FACT: INTEGRATED PEST MANAGEMENT (IPM) IS AN IMPORTANT WAY TO MANAGE INSECTS THAT ARE HARMFUL TO CORN

LESSON 1:	A Beauty Pageant	(Language Arts, Music, Dance, Art)*
LESSON 2:	Weather or Not to Act	(Math, Science)*
LESSON 3:	Prolegs, Head Capsules & Warts	(Science)*
LESSON 4:	Give Me an "I" "P" "M"	(Science, Social Studies)*

* *All Lesson Plans are adaptable for ALL ages!*

ELIZABETH SEES A BAD SIDE TO HER FAVORITE CREATURES

When she was 7, Elizabeth held magical powers over insects. *She directed crickets to chirp at the same time. She cheered caterpillars to crawl faster. She called fireflies to light her path in the dark.*

She loved and cared for insects. *She rescued spiders from the vacuum cleaner. She buried moths hit by the front grill of the car. She flagged anthills so no one would step on them*.

She imagined herself to be as small as insects. *She wanted to float high above the trees on the back of a green lacewing. She dreamed of roaring through the grass on the back of a technicolor beetle. She thought it would be exciting to live inside a honeycomb.*

She eagerly anticipated every spring, the time of year her friends, the insects, filled the earth around her.

One particular spring morning, Elizabeth was chasing water striders as they walked on the creek. She was stepping from stone to stone, invisibly she thought, when she saw a pickup truck drive into the yard. It was the man who was going to work for her mom's company.

"He's an entomologist," her mom had explained. "An entomologist studies insects."

The man lifted something heavy from his truck. It looked like three long light bulbs in a cage. Elizabeth watched him hang it behind the garage, with a basket below it. Then she went back to her friends.

That night the light was turned on. It was PURPLE!! The whole yard glowed in a mysterious light. "The insects are attracted to that kind of light," said Elizabeth's mom.

In the morning the basket was filled with insects. Elizabeth had never seen so many kinds in one place, at one time. She never imagined so many flew at night. Why weren't they sleeping? Now they were captured!

She watched the entomologist, his name was Al, sort the insects, count them, then write on a clipboard. He said he was monitoring the kinds and numbers of insects so he could learn more about their life cycles. He said he would do it all summer.

Elizabeth didn't understand it. She didn't like it either. She wanted to warn all insects to stay away. She loved them. They were her friends.

She didn't want to lead them into a trap.

She ordered all the grasshoppers not to jump into the basket. She hummed a danger signal to the bees, and blew magic messages into the air to keep the dragonflies far away.

Then Al hung another trap. This one looked like a flying sandwich, like two pieces of white bread with a space between. The bottom piece was covered with something very sticky.

"It's a black cutworm trap," he explained. "There's a pheromone lure inside. It smells like a female, so the males fly to it."

"Worms can't fly," Elizabeth said to herself. She had better things to worry about than a sandwich in a tree that was supposed to catch worms.

But the next morning, Al showed everyone what he had caught. Stuck on the bottom were eight beautiful black moths! Their wings were two to three inches across, their bodies covered with soft hairs.

"Looks like we had a significant flight last night. These moths came up on the wind from the south. They're probably laying eggs in the soybean stubble right now."

Elizabeth knew "soybean stubble" meant the leaves and stems left in the field from last year's soybean crop. She was happy these moths visiting from the south could find safety in her field. "Do they speak Spanish?" she wondered.

And so the weeks went by—Elizabeth trying to wish the insects away, but Al still catching and counting them every day.

Tractors came to the field by her house, and left. "Dave is planting corn," her mom said, and showed Elizabeth how to find the seeds planted two inches under the soil.

At first the seeds just sat there. Then it rained, and pretty soon Elizabeth could see little green plants in rows in the field. Every day the corn grew a little more, and the lines of green grew easier to see.

Elizabeth loved to run in the field. Everywhere she looked there were baby corn plants pushing small leaves out into the sun.

"My corn is growing!" She was so excited!

Then one day Al said it was time to check for cutworms. "There have been enough Growing Degree Days (GDD) since the flight of moths into our area. After the eggs are laid it takes a certain amount of heat for them to hatch, and more heat for them to grow into worms that can cause problems. The amount of heat needed is called "Growing Degree Days."

Elizabeth and her mom walked through the field. Her mom called it "scouting." They walked and walked. There was corn everywhere. They dug in the soil by the roots, and in many places they found a worm. A cutworm!

They found a few worms that were already very big, about 1 ¼ inch long. “They hatched earlier,” explained Elizabeth’s mom.

There was no corn left by those big worms. The black cutworms had crawled down the row eating corn plants, one after another, getting bigger and bigger as they ate. Sometimes the plant was still lying where they’d cut it off. Sometimes it was still standing, but there was a hole through the bottom of the stem, and it was dying.

“Mom, QUICK! The worms are killing my corn. We have to stop them!” Elizabeth didn’t know insects could hurt anything so bad. She wanted them to stop.

