains of this black bear. Just as in any crime scene, you may not touch the remains as you cross the crime scene area.** To assess the tightness of the bear’s body with a wooden stake, when testing the remains by poking them with a wooden stake, you must use care. Do not move the remains. For this portion of the exercise, an exchange or you completing part of their role after an assignment. At this event, you may walk quietly after a specified place in full view of the teacher.

A

**Once the students are fully aware of their roles and what they are looking for, the whole class should be escorted to the crime scene by the teacher. Allow each student to have an initial reaction to the scene before beginning their job. After the initial reaction, each group member should begin their assigned job (as described above).**

**Day 8A**

Students should go outside and fill out observation forms again. Any changes to the crime scene should be noted. The descriptions and drawings of Scribe and Illustrator. Crime Scene Manager should fill in the same roles as they did before.

A

Students should identify any insects described or drawn by using one or both of the recommended references (Forensic Insect Identification Cards or http://ipm.ncsu.edu/4H/CSIfinal.pdf). Students can also refer to other insect photo guides or websites at the instructor’s discretion.

**NOTE:** Leader may want to use a camera (instant or digital) to record evidence and require youth to make a collage or add to their “files.”
Day AA

Students should begin class in their small groups. If they did not finish insect identifications from Day 3, this may be an appropriate time to do so.

Pass out suspect sheets to each group. Allow groups to determine amongst themselves who they think the criminal offender is. Ask them to not shout out or share with the class, but rather begin to answer the questions on the back of the suspect sheet.

Collect groups’ data and compile as a class: animals seen at the crime scene, other important observations, and what this tells you about how long ago the bear was killed.

After compiling the data, ask each group to write down the name of who their group thinks is the suspected criminal on a piece of paper and turn it in (or to a designated student) as a silent ballot.

Announce the results to the class, then follow up with a reflect and apply questions (out loud, or as part of a written assignment).

Let’s Reflect

- How did you work as a team to complete this activity and solve the case (the problem)?
- Why was it important to be a careful observer when it came to recording or drawing details?
- How did your group communicate your findings to another? To the class?
- Do you need any additional information to make an inference about which person is guilty? Why or why not?
- Which insects (or other animals) that you observed came to the corpse first?
- What methods did you use to classify these insects? In other words, how did you figure out what they were?
- Once you had your data (based on your observations), how did you use this to make a conclusion about the identity of the guilty party?
Let's Apply

- How is the skill of working as a team important for working in groups on school projects or in athletics?
- Have you had to use problem-solving skills in a situation with your family? How did you solve the problem?
- When does the skill of observation help you in your daily life?
- Think of five times you have used the skill of communication already today. (You may want students to list these on paper.) How can someone become a better communicator?
- Has someone ever made an inference about you? Are inferences always true/factual?
- When do you use the skill of classification in your everyday life? (Think of organizing closets or drawers at home.)
- Imagine you are working on a science fair project. What would you do once you have gotten all your data? (Make a conclusion by processing, or interpreting, your data.)

EXTENSION ACTIVITIES

If you would like to view more of the insects that come to a decaying corpse, allow the chicken livers to decay for several days (having them in jars works well because they are easy to transport and put lids on when needed) before setting up the crime scene. This would cause another suspect to be the correctly accused suspect. Have the students research what types of insects they would see on the bear at the different stages of PMI.

Have students collect insects around bear crime scene using tweezers and collecting nets. Students may identify insects to order or family level using pictures or a key.
The Case:
In 1994, The Florida Fish and Wildlife Conservation Commission (FWCC) outlawed the shooting of a Florida Black Bear anywhere in Florida. However, a call came in to the Director of FWCC that a Florida Black Bear was found, shot and abandoned (with much of the fur missing), in the Ocala National Forest.

Your Task:
Examine the remains of the bear and determine when this bear was actually killed so that the FWCC can try and determine the person responsible for its death.

The Suspects:

Bayer “Taxi” Dermist
Selling black bear pelt in Jacksonville, Florida.
Investigators collected pelt and say the fur is about one week old.

