Discovering IPM: An Inquiry Approach to Learning Integrated Pest Management (IPM)

A curriculum for grade 4

Adapted by Janet McLeod Scott from a curriculum developed by Corine C. McCarthy in partial fulfillment of requirements for her Master's degree.

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CONTENTS

Preliminary Lessons – Ecology and You

Introduction

These lessons are designed to give the students a general understanding of ecology and their place with in an ecosystem. For students to understand the concept of Integrated Pest Management (IPM) they must first be aware of some of the basic components of ecology because IPM is a form of applied ecology. The following lessons will give the students an understanding of population dynamics and of factors of environmental resistance that serve to regulate densities within a community. Additionally they will understand how organisms fulfill specific roles in an ecosystem and what elements are necessary for organisms to sustain life. These lessons are meant to be precursors to the integrated pest management lessons, in which students will apply their knowledge of ecological relationships to the study the pest populations they will discover in the IPM lessons.

Appropriate SC Science Standards for the Following Preliminary Lessons

Grade 4:

- I. Inquiry
  A. Process Skills – 1, 4a, 5a
  B. Inquiry – 1ae
- II. Life Science
  A. Characteristics of Organisms – 1c
  B. Organisms and their Environment – 1ab, 2ab, 3abcd

Resources for the Following Ecology Lessons

Lesson Planet
http://www.lessonplanet.com/search/Science/Ecology
http://www.education.com

Yale-New Haven Teachers Institute
http://www.cis.yale.edu/ynhti/curriculum/units/1992/5/92.05.10.x.html
http://www.cis.yale.edu/ynhti/curriculum/units/1992/5/92.05.10.x.html#s
http://www.cis.yale.edu/ynhti/curriculum/units/1992/5/92.05.10.x.html#e
http://www.cis.yale.edu/ynhti/curriculum/units/1980/5/80.05.12.x.html

Steve Trash
http://www.stevetrash.com/booking/ecoleson.htm
http://www.stevetrash.com/booking/lessons/lesson1.htm

MC Biology
http://www.marietta.edu/~biol/102/ecosystem.html

Access Excellence – Design an Ecosystem
http://www.accessexcellence.org/AE/ATG/data/released/0079-KarinWesterling/index.html

Preliminary Lesson 1 – EcoTag

Introduction
This is a fun activity in which students are allowed to discover something about food chains and food webs. It is a guided inquiry approach to revealing the food web. Students will become excited to tell you how the food web works, and enjoy designing trophic interactions. This activity helps students conceptualize predator-prey relationships, address ecosystem and population dynamics, and allows students to see how ecosystems sustain themselves. This is a good activity to refer to throughout the following lessons because students will remember this activity.

Duration 1-1.5 hours

Objectives
Students will:
- Discover the fundamental components of ecology
- Learn about predator-prey relationships
- Understand how organisms fulfill niches within an ecosystem
- Learn what organisms need for survival (shelter, food, water, space)
- Understand the consequences of man's actions upon an ecosystem

Vocabulary (for Preliminary Lessons 1 & 2)

Ecology	Herbivore	Prey
Ecosystem	Carnivore	Population
Producer	Habitat	Energy
Consumer	Omnivore	Niche
Decomposer	Predator	Community

Materials needed for activity
Large colored index cards or construction paper
Safety pins or string to attach the name tags
Markers
Large open space to play

Discussion
Begin by asking students questions that will lead their thoughts to basic relationships within the ecosystem. Start by making the lesson personal. Ask the students about what they need to survive, and what kinds of things they eat. Then relate that information to animals in nature.

1. What did you eat for breakfast this morning?
    - Cereal, toast, eggs, etc.
2. Where did you find that food? How did it get there?
    - In the cabinet, refrigerator, etc. Mom or Dad bought it.
3. Did you have anything to drink with breakfast?
    - Water, juice, etc.
4. Where did you eat breakfast?
    - At the house, in the kitchen.

5. Imagine now, that you were a baby squirrel, and it was time for breakfast. What would you eat and drink?
    - Nuts, human scraps, milk from my mother, maybe water
6. Where did you get the food? How did it get to you?
    - From trees in the forest, Mother or Father brought it to you
7. Where did you eat it?
    - In the nest.

Summary
Continue asking the students questions that will allow them to draw conclusions and form relationships. What things did you find you needed to survive the morning that are the same as the baby squirrel: food, water, protection/home/shelter, and a space for that home? What is the importance of these things? Surviving, and living. You may then want to ask more questions about the significance of shelter as protection from predators, as it will become more significant in the activity.

Activity - Eco-Tag
This activity is essentially a game of tag, but one in which students will gain an appreciation of ecology, food webs, and predator-prey relationships. The food chains (within the food web) should be constructed to be appropriate for organisms in your area. This will enhance the students' understanding of their own ecosystem. It is best played outside or in a gym.

Create nametags for participating "organisms" using large colored index cards. The nametags should reflect organisms involved in an actual food pyramid, and allow each student to play. An example food chain might be: Hawks-squirrels-fish-flies-grasshoppers. Write on each nametag, in large print, the name of each animal (Predator) the student will represent. Under that animal, in smaller print and in a different color, write the names of the animals which may be eaten (prey) by the predator. (Writing the names of the prey is optional, and you may choose to exclude it for older students) Be sure that only a few students represent the animals at the top of the food chain, such as hawks, and that there are larger groups of students representing the animals at the lower end of the food chain, such as grasshoppers and flies.

Randomly give each student a nametag; students "become" that animal. Explain that they are only allowed to tag (hunt/kill) the food that they would take as prey. Once outside, each animal group has a specific "safe site" that represents their shelter, this might be a tree or a corner of a building, and when the student is touching that tree or building, they are safe in their "shelter". The last student(s) standing is/are the best hunter(s) or winner(s).

Alternative Versions of Play
1. Once a predator has tagged its prey, the prey may sit out until the top predators have no more prey to hunt. Then you may mix up nametags and allow the students to become a different animal. Continue play.
2. Make detritivore/decomposer stock cards. Detritivores are animals such as flies, earthworms, vultures, millipedes, and dung beetles that feed directly on dead organic material, and decomposers are organisms such as bacteria and fungi that feed on by-products of decaying organic materials. When a prey is tagged, the predator brings their prey to you and you may

exchange the prey tag for a detritivore/decomposer tag. This represents recycling in a true ecosystem and promotes an idea of how ecosystems sustain themselves.

3. Stop the game in mid-play and describe some imaginary complication on some part of the playing field, such as fire, or a human interruption such as the application of an insecticide that kills half of the insects or a road through the middle of the playing field, to provide students with more limitations. This allows students to contemplate man's effect on ecosystems. With this option you may choose to play under version one, or version two.
4. Place paper "leaves" in boxes at different locations to represent plant materials that herbivores feed on. They must gather at least 3 different kinds of leaves during the duration of the game, (or a set time limit you choose to give them) or they will starve. Remember to provide name tags for herbivores.

Follow-Up

Leave enough time at the end of the activity to discuss with the students the basic components of the ecosystem.

- Which animals were the carnivores, herbivores, omnivores, detritivores?
- Which animals were the producers and consumers?
- What represented each animal's habitat, and what would constitute an ideal habitat for that animal?
- Which animals were the predators? Which animals were the prey?
- Can animals be both predator and prey?
- How did energy transfer in the food web?
- Using the activities as examples, define an individual, population, and community.
- What is a niche? What is the niche of the predator? Of the prey?
- How are populations regulated?
- Ask them what they have learned, and what is necessary for an organism's survival.

Sample name tags for Lesson 1 – Eco-Tag

(Predator)

Hawk

(Prey)

Squirrels
Fish
Mice
Woodchucks (=groundhogs)

(Predator)

Bobcat

(Prey)

Mice
Squirrels
Woodchucks (=groundhogs)
Raccoons
Foxes
Birds
Reptiles

(Predator)

Red Wolf

(Prey)

White-tailed deer
Marsh rabbits
Raccoons
Rodents
Birds

(Predator)

Coyote

(Prey)

Birds
Woodchucks (=groundhogs)
Frogs
Toads
Snakes
Insects
Many kinds of fruit

(Coyotes hunt in packs. This fact can be used as a variation in the game.)

(Predator)

Raccoons

(Prey)

Grapes
Nuts
Berries
Grasshoppers
Crickets
Baby birds

(Predator)

Grey Fox

(Prey)

Insects
Fruits
Birds
Squirrels
Woodchucks (=groundhogs)
Mice
Eggs

(Predator)

Eastern Diamondback Rattlesnake

(Prey)

Mice
Rabbits
Cotton Rats
Squirrels

(Predator)

Black Bear

(Prey)

Plants
Insects
Fruits
Birds
Mice
Almost anything

Preliminary Lesson 2 – Design a Food Web

Photo courtesy of Bigelow.org
(http://www.bigelow.org/edhab/fitting_algae.html)

Introduction
This lesson is designed to reinforce and expand on the material learned and discussed in Lesson 1 – Eco-Tag. A variety of activities are included to appeal to different learning styles – kinesthetic, visual and auditory. Utilize as many activities as needed based on students' needs for reinforcement, as well as time and space constraints.

Duration 1-1.5 hours

Objectives
Students will:
- Observe and make note of their immediate ecosystems.
- Draw specific simple food chains.
- Draw and expand food chains into more complex food webs.
- Assume their Eco-Tag identities and use string to connect the plants to the herbivores to the carnivores to demonstrate the interconnectedness of organisms in an ecosystem as well as the transfer of energy.

Materials needed for activities
Transparencies of food web diagrams provided at end of lesson
120 pieces of string or yarn (each 10 feet in length) with colored tape wrapped around one end
Colored pencils, crayons, or markers
Overhead projector
Marking pens

Discussion/Presentation and Motivation
Review the components of the ecosystem that were previously learned in Eco-Tag. Allow students to explain what happened to the different animal groups as the game was played.

Activities
1. Take students on a brief nature hike to allow them to observe their immediate ecosystems. As you are hiking, help them make notes about the following:
    - In what way do animals need plants?
    - In what way do plants interact with other plants?

- How do plants and animals depend on each other?
- Which living things need each other to survive?
- Identify the nonliving (abiotic) components in the environment. What part do they play in the lives of living things?
- What is energy? Where does it come from?

Discuss with students what they observed on their nature hike. Be sure to reemphasize and relate it to what they practiced in Eco-Tag. Introduce them to the concept of energy flow through a food chain. With the sun as the ultimate source of energy, plants incorporate light energy into plant materials which provide energy to the herbivores that eat them which then provide energy to the carnivores that eat them.

2. Create a transparency of the wetland ecosystem diagram or food web diagram found at the end of the lesson to project for the class to see. With the wetland diagram, you may have to introduce some animals if they are not well known in your area. Alternatively, you may choose to use the alternative food web diagram included at the end of this lesson or design your own ecosystem. Allow students to tell you who-eats-whom in the predator prey relationships. Draw the arrows of energy transfer to the predators (arrows point to those who gain energy). This will allow the students to begin to visualize a food web. Discuss, or ask students to define the differences between food webs and food chains. Discuss with students how the transfer of energy from one organism to another enables an ecosystem to be efficient and sustainable.

3. Provide students with their nametags from the Eco-Tag activity in Lesson 1 so that they can resume their identities to form a "living" food web. Give each student/animal 3 to 5 strings with colored tape wrapped around one end. If this activity takes place outside, have the herbivores tie the non-taped end of their string to one or more plants or lay the end of the string in the grass. If the activity takes place indoors, identify some objects as plants and have the herbivores attach their strings. Have omnivores and carnivores hand the non-taped ends of their strings to plants or prey, as appropriate. To best give the impression of a web, students should hold the strings somewhat tautly so that they do not touch the ground. Allow the activity to continue until as many of the strings are used as possible. Point out that the non-taped ends of string should be held by the organism being eaten and the taped ends by the organism doing the eating. The taped ends of the string show the direction of energy flow through a food web (like the arrows in activity 3 above). The organisms doing the eating receive their energy from the organisms they eat.

4. Have students design a diagram of an original habitat with specific food chains; encourage them to expand these food chains into larger food webs. Remind students to include: producers, consumers, decomposers, energy, predators, prey, water, and shelter. These creative and colorful food webs will be great reminders for organism needs as they expand into the IPM lessons.