Then her mom explained that the farmer would put an insecticide on the field that day to control the worms. She explained that sometimes insects could be bad.

She explained that entomologists and farmers use traps to catch insects to predict if they will be a problem. They monitor weather and temperatures to predict when problems will begin. But after their prediction, someone still must go to the field to see if there is a problem. No one wants to spray an insecticide unless they need to. But if there is a problem they need to take care of it fast, before their crop is destroyed!

Elizabeth had a different feeling about insects after that day. She still loved them. But she’d seen the harm they could do. She decided she wanted to learn more about them, the good ones and the harmful ones.

Maybe if she learned enough about the different worlds of insects and people, she could use her magic powers to help them both.

LESSON 1: A BUG BEAUTY PAGEANT

SUBJECT: Language Arts, Music, Dance, Art
OBJECTIVE: Students will learn that insects are diverse and fascinating, and that studying them and appreciating them can enrich their lives.
MEASUREMENT: Students will appreciate insects. They will notice that every insect is unique and fascinating in its own way.

BACKGROUND FOR TEACHERS:

Insects are remarkable. They make up more than half of all the living things on this planet; there are several hundred thousand different kinds.

Most are 1 to 10 mm in size. But some tiny insects are smaller than some Protozoa, and some giant insects are larger than small mammals. The "smallest" insect is a wasp, measuring 0.17-0.18 mm in length, that lays its eggs in the eggs of other tiny insects, the thrips. The adult female is smaller than the period at the end of this sentence.

At the other end of the scale, there are several giant insects. The champions of all time are the extinct dragonflies that measured over 700 mm from tip to tip. Among living insects, a very large moth, measuring 240 mm, lives in Brazil, and a 110 mm "Goliath" beetle lives in Africa.

Insects occur almost everywhere on earth. Many species of insects have been found in the Himalayan Mountains at altitudes over 19,000 feet. Over 300 species live in the Arctic. They have been found in deep caves, hot springs, salt lakes, and pools of petroleum. They live in arid deserts, in forests, in soil. One kind of water striders lives permanently on the surface of the open ocean. Many insects live in different habitats during different stages of their lives.

Insects are missing entirely only in the deepest waters of the ocean.

Their diversity is unsurpassed. Insects exhibit some very unusual, extraordinary, peculiar, marvelous, and unimaginable characteristics.

STUDENT ACTIVITIES:

1. Ask students to read the story <u>Elizabeth Sees a Bad Side to Her Favorite Creatures,</u> and discuss the first several paragraphs in which many kinds of insects are mentioned. Discuss Elizabeth's feelings for insects, and her imagination!

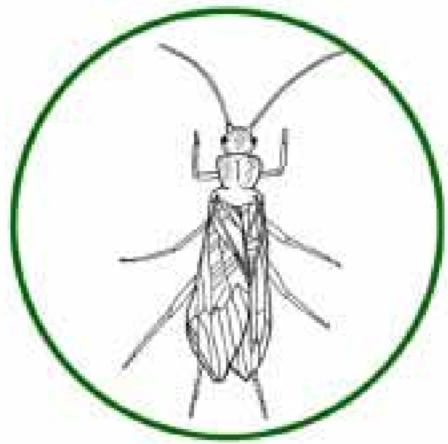
2. Use some of the following drawings. Encourage students to study the diversity of insects—their shapes, colors, and sizes. Compare body parts like wings, legs, antennas, and mouths, between different species. (Example 1)

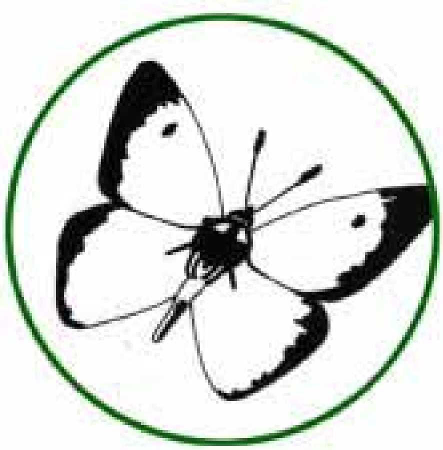
3. Listen to the song “Flight of the Bumblebee” by N. Rimsky-Korsakoff, and discuss the sounds that insects make.

4. If movies or videos are available, let students watch the movements of insects. Remind them of all the stages in the insect’s life cycle. For example, an inchworm becomes a moth. The movements of those two stages are very different!

5. Then ask students to complete one or more of the following:
   - Produce a beauty pageant in which every student is a different insect. Have them model their best features—legs, wings, quick movement, etc. as they walk down the runway. Ask them to write awesome descriptions of themselves that can be read as they model.
   - Build a clay or paper “model” of their favorite insect.
   - Write a story in which they shrink to the same size as insects. Ask them to describe what they see and do. (The Disney movie “Honey, I Shrunk the Kids” has some great examples!)
   - Create a collage of all the insect pictures they can find.
   - Create a cartoon character based on an unusual insect.
   - “Choreograph” a dance of a community of insects interacting with each other. Use as many unique movements as students can imagine—flying, jumping, crawling, hovering, drinking nectar, stinging, etc.
   - Write a poem about insects making our lives more beautiful and interesting.