Hunter O’Bears
Was spotted, yesterday, illegally hunting out of season in Ocala National Forest, and brought in for questioning.

Ishoda Behr
Repeat Florida Black Bear hunter. Was seen in the Ocala National Forest two weeks ago, and has been out of the country since then.
**Crime Scene Team**

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Illustrate the crime scene in detail.

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The Black Bear Murder Mystery

1. Which insects came to the bear remains first? A
   A
   A

2. What does this tell you about how long ago the bear was killed? A
   A
   A
   A

3. Which suspect most likely killed the bear? Why? A
   A
   A
   A

4. What kind of evidence do you think is still needed to find this person guilty? A
   A
   A
   A
   A
   A
Exploring the Field of Forensic Entomology

Main Idea
This final lesson provides youth with an opportunity to explore what it would take to become a part of the field of forensic entomology.

Objectives
Youth will be able to:
Discuss the requirements for working in the field of forensics, entomology, or forensic entomology.

Activity 9

Read the following:
You have now completed the Black Bear Murder Mystery. What do you think of the field of forensic entomology? What do you think about the way insects can aid forensic scientists, but what does it really take to become one of these scientists? This final activity gives you an opportunity to explore what it would take for you to become a part of this field.

Let's Begin

Provide youth with Handout 9 and access to the Internet (allow them to pair up to complete the activity if computer resources are limited). Give them the remainder of the time to research the answers to the questions presented on Handout 9.
Let's Reflect

- What was the most surprising fact you found about being a forensic entomologist?
- Which schools would you have to attend or what kind of degree would you need to have earned in order to work in this field?
- If you had not been interested in any of these fields, what courses will you need to focus on in middle and high school in order to be well prepared for college?
- Is there anyone who might want to work in this field? Explain why you feel that way. What interests you about it?

Let's Apply

- Why is it important to have an idea about what you would like to do once you graduate from high school?
- What are some steps that you would need to plan out in order to be best prepared to enter college?
- Everyone has strengths and weaknesses, things they like and things they do not. That's what makes our world so wonderful. What are some of the strengths you have that would make you a good scientist? What skills would you have to improve to overcome any of your perceived weaknesses?
- How could you use the activity we did today to explore any other field you might be interested in? Are there any other questions you would ask?
To begin, let’s take a look at what it would take to become a FORENSIC ENTOMOLOGIST.

1. What is a forensic entomologist?
2. Which college/university would you have to attend to study forensic entomology?
3. What college majors do forensic entomologists often have?
4. What are some of the main courses you would have to take once you got into college?
5. Would you be able to work as a forensic entomologist after you completed your undergraduate degree or would you need to get a more advanced degree?
6. Other than investigating crime scenes, what are some of the jobs that a forensic entomologist might also do?
7. Would you be limited in where you might live, or does every city have a trained forensic entomologist?
8. What professional networks exist that you would be able to join as a professional forensic entomologist?

OK, so, what if you like the CRIME SCENE, but not the bugs? That might mean you would be interested in the broader field of FORENSIC SCIENCE. Use the American Academy of Forensic Science website below to answer questions 9–15. If you prefer the BUGS but not the crime scene, skip question 6.

http://www.aafs.org/default.asp?section_id=resources&page_id=choosing_a_career

9. What skills do you need to be a forensic scientist?
10. What are the minimum requirements to become a forensic scientist?
11. What are some of the possible areas in which you could specialize? Which of these would you choose?
12. What major would you have in college if you chose that specialization?
13. What are some of the main courses you would have to take once you got into college?
14. Would you be able to work as a forensic scientist after you completed your undergraduate degree, or would you need to get a more advanced degree?
15. Other than investigating crime scenes, what are some other jobs that you might also be able to do with that degree?
So, you are more interested in the bugs than in the crime scene. That might mean you would be interested in a broader field of entomology. Use the Entomological Society of America website http://www.entsoc.org/resources/education/index.htm to answer questions 16–21. (If you answered questions 9–15, skip this section and go to question 22.)