Wetland

Circle the items
in the picture

cattails 

muskrat
lodge 

bulrushes 

trees 

frog 

Hognose Snake

Hawk

Toad

Garter Snake

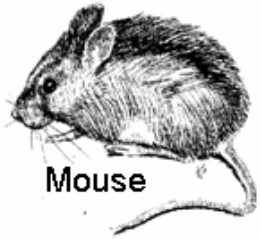
Rabbit

Spider

Praying Mantis

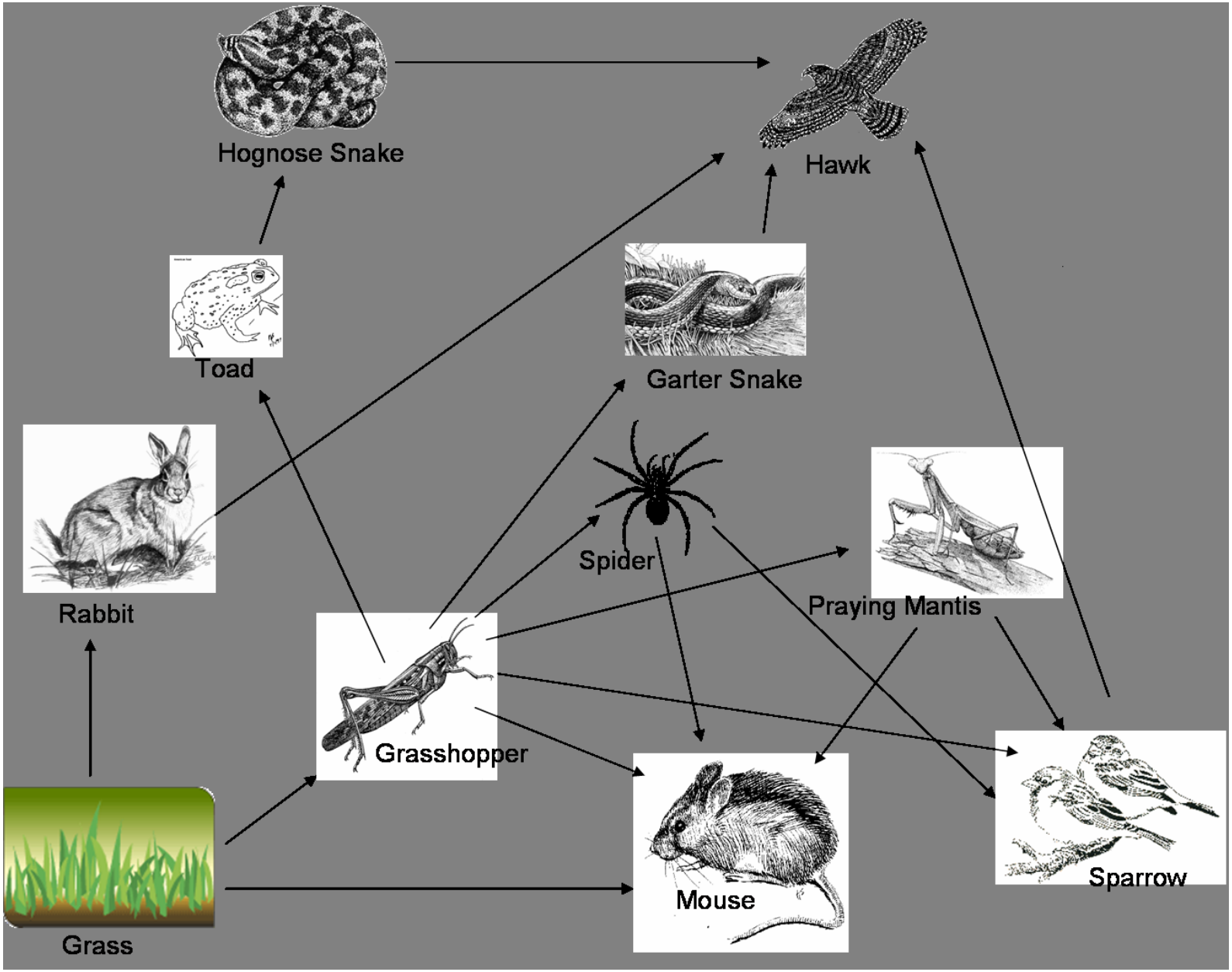
Grasshopper

Grass



Mouse

Sparrow


Hognose Snake
Hawk
Toad
Garter Snake
Rabbit
Spider
Praying Mantis
Grasshopper
Grass
Mouse
Sparrow

Preliminary Lessons 1 & 2: Learning Extensions

Language Arts

Have the class read the poem, "Hurt No Living Thing" (see page 13) and then write a paragraph summarizing the main idea of the poem. How does this poem relate to their Eco-tag and food web activities? Do the students agree with the poet's sentiments? Why or why not? (Language Arts Standards: 4-R1.3, 4-R1.4, 4-R1.9, 4-R2.10)

Hurt No Living Thing

By Christina Rossetti (1830-1894)

Hurt no living thing;
Ladybird, nor butterfly,
Nor moth with dusty wing,
Nor cricket chirping cheerily,
Nor grasshopper so light of leap,
Nor dancing gnat, nor beetle fat,
Nor harmless worms that creep.

IPM Lessons

IPM Lesson 1 – Discovering Pests (Building Observation Skills, Investigating)

Introduction

The first step of integrated pest management is to find out what pests are present. This lesson starts with what the students know. It enables students to start investigating in familiar environments, such as their homes. It encourages them to think more broadly about all of the other organisms in an environment. It might be helpful to refer to Eco-Tag throughout this lesson if students are having trouble visualizing more than just students and teachers at school or more than just their family members at home. This lesson introduces students to the concept of a pest.

Duration 2.5 – 3 hours

Appropriate SC Science Standards for the Following Lesson

Grade 4:

- I. Inquiry
  A. Process Skills – 1a, 2ab, 4a
  B. Inquiry – 1b
- II. Life Science
  A. Characteristics of Organisms – 1bc
  B. Organisms and Their Environment – 1b, 2abc

Resources for the following lesson

Minnesota Department of Agriculture, "What is a pest"
http://www.mda.state.mn.us/IPM/IPMPubs.html#PestPatrol

IPM Institute of America, "Inspect our house"
IPM Super Sleuth home page: http://www.ipminstitute.org/supersleuth.htm
IPM Super Sleuth Briefing Room:
http://www.ipminstitute.org/Super_Sleuth/homework_house.htm

University of California
http://www.ipm.ucdavis.edu/PMG/selectnewpest.home.html

National Pest Management Association (http://www.pestworld.org) developed http://www.pestworldforkids.org to meet curriculum standards of the National Science Foundation.

Objectives

Students will:

- Build reasoning skills by critically thinking about the other organisms that may exist in the same environments as them.
- Build observation skills by searching for pests in their habitat
- Build observation skills by making notes of their surroundings

- Build communication skills as they conduct interviews
- IPM objective - discover and define the meaning of a pest

Vocabulary
Pest
Symptoms
Signs

Materials
Scavenger hunt worksheets (& transparency)
Flashlights for inspections
Mirrors
Tape recorders & cassettes

Opening Discussion
Begin by having a brainstorming session with your students. Ask them questions that will heighten their observation skills. Get them to think about the other critters that might share their living or learning space. Write their ideas on the board. The following are some questions you may want to use to help begin the discussion.

1. Who uses the school?
- Students, teachers, principals, cafeteria people, custodians, nurse, parents
2. Are these the only school inhabitants? Could there be other living things in the school?
- No, people are not the only inhabitants, and yes other organisms are in the school
3. What are these other organisms?
- Bugs, ants, cockroaches, flies, bees, wasps, spiders, mice, rats
4. Where do you find them?
- Classrooms, hallways, closets, bathrooms, lunch room
5. Do they live inside or outside?
- Some live inside, and some can live outside, some live in both places
6. Do you see them during the day or at night?
- Some you might see in the dark and others in the light
7. Do people want them? Why or why not?
- No, they are not wanted because they are dirty and spread sickness. It is not healthy for them to be in our school.
8. Are they all harmful?
- No. Some of them are in our habitat, but they don't really cause us any harm.

Use these questions to lead into a discussion of what defines a pest. Pests can be any unwanted organism present in your personal environment, from weeds and fungi to insects. Usually students think of insects as pests, mostly because they think insects are scary walking around on more legs than us! Help them to understand that in nature there really is no such thing as a pest and that every living being has some purpose. Pest is a name that people give to those critters that are unwanted in the school or house because when they are abundant they can cause harm to our homes, schools, and health, as well as possibly causing a financial burden. It is true that some pests, such as mice, can be dangerous in our living space. This danger is the result of their potential for spreading disease.

As an introduction to the process of inspection (finding out what pests are present), it is suggested that the 4th grade students participate only in the home scavenger hunt (Activity 2). As 5th graders they can expand the process to the school scavenger hunt (Activity 1). However, both activity 1 and 2 have been included to allow you to adapt the curriculum to your circumstances.

Activity 1 (*Recommended for 5th graders*)
School Scavenger Hunt:
Send your students around the school in search of pests. Have them fill out the scavenger hunt worksheet. Explain that it may be difficult for them to find most pests, assuming the school has a pest management program. However, in their search for pests they may find evidence that a pest was present (symptoms or signs). Such evidence may include droppings, chewed areas, cast skins, eggs, etc. It is just as appropriate to find symptoms and signs of pests as it is to find the pest itself.

Be sure to inform appropriate administrative staff (with Activity 1) and parents (with Activity 2) of your students' mission.

Activity 2 (*Recommended for 4th graders*)
Home Scavenger Hunt:
If your students will be doing only the home scavenger hunt (Activity 2), be sure to read the school scavenger hunt information first. This activity is comparable to the school scavenger hunt, but takes place in the home. In most instances, there will be the same pests in/around the home as there are in the school. Two scavenger hunt worksheets are provided. One provides more hints than the other.

Activity 3
Online Scavenger Hunt:
This online activity will further introduce students to the concept of IPM and the idea that pest problems occur because conditions favor them in one way or another.

Go to: http://www.ipminstitute.org/supersleuth.htm.
Read or have the students read aloud the introductory material and "What is IPM?" paragraph.
Select "Start Here" to go to http://www.ipminstitute.org/Super_Sleuth/homework_briefing.htm.
Select "Case 1: Inspection Is the Key to IPM Success!"
Select: "Inspect Our On-Line House for Grades 1 – 5." (*Note: A PDF version is also available and can be used for students who are absent.*) Read instructions on the web page and then begin. There are 4 rooms that contain conditions that would encourage pest problems. Have students (working alone or with partners) study a room and then list the problems in the virtual room on the Lesson 1, Activity 3 Handout **before** they move the cursor. *Note: the cursor turns to a pointing finger over each potential problem area and can be used as a hint if they have problems*. Once they have recorded what they think are the problem areas, have them move the cursors to see if they are correct. By clicking on each problem, a new page opens. Once the students have checked to see if they have chosen the correct problem areas, have them discuss with a partner why each situation might encourage pest problems. (*Note: In the yellow box on the left of each "problem" page is an explanation of why the situation would or would not encourage one or more*

pest problems.) When all groups are finished, ask questions of the class to see if they understand how each situation might encourage pest problems.

Ask students to think about what things pests need to survive and then write the list on their handout. Discuss with the class what pests need to survive and then write the list (Answers: Food, Water, Shelter, and Air) on the board. Have students add anything they miss to their list.

Ask students to make a list on their handout of what humans need to survive (Answers: Food, Water, Shelter, and Air) and then compare the two lists.

Have students make a list of as many pests as they can.

Activity 4 Follow-Up *(See Learning Extension, page 23)*
After students have investigated their home surroundings, they should begin to have more questions about pests. This follow-up activity is a precursor to the next set of lessons and the next step in IPM.

The students should begin by developing questions to conduct interviews about current pest management practices that are used at home. Help them to formulate questions such as:

- Which pests have you seen?
- Where have you seen them?
- Have they been monitored? If so, how?
- How have they been controlled?
- When do you control them?
- How many of a particular pest must you see before you control it?

Once students have decided on a list of questions, they will interview their parents, recording their answers either in writing or on a tape recorder.

This lesson, "Inspect and Investigate – Interviewing," is adapted from pages 25-27 of Exploring Urban Integrated Pest Management by Erica Bosley Jenkins of Michigan Sate University Pesticide Education, and more details can be found at:
http://www.pested.msu.edu/CommunitySchoolIpm/curriculum.htm

School/Home Scavenger Hunt (version 1) **Name_____**

IPM Lessons 1-2 – Discovering Pests

Pest	**Did you find this pest, yes or no?**	**What evidence of the pest did you find (symptoms and signs)?**	**Where did you find the pest?**	**Drawing or description of the pest.**
Cockroach			In a dark corner	
Mouse		droppings		
Spider				Has 8 legs
Ants		Ant hills near a door		
Bee or wasp				Has a yellow and black body

School/Home Scavenger Hunt (version 2) **Name**_____

IPM Lessons 1-2 – Discovering Pests

Pest	**Did you find this pest, yes or no?**	**What evidence of the pest did you find (symptoms and signs)?**	**Where did you find the pest?**	**Drawing or description of the pest.**

IPM Lesson 1
Corresponding activities – 1 & 2
Discovering Pests
Teacher Information Sheet: What is a Pest?

Ecologically, pests do not exist. In natural ecosystems, every organism has some specific role. This specific role that each organism must fulfill is its niche. Without that organism present to fulfill its role that niche is left empty, or may eventually be filled by some other organism. In natural ecosystems, groups of populations interact among each other fulfilling their individual niches. It is a complex system of checks and balances, and competition determines which individuals in a population will best fulfill the niche, while the others remain unsuccessful.

The Random House Webster's Unabridged Dictionary states that a pest is "an insect or small animal that harms or destroys garden plants, trees, etc." Webster's Third New International Dictionary (1981) says that pests are "(a) plant or animal detrimental to man or his interests." Lastly, the United States', Federal Insecticide Fungicide and Rodenticide Act (FIFRA) has defined a pest as "any organism that interferes with the activities and desires of humans."

The commonality among all of these definitions is that a pest is a human-defined concept. It is an organism that is aesthetically or monetarily intolerable to humans, or is in competition for a human resource. Humans consider undesirable organisms pests for several reasons. People consider pests a nuisance in their homes because they are aesthetically not pleasing. Pests in the home can represent uncleanness and contamination. They can also be indicators that there is something physically wrong with the home or building structure, for example termites may be feeding on rotting or decaying wood. Other animals such as cockroaches and ants find crumbs and leftover food bits that have been missed. Larger pests such as rats and mice in our homes and schools are considered pests because they can be the source of health hazards. Mice and rats have been documented to carry deadly diseases such as the black plague and the Hanta virus.

Undesirable animals or pathogens in vegetable gardens and on farms are considered pests because they compete for human food resources or in some way inhibit the health of crops and cause growers to invest in control thereby forcing them into some monetary loss. If pest population densities are high growers could suffer both yield and economic damage.

We consider unwanted organisms in our flower gardens and greenhouses pests because they decrease the aesthetic value of our crop. Humans grow these ornamental crops for enjoyment or perhaps for the benefit of helpful insects, and when they become infested with pests we suffer aesthetic and monetary loss.

Sources:

Metcalf, Robert L., and William H. Luckman. Introduction to Insect Pest Management. New York: A Wiley-Interscience Publication, John Wiley & Sons Inc., 1994

Norris, Robert F., Edward P. Caswell-Chen, and Marcos Kogan. Concepts in Integrated Pest Management. New Jersey: Prentice Hall, 2003.