Insect Field Guide


LESSON 2: "WEATHER" OR NOT TO ACT

SUBJECT: Science, Math

OBJECTIVE: Students will learn how to count the number of black cutworms in a pheromone trap. They will also learn how to use daily temperatures to calculate the Growing Degree Days in order to predict when the worms will cause problems in corn fields.

MEASUREMENT: Students will understand the process of insect monitoring.

BACKGROUND FOR TEACHERS:

Black cutworm moths do not overwinter in the Corn Belt but are brought north on winds from Mexico and the southern United States. At dusk, emigrating moths fly upward, are caught by surface winds and rising air in advance of thunderstorms into the lower-level jet stream. The can fly from Texas to Minnesota in as little as two days. Moths are carried along until they decide to "drop out," encounter cold air or thunderstorms.

After she finishes her migration, the female moth releases a sex attractant to draw in males. That same sexual pheromone is used as a lure in a sticky trap (see picture). The moths caught in that trap are then used to determine the date of arrival and the number of moths in each flight. Traps are checked daily and the numbers recorded.

Once the arrival date is known, it becomes possible to predict what day the eggs will hatch, and what day the worms will start eating, and how fast the worms will grow. This predictive ability is an important tool! It indicates when to start looking for problems, so no time is wasted, and no problems are missed. It helps prevent economic loss and unnecessary use of pesticides.

This prediction is possible because of two things—time and temperature.

The importance of time is obvious. Animals obviously do not change from infant to adult overnight; neither do insects. It takes time.

Temperature is also important to growth of organisms. However, in humans it is not very apparent. That is because humans and other mammals maintain a constant body temperature. That's not true of plants and insects. Their temperatures vary with their environment, so, for predicting growth of plants and insects, it becomes important to find a way to combine both time and temperature.

The method used to measure their development is called "physiological time." Growing degree days, or heat units as they're sometimes called, measure both time and temperature. They represent the number of degrees above some minimum temperature necessary for growth multiplied by time in days.

For example, 10 degrees above the minimum for 5 days represents 50 degree days (10 x 5) just as does 2 degrees above the minimum for 25 days (25 x 2). Both represent the same amount of physiological time—an insect would have grown the same amount under either condition!

STUDENT ACTIVITIES:

1. Ask students to read Elizabeth Sees a Bad Side to Her Favorite Creatures, paying close attention to the discussion of the sticky trap (that looks like a flying sandwich and catches worms), and the discussion of Growing Degree Days. Discuss how this knowledge helps farmers protect corn plants from bad insects. (Example 1)

2. Then, younger students can complete the worksheets in which they count and record the number of moths flying into a region over a week-long period. (Unit 3, Lesson 3 has more information on the life cycle of the moths and the appearance of the larvae.) (Worksheet 1)

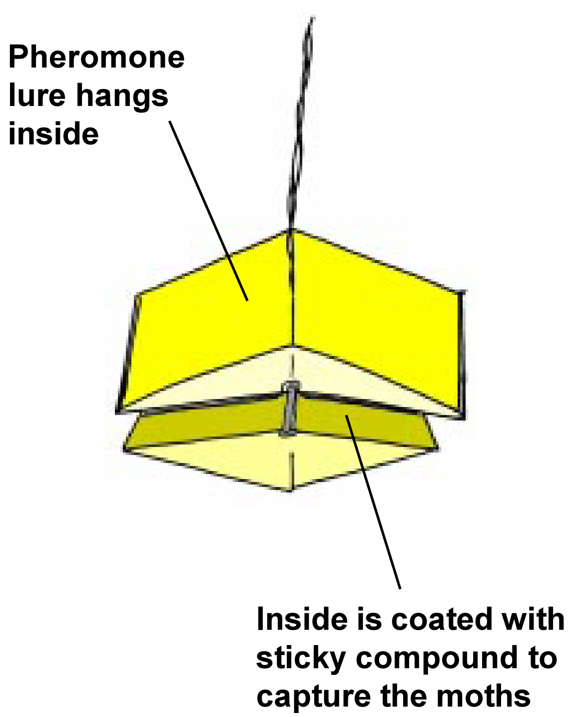
3. Older students can complete the Growing Degree Day calculations that will predict when the eggs will hatch and the worms begin feeding. (Worksheet 2)

4. The Growing Degree Day concept could be demonstrated to younger children using a thermometer to read the high temperature of the day and the low temperature, explaining that a formula uses those two values to determine how much an insect grows on that day. Remind them that an insect (and a plant) can only grow at certain temperatures. They grow slowly on cold days and quickly on hot days. ("You can hear the corn grow on warm summer days" has a lot of truth to it!) But if it's too hot, or too cold, no growth occurs at all.