16. Which college/university could you attend in order to study entomology?

17. What are some of the possible areas you could specialize in? Which one would you choose?

18. What major would you have in college if you chose that specialization?

19. What are some of the main courses you would have to take once you got into college?

20. Would you be able to work as a forensic scientist after you completed your undergraduate degree? Would you need to get a more advanced degree?

21. Other than investigating crime scenes, what are some other jobs that you might also be able to do with that degree?

Now, based on everything you have researched, let’s look at what you could do now to prepare for one of these fields.

22. If you wanted to work in any of these three fields, what courses would you need to focus on throughout middle school and high school?

23. A great way to find out more information about what these scientists actually do is to contact them. Find someone in the field you are most interested in and ask them any questions you might have about their field of study. Explain what you have just completed and would like more information about what they do. Most scientists appreciate sharing their love for science with others.
This lesson provides background on the role that insects have played throughout history, including both the good and the bad impacts they have had on numerous societies.

Objectives
Youth will be able to:
1. Justify why (or why not) insects are the most important animals in the history of the world.
2. Describe one way Earth would be different without insects.
3. Compose a timeline including insect and non-insect related historical events.
4. Illustrate an event in his/her life that (positively or negatively) involved insects.
5. Define “vector” in terms of insects and disease transmission.
6. Compare symptoms of malaria and plague.
7. Compose an original vignette of a “day of the life” of another illness/disease.

Vocabulary
- **Pollination**—transfer of pollen from male to female plant parts, assisted by insects such as bees and butterflies.
- **Earwigs**—elongated insects with pincer-like appendages protruding from the rear of the abdomen.
- **Springtails**—insects with a pair of elastic caudal styles that can be bent under the abdomen and then suddenly extended like a spring, enabling them to leap.
- **Vector**—an insect or other organism that transmits disease (via bacteria, virus, fungus, etc.).
- **Proboscis**—an extended, beak or straw-like mouthpart of an insect.
Let's Begin

Read the following:

In addition to knowing the type of an insect and what stage of life, it is also very important to be aware of the impact that insects can have on humans. Forensic archaeologists and entomologists often study fossilized insects or insect remains at an ancient site to understand the role insects may have played during that time. Let’s take a look at some of the critical roles that insects have played throughout history.

1. Break out youth into groups of 3-4. Give youth 10-15 minutes to work in groups: they should cut out insect answer boxes, and make their best guess as a group for the matching of the timeline.

2. After groups appear done with their best guesses, go through each answer as a class. Call on groups for their answers and their reasoning. If their answer is correct, let them know, and move onto the next item on the timeline. If incorrect, ask other groups’ answers.

3. Once the timeline is complete and correct, pass out glue to each group and have them glue correct answers onto timeline. If time remains following the Let’s Reflect and Let’s Apply sections, pass out colored pencils/markers and allow youth to color their timelines and hang them up in the classroom.

Answer Key

1. DRAGONFLIES - 285+ million years ago: Paleozoic Period; Appeared during prior to dinosaurs existence
2. EARWIGS - 145-245 million years ago: Mesozoic Period; Appeared during dinosaur existence
3. BUTTERFLIES - 25-40 million years ago: Cenozoic Period; Appeared after dinosaurs existence
4. SCARAB BEETLE - 2000 B.C.: Ancient Egyptians; Symbol of life, hope, and regeneration
5. BLOWFLIES - 1235 M.D.: Chinese; First recorded case of insect evidence in a criminal investigation
6. RAT FLEA - 1347 M.D.: Europe; Spread bubonic plague throughout Europe (wide spread)
7. BODY Louse - 1812 M.D.: Russia & France; Spread typhus fever, aid to defeat of Napoleon
8. MOSQUITO - 1847 M.D.: Mexican/American Border; Yellow fever caused 90% of the deaths, not battle
9. HARLEQUIN BUG - 1861 M.D.: America; First instance of alleged use of insects as a weapon of war
10. BOLL WEEVIL - 1919 M.D.: America; Trouble with this pest led to growth of valuable crops like peanuts