IPM Lesson 1
Corresponding activities – 1 & 2
Discovering Pests
Teacher Information Sheet: Symptoms and Signs

Pests can be present in our homes, schools, gardens, yards, and greenhouses, yet we may not see them. We may be aware that pests have been in our habitats. The evidence pests leave behind can be characterized into two categories, symptoms and signs. It is important to know the difference between these two types of evidence, since they are characteristics of the pests that we hope to find.

Signs are biological remnants of the pest. Some examples of signs might be, fecal material from mice or rats, fecal material (i.e. black specks or frass) from insects, slime trails of snails or slugs, insect eggs, cast skins or shed skins from insects, hairs or whiskers from mammal pests, or spores of fungal pathogens. Signs are indicators that have been left by a specific pest.

Symptoms are the reaction of the host in response to the pest. Some examples of symptoms may be chewed leaves, yellowing or browning of leaves, bored holes in wood, and allergic reactions. Symptoms are usually some change that is seen in the host. Also it is not uncommon to find symptoms of the pest long after the pest has left the host.

Source:
Norris, Robert F., Edward P. Caswell-Chen, and Marcos Kogan. Concepts in Integrated Pest Management. New Jersey: Prentice Hall, 2003.

IPM Lesson 1, Activity 3 Handout Name_____
IPM Home Inspection

Bathroom: Four items that might invite pest problems.

1. _____ 2. _____

3. _____ 4. _____

Bedroom: Five items that might invite pest problems.

1. _____ 2. _____

3. _____ 4. _____

5. _____

Living Room: Four items that might invite pest problems.

1. _____ 2. _____

3. _____ 4. _____

Kitchen: Three items that might invite pest problems.

1. _____ 2. _____

3. _____

What do pests need to survive?

_____

_____

What do humans need to survive?

_____

_____

Make a list of as many pests as you can. Use the back if needed.

_____

_____

IPM Lesson 1: Learning Extensions

Language Arts

In conjunction with "Activity 4 – Follow-Up," have students practice interviewing skills, including:

- Facing the interviewee, maintaining eye contact, and using an appropriate voice level.
- Listening carefully to the interviewee's responses.
- Recording the interviewee's statements either in writing or via a tape recorder.
- Summarizing what is said after the interview.

(Language Arts Standards: 4-C1.12, 4-C2.2-4, 4-C2.6, 4-C3.3, 4-C3.5)

IPM Lesson 2 – Learning More About Pests

Introduction

In the previous lesson, your students interviewed individuals at home about the pests that were found and where they were found. They began to discover the basic needs of a pest and what gives an organism the status of a pest. To better understand IPM as applied ecology, students need to gain a further understanding of the needs, behaviors, and biology of pests. This knowledge will help them understand how and what type of damage has occurred. It will also help them later to make informed decisions about management tactics and control options.

In this lesson students will study in greater detail some of the pests they discovered in Lesson 1. They will learn that pests (just like humans and other organisms) need food, water, and shelter to survive in any ecosystem. The students will learn more about pest biology such as reproduction, feeding activities, communication and habitat. Additionally they will learn (if they have not already done so) that pests can be any of a variety of different organisms, including insects, mammals, fungi, and weeds.

Appropriate SC Science Standards for the Following Lesson

Grade 4:

- I. Inquiry
  - A. Process Skills – 2ab, 4a, 5a, 6a
  - B. Inquiry – 1e
- II. Life Science
  - A. Characteristics of Organisms – 2abc, 3ac
  - B. Organisms and Their Environment – 1ab

Resources for the following lesson

Exploring Urban Integrated Pest Management by Erica Bosley Jenkins – "Wanted Dead or Alive"
Used with Permission
http://www.pested.msu.edu

PBS – This website provides insect masks in color and in black and white
http://www.pbs.org/wnet/nature/alienempire/multimedia/butterfly_color.pdf
http://www.pbs.org/wnet/nature/alienempire/multimedia/cricket_color.pdf

Clemson University – Insect Communication Lessons by Dr. Joe Culin
Used with Permission
http://entweb.clemson.edu/buttrfly/Educatn/instcomm.pdf

University of California – Berkeley, Anatomy drawing
http://www.cnr.berkeley.edu/citybugs/allaboutbugs/basicanatomy.htm

Iowa State University, Anatomy drawing
http://www.ent.iastate.edu/ref/anatomy/ihop/

Bellarmine – Anatomy drawing
http://cas.bellarmine.edu/tietjen/Laboratories/FlowerCommunities/insect_anatomy.htm

North Carolina State University
http://www.cals.ncsu.edu:8050/course/ent425/tutorial/thorax.html

Discovery Channel Kids – All about insects
http://yucky.kids.discovery.com/noflash/roaches/index.html

University of California – Berkeley
CityBugs – Making Clay Ants
http://www.cnr.berkeley.edu/citybugs/teachercorner/teachercorner/clayAntsActivity.htm

University of Arizona – Using Insects in the Classroom
http://insected.arizona.edu/uli.htm

American Phytopathological Society – Disease triangle/Pest tetrahedron
http://www.apsnet.org/education/InstructorCommunication/TeachingArticles/Francl/Top.html

Ohio State Univeristy – Disease Triangle, interactive
http://telr-research.osu.edu/curtis/disease.htm

University of Wisconsin
http://www.plantpath.wisc.edu/PDDCEducation/MasterGardener/General/Slide2.htm

PBS Nature Program – Critter Guide – Has descriptions and interesting facts about many organisms including some insects.
http://www.pbs.org/wnet/nature/critter.html

Duration 7.5 hours

Objectives
The Students will:

- Investigate the necessary requirements for an organism to survive (food, water, shelter)
- Investigate pest habitats, activities, anatomy, biology, reproduction, and communication
- Understand differences between symptoms and signs of pests
- IPM objective – learn more about pests to make knowledge-based decisions about management practices and control options later

Vocabulary

Environment
Time
Symptoms
Signs
Morphology
Complete metamorphosis
Hosts
Pest
Incomplete metamorphosis
Head
Thorax
Abdomen
Legs
Spiracles
Wings
Labrum
Antennae
Labial palps
Compound Eye
Auditory communication
Mandibles
Maxillae
Maxillary palps
Labium
Olfactory communication

Discussion

Begin this activity with a discussion about the pests your students discovered in Lesson 1. Hopefully you will find that not all of the students discovered only insects; however, the majority of them may have. Talk with the students about the fact that there are many different types of pests. Some examples of pests include mammals that enter a home (e.g., mice, rats, squirrels), fungi or mold that may grow on shower walls or fruit, weeds in a garden, and insects that live in your home, invade a wooden structure (e.g., termites) or feed on your vegetable garden (e.g., caterpillars and beetles). Since insects are often considered pests, the focus in the next few activities will be to learn about these organisms. Be sure to stress to the students that it is critical that a pest organism be identified correctly and that as much as possible be known about it before trying to manage it.

Activity 1 – Introduction to Insects

Watch the video, "Basic Facts about Insects" (26 minutes). Have students fill out the study guide (pages 32-33) as they watch the movie. Go over the study guide before the video begins so that they can listen for answers to the questions. After watching the video, review with students what they have learned about insects.

After the review, go to the website, "Let's Talk About Insects", at http://www.urbanext.uiuc.edu/insects/index.html. This wonderful, interactive site is provided by the University of Illinois Extension and is designed to help 4th to 6th grade students learn about insects and their importance in the environment. The website includes a teacher's guide, which has been included with the handouts in your binder and can also be accessed at: http://www.urbanext.uiuc.edu/insects/guide/index.html. Additional classroom activities (including some worksheets) are provided on their webpage: http://www.urbanext.uiuc.edu/insects/guide/activities.html, as well as being included in your binder.

If the computers utilized for this activity have speakers, the students can read along as the narrator presents the material. Once students have completed the interactive presentation, they can click on "next" to go to CP's Fun Place and participate in the "Am I An Insect?" activity. This activity will help them determine if they can differentiate between insects and other organisms. By returning to CP's Fun Place, students can click on the "Eee Gads…A New Bug" link to create a new insect. Once the new insects have been named and described, they can be e-mailed to a friend, printed and mailed to a friend, and also e-mailed to C.P. to be posted online in his bug collection, the Insect Hall of Fame.

Activity 2 – Ahead of the Game
Introduction
Pest biology is an important part of pest identification. It is important that students understand pest anatomy, communication, and life cycles in order to make sound decisions concerning the integration of management practices in an IPM program. It may be necessary to implement tactics that inhibit one or more of these elements in order to make situations unfavorable for pest populations. This first activity allows students to explore the anatomy of an insect head. Learning the basic parts of an insect head is important as the majority of pest damage is done by feeding. Likewise learning about insect anatomy and morphology are important for IPM because pest managers consider insect mobility and susceptible life stages when making decisions about which control practices to implement.

PBS.Org (see Resources on page 28) provides patterns for cricket and butterfly head masks (included with construction instructions in your binder) that will be helpful for students learning the parts of an insect head. While crickets can be more easily classified as pests, the larvae of butterfly (i.e. caterpillars) are defoliating pests that can be troublesome in vegetable and ornamental gardens as well as farmers' fields. Before making the masks, students should watch the animated instructions provided on the following web pages: http://www.pbs.org/wnet/nature/alienempire/multimedia/cricket-flash.html and http://www.pbs.org/wnet/nature/alienempire/multimedia/butterfly-flash.html. Written

instructions provide more details and are available in your binder. Remind students to label the mask parts on the back of each piece, being sure to include both the letter and the name of the structure according to the following list:
Butterfly – antennae = F, G; proboscis = D joined to E; head = A; sides of head = B,C.
Cricket – mandibles = D; maxillary palps = E, F; antennae = G,H; head = A; sides = B,C.
For more information about the functions of different insect head structures, see teacher information sheet, "Insect Anatomy".

Resources
PBS – This website provides insect masks in color and in black and white.
http://www.pbs.org/wnet/nature/alienempire/multimedia/maskindex.html

University of California – Berkeley CityBugs – Making Clay Ants
http://www.cnr.berkeley.edu/citybugs/teachercorner/teachercorner/clayAntsActivity.htm

Materials
Construction paper, enough for each student
Cricket and butterfly patterns, enough for each student
Pencils
Markers
Crayons
Colored pencils
Scissors
Glue
Hole punch
String or yarn

Activity 3 – Pin the wings on the insect!
In the last activity students learned the basic parts of an insect head. This next lesson allows students to review what they learned about insect anatomy in Activities 1 and 2. Talk with students about insect body parts. You may want to begin by asking them questions to review external insect anatomy or you may just want to tell them that they are going to build an insect using the "body parts" that are provided.

For this activity, cards shaped like various insect body parts (head, thorax, abdomen, antennae, mouth, wings, compound eyes, and legs) are provided. The back of each "body part" contains a label telling what it is. In addition, three posters are included of a generalized insect: one labeled, one unlabeled and one that contains only a head, thorax and abdomen.

Working individually or in pairs, have students collect the insect "body parts" and create their own insects. When everyone is finished, display a labeled insect body (see provided poster), and ask them to compare their creations to the poster. Then, for added fun, you may wish to blindfold students and have them add body parts to the head/thorax/abdomen poster. Once all parts have been added, have students move the misplaced body parts to their anatomically correct location. Once everyone understands external anatomy, talk briefly about the function of each part.

Activity Resources
University of California – Berkeley, Anatomy drawing – see page 37 of this curriculum.
http://www.cnr.berkeley.edu/citybugs/allaboutbugs/basicanatomy.htm

Iowa State University, Anatomy drawing – detailed internal insect anatomy
http://www.ent.iastate.edu/ref/anatomy/ihop/

Bellarmine, Anatomy drawing – fairly detailed external anatomy
http://cas.bellarmine.edu/tietjen/Laboratories/FlowerCommunities/insect_anatomy.htm

Enchanted learning.com – excellent source of insect printouts.
http://www.enchantedlearning.com/subjects/insects/printouts.shtml

Assessment
Ask each student to cut out pictures of insects and label as many parts as they can see. This is also a great opportunity to teach students about field guides!

This assessment idea was borrowed from
Bosley Jenkins, E. Exploring Urban Integrated Pest Management. "All About Insects." (Classroom Activity #12) Michigan State University Pesticide Education. 2001.
http://www.pested.msu.edu/CommunitySchoolIPM/curriculum

Materials
Insect posters, labeled and unlabeled
"Body parts" cards
Thumb tacks

Activity 4 – A Closer Look at Insects
Activity Resources
Nova Online: Japan's Secret Garden – Includes five video clips of insects completing metamorphosis to become adults. http://www.pbs.org/wgbh/nova/satoyama/transform.html

Jenkins, E.B. Michigan State University Pesticide Education. 2001. "All About Insects" Classroom Activity #12 from *Exploring Urban Integrated Pest Management*. This activity can be accessed at http://www.pested.msu.edu/CommunitySchoolIpm/curriculum.htm.
The teacher fact sheet (pages 67-68 of *Exploring Urban Integrated Pest Management*) provides concise information about insects. (*Printed and included in your binder*.)

West Virginia University Extension Service – "Insect Metamorphosis"
http://www.caf.wvu.edu/~forage/4002.htm

Amazing Insects – Insect facts and information – Includes information on insect anatomy, complete metamorphosis, and characteristics of insects.
http://www.ivyhall.district96.k12.il.us/4th/kkhp/1insects/buginfo.html

In this activity, have students, individually or as a class, watch the video clips from the PBS Nova program, *Japan's Secret Garden* (see activity resources). Depending on the speed of your internet connection, you may want to download all of the clips before students get to class. These video clips show five kinds of insects completing metamorphosis. After watching the video clips, have students take notes based on information that you provide them from the Teacher Information Sheet "Metamorphosis" that follows this lesson. Between knowledge gained in previous activities, the PBS videos and the information provided from the Teacher Information Sheet, students will be able to expand class discussion. The "All About Insects" worksheet by Jenkins (included in the binder and also available on the web – see resources) is a perfect follow-up for your students at this point. You may choose to have students complete the worksheet individually, with a partner or as a class.