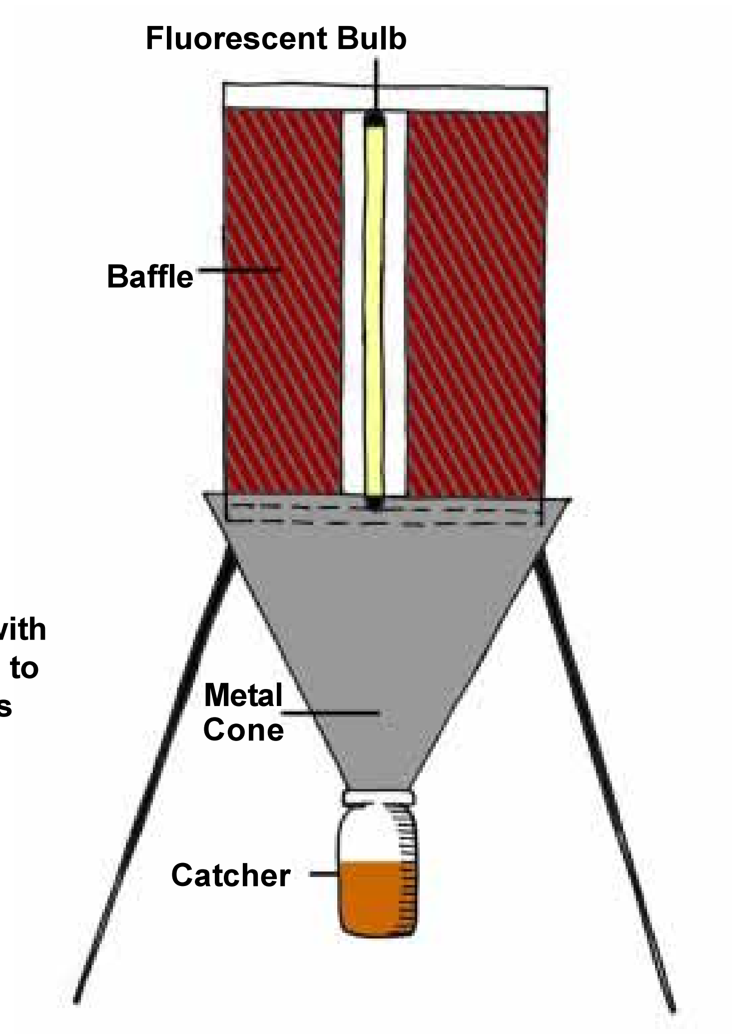
5. It would be good to include a discussion of predictability of growth.
   - Can we predict how fast we will grow? How do we make those predictions about ourselves? (Do we use time and temperature?) How are those predictions useful?
   - This story illustrates the benefits of predicting the growth of insect larvae. (It tells farmers when they need to look for problems. It prevents problems from happening without their knowledge…) We can also use this same method to predict how fast the *corn* will grow. How would that be beneficial?
   - What else would the students like to be able to predict? Why?

Insect Monitoring Tools

Sticky Trap

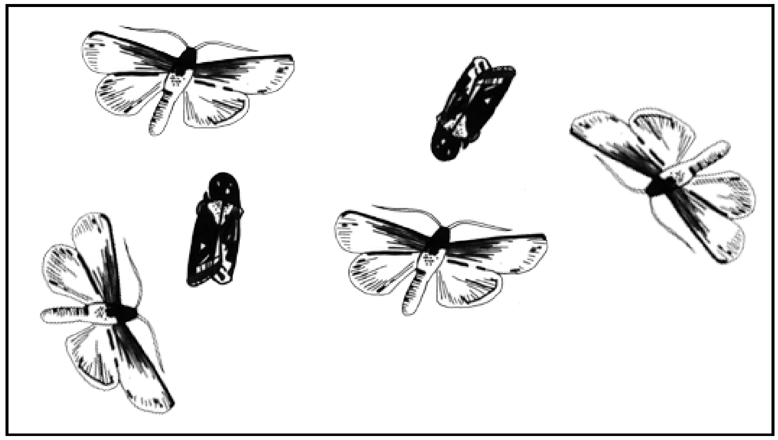


Light Trap



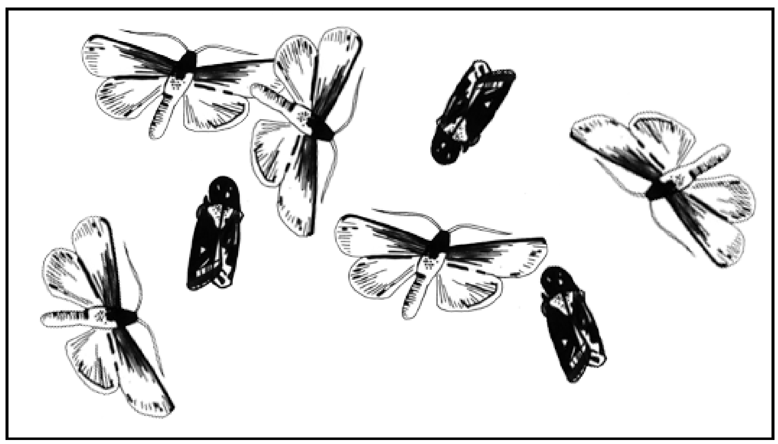
Count the number of moths flying into a phero-mone trap in a one week period.