NOTE: Leader may want to use a camera (instant or digital) to record evidence and require youth to make a collage or add to their “files.”
Let's Reflect

When groups have glued down their timelines, ask the class the following questions:

- What was the hardest part about this activity?
- What process did you use to figure out which insect went with a certain time period?
- What was the easiest insect to match with its time period? Why do you think that was the easiest to match?
- What other insects can you think of that were important in history that were not mentioned in this activity?
- Do you think insects are the most important animals in our history? If so, why? If not, why not?
- What would be different about our world today without insects?
- Add to the timeline other historical events, such as the appearance of humans or various wars.

Let's Apply

- Do you think insects are the most important animals in our history? If so, why? If not, why not?
- What would be different about our world today without insects?
By this time, however, dinosaurs were extinct, which means dinosaurs could never be recreated with DNA trapped in amber as in the movie "Jurassic Park." The premise of the movie (and book) "Jurassic Park" is that mosquitoes with dinosaur DNA were preserved and then trapped in tree resin as it hardened (and turned into amber). It was this blood that was extracted in the movie, and this is how the dinosaurs were cloned. However, this scenario probably could never happen, because by the time insects were being preserved in amber, dinosaurs were already extinct!
285+ MILLION YEARS AGO
PALEOZOIC PERIOD
These insects, along with beetles, flies, mammals, and dinosaurs, roamed the earth. Dinosaurs did not yet exist.

145-245 MILLION YEARS AGO
MESOZOIC PERIOD
This insect, along with beetles, flies, mammals, and dinosaurs, roamed the earth.

25-40 MILLION YEARS AGO
CENOZOIC PERIOD
These insects came into being, and it is during this time that insects were trapped in amber.

2000 B.C.
Ancient Egyptians considered this insect a powerful symbol of life, hope, and regeneration. Images of it can be seen on their jewelry and on their tombs.

1235 A.D.
These insects were used in the first recorded use of insect evidence in a criminal investigation. A murder case was solved because the insects were attracted to traces of blood on the killer's weapon.

25-40 million years ago
Cenozoic period
These insects came into being, and it is during this time that insects were trapped in amber.

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Handout 2
Forensic Entomology, Handout S1.2
1347 A.D.
This blood-sucking insect was responsible for transmitting bubonic plague. The disease wiped out much of the European population.

1812 A.D.
Typhus fever ended Napoleon's invasion of Russia. It was spread by this insect.

1847 A.D.
Yellow fever was spread by this insect during the Mexican-American War. Ten times as many soldiers were killed from the disease than in battle!

1861 A.D.
The American Civil War marked the first instance of alleged use of an insect as a weapon of war. The Confederacy accused the Union of introducing this type of insect into the South. Tremendous crop damage resulted in the South because of this pest.

1919 A.D.
A monument was built to honor this insect. Bad luck with this pest eventually led cotton farmers to turn to other valuable crops like peanuts.

Handout 2
Forensic Entomology, Handout S1.2
Background Information

**Vector-borne DISEASES**

In the study of human health and disease, a vector is any living carrier that transmits infections. That commonly includes insects. Two vector-borne diseases that you have heard of are malaria and the plague. These diseases have been around for centuries and are still being fought today.

A widespread disease in both tropical and subtropical regions, affects between 500,000—500 million people every year. Of the people affected by malaria each year, approximately 1.5—2.7 million die from the disease. The plague, another disease, affects 2,000—3,000 people about 10—15 times per year. During the Middle Ages, the plague claimed the lives of nearly a third of the population of Europe.

A Handout 3 or more information on malaria and the plague. Other good sources for reading about insect vector-determined human diseases are listed below.

**Books**

- *Buzz: The Intimate Bond Between Humans and Insects* by Glausiusz and Steger
- *Medical and Veterinary Entomology* by Mullen and Burden
- *Medical Entomology for Youth* by Mike Service

A Most encyclopedias have good descriptions of many insect vector-determined diseases like encephalitis and yellow fever.