In this activity students have the opportunity to discuss complete and incomplete metamorphosis as well as talk about insect body parts and their function. This is a wonderful opportunity to rear insects in the classroom as you learn about metamorphosis. If you choose not to rear insects in your classroom, other options include: allowing students to collect insects and bring them to class (live or mounted); asking a university entomology club to present insect displays (live or mounted); or using insect pictures from the web or other resources. Have students try to find the various insect parts on the live insects or insect photos that they are using.

Materials
Student worksheets, "All About Insects" (provided in binder)
Teacher key
Teacher Information Sheets, "Insect Anatomy" and "Metamorphosis"
Insects

Activity 5 – Insect Communication
Now that students have a greater understanding about pest anatomy and morphology, learning about insect communication is a great way to wrap up this lesson.

Introduction
Just like humans, insects use hearing (auditory), smell (olfactory), and sight (vision) as their means of communication. Insects need to be able to find a mate, find food sources, and avoid enemies. They use their senses to accomplish these activities. Insect communication is important in IPM because there are several devices designed to monitor insect populations or to interfere with insect communication. One example is a pheromone trap. Pheromones are chemicals released by an organism that affect the behavior or development of other organisms of the same species. A pheromone device mimics insect pheromones in excessive amounts and is used to confuse insects. Light traps are used to disorient insects at night and draw them away from feeding resources.

The following games were developed by Dr. Joseph Culin, Department of Entomology, Soils, and Plant Sciences at Clemson University. *They are available at the Entomology website (*http://entweb.clemson.edu*) and are used with permission*. As an introduction to these games you may wish to talk to students about how they gain information from other people, excluding conversation. What kinds of information can they gain from listening? What do they think

when they smell a sweet smell or a sour smell? During these games, students will learn how insects discover their mates through the use of their auditory and olfactory senses.

Auditory Communication game (Culin 2004)
Almost everyone has heard insect songs at night, but not everyone has realized that the insects were trying to find each other. This game is based on the communication of loud singing insects such as crickets, katydids, or grasshoppers. (Note: *To hear cricket and katydid songs, go to*: http://buzz.ifas.ufl.edu/a00samples.htm. *Cicada songs can be heard at*: http://buzz.ifas.ufl.edu/c700fl1.htm.)

Instructions
Divide students into groups. Give each student an empty film canister and a comb. Instruct each group to create their own song. Each groups' song should be unique. Once each group and each group member knows their song, choose a member from each group at random to come to the front of the class. Have that person turn with their back to the class. Then pick one group at a time to play their song. Tell the selected individual in the front of the class to raise their hand when they hear his group's song. Have that person rejoin his group. Then ask for a volunteer from each group to step out of the classroom. As that person is waiting in the hall, have all of the students stand in a circle around the classroom; mix the groups well. Bring the volunteers, blindfolded, back into the classroom. Ask all of the groups to play at once. Ask the volunteers to walk around the circle listening for their mate. When they find that person they should raise their hand. You may choose to have guides for the blindfolded students.

Olfactory Communication game (Culin 2004)
Insects emit chemicals called pheromones to either attract one another or to repel other species. Pheromones allow insects to follow one another, cluster into groups, cause each other to move from one location to another, signal danger, or increase mating.

Instructions
This game is played in a similar manner as the auditory game. Provide each student with a film canister containing a cotton ball with a drop of some scented liquid (see materials list). Have the students wander around until they locate the rest of their group. Tell the groups to become very familiar with their scent. Choose one student, at random, to temporarily exit the classroom. While that person is gone, ask the students to randomly arrange themselves in a circle around the classroom. Bring in the (blindfolded) volunteer and ask them to smell their way around the circle looking for a mate.

Materials
One set of 35mm film canisters, one for each student
Combs – need 4 each of 8 kinds of combs (i.e., different size teeth), one for each student
Another set of empty 35mm film canisters, each with a cotton ball, one for each student
7 different scents (depending on class size), you can use essential oils, liquid candle scents, cooking oils, cooking extracts, perfumes etc.
Scent Key: A-E = banana; F-J = peppermint; K-O = Cinnamon; P-T = Orange; U-Y = pineapple; AA-EE = cherry; FF-JJ = anise.

Basic Facts about Insects **Name_____**
Study Guide Handout

True or False

_____ 1. Insects only thrive in a few environments.

_____ 2. Insects, pillbugs, millipedes, shrimp, lobsters and spiders are all arthropods.

_____ 3. There are more insects and more kinds of insects than all other animals combined.

_____ 4. Arthropoda means "jointed legs".

_____ 5. The hard covering of an arthropod is called an exoskeleton.

_____ 6. A spider is one kind of insect.

_____ 7. A young insect that looks very similar to an adult of the same species is called a larva.

_____ 8. Insects can see sharp images with their compound eyes.

_____ 9. Insects use their antennae to detect odors.

_____ 10. Ants that live in the same nest recognize one another by odors called "pheromones."

Fill in the blanks.

11. Name two products that insects make that are useful to humans.
_____ and _____

12. What are three kinds of social insects? _____,
_____, and _____.

13. How many legs, wings, and main body parts do most insects have? _____ legs,
_____ wings, _____ main body parts.

14. The larvae of _____and _____ are known as caterpillars.

Basic Facts about Insects
Study Guide Answers

True or False

False 1. Insects only thrive in a few environments.

True 2. Insects, pillbugs, millipedes, shrimp, lobsters and spiders are all arthropods.

True 3. There are more insects and more kinds of insects than all other animals combined.

True 4. Arthropoda means "jointed legs".

True 5. The hard covering of an arthropod is called an exoskeleton.

False 6. A spider is one kind of insect.

False 7. A young insect that looks very similar to an adult of the same species is called a larva.

False 8. Insects can see sharp, clear images with their compound eyes.

True 9. Insects use their antennae to detect odors.

True 10. Ants that live in the same nest recognize one another by odors called "pheromones."

Fill in the blanks.

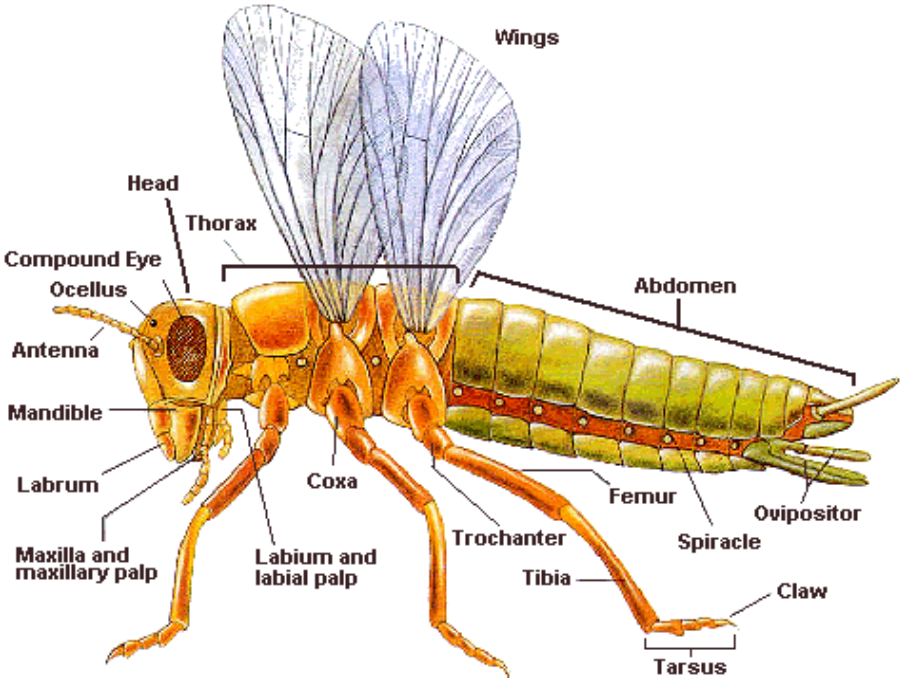
11. Name two products that insects make that are useful to humans.
_____honey_____ and _____silk_____

12. What are three kinds of social insects? _____termites_____,
_____ants_____, and _____honey bees_____.

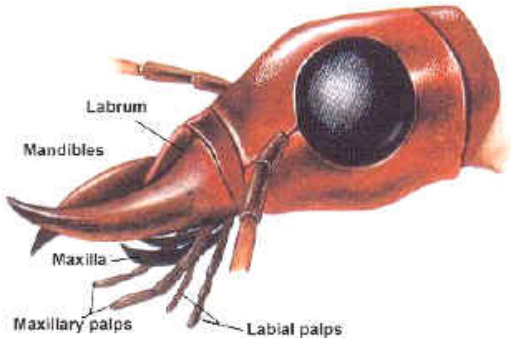
13. How many legs, wings, and main body parts do most insects have? ____six___ legs,
____four___ wings, ____three____ main body parts.

14. The larvae of _____butterflies_____and _____moths_____ are known as caterpillars.

Lesson 2
Corresponding Activities – 2 & 3
Learning More about Pests
Teacher Information Sheet: Insect anatomy



Insects have three major components to their body: the head, thorax, and abdomen. The head is composed of the major sensory organs of the body: antennae, eyes, and mouth. The thorax consists of structures that allow the insect to be mobile: wings and legs. Lastly, the abdomen is made up of the digestive, excretory, reproductive, circulatory and fatty storage structures of the body. Insects have no bones but have a hard outer covering called an exoskeleton. The exoskeleton is lighter and stronger than bone. It protects the insect from the harsh external environment by preventing the body from being flooded with water or drying out. It also helps the insect to resist attack from pathogens.



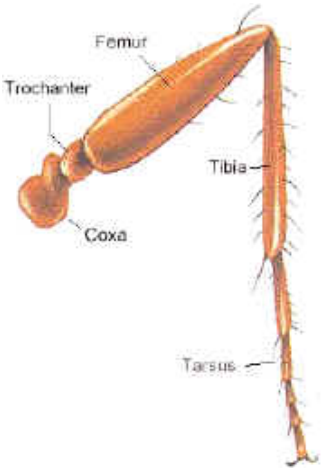
Head: The antennae are structures that protrude from the head. They are a pair of long, flexible, sensitive "feelers" that are used for olfaction. Depending on the insect, antennae can also be used for other communication procedures, including feeling, finding a mate or food, communicating with each other, smelling, and hearing (e.g. male mosquitoes). Antennae contain pores that sense chemicals or pheromones in the atmosphere. Pheromones are chemicals used

for a variety of communication purposes between individuals of the same species, including mating, foraging, trail making, and danger warnings. These chemicals are put out by one insect to affect the behavior of another.

The head also contains the eyes. The eyes can be compound or simple. A simple eye is called an ocellus.

The mouth has four major parts, and is layered from front to back. The first part or front covering is the upper lip or labrum. Just behind the upper lip are the very strong mandibles. Behind the mandibles are maxillae. The maxillae manipulate the insect food. They are composed of the maxillary palps which are sensory organs much like the antennae. In the very back is the labium. It is the bottom lip and is composed of labial palps. These mouthparts are modified into suction structures in many insects that pierce plant or animal tissues, such as mosquitoes. In other insects mouth parts are modified into a sucking structure, called a proboscis that coils and uncoils to obtain nectars within flowers.

Insects have a simple brain that is capable of secreting hormones for the development of muscles, molting and metamorphosis. It also controls the mouthparts and salivary glands.



Thorax: The thorax has three segments, the pro, meso, and meta thorax. Insects have three pairs of legs or six individual legs. They are used for movement, propulsion, jumping, and producing sound. The first pair of legs is located on the prothorax, the second on the mesothorax, and the third on the metathorax. Some insects have legs adapted for jumping on the metathorax. The feet of insects are sensory structures that enable insects to taste their food. Insects have two pair of wings located on the second and third segments of the thorax.

Abdomen: This segment of the insect body contains the majority of the insect's fatty storage, digestive, excretory, circulatory and reproductive systems. Food travels through the insect's digestive tract (beginning with the front of the insect) passing through the organs in the following order: esophagus, crop, proventriculus, ventriculus (where food is absorbed), intestine, and rectum. The heart runs along the top of the digestive tract directly under the dorsal exoskeleton. Insects have an open circulatory system, and their blood is called haemolymph. Directly in front of the intestine is a group of hollow tubes, called the malpighian tubules, which function as kidneys. Along the sides of the insect's abdomen are small holes called spiracles.

The spiracles open into chambers which open into trachea which together serve as the respiratory system of the insect.