Day 1



How many moths? _______

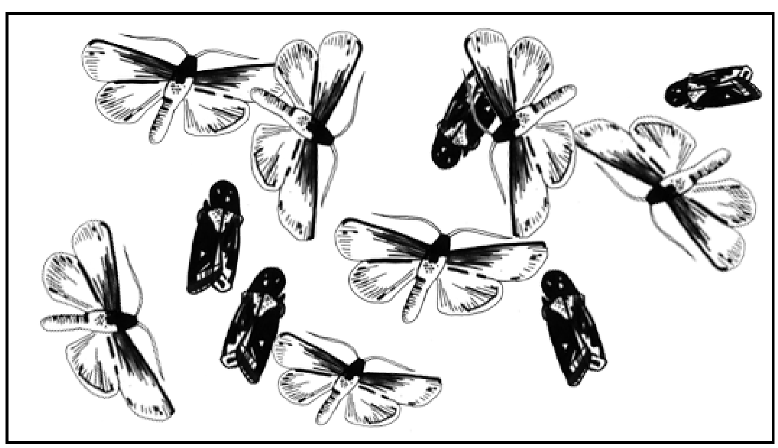
Day 2



How many moths? _______

How many came last night? _______

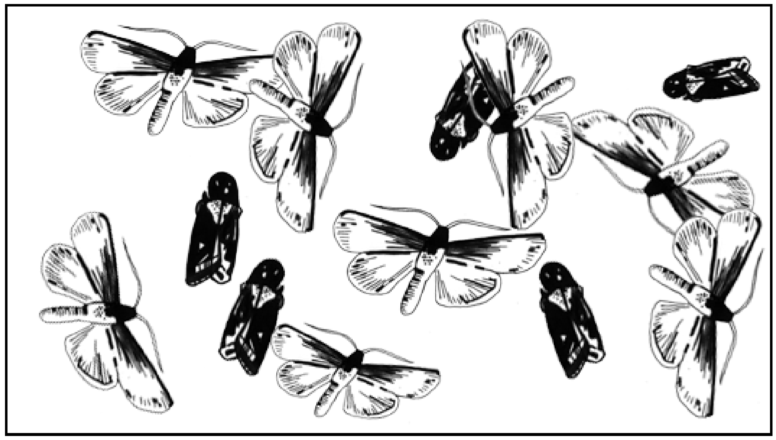
Day 3



How many moth _______

How many came last night? _______

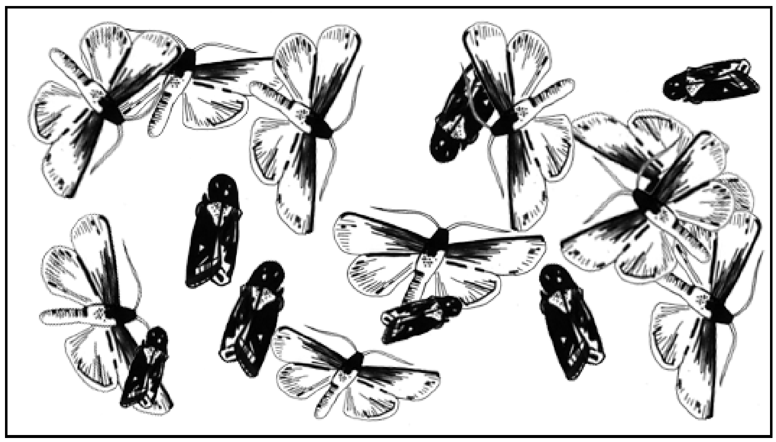
Day 4



How many moths? _______

How many came last night? _______

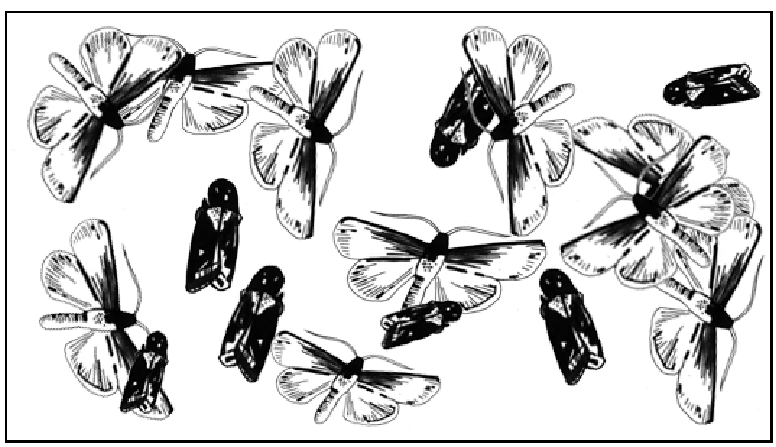
Day 5



How many moths? _______

How many came last night? _______

Day 6



How many moths? _______

How many came last night? _______

Day 7

How many moths _______

How many came last nigh _______

Which day did the most arrive?_______

How many moths have their wings folded?_______

How many moths have their wings spread?_______

GROWING DEGREE DAYS

The formula for determining GDD is:

$$\frac{\text{Maximum Daily Temperature} + \text{Minimum Daily Temperature}}{2} - 50$$

- If the temperature is below 50 degrees F, 50 degrees is **substituted** as the minimum temperature in the above formula. This is because 50 degrees is the base temperature below which black cutworms, like corn plants, do not grow.
- If the temperature is above 86 degree F, 86 is **substituted** for the maximum temperature in the above formula. The growth rate (how fast growth occurs) of black cutworms, like corn, will increase up to 86 degrees, but over that, the growth rate will stay constant instead of increasing. (There are different maximum and minimum temperatures for different species of plants and insects.)

For example, to calculate the GDD for a Saturday when the maximum and minimum temperatures were 73 and 53 degrees respectively, you use the formula: (73 + 53) / 2 minus 50 = 13 GDD.

If on Sunday, the temperatures were 73 and 48, the calculation would be: (73 + 50) / 2 minus 50 = 11.5 GDD. In this example, 50 degrees were substituted for 48, because growth stops below 50 degrees.

Black cutworm development as related to Growing Degree Days is indicated in the following chart. The "instar" stages indicate the size of the larvae. Black cutworms hatch as very small larvae and continue to grow larger as they eat. The tiny larvae don't do as much damage—they eat holes in the corn leaves. The largest larvae don't do much damage either—they're about to pupate. The most serious damage to crops is done in the middle instar stages.

Stage	Black Cutworm Activity	Degree Days
Egg hatch		90
1st-3rd instar	Light leaf feeding	91-311
4th instar	Initial cutting	312
5th instar	Cutting	365