**Internet:**

- Centers for Disease Control
  - [http://www.cdc.gov](http://www.cdc.gov)
- World Health Organization
  - [http://www.who.int](http://www.who.int)

---

Let's Begin

1. Read all or part of the two vignettes (malaria and the plague) aloud to a youth.
2. Read aloud “What Really Happened” at the end of each vignette.
3. Define a vector and a proboscis. Explain that a vector is a ‘spreader’ and a proboscis is a mouthpart of an insect. Examples include a needle-like organ or a straw-like proboscis for a butterfly. This can be a demonstration on an insect for a lunch lesson.
4. Pass out copies of vignettes (Handout 3) and worksheet (Handout 8.4) to each youth.
5. Construct a Youth Handout 3.4 as a group assignment. Have them form groups of 2-3 to work on the first three questions of the worksheet. Questions 4 should be answered individually as homework or as a class activity. Sources above for information on insect vector-determined human diseases.

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Image: UF University of Florida IFAS Extension
Let's Reflect

- What is a vector? How does it relate to entomology?
- What are some of the symptoms of malaria? How does it spread? How can it be prevented?
- What are some of the symptoms of the bubonic plague? How does it spread? How can it be prevented?
- Which disease did you think would be worse to have—malaria or the plague? Why? Give at least three reasons to justify your answer.
- Someone share what they found out about another vector-borne disease. Be sure to tell us what the vector is, how it spreads, symptoms, and any prevention methods you researched.

Let's Apply

- Why is it important to know the vectors for any disease?
- How could knowing how a disease is spread help scientists come up with ways to prevent the disease from spreading?

Extension Activities

Using the Internet or library resources, have youth explore additional personal accounts from these diseases. Have them share the stories they found during the next session.

Have youth create informational boards about a vector-borne disease.
January 23, 2004
Kampala, Uganda

I woke up in the night with a bad headache and nausea. I shivered but I was sweating like I was hot. I have been waking up like this every night for two years now—ever since I was eleven years old. My whole family has malaria. My mom and dad both seem ok—they are able to work and sleep better than I can.

I am tired and only get out of bed when I have to use the toilet. Ugh, the toilet. That word brings back thoughts of standing over it, nauseated and throwing up. Sitting on it, days of diarrhea. My mom gave the disease to my baby sister when she was pregnant with her. My baby sister was born with malaria. She died the day before she turned two years old. Her body got too sick because she was so little.
The Plague: A personal story

November 15, 1347
Venice, Italy

I woke up screaming with a terrible headache. My body shook and I couldn’t make it stop. I held on to the bedpost and tried to steady myself to stop the shaking. My stomach felt like it had been turned inside out and all of a sudden I realized I must have been vomiting in the night. In my bed. I tried to lift my arms to reach a glass of water. They wouldn’t move. My legs felt like they were glued to the bed. My eyes were the one thing that could still move, blink, blink, around and around. The light was too bright, though. I had to close them. I fell back into sleep for another day. Or was it two? I noticed my door and windows were boarded shut. How long had I been inside, I wondered? No one else was inside—my family and dog had already died of this terrible plague and I was the next victim. The next time I woke, there were lumps on my neck, my underarms, my thighs. They burned like they were on fire. Later the lumps turned black and split open. I could see lumps inside my thighs the size of oranges. Now I lie in bed, and I am bleeding internally. There is blood in my urine, blood in my stools, and blood collecting in pools under my skin. It looks like bruises, like I was badly beaten.

Thoughts race through my head. The past few months were terrible for my town. No one knows what this sickness is, or where it came from. Some people say it can be warded off by incense to keep away the deadly vapors. The air smells terrible, the smell of decaying bodies. There are no longer proper funerals, only holes in the ground for mass graves. Towns next to us have resorted to using sound to scare the disease away—clanging church bells and firing cannons. My mother bought charms and spells from the local apothecary, but she died last week anyway.

What exactly is happening?