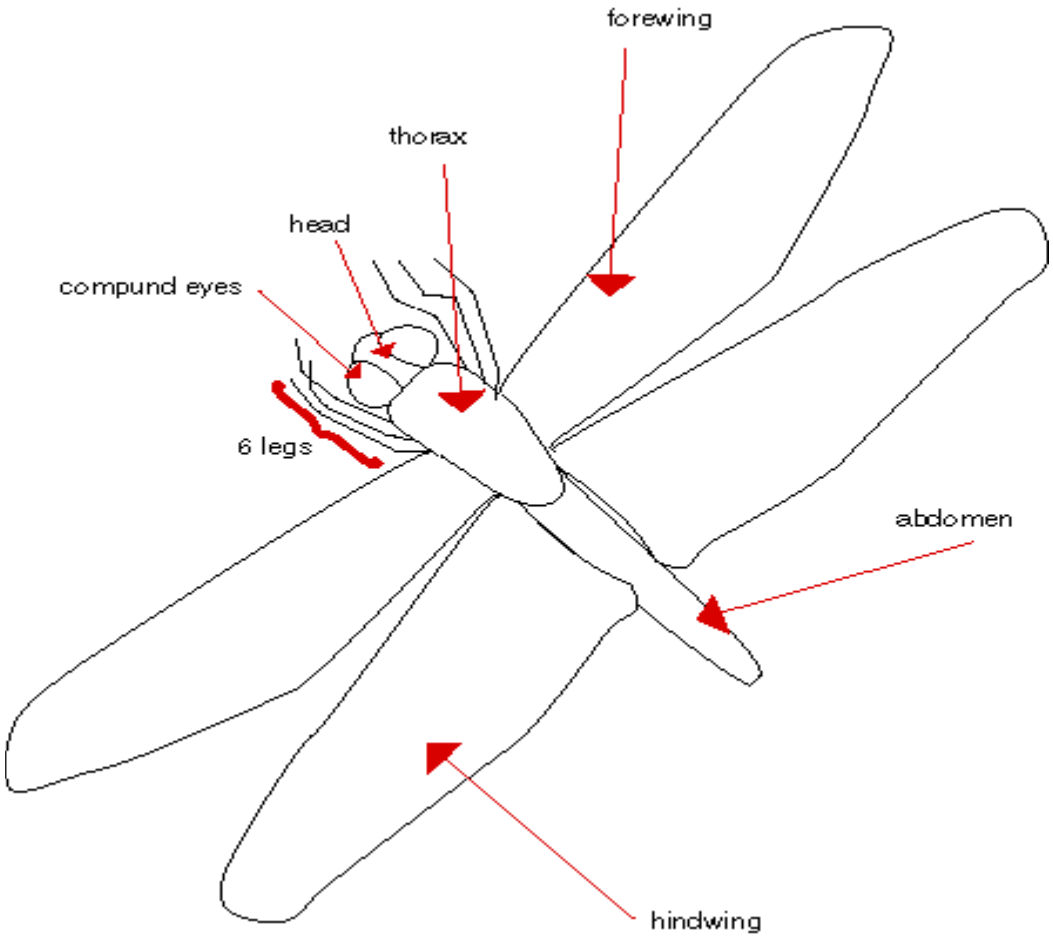
Sources:
Metcalf, Robert L., and Robert A. Metcalf. Destructive and Useful Insects: Their habits and control 5th ed. New York: McGraw-Hill. 1993.

Cartage.org with information from http://www.arthropod.net (photos courtesy of this site)
http://www.cartage.org.lb/en/themes/Sciences/Zoology/Insects/InsectAnatomy/mainpage.htm

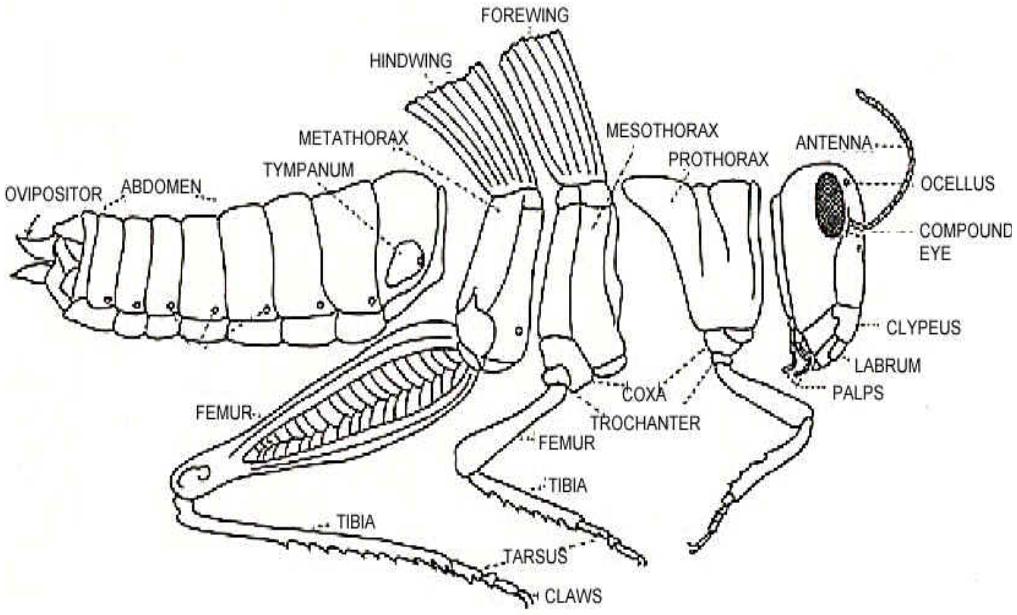
Lesson 2
The following two drawings correspond to activities 3 and 4
Learning More About Pests

Basic Insect Anatomy - http://www.cnr.berkeley.edu/citybugs/allaboutbugs/basicanatomy.htm

Drawings Courtesy of University of California –Berkeley
And Bellarmine



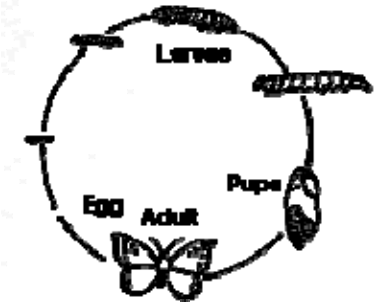
Detailed Insect Anatomy –
http://cas.bellarmine.edu/tietjen/Laboratories/FlowerCommunities/insect_anatomy.htm



Lesson 2
Corresponding Activity - 4
Learning more about pests
Teacher Information Sheet: Metamorphosis

Photo courtesy of Pacific Science Center
http://www.exhibits.pacsci.org/insects/metamorphosis.html

Metamorphosis or insect development can occur in two very different ways. The first is *complete metamorphosis*, in which each life stage of the insect is different from the previous. The second is *gradual metamorphosis*, in which each stage resembles the previous stage.



Complete metamorphosis: A butterfly is an insect with complete metamorphosis. There are four life stages, the egg, larva, pupa and adult. A life stage is a period of an insect's life that is drastically different from the previous or next stage. It is different in appearance and behavior. Following the egg stage, growth only occurs until the pupal stage. At that point the insect stops growing. Once the adult emerges from the pupal stage, it has fully grown and fixed wings. At this point, the insect will grow no larger, except to expand its body for a large meal.

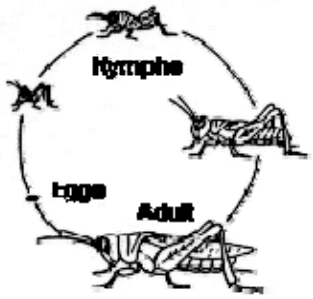
Egg: There are different types of reproduction. Insects that lay eggs are termed oviparous. That is the egg is formed inside of the mother's body, and then deposited in some protected environment such as in a tree crack or under a leaf for the egg to fully develop. This is similar to egg laying in birds but insect eggs do not require incubation. Another type of insect reproduction is called ovoviviparous reproduction. In this case, the mother is fertilized and eggs are produced. However, she does not deposit the egg outside her body; rather she retains the eggs inside herself, and once the young hatch from the eggs, she gives birth to them. This is different from animal birth because the insect receives its nourishment from the egg yolk rather than from the mother.

Insect eggs are generally deposited in a protected area, which also contains a food source for the young to feed upon when they hatch. Eggs are distributed in several ways, depending on the insect. Eggs may be laid singly, which is rare, or in masses. When eggs are laid in masses, females may lay several hundred to several thousand eggs per day. Eggs can be laid at one time, a few per day, or at intervals. Depending on the season, eggs may hatch right away or they may be dormant for a period of time, such as over the winter.

Larva: This is the first life stage after the insect hatches. The larval stage may be subdivided into phases known as instars. This is the life stage where the insect does all of its growing. The outer body covering, or exoskeleton, does not expand like human or animal skin, instead when the insect's inner body increases to a size which can no longer be contained by the exoskeleton, the exoskeleton splits. This shedding of the exoskeleton is called molting. The old cuticle is cast off and the new one has formed under it. Molting and then leaving the old skin behind is known as a cast-skin. From the beginning of the new skin to the shed of that skin is called an instar. Insects may go through 5 or 6 (and up to as many as 20) instars before reaching the next life stage. Genetics and diet of the insect determine molting.

Pupa: This is sometimes considered an inactive larval stage. The last instar retreats, usually, to some protected area, such as under leaves, in logs, or under limbs, before it transforms into the most helpless, defenseless stage of life. Then an outer covering is formed around the larva. This outer covering may be made of leaf material, small pebbles, fine bits of wood, pieces of soil, hairs from the body of the larva, and any other material that may surround the larva as it pupates (or begins its transformation to an adult). The material is fastened together by silk threads that are secreted from the mouth of the larva.

Adult: The adult stage is the last stage of development. At this stage there are no further increases in size. Adults are complete with three body segments and three pairs of legs, and in most cases, fully developed wings. They also possess reproductive structures at this stage.



Gradual metamorphosis: Insects such as grasshoppers undergo gradual metamorphosis. The young, called nymphs, resemble the adult through their life, though there are some differences. The nymphs do not have wings or reproductive organs. As in complete metamorphosis, the insects that undergo incomplete metamorphosis also go through several stages of growth, or molts. However, with each stage the nymph more closely resembles the adult. After several molts nymphs will develop wing pads, which will become larger with each molt. This development is very gradual. Unlike complete metamorphosis, nymphs and adults often feed on the same food source, and can be seen doing so.

Sources:
Metcalf, Robert L., and Robert A. Metcalf. Destructive and Useful Insects: Their habits and control 5th ed. New York: McGraw-Hill. 1993.

West Virginia University Extension Service (source for diagrams)
http://www.caf.wvu.edu/~forage/4002.htm (Printed and included at the end of Lesson 2)

Nova Online: Japan's Secret Garden – Includes five video clips of five species of insect completing metamorphosis to become adults.
http://www.pbs.org/wgbh/nova/satoyama/transform.html

Lesson 2
Corresponding Activity - 5
Learning More about Pests
Teacher Information Sheet: Insect Communication and senses
(Information directly from Mississippi State University website)
http://insectzoo.msstate.edu/Students/basic.senses.html

Moth antenna photo courtesy of Arthropod.net

Sense Organs: Insects have sense organs for taste, touch, smell, hearing, and sight--the same senses in humans. Some insects have sense organs for temperature and humidity as well as stresses and movements of their body parts. Most sense organs of insects are microscopic in size and are found on their body wall. Many are small hairs, and others are small domes or other shapes. Regardless of their shape, all sense organs have one or more nerves leading to them. These small sense organs are called sensilla (a sensillum is one sense organ). A single antenna of an insect may have more than five thousand sensilla.

Sense organs, or sensilla, that function for taste and smell always have at least one small hole, or pore, through which chemical molecules enter the organ. A single sense organ on the antenna of the polyphemus moth has 18,000 pores for chemicals to enter. There are always two or more nerves inside these sensilla that respond to chemicals.

Sense organs that respond only to mechanical touch or vibration do not have holes in them, and they only have one nerve. Some of these sensilla respond to changes in the body wall when the insect moves.

Taste: The organs of taste may be found on all parts of the insect's body, but they are located primarily on mouthparts and feet (or tarsi). Some insects, including bees and wasps, have taste organs on their antennae. Wasps and crickets know where to lay their eggs because they have taste organs on their ovipositor (structure for laying eggs into a substrate).

Most insects have the same four taste sensations as humans--salty, bitter, sweet, and sour. Many insects also have taste organs for particular chemicals found in only certain plants. The cabbage butterfly, for example, has a taste organ for mustard.

Smell: Antennae sometimes are called "feelers." However, antennae are primarily "smellers"; they are the insect's "nose" since they are covered with many receptors for smell. These organs help the insect find food, a mate, and places to lay eggs. Insects can even decide which direction to fly by using their sense of smell.

The organ of smell of an insect does not detect as many different odors as a human's nose, but the insect's organ is tuned more finely. It can detect differences between very similar chemicals, and it can detect chemicals at much smaller amounts. For example, the male of the lesser emperor moth can smell the chemical pheromone of the female moth at a distance of greater than six miles. Social insects, like ants and bees, know when an unwanted visitor enters their nest because they recognize the members of their own colony with their sense of smell.

Touch: Small hairs with a nerve at their base are sense organs that respond to touch. The insect can sense the movement of this hair if it touches another object. These sensory hairs help honey bees orient to the earth's gravity when they are upside down.

Sense organs of touch can respond to the wind or a gentle breeze. This is one reason why it is difficult to catch a fly. Flies can sense the air being pushed towards it when your hand is moving. One grasshopper species can feel air moving at less than one-tenth mile per hour.

Hearing: Insects can hear sound passing as vibrations through the air as well as through the ground, water, or the leaf of a plant. Some insects can hear sounds that people cannot. Insects have many different kinds of "ears" or hearing organs. The simplest hearing organs are the same hair-like sense organs that respond to touch. Some insects, such as cicadas and crickets, detect sound with a tympanum, a large membrane like the eardrum in humans.

Bats make sounds that echo from a flying insect. Bats use this echolocation to catch their food. Many different moths have a tympanum on their wings, thorax, or abdomen. These moths can hear the clicking sounds of the bats and take evasive action, dropping in the air or changing their flight path to avoid being caught.

Many insects have hearing organs within their legs. These ears in legs respond to vibrations passing though the ground or a plant. This is why ants will come out of their nest when you stomp the ground.

Sight: Adults and nymphs of insects have two compound eyes and up to three simple eyes on their head. Larvae of insects with complete metamorphosis, such as caterpillars and grubs, do not have compound eyes, but they may have 1-6 simple eyes. A simple eye is a single lens that tells the difference between light and dark. Larvae can also see rough shapes with their simple eyes. A compound eye includes many lenses that have six sides and fit together like the cells of a honeycomb. Compound eyes differ among insects in their ability to see, but some can see sharp images and different colors. All insects can see movement better than shape.

Insects with large compound eyes, like cockroaches and dragonflies, can see 360 degrees from a focal point. Color vision in insects differs from that in humans. Many insects can see the

ultraviolet color not visible to humans, but most insects cannot see the color red. If a red plastic film is placed over a flashlight, insects can be observed at night without them detecting the light.