6th instar	Cutting slows	431
Pupa-adult	No more cutting	641

Calculate the GDD for each of these days, and use the chart to answer the questions at the end:

Date	Minimum Temperature	Maximum Temperature	Formula	Degree Days
April 15	46	62	*50 + 62 / 2 - 50*	*6*
April 16	47	67		
April 17	44	66		
April 18	40	62		
April 19	45	66		
April 20	50	69		
April 21	48	68		
April 22	47	68		
April 23	50	71		
April 24	52	72		
April 25	51	73		
April 26	53	73		
April 27	52	68		
April 28	54	70		
April 29	55	74		
April 30	53	72		
May 1	58	76		
May 2	60	76		
May 3	61	77		
May 4	56	72		
May 5	58	72		
May 6	61	75		
May 7	63	76		
May 8	64	76		
May 9	65	74		
May 10	68	78		
May 11	65	79		
May 12	63	76		
May 13	63	73		
May 14	60	72		
May 15	62	74		

QUESTIONS

1. How many Growing Degree Days accumulated from April 15 to May 5?
2. Approximately what day will the black cutworm eggs hatch?
3. Approximately what day will initial cutting begin?
4. Approximately what day will the cutting slow down?
5. During what time period will the greatest damage be done if nothing is done to stop it?

LESSON 3: PROLEGS, HEAD CAPSULES, AND WARTS

SUBJECT: Science
OBJECTIVE: Students will learn some identifying features of the black cutworm larvae and understand why such small details are so important.
MEASUREMENT: Students know that a worm is not just a worm. If they look closer, it might be a larva with many specific, identifying factors!

BACKGROUND FOR TEACHERS:

The scientific name for Black Cutworm is *Agrotis ipsilon*. This insect is in the Order Lepidoptera which includes butterflies and moths, and the Family Noctuidae which is the largest family in the order, with over 20,000 species, over 2700 in North America. Many are common moths, and although they vary in size and color, most have a wingspread of 20-40 mm and are dark-colored.

Noctuid larvae are smooth and dull-colored and most have five pairs of prolegs; a few, called loopers, have only three pairs and move like inchworms. Larvae of some species (cutworm) feed on roots and shoots of plants, and often cut off the stem just above the ground. Larvae of other species (corn earworm) feed on growing ears of corn, tomatoes, and cotton bolls.

In terms of economic damage to crops, the Noctuidae family is easily the most significant.

Noctuids are nocturnal and the moths constitute a major proportion of insects attracted to lights. The larvae are also nocturnal, emerging at night to chew through stems or other food source.