The plague or “Black Death” is spread by fleas, which people did not suspect. Fleas were always around, but people did not even know insects could transmit disease. The plague killed nearly one-third of the population of the European continent (20 million people!) between 1347–1351.

The actual cause of the disease is a bacteria. The bacteria usually infects rodents but can be accidentally transmitted to humans.

Symptoms of the disease include high fever, headache, convulsions, blood poisoning, extremely swollen lymph nodes, and swollen buboes.

Now, the plague affects 2,000–3,000 people per year (about 10–15 in the United States). There is currently treatment available that greatly increases the chances of surviving the disease.
Insects & the Diseases they can spread to People

1. What is a vector?

2. What is the vector for malaria?

3. Which sounds like it would be worse to have — malaria or the plague? Why? Give at least three reasons (symptoms, for example) to justify your answer.

4. Search books or the internet to research an insect-vectored disease besides malaria or the plague. Some examples include West Nile Virus, Typhus, Dengue, Yellow Fever, or Encephalitis.

   a. First, list the cause of the disease (such as a bacteria or a virus) and the vector for the disease (such as a mosquito or fleas).

   b. On the back of this page or a separate sheet of paper, write a vignette, journal entry, or a story about the life of a person infected with the disease. Be sure you use complete sentences and describe symptoms the person experiences. Your entry should be 2–3 paragraphs. Think about how the disease is spread, what the symptoms are, how long a person can be infected, and any prevention methods that might be implemented.

Handout 4

Forensic Entomology, Handout S1.4
Insects & the Diseases they can spread to People
Biodiversity in the Food Court

Grade Levels: 6-8
Subjects: Science
Setting: Food court at shopping mall or other location.

Time Needed: One 50-minute block plus travel time

Science Skills: Observation, Communication, Classification, Prediction

Life Skills: Problem solving, Cooperation, Communication

Materials for this Lesson:
Food Court Activity
- Handout 5.1 (both sides, copied double-sided)
- Clipboard
- Pen/pencil
- Lunch money

Additional Handout:
- Handout 5.2 (both sides, copied double-sided)

Vocabulary:
- Diversity - variety or multi-uniformity
- Biodiversity - the diversity of plant and animal life in a particular habitat (or in the world as a whole)

Objectives:
- Students will be able to:
  1. Define biodiversity.
  2. List at least three types of plants (fruits, vegetables, and good examples) sold in an all food court.
  3. List at least three animals or animal products sold in an all food court.
  4. Estimate the total number of species involved in creating a lunch.
  5. Give an example of how biodiversity is important to an individual's life.

Background Information:

Understanding BIODIVERSITY

The word biodiversity was coined in 1985, a combination of the words biological and diversity. The amazing variety of life on Earth is called biodiversity. All life is species and forms a diversity of genes within these species. You recognize biodiversity at home, in your world, in all places. Biodiversity enables our ecosystem to work and be preserved. A variety of crops and animals is necessary for a healthy ecosystem.

Sunshine State Standards:
SC.(5,6,7).N.1.1
Before leaving for the Food Court, read the following:

Now we've learned how to determine the general type of insect we are looking at, what stage of life it is in, and the important impact that insects can have on human life. All of these aspects of insect life play a part of the larger circle of life, known as biodiversity. Biodiversity refers to the diversity of plant and animal life in a particular habitat, or in the world as a whole. Plants and animals all have the ability to interact with one another, creating a unique habitat as they go.

A

Being able to identify the biodiversity in an area sometimes helps forensic entomologists identify what belongs in a crime scene and what doesn’t. A

A

Be sure to review rules for behavior and the plan of action for the assignment (listed below). Pass out Handout 5.1 to youth, and then have them form groups of 2–3 for their time in the Food Court.