Other Senses: Insects have special organs for sensing their movements, which cause internal changes in pressure and stress inside their body. These sense organs are similar to those for touch, except they are dome-shaped and have no hair. Insects have many of these pressure and stress organs on their wings and legs, and they could not walk or fly without them.

Instinct and Learning: Insect behavior is mostly instinctive. Genes determine instinct before the insect hatches from the egg. A caterpillar does not make a conscious choice of which plant to eat. The caterpillar is programmed to eat a certain kind of plant, even though other nutritious plants might be available. Likewise, a wasp does not choose to sting a person. The wasp is reacting by instinct to a threat or invasion of its territory.

Insects also have the ability to learn. Some moths first locate flowers instinctively by their scent. These moths later learn to identify the flower by their vision. Some kinds of wasps make orientation flights to learn landmarks near their nest, and these landmarks are remembered so they can find their nest after a longer flight.

Honey bees can be trained, or conditioned, to associate sugar water with a particular color or aroma. Honey bees also learn to come to food at certain times during the day when there is nectar available.

Insects also learn by "trial and error." When Colorado potato beetles first attempt to mate, they are not good at identifying their own species or even distinguishing the head from the tail end of the body. With repeated attempts and mistakes, they learn to recognize their own species and to differentiate the head from the tail.

From Mississippi State University
http://insectzoo.msstate.edu/Students/basic.senses.html

IPM Lesson 2: Learning Extensions

Science

Mapping Insect Behavior – When scientists have a question about animal behavior, they generally cannot look at every individual in a population to find their answer. Instead they observe a sample group to make inferences about a larger population. This hands-on activity uses sticky dots to "map" a community of crickets. It enables students to learn how to make inferences about animal behavior by observing a sample group. When completed, students will take their data to their math class to graph. When students return to science with graphs, they will determine what inferences can be drawn from their data. What predictions? See Lesson 2 Resources for activity reference and details. Also, see Math extension for this activity. (4-I-A5ab, 6ab)

Math

1. Graph insect behavior (http://www.eduref.org/Virtual/Lessons/Science/Animals/ANM0040.html). See pp.45a-c for resources. Have students take their mapping insect behavior data to math class to graph. What kind of graph would be most appropriate for this data? What inferences can be drawn based on the results of the 3 trials. (Math Standards: 4-Data Analysis-I-C1,2, D1,2)

2. Have students collect some insects and bring them to class to practice measurement of their body lengths. A second option is to measure insects in photos on the handout provided in the IPM Lesson 2 resources (pp. 45d-e). (Math Standards: 4-Measurement-I-A4, C1)

IPM Lesson 3 – Taking a Closer Look at Pests (Monitoring)

Introduction

In Lesson 1, students took a look around their homes to see if they could find any pests or signs/symptoms of pests. They also interviewed their parents about pests that they had seen. In Lesson 2, students learned more about the biology of insects, some of which are considered pests. This lesson introduces students to the concept of monitoring (and scouting) pest populations. It also introduces the concept of tolerance for pests and some commonsense pest management techniques.

With their increased knowledge, students will scout for pests identified in Lesson 1 and also for specific symptoms and signs. At this point the students should be familiar with the concepts of symptoms and signs, but in this lesson they will be looking for them specifically. Monitoring is an essential component to any IPM program. It helps pest managers determine pest population density and pest location. In addition, during monitoring, pest managers notice conditions that are likely to encourage pest infestations. With this information, they can make recommendations for non-chemical management strategies.

Knowing the biology, habitats, and habits of pests is an important part of a monitoring program. With this information, pest managers can assess the pest life stage for virulence and potential resource damage. Information about pest habitat and habits make monitoring programs more effective, providing pest managers with clues about where to locate pests. Monitoring programs also help pest managers determine injury and tolerance levels. If injury increases or tolerance levels decrease during the monitoring program, the pest manager will then implement management tactics

Appropriate SC Science Standards for the Following Lesson

Grade 4:

- I. Inquiry
  A. Process Skills – 1a, 2ab, 4a, 6a
  B. Inquiry – 1abde
- II. Life Science
  A. Characteristics of Organisms – 1bc
  B. Organisms and Their Environment – 1b, 2ab, 3abcd

Resources for the following lesson (All have been printed and included in the binder.)
Virginia Cooperative Extension
http://www.ext.vt.edu/schoolipm/pages/establish.htm

University of California
http://www.ipm.ucdavis.edu/PMG/r280390211.html

Maryland Department of Agriculture – Action Thresholds in School IPM
http://schoolipm.ifas.ufl.edu/doc/MD_thres.pdf

University of Massachusetts – Two web pages dealing with the concept of thresholds.
Setting Thresholds for School IPM
http://www.umass.edu/umext/schoolipm/school_daycare/school_ipm_sch03a4.html
and Thresholds: Setting Injury & Action Levels
http://www.umass.edu/umext/schoolipm/school_daycare/school_ipm_sch03a4a.html

Exploring Urban Integrated Pest Management, "Inspecting the School" (Classroom Activity #7) by Erica Jenkins, Michigan State University.
http://www.pested.msu.edu/CommunitySchoolIpm/curriculum.htm

Duration 3.5 hours

Objectives
Students will:

- Review what they have learned about pests so far.
- Use previously learned information about pests and put it into practice.
- Scout their homes for pests.
- Use communication and interviewing skills.
- Understand tolerance levels in relation to pests.
- Recognize situations that encourage pest infestations.
- Make decisions about when management tactics may be necessary.

Vocabulary
Pests
Symptoms
Signs
Scouting
Monitoring
Control
Tolerance

Discussion/Review
Take a few moments to review with your class what they have learned thus far. Ask them questions such as:

- What pests have we discovered in our homes? (Animals, insects, fungi, etc.)
- Where did we discover them? (Ask for specific details, e.g. in a dark closet, near a crack in the wall, close to moisture.)
- What do we know about them? What are their eating habits? How do they grow? How do they communicate (if they are not insects)?

Begin to ask students more details about how they discovered their pests.

- Did they see any *signs* such as droppings, eggs, cast skins, or the pest itself?
- Did they see any *symptoms* such as chewed areas, holes, scratch marks or any other evidence of a pest?

Summary
This is a good opportunity for students to review the difference between symptoms and signs. *For review, refer to teacher information sheet – symptoms and signs at the end of Lesson 1.* Signs are biological evidence of the pest, something that must come from the pest, such as droppings, eggs, hair, whiskers, cast skins, or the pest itself. Symptoms are abiotic bits of evidence created by the pest such as chewed holes, burrowed or bored holes, or scratch marks.

Activity 1
Scavenger Hunt Part 2: Preparing to hunt
Have students refer to their worksheets from their first scavenger hunt (IPM Lesson 1) and their notes from their interviews with parents. This will give them some background information for their scouting and monitoring activity. As a class, combine all of the students' pest information onto one large classroom chart (on the board, overhead, or as a poster).

Using the information from the class chart, divide the students into groups of two or three. Each group will research one of the pests on the chart and then present their information to the class. (*If there are not enough pests listed on the chart for each group to have a different one, let students choose another pest that commonly infests homes*.) Student reports should include information on where the pests live, what they eat, how they develop, how they communicate, and perhaps some important role they fulfill in the environment. You may choose to make a classroom chart of their findings or have them create one chart on the computer to which each group adds information about their particular pest.

Materials
Paper for worksheets
Poster board
Markers

Activity 2
Bug Survivor Game & the Model IPM House

In preparation for scouting their homes again, students will participate in the *Exploring the IPM House* activities. Complete details of these activities are provided at http://www.clemson.edu/scg/ipm/02ipmlessonplan2.pdf. The Bug Survivor game introduces the students to the basic survival requirements of four common household pests. The model IPM House contains numerous conditions that would likely encourage pest problems if they occurred in a real house. It gives students a chance to identify these kinds of potential problem areas before going back to their own homes to monitor for pests.

Materials
Model IPM House
Bug Survivor game cards
Stickers

Activity 3
The Hunt
Be sure to notify parents before beginning this activity. Explain that your students will be scouting their homes for pests, their symptoms and signs.

Note: Make copies of the Lesson 3, Activity 3 worksheet for this activity. It will help students to record information as they scout their homes.

Students (preferably with adult supervision) will scout their homes looking for pests and their symptoms and signs. Before students begin scouting, be sure to review with them the difference between symptoms and signs. Remind them that they are not to collect or disturb any pests and that they are only observing. Tell them to take detailed notes on their worksheets because it will help them later.

When students have finished hunting, ask them to bring their sheets to class. Make a class chart (*Note: retain for use in Lesson 4*) of the pests that were found, including signs, symptoms, pest habitat, and pest numbers. Ask your students:

- Did anyone find a pest (or its signs/symptoms) that was not found in the first pest scavenger hunt?
- How often they believe they should scout the pest infested areas: times per week, month, year and why?
- Will the time of the year affect how often they should scout and why?
- Be sure they understand that regular scouting is necessary to monitor pest populations.

Discuss the students' findings with them. Review the new classroom chart.

Up to this point students have learned a great deal about the environment in which they fulfill some role every day. They have learned that they are not the only living organisms in their homes or their school. They have discovered where these other organisms live, how they live, what they eat, how they develop, how they communicate, and perhaps some important role they fulfill in the environment. They should also be able to recognize certain conditions that encourage pest problems.

Materials
Worksheets
Mirrors
Poster board

Activity 4 – Tolerance or how many is too many?
In this activity your students will begin to explore further what tolerance means as far as pest populations are concerned. They will also begin to think about different kinds of management tactics. Encourage students to think about how and which management tactics they could use simultaneously.

Begin by talking with your students about tolerance, or how many of a particular pest can you stand to see or live with before you feel that you need to manage the population. To get them to start thinking about their personal tolerance levels, ask questions such as:

- If they see one cockroach, would they kill it?
- How many cockroaches would they need to see before they investigated some management procedure?
- How many ants, spiders, flies?

Your students will interview each other in order to determine some pest threshold i.e. some level at which a particular pest population is no longer tolerable and must be managed. They will ask each other questions about how many is too many, and what can be done to manage a pest problem? They will ask each other why they chose the numbers they chose. Students will also ask one another how much control is necessary, i.e. must they get rid of the entire pest population to be satisfied? What management tactic is easiest, i.e. most efficient to use?

After interviewing classmates, students should interview parents to find out what their tolerance levels are for particular pests. Decide as a class what questions should be asked.

After they have interviewed each other and their parents, have a class discussion about their findings. Have the class determine what they think is a reasonable tolerance level for each pest before they should take some measure or action to manage the pest population. Also have the class determine how much control is necessary for each pest population that they have listed.

You may want to contact your local University pest management extension specialist and ask if they would be willing to visit your class to be interviewed about tolerance. Have your class interview this person in the same manner as they previously interviewed their parents and each other. Additional questions they might ask include:

- What kinds of pests do you generally deal with?
- Can you give us some examples of pest situations where even one pest is too many?
- What recommendations did you make to manage that pest population?
- Can you give examples of pests with whom you do not mind sharing your home?

After interviewing the extension specialist, discuss with the students any new information.

Materials

Paper for interview sheets
Tape recorders & cassettes

Name_____

Lesson 3 – Activity 3
Scavenger Hunt part 2: Preparing to Hunt & The Hunt

Pests (drawing or description)	**Pest Habitat** (where it was found)	**Pest Evidence** (Symptoms and signs)	**Pest Numbers**	**Monitoring** (how often and when)	**Manage-ment** (when, how, with what)

Lesson 3 – Activity 4
Student Interview: How Many is Too Many?

Name of Interviewer_____

Name of Person Interviewed_____

Q: Recently you have been learning about pests in your home. Which pests have you discovered?

A:_____

_____.

Q: What time of day did you discover these culprits?

A:_____.

Q: What have you learned about these pests?

A:_____

_____.

Q: Let's focus on the pest that you find the most annoying. What interesting fact have you found out about it?

A:_____

_____.

Q: Now that you know more about this irritating pest, do you still find it as disgusting? Is it more tolerable or less tolerable to you? Are you more able to live with it?

A:_____

_____.

Q: When you discovered this particular pest, how many did you find? If you did not find the pest, did you find any symptoms or signs of the pest? What were they?

A:_____

_____

Q: How often would you scout for this pest? Would you expect your findings to be the same every time you scouted? Why or why not?

A:_____

_____

_____.

Q: How many of these pests do you think you could tolerate before you would have to take action? Why?

A:_____

_____.

Q: Now that you know something about the pest biology and its living habits, what kind of drastic measures would you take in order to manage this pest population? How much of a drastic measure would you use on your pest population? Why?

A:_____

_____.

Q: Which management tactic, do you think, would be the easiest to use?

A:_____

_____.

Q: If you could use more than one tactic which would you use? When? How? Why?

A:_____

_____.

Q: Thank you for your time. This has been a fun interview.

IPM Lesson 3: Learning Extensions

Science

Using GPS units, mark off quadrants on school grounds and locate and mark (3" nail through piece of aluminum flashing – flush with the soil) ant mounds within those quadrants. Revisit these sites in the spring and determine what has happened to the number of mounds.

Language Arts

Have students write a poem or 2-3 paragraphs in which they choose any 2 organisms that are considered pests by some people. One of the pests that they choose should be one that they really dislike, and the other one should be one that they tolerate or even like. Have them explain why they consider one a pest, and why they tolerate and even like the other so-called pest. (Language Arts Standards: 4-R1.16; 4-W1.6; 4-W1.6.1; 4-W2.1, 4-W2.2)

Math

1) In Lesson 3, students will be interviewing parents and students about how many of different kinds of pest they can tolerate before they feel the need to try to control them. Help them develop strategies to obtain unbiased results. (Math Standards: 4-DA&P-I-A1, 4-DA&P-I-B1)

2) Working with the quadrants in the science extension:

- describe location and movement using common language and geometric vocabulary and illustrate both with and without GPS unit technology. (Math Standards: 4-Geometry-II-A1; 4-IV-F1);
- estimate distance between objects (4-Measurement-II-B1);
- measure length of each quadrant side and area of quadrant (4-Measurement-I-A4);
- convert units of measure within metric system (4-Measurement-1-C1).