The life cycle is one of complete metamorphosis, meaning it progresses from egg to larvae to pupa to adult. The larvae are the destructive stage for corn producers and the only stage diagramed in this lesson. (See Unit 3, Lesson 2 for information on the time required to move from one growth stage to the next.)

The size of the head capsule is an indicator of the size of the larva, and how much damage it can do before it quits eating corn, and pupates.

Larval instar	Head capsule width
4	
5	
6	
7	

Proper identification of insects is essential for proper management. In cornfields, black cutworms are often confused with larvae of the crane fly, which have no legs as compared to the prolegs of the black cutworm. They're also confused with dingy cutworms, which are less aggressive feeders and so do not require the same degree of control. The paired tubercles, or "warts" on dingy cutworms are both the same size, as compared to black cutworms, in which one is much larger than the other.

STUDENT ACTIVITIES:

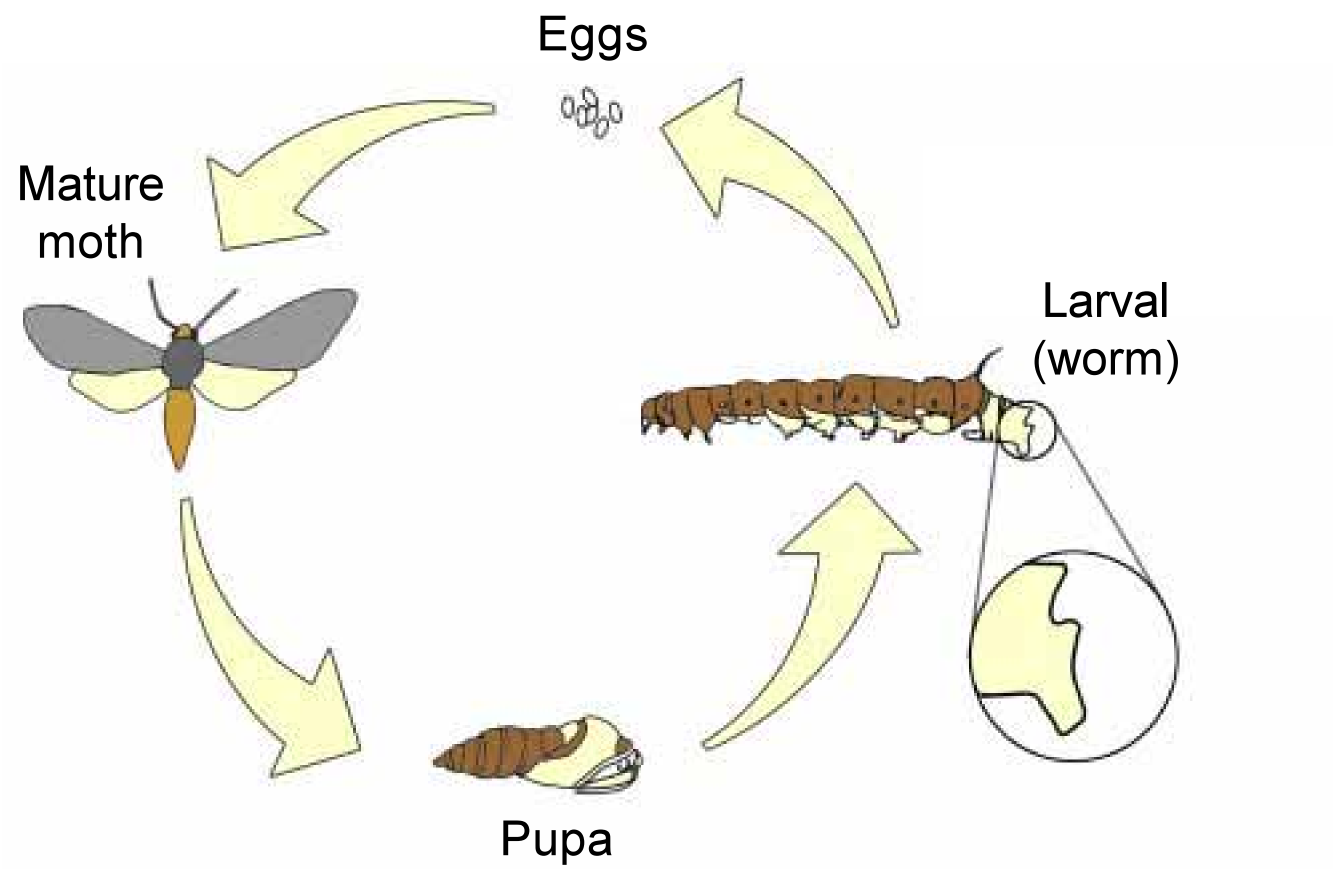
1. Ask students to read the story, Elizabeth Sees a Bad Side to Her Favorite Creatures, paying close attention to the descriptions of the black cutworm moths and worms (larvae).