### Biodiversity in the Food Court

- **Travel to Food Court**
- **Food Court**
- **20–35 minutes** Lunch at Food Court, eat, and answer Part A of Handout 5.1 A
- **Travel back to school**
- **10–15 minutes** Allow students to complete Part A of Handout 5.1 A (or it may be completed at home for homework)

**NOTE:** Leader may want to use a camera (Polaroid or digital) to record evidence and require youth to make a collage or add to their “files.”
Let's Reflect

- Someone tell me three types of plants or plant products that were being sold in the Food Court.
- What are three animals or animal products that were being sold as food in the Food Court?
- Someone share with us what you chose to eat for lunch and what you think the total number of species involved in creating your lunch. Explain how you came up with that number.
- Someone define biodiversity in their own words.
- What was the hardest part of figuring out the biodiversity in your meal? How did you solve that problem?
- Did working in a group help you accomplish this task? Why or why not?
- Can someone give us an example of how biodiversity is important in your life?
- Why do you think it is important to preserve biodiversity? Give at least two reasons.
- It is often necessary to work on problems that may not have a perfect answer. Some of you may have guessed the right number of species, some may not. How do you work through a problem even when you might not get the right answer?

Let's Apply

- Can someone give us an example of how biodiversity is important in your life?
- Why do you think it is important to preserve biodiversity? Give at least two reasons.
- It is often necessary to work on problems that may not have a perfect answer. Some of you may have guessed the right number of species, some may not. How do you work through a problem even when you might not get the right answer?

Extension Activities

Have youth keep a journal for 24 hours of all the foods that they eat. Once they have completed the journal, ask them to figure out how many contributors they had to their meals over the course of a day.
Products made by or with insects...

**Bees**

Honey
- candy
- cough drops
- honey butter
- Humans’ earliest sweetener

Beeswax
- Humans’ earliest form of wax
- Candles
- Crayons
- Soap
- Make-up
- Lotion
- Lip balm
- Waterproofing products
- Modeling clay
- Sealing putty
- Furniture polish
- Shoe polish
- Wax for braces
- Molds for crowns, bridges for teeth
- Waxes for golfing, fishing, skiing, sewing needles, floors

**Silk moths:** Produce silk—a strong, natural fiber
- Clothing
- Stitches (humans)
- Thread for musical instruments
- Carpets and rugs
- Sheets

**Scale Insects:** Used as source for red dyes for food coloring and cosmetics. About $9 million worth of shellac, made from scale insects, is used annually in the United States.

**Insect Galls:** Used for tannic acid (for tanning hides to make leather) as well as for making tans.

**Blow Fly Larva (maggots):** Used to treat battle wounds for centuries, and now also to treat bone infections. They feed on dead tissue and secrete a substance called allatonin.
Biodiversity in the Food Court

Directions: In your small groups, complete questions 1–3 during lunch; complete questions 4–6 when you get back to school.

1. List three types of plants (or plant products) sold in the food court.

2. List three animals (or animal products) sold as food in the food court.

3. What did you eat for lunch? Estimate the total number of species that were involved in creating your lunch. List the animals and plants you think might have been a part of your lunch below:

4. Define biodiversity in your own words.

5. Give one example of how biodiversity is important in your life.

6. Why do you think it is important to preserve biodiversity? Give at least two reasons.
Biodiversity in the Food Court

The word biodiversity is a combination of the words “biological” and “diversity.” The amazing variety of life on Earth is called biodiversity.

All the species of plants, animals, and microorganisms make up a biologically diverse Earth. Plus, the diversity of genes within these species (your skin and eyes aren’t exactly the same as everyone else’s) makes for even more diversity on Earth.

What’s a way that your life depends on biodiversity? How about sitting down to dinner—how many different species does it take to make a meal of a hamburger, French fries, and cherry pie? Make a guess before reading the menu below.

Diagram modified from Biodiversity-Our Living World: Your Life Depends on it! A PennState Publication, 2001
How can I help preserve Biodiversity?

Help protect tropical forests and birds by buying shade-grown coffee. Coffee plantations that grow coffee under a canopy of trees provide better habitat for biodiversity than plantations that strip away all vegetation but the coffee plants.

Instead of buying a new table or dresser, shop around at used furniture outlets, yard sales, and antique stores. Not only will you save money, but you’ll also save trees and wood.