IPM Lesson 4 – Making Decisions (Management)

Introduction

This set of activities will guide your students through the decision-making process that is an integral part of IPM. Making knowledge-based decisions for effective and environmentally safe management of a pest is a critical step in any IPM program. In this lesson, students will use their knowledge about pest status, biology, habitat, habits, pest density (from scouting), and tolerance to help make decisions about which management strategies to use on a pest population. It is likely that many students will think that pesticides are the only means of managing a pest population (especially if they have ever been visited by a pest control professional at their home or school). This lesson introduces students to a variety of non-chemical management practices implemented in IPM programs. While students will also learn more about pesticides and safety issues concerning pesticides, these lessons will help them apply what they have learned to effectively manage pests without the use of pesticides.

Appropriate SC Science Standards for the Following Lesson

Grade 4:

- I. Inquiry
  A. Process Skills – 5a, 6a
  B. Inquiry, 1a
- II. Life Science
  A. Characteristics of Organisms – 1c
  B. Organisms and Their Environment – 1b, 2ab, 3abcd

Resources for the following lesson

Integrated Plant Protection Center – reference to several links on control
http://www.ippc.orst.edu/cicp/Index.htm - Database of IPM Resources
http://www.ippc.orst.edu/cicp/tactics/category.htm – Database of IPM Resources: Listing of resources on many kinds of pest control tactics

University of Georgia - "IPM: Control pests without excessive pesticides."
http://interests.caes.uga.edu/gardening/gardenpacket/spring03/stories/spg03_20ipm.htm

U.S. EPA – Pesticides Website – http://www.epa.gov/pesticides/ipm/brochure/

Household Products Database – A National Institutes of Health database that provides health and safety information on common household products. http://householdproducts.nlm.nih.gov/

Safer Pest Control Project
http://www.spcpweb.org/factsheets/kidfs2.pdf – Kids' guide to pesticides
http://www.spcpweb.org/schools

Pesticide Education Resources. University of Nebraska-Lincoln.
Principles of Pest Control (http://pested.unl.edu/pat1.htm) contains lots of good information on IPM and types of management techniques.

Cornell University – North American biological control guide
http://www.nysaes.cornell.edu/ent/biocontrol/ - Information on biological control

Duration 2-3 hours

Objectives
Students will:

- Review information they have learned about their problem pests
- Understand that management tactics need to regulate a pest population below tolerable levels
- Learn about the different management methods practiced in an IPM program: cultural, biological, physical, chemical
- Learn to choose which control options are best for a given situation
- Think critically about the decision-making process
- Understand the dangers, consequences, and safe use of pesticides
- Be able to recognize pesticides in their environment

Vocabulary

Pest	Insecticide
Host	Fungicide
Suitable environment	Rodenticide
Cultural control	Physical controls
Biological control	Sanitation
Predator	Habitat modification
Prey	Pesticides
Resistant plants	Prevention
Chemicals	

Discussion/Review
If a university extension pest management professional visited your students in Lesson 3, Activity 4, begin this lesson by reviewing what was learned from this person. Ask students about the different pests with which this person had experience. What pests were they? When were there too many of them i.e. how large was the population before it was necessary for that pest population to be managed? Also, what recommendations did the pest manager give to manage the pest population, i.e. how was the pest population managed? You may find that your students may report that the pest manager managed mostly insects and that generally they were called to manage the problem when pest populations were very high (i.e. intolerable to the client).

If you were unable to have a pest management visitor, revisit your students' problem pests. In the last exercise they determined tolerable levels for pest populations about which they now know a great deal.

Activity 1 - Brainstorming
Ask students to think of as many 'management methods' as they can. List their suggestions on the board. Ask students several questions about pest management tactics; begin with general questions to see what kind of ideas they formulate. Ask more specific questions that will lead them to different methods of management. You may want to use examples to help phrase your

questions. *It is important in this activity that students understand that management should be thought of as a way to regulate populations below tolerable levels.*

Example Questions and Explanations:

- **Ask**: How many management methods can you think of?
  - Expected Answer: Chemicals, predators, cleaning
  - Explanation: Chemicals or *pesticides* are one important way that many of us manage unwanted pests, and we will talk about pesticides later. However, there are other very important ways for managing pest problems.

  - Predators that manage pests are called *beneficials* and they are a source of *biological control*. Spiders are beneficial arthropods.

  - Cleaning or *sanitation* is another very important way to manage pests. If you wish to avoid having mice or cockroaches in your house, then you will want to sweep your floors (especially under warm appliances) and wash your tables every day. If you wish to avoid mold on your shower wall, then you should clean your shower walls every week. Sanitation is a form of *prevention* and *cultural control*.

- **Ask**: In the winter, ladybird beetles often try to get into our homes. While these little beetles are beneficial insects when they are outside, people often consider them a nuisance when they enter homes. What can we do to stop them from entering our living space?
  - Expected Answer: We can seal up cracks along windows and doors.
  - Expected Answer: Be sure all windows and doors are closed tightly.
  - Explanation: Sealing windows and doors is another type of *cultural control*, called *prevention*. Another way to rid the home of an annoying beetle population is to simply vacuum them up and dispose of the vacuum bag. This type of control is a form of *physical control*.

The class has not yet explored pest management outside of buildings such as their homes or school. However, this is a good time to introduce a few new ideas.

- **Ask**: How many students have been to a greenhouse or out in their mother's garden? Often there are unwanted plants growing among the flowers, we refer to them as weeds. If they are unwanted, could we consider weeds to be pests?
  - Expected answer: Yes
- How do we dispose of weeds, other than by pesticides (herbicides)?
  - Expected answer: Pull them out.
  - Explanation: Yes, pulling weeds is a form of *cultural control*.

Physical, cultural, biological, and chemical controls must be practiced with a certain amount of effort. Discuss with students the most efficient way to manage a pest population. Is it more efficient to practice good, consistent cultural controls such as sanitation to keep pest populations low? (Yes.) Or is it more efficient to allow the pest population to grow and then try some form of control? (No.) Help the students to understand that it is more effective and takes less effort in the long run to practice good physical and cultural controls that will keep pest populations below

tolerable levels than to wait until the population is very high. Also help students understand that several management tactics can be practiced at the same time. It takes more effort, time and money to reduce pest populations after they have become large. To reinforce the importance of using non-chemical control tactics first, have students color and then cut out and create the IPM Pyramid of Tactics for Schools (*created by the Pennsylvania IPM Program and available at*: http://paipm.cas.psu.edu/pdf/PyramidPDF1.pdf). Explain that the tactics contained in the pyramid also work for home pest management. Be sure to go over the colors that are recommended for the different tactics. Ask the students what the yellow color should remind a person to do? (*Use Caution.*) What about the red color? (*Stop. Use as a last resort when other tactics do not work.*)

Materials
IPM Pyramid of Tactics for Schools handout printed on card stock (*provided*)
Markers

Activity 2 – Management Decisions
Return to the class list that was made of pest problems students found in their homes. Divide students into pairs or groups and assign each group (or have them select) one of the pests listed. Each group will then research their pest and come up with a list of management suggestions that do not include pesticides. The groups should draw pictures, or write short paragraphs about how they chose to control their pest population, and present to the class. Encourage students in the audience to ask questions, to brainstorm possible problems that might be encountered with the management plans, and to conclude whether the recommended tactics could be reasonably implemented.

This assignment is designed to give the students an opportunity to think through a problem and come up with some solutions, evaluate for potential problems and revise their proposed solutions. It provides students with a real life team situation in which proposals are made, then evaluated and often revised. Note: Remind students to treat other students and their ideas with respect. The point is to collaborate to come up with the best solution to a real life problem.

Materials
Class list of pest problems (from Lesson 3)

Activity 3 – Implement

If possible, have students implement their management practices at home for the pests they have been learning about in their home environment. Be sure a parent is helping the student with this portion of their pest management project. Have students turn in a paragraph about what management practices they decided to use and why. If implementation is not possible for whatever reason, have students turn in a paragraph about what management practices they would use and why.

Activity 4 – Learning about Pesticides

This activity is only an introduction to pesticides, their use and consequences. For background information, "About Pesticides" (http://www.epa.gov/pesticides/about/index.htm) by the United States Environmental Protection Agency (EPA) has been included in the resources that follow this lesson.

Begin this activity with a discussion of pesticides. Find out what your students know about pesticides. You may wish to use some of the following questions in your discussion. Make a list of pros and cons of pesticide use on the board for your students.

- What are pesticides?
- Where are pesticides found?
- What are pesticides used for?
- Who uses pesticides?
- Are pesticides helpful for managing pests?
- Are pesticides good for people and pets to be around?
- What kind of harm do pesticides cause?
- What are signal words? (see following note)

Note: Signal word definitions:
Danger = slight taste to 1 teaspoon to kill an adult
Warning = 1 teaspoon to 1 tablespoon to kill an adult
Caution = slightly toxic to humans, an ounce to a pint to kill an adult

While pesticides are useful under specific circumstances, they also pose a danger. People who use pesticides have a responsibility to use pesticides according to the pesticide's label. In fact, it is illegal to use a pesticide in a manner contrary to what is specified on the label. A pesticide label is designed to provide the consumer with certain very important information to allow the pesticide to be used as safely and effectively as possible. It is critical that a consumer read and understand the label before using the pesticide.

The following activity will introduce your students to the kinds of information that can be found on a pesticide label. You may want to have students do the activity individually, or it can also be done as a class. Have students go to the EPA's web page (http://www.epa.gov/pesticides/label/) and click on the pesticide label image in the right column. On the new page that opens, place the cursor over the blue text to read a description of that particular label section. Point out that all pesticide labels contain the sections that are seen on the generic pesticide label, including:

- Directions for use,
- Precautionary statements (in terms of hazards to humans and domestic animals, environmental hazards, and physical and chemical hazards),
- Storage and disposal,
- Signal words,
- First aid,
- Active ingredients,
- Inert ingredients,
- Warranty statement,
- Manufacturer's address,

- Net weight,
- EPA registration number,
- EPA establishment number.

EPA's generic pesticide label has been recreated for you and is included in the resource materials that follow Lesson 4 in the binder. A poster-size version is available in the *Discovering IPM* kit. Thirty sample pesticide labels (10 fungicides, 10 insecticides, and 10 herbicides) of actual pesticides have also been included in the *Discovering IPM* kit. Additional pesticide labels are available on the Crop Data Management Systems, Inc. webpage, http://www.cdms.net/manuf/manuf.asp, by first clicking on a manufacturer's name and then on the label icon to the right of the pesticide name.

After viewing and discussing the generic pesticide label, give each student one of the sample pesticide labels and a copy of the Pesticide worksheet. Have the students look at the sample labels to find the following information: product name, type of pesticide (rodenticide, insecticide, etc.), signal word, and environmental hazards. Some of the pesticides may list more environmental hazards than there is room on the chart. You may want to limit how many environmental hazards the students have to list or let them continue the list on the back of the worksheet when they run out of room on the chart. When finished with the first label, have students trade with another student and fill in the chart for two more pesticides.

Pesticide Safety Issues
As a fun review, have students go to http://www.pested.psu.edu/youth.shtml to play the interactive game, D.B. Pest: Up Close and Personal. This interactive game deals with pesticide safety issues on both the environmental and personal levels.

Materials
Generic pesticide label (8 X 11 and poster)
30 sample pesticide labels from actual pesticides
Pesticide worksheet (Lesson 4, Activity 4)

Optional Enrichment Activity
Most of the focus of this curriculum has been on home/school pest management. However, anyone who has a garden, whether ornamental or vegetable, knows that pest problems often occur in these locations. Integrated pest management works for pests in gardens as well as indoor environments. One important concept that anyone with a garden should know is that of beneficials.

Earlier in this lesson, there was a brief introduction to biological control, the use of one organism (a beneficial) to control another organism (pest). Biological control organisms tend to be predators, parasites or pathogens. In this activity, have students watch the video, *Backyard Bugs*, to learn about beneficials. Then divide students into groups to find information about a particular beneficial. They should include information about the life cycle of the beneficial, what the different stages of the life cycle eat (if anything), what the different stages look like, etc.

Lesson 4
Corresponding to Activity – 1: Making Decisions
Teacher Information Sheet: Control Options

Cultural: Cultural methods involve manipulation of a resource (i.e. crop, kitchen, greenhouse, etc.) so that it becomes less suitable to the pest. Practices that make it more suitable for natural enemies and enhance the resource so that it is better able to withstand pest attack are cultural methods. Cultural controls affect the pest indirectly, are slow acting, and must be a continuous apart of an IPM program. Cultural tactics include:

- Preventing invasion of a pest through: planting certified seed, sanitizing tools, equipment, and removing debris
- Changing the pest population dynamics so that populations remain low
- Controlling alternative hosts or habitats - removal, and monitoring of hosts that can serve as an alternate host for pests
- Rotations - alternating crops or plants that are non-hosts to previous pests will help reduce pest populations
- Planting and harvesting dates - adjusting planting and harvesting dates to avoid pest population outbreaks and gain an advantage over weed emergence to reduce pest populations.
- Crop density - planting the crop in such a way so that there is little competition with weeds
- Transplanting - planting seedlings that are already growing as opposed to seeds
- Soil maintenance - making sure that low spots are adequately drained to avoid heavy moisture, and ensuring that soil has proper nutrient availability for plants through fertilization
- Trap crops and intercropping - planting crops around the edge or within the crop that lures pests from the crop, and planting more than one crop in a field increases diversity of organisms including biological controls and reduces pests from increasing in population.