2. Show students the picture of the moth and explain that the moth lays the eggs that hatch into the larva (worm) you're going to study. Explain that after the larva grows to its full size it pupates into another moth. The cycle of complete metamorphosis is therefore: egg to larvae to pupa to adult.(Example 1) Again, the size of the head capsule is a way of measuring a larva's size, and knowing how soon it will pupate. In the case of black cutworm, the moth does not overwinter in the north, but relies on strong southern winds to bring it back in the spring.

3. Use the example of student's fingerprints to emphasize that small details can be very important for proper identification. Explain that there can be more kinds of insects in one acre of land than species of birds in the entire United States, as many as several million, and it is very important for farmers to know exactly what insect they need to manage. There are different management systems or pesticide treatments for different insects.

4. Mistaken identities can cause lots of problems. Students can discuss some of the possible consequences. They can also understand why farmers hire crop consultants or other advisors to help identify insects, weeds, and diseases in their cornfields.

Metamorphosis



You can tell how old the larva is — and how much he eats by the size of his head

Larval instar	Head capsule width
4	
5	
6	
7	

LESSON 4: GIVE ME AN "I," GIVE ME A "P," GIVE ME AN "M"

SUBJECT: Science, Social Studies, Current Events
OBJECTIVE: Students will learn what IPM stands for, and will learn it is a system that is good for farmers and good for the environment.
MEASUREMENT: Students will know what IPM stands for, and will know it is a good system.

BACKGROUND FOR TEACHERS:

Insects affect man—both directly and indirectly. Some are very destructive. They may damage or kill cultivated crops. They may damage or contaminate stored foods. They may attack man or animals and bite, sting, or act as carriers of disease. Annual losses caused by insects in the U.S. have been estimated to be about $3.5 billion.

On the other hand, insects do a lot of good. They are important as pollinators for fruits and vegetables, a service valued at $4.5 billion annually in the U.S. They provide products of commercial value such as honey and silk. They are important as food for birds, fish and other mammals. They are valuable scavengers. Some have been used in the treatment of disease. Many have been used in studies of heredity, evolution, and other biological problems. Beneficial insects serve as predators of harmful species. They are also interesting, and often very beautiful.

Integrated Pest Management (IPM) is a system for managing crop pests. These "pests" include weeds and diseases, as well as insects, but insects are used as an easily understood example in this lesson.

IPM requires an understanding of insect life cycles, continuous monitoring through trapping systems, and field scouting. It utilizes insecticides when they are necessary, but also relies on other methods such as crop rotation, biological insecticides, or genetic resistance. It also uses other insects—the beneficial ones—for control of pests whenever possible. Environmental and economic thresholds are always considered in this system. Farmers, entomologists, and crop consultants continue to develop new understandings and improved methods of managing insects using IPM.

STUDENT ACTIVITIES:

Ask students to read the story in which <u>Elizabeth Sees a Bad Side to Her Favorite Creatures</u>, paying close attention to Al's monitoring of the insects so he can help Elizabeth and her mom know the correct time for scouting in the field.

Use worksheet 1 as a guide for discussions with younger students. It focuses on the three words, "integrated," "pest," and "management," and concludes that IPM means "combining many different ways to solve a problem…"

Invite someone from your community to speak to the classroom about IPM. Possible visitors are:

- Private crop consultants provide monitoring, scouting, and pest management recommendations (Names of members of the National Alliance of Independent Crop Consultants are available at www.naicc.org).
- Agricultural chemical dealers may employ agronomists or crop advisors knowledgeable in IPM.
- Major food processors strongly encourage contract growers to use IPM methods, and often employ IPM specialists.
- Land grant universities, state and county extension offices, and USDA offices all have IPM programs and professionals.
- Farmers who utilize IPM methods.

GIVE ME AN "I", GIVE ME A "P", GIVE ME AN "M"

"I" Stands for "Integrated" Integrated = Combined

1. Think of some words that mean the same thing as "integrated": ________________________

2. List some examples of things that are "integrated" __________________________________

"P" Stands for "Pest" Pest = Problem

1. Think of some words that mean the same thing as "pest"___________________________

2. List some examples of "pests" _____________________________

"M" Stands for "Management" Management = Decision

1. Think of some words that mean the same thing as "manage":___________________________

2. List some examples of "managing" ___________________________

IPM means COMBINING many different ways to solve a PROBLEM. Sometimes the DECISION is easy to make, and sometimes it is very difficult.

1. Think of some examples where you thought of many solutions to solve a single problem.
____

2. Discuss some solutions that farmers could use when they have a pest in their fields. (The AgEd worksheet for older students has specific examples. Younger children can use their imaginations.)
____

3. Would combining several of these solutions be better than using only one solution?_________
Why? ____

4. Could farmers use one solution for one pest, and another solution for a different pest?

____

5. Do you think farmers would like someone (for example, a crop consultant) to help make the decisions? _____________________________ Why?____