Plant and nurture trees in your community and around your school. Trees not only produce oxygen but also guard against global warming by absorbing CO2. They even lower our air-conditioning needs in summer by shading our homes and offices. The National Arbor Foundation (<www.arborday.org>), the National Tree Trust (<www.nationaltreetrust.org>), and TreeLink (<www.treelink.org>) can provide information and resources and can help you find others in your community with similar interests.

At your dinnerable, use cloth napkins rather than disposable paper ones. Paper accounts for the largest percentage of solid waste at landfills. By using cloth napkins, you can help cut down on solid waste and help protect forests.

When shopping, choose products in limited packaging, such as buying pasta and cereal in bags rather than boxes. This will not only help cut down on the amount of waste in landfills, but will also help reduce our need to produce throwaway paper packaging.

Look for ways to reduce your paper use. Try using both sides of every sheet of paper, cutting paper into smaller squares for memo paper, reusing envelopes, and other paper-saving techniques. On average, each American uses 730 pounds of paper per year. That’s seven times as much as the world average.

Handout 2

Archival copy: for current recommendations see http://edis.ifas.ufl.edu or your local extension office.
Help start a paper recycling program at your school if there isn’t one already. You can collect information about recycling services in your community, organize students to help in paper collection, and provide information about how many resources can be saved by recycling paper.

Buy recycled paper products for your home, including sheet paper, envelopes, paper towels, napkins, and toilet paper. Look for products that contain at least 50 percent post-consumer waste. This means that at least half of the material used in making the item comes from paper that people like you have recycled. If your store doesn’t carry recycled paper products, tell the manager you would like it to do so. Encourage your school to also buy recycled paper products.

Consider taking a family vacation that will help biodiversity. Earthwatch (www.earthwatch.org) is an organization that allows citizens to assist with scientific research, and the group’s website details a range of research expeditions that explore the biodiversity of the planet. You could spend your next vacation working with scientists studying anything from ospreys to orangutans.

Visit forests responsibly, remembering to bring out everything you take in, clean up litter left by others, stay on marked trails, and respect wildlife. To learn more, contact the Leave No Trace program for publications and educational materials at 1-800-332-4100 or on the Web at www.lnt.org.

Participate in National Trails Day and other events that highlight the need for parks, rails, and open spaces. The American Hiking Society (www.americanhiking.org) can help you find an event near you and can even help you plan an event.

Donate used books and magazines to hospitals, retirement homes, women’s shelters, or libraries. The donations not only will help these organizations, but also will reduce the resources used to produce paper. Paper accounts for the largest percentage of the volume at solid waste landfills.

Recycle your old newspapers. Americans throw away the equivalent of more than 80 million trees in newsprint each year. Take them to a commercial or community recycling center if your town doesn’t have curbside recycling. Recycling 1 ton of newsprint saves 17 to 20 trees, uses 30 to 70 percent less energy than does making paper from trees, and reduces related air pollution by 95 percent.

(Modified from “Taking action for forests.” From Biodiversity 911: Saving Life on Earth, a traveling exhibit by the World Wildlife Fund)
I certify that has successfully completed the requirements of the Forensic Entomology Achievement Program.

Certificate of Completion

Leader: __________________________________________

Date: __________________________________________
The 4-H Motto
To make the best better.

The 4-H Pledge
I pledge
my head to clearer thinking,
my heart to greater loyalty,
my hands to larger service, and
my health to better living,
for my club, my community,
my country and my world.

Visit the 4-H website for more information:
http://www.florida4h.org/projects/forensics.shtml

The Forensic Entomology (4H ENL 41 / 4H310) curriculum package was developed by Erika Andersen, graduate student, and Russell Mizell, professor, Department of Entomology and Nematology; Jessica Kochert, graduate student, and Joy Jordan, associate professor/4-H curriculum specialist, Department of Family, Youth and Community Sciences; Institute of Food and Agricultural Sciences; University of Florida.

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