Physical and mechanical: This is the direct manipulation of the environment. It is a rapid eradication method of pest management. It creates an environmental stress that the pest cannot tolerate and its mode of action is to kill. There are three major approaches to physical and mechanical pest management:

- Environmental modification - changing temperature, water, and light availability
- Exclusion - using barriers or traps that stop pests from reaching their host
- Destruction of pests by direct physical means - physical removal (hand labor), cultivation, and shooting

Biological: This is the utilization of natural enemies (predators, parasites, and pathogens) to manage pest populations. These are predators of pests that invade our schools, homes, gardens, greenhouses, and crops. They regulate pest populations by establishing some level of natural population regulation. Most often biological controls are used in combination with some other form of management because they are not usually sufficient to manage pest populations independently. The advantages are that with the use of biological controls: pests will reach harmful levels less rapidly; there are no pesticide residues; and biological controls can be effective in permanent ecosystems without causing harm. They can be used with other control tactics including selective pesticides that are safe for beneficials. There are several forms of biological control:

- Classical - this is implemented by regional and national agencies. Its purpose is to regulate the introduction of invasive species and is not usually used by individual growers, and pest managers. It involves the discovery and study of exotic animals and their predators. When an invasive species is discovered, regulatory agents eradicate the pest immediately. If an invasive species should enter an area unnoticed and is discovered later, the pest is correctly identified, quarantined, its country of origin and natural enemies are researched, and natural enemies reared in culture and released.
- Inoculative - this is the introduction and release of biological control agents. These predators may die out each year but have the ability to expand their population when conditions are conducive. These programs are regional and are implemented by local government agencies. They are most successful in perennial crops.
- Augmentative - this is the release of a biological control that is already living in the ecosystem but whose populations are not sufficient to manage pests. The individual pest manager can implement this program.
- Inundative - this is the mass release of a control agent that cannot reproduce and does not contain adequate population size without the help of humans. This program may be considered a biotic pesticide.
- Conservation - this includes maintaining the ecosystem in such a way it that benefits the beneficial population, and includes avoiding ecosystem disruption. This is implemented at both the regional and farm levels.

Chemical: Chemical control is the implementation of pesticides as a means of management. It may be part of a successful IPM program but must be used as a last alternative. Pesticides often affect non-target organisms, tend to become very costly, leave residues, can drift, and contaminate food, and water. They also are hazardous, and reliance upon them results in pest resistance, resurgence, and secondary pest outbreaks. When pesticides are relied upon, it becomes difficult to manage the pest population Pesticides must be used very specifically to target only the pest organism. There are three classes of pesticides, the inorganic chemicals that are made from elements other than carbon, the synthetic organic chemicals that are made from carbon and other synthesized components, and the biopesticides that have some biological origin. Pesticides include insecticides, fungicides, rodenticides, bactericides, herbicides, nematicides, algicides, araricides (spiders), and predacides (vertebrates). These divisions are based on the type of organism that they are intended to target.

Pesticides can work in several ways:
- Contact - kills the pest when it comes in contact with the pest or when the pest comes in contact with a surface that harbors the chemical.
- Ingestion - the pest must eat the pesticide.
- Translocated pesticides - these are pesticides that are applied to the plant and the plant takes up the pesticide into its tissues, an example is a mobile herbicide. The pest then ingests the pesticide.

Sources:
Norris, Robert F., Edward P. Caswell-Chen, and Marcos Kogan. Concepts in Integrated Pest Management. Pearson Education, Inc. Upper Saddle River: New Jersey 2003

Texas A&M University - Cultural controls
http://organiclifestyles.tamu.edu/pestdisease/cultural.html

Oklahoma State University – Physical or mechanical controls
http://pods.dasnr.okstate.edu/docushare/dsweb/Get/Document-2291/F-6432web.pdf

Cornell University – Biological controls
http://www.nysaes.cornell.edu/ent/biocontrol/

EPA – Pesticides: Health and safety
http://www.epa.gov/pesticides/food/

Lesson 4
Corresponding Activity - 4
Pesticides
Teacher Information Sheet: Pesticides

Pesticides are commonly thought to be the easiest and most effective means of pest management. Sometimes pesticides are thought to be the only means of pest management. Indeed there are many advantages to using pesticides. Pesticides:

- Can manage some pests that other management strategies cannot.
- Are sometimes inexpensive.
- Can increase yield.
- Require less energy put into a managed situation.
- Require less knowledge about pests and their biology.
- Provide rapid action.
- Decrease the amount of planning for the pest manager and grower.
- Reduce the risk of toxins from microorganisms that can harm food.

However, the benefits of immediate effects can often be detrimental to the future management of the pest situation. The use of pesticides and their long-term negative effects have a greater consequence than many people realize. The many disadvantages of pesticides include:

- Killing non-target, beneficial organisms that often regulate pest populations.
- Currently, older, environmentally-toxic pesticides that are harmful to human health are being banned. Many of the remaining pesticides are very specific in their use but are more expensive. In the long run, the reliance on pesticides will become very costly, even though they are relatively economical at this time.
- The presence of residues and drift of pesticides in the environment. Many pesticides used in the past, and some that are currently used, do not break down rapidly in the environment. They persist in the soil, groundwater, and on plant materials.
- Food contamination. Some pesticide residues left on food can lead to long-term health problems in humans.
- Toxicity. Pesticides, by their very nature, may be very toxic to humans and other non-target animals.
- Handling hazards. People can increase their risk of exposure to pesticides through such means as mixing and application.
- Ecological pest problems. Reliance on pesticides increases resistance in pests. The pesticides select against the weaker individuals, thus allowing the pests with hardier physiological, morphological, and genetic characteristics to survive the pressure of the pesticide, creating population resistance. The use of pesticides can also cause pest resurgence. The pesticide initially kills pests but those that resisted pesticide pressure remain and continue to reproduce. Then the population grows more rapidly than before pesticide pressure. Pesticides can also cause secondary pest outbreaks. The chemical will kill the major or key pest, but then a lesser pest can become a substantial problem. The secondary pest may cause minor problems because of competition from the key pest, but when the key pest is removed the secondary pest thrives.
- Pesticide Treadmill. The reliance on pesticides can lead to their excessive use. If they are improperly used, then more applications at higher rates may be necessary, leading to

resistance, resurgence, and replacement (by secondary pests), which then leads to more applications at higher rates and so on. Relief from pesticides never occurs.

Use of pesticides presents several advantages and disadvantages for management of pest populations. They are easy, convenient, and effective. They remain an often necessary rescue or prevention method for many menacing pests, eliminating pests that are themselves a health or environmental threat. But pesticides are toxins and have potential to cause detrimental affects on human and environmental health. Historically, pesticides created problems because they were environmentally persistent toxins. Today the problem of pesticides persisting in the environment has been solved through the development of newer, more environmentally safe pesticides. Despite improvements in pesticides, their use still has negative ecological effects. Therefore, it is necessary to develop sound IPM programs to reduce reliance on pesticides, and to promote environmental and ecological health.

Sources:

Norris, Robert F., Edward P. Caswell-Chen, and Marcos Kogan. Concepts in Integrated Pest Management. Pearson Education, Inc. Upper Saddle River: New Jersey 2003

EPA Pesticides
General information http://www.epa.gov/pesticides/
Health and safety http://www.epa.gov/pesticides/food/

PAN Pesticide database
http://www.pesticideinfo.org/Index.html

Northwest Coalition for Alternatives to Pesticides
http://www.pesticide.org/

Lesson 4, Activity 4 **Name _____**
Pesticide Worksheet

Directions: Every pesticide label is required to include certain kinds of information. Use the information found on 3 different pesticide labels to fill in the chart below.

Product Name	Kind of pesticide (i.e., rodenticide, insecticide, etc.)	Signal Word	Environmental Hazards
1.			
2.			
3.			

Lesson 4, Activity 4 **Name _____**

<u>Sample</u> Pesticide Worksheet

Directions: Every pesticide label is required to include certain kinds of information. Use the information found on 3 different pesticide labels to fill in the chart below.

Product Name	Kind of pesticide (i.e., rodenticide, insecticide, etc.)	Signal Word	Environmental Hazards
1. Clincher	**Herbicide – kills plants**	**Warning**	• **Toxic to fish and aquatic invertebrates.** • **Can contaminate surface water.** • **Can contaminate groundwater.**
2. Quintec	**Fungicide – kills fungi (molds, mildews)**	**Caution**	• **Toxic to fish and aquatic invertebrates.** • **Can contaminate water.**
3. Lock-On	**Insecticide – Kills insects**	**Caution**	• **Toxic to fish, aquatic invertebrates, small mammals and birds.** • **Highly toxic to bees.** • **Can contaminate water.**

IPM Lesson 4: Learning Extensions

Science

In IPM Lesson 4, there is a brief introduction to the concept of biological control (i.e. the use of one organism, a beneficial, to control another organism, a pest). Biological control organisms tend to be predators, parasites or pathogens. In this activity, have students watch the video, *Backyard Bugs*, to learn about beneficials. Next, divide the students into groups to find information about a particular beneficial. They should find information about the life cycle of the beneficial, what the different stages of its life cycle eat (if anything), what the different stages look like, what individuals can do to encourage their presence in the garden, etc.

Language Arts

In conjunction with the science extension above, have students create posters featuring their beneficial. Include a photograph of the beneficial as well as other information they discovered that would make people aware of its beneficial aspects and what they can do to encourage its presence. Place posters in public locations around the school.
(Language Arts Standards: 4-W1.6, 4-W2.1, 4-W2.2)

Math

In Lesson 3, Activity 4, students interviewed parents and fellow students to find out what their tolerances were for different kinds of pests (i.e., How many of a particular kind of pest would they have to see before they felt the need to try to control them?). Have students graph the data that they collected and compare data for different groups: students vs. adults, males vs. females, etc.
(Math Standards: 4DA&P-I-C1, 4DA&P-I-C2, 4DA&P-I-D1, 4DA&P-II-A1, 4DA&P-I-B1, 4DA&P-II-C1)

IPM Lesson 5 The Big Picture – IPM Discovered (Evaluate & Educate)

Introduction

Throughout the previous lessons, students discovered the steps used in an integrated pest management plan. They have independently discovered some organisms that can be considered pests, where these pests are found, what their habitats are, and how they live their lives. The students have learned the ideas of how to scout, monitor, and make control decisions. This lesson will put the concept of IPM into focus for the students and provide them an opportunity to educate others.

Appropriate SC Science Standards for the Following Outlined lessons

Grade 4:

- I. Inquiry
  - A. Process Skills – 1a, 2ab, 4a, 5a, 6a
  - B. Inquiry – 1de
- II. Life Science
  - A. Characteristics of Organisms – 1bc, 2abc
  - B. Organisms and Their Environment – 1b, 2, 3abcd

Resources for the Following Activities

Integrated Pest Management – University of Florida
http://ipm.ifas.ufl.edu/

IPM institute of North America – IPM Super Sleuth
http://www.ipminstitute.org/supersleuth.htm

Integrated Pest Management at Iowa State University
http://www.ipm.iastate.edu/ipm/

New York State Department of Law – Integrated Pest Management: An Introduction
http://www.oag.state.ny.us/environment/ipm3fold.html

Bio-Integral Resource Center – specialize in finding non-toxic and least-toxic, integrated pest management (IPM) solutions to urban and agricultural pest problems.
http://www.birc.org/

Michigan State University – Exploring Urban Integrated Pest Management
http://www.pested.msu.edu/CommunitySchoolIpm/curriculum.htm

Pennsylvania IPM – School IPM
http://paipm.cas.psu.edu/schoolIPM.html

Duration 4 hours for all of the following lessons

Objectives
Students will:

- Learn the terms Integrated, Pest, and Management.
- Learn the concept of Integrated Pest Management (IPM).
- Relate the steps of an IPM program to the activities they have done.
- Evaluate the control practices that were implemented.
- Educate their peers and adults about IPM and preventative pest measures.

Vocabulary
Integrated
Pest
Management
Evaluate
Educate
Prevention
Environment

Activity 1 – Discovering IPM
Have students look up the following words in a dictionary: integrated, pest, management and write their definitions on the Lesson 5, Activity 1 Worksheet. The following definitions were found in *The American Heritage College Dictionary*, Houghton Mifflin. 3rd edition.©2000.

- Integrated – made a whole by bringing all parts together; to join with something else
- Pest – an injurious plant or animal, especially one harmful to human beings
- Management – the act or practice of exerting control over

Now have students review the "What Does Integrated Pest Management Mean?" poster, which is located with the IPM House materials. A transparency of this poster has also been provided in the resources following Lesson 5.

Talk about each word and its meaning individually and then talk about what the words mean when they are put together in the phrase, integrated pest management. Help students make the connection between the concept of IPM and what they have already practiced. Discuss the steps of an IPM program and see if they can match their activities with the steps. Have students work in groups or individually to complete the Lesson 5, Activity 1 worksheet which will help them make the connections between the activities they have performed and the steps of an IPM program.

Steps in a successful IPM program:

1. Observe the pest or problem.
2. Identify the pest and learn about its biology.
3. Develop a monitoring program - scout and monitor for symptoms, signs, and quantities of pest populations.
4. Make decisions about management options.
5. Implement management strategies.

6. Evaluate the management practices and educate about the pest and preventative measures.

Once the students have completed their worksheets, ask them (based on the steps listed above), if there is anything left to do in their home IPM program. The students should realize they have not completed the last step of their program.

Materials
Lesson 5, Activity 1 Worksheets
Transparency – "What Does Integrated Pest Management Mean?" poster
Transparency – Lesson 5, Activity 1 Worksheet
Dictionaries

Activity 2 – Evaluate
The next IPM step is to evaluate whether the management plan was successful and to modify it if necessary. Since implementation is heavily dependent on parental assistance that may or may not be available, and since pest reduction is a long term process, evaluation may or may not be feasible. If you choose not to perform the evaluation, an alternative is to discuss the process of this step with students (see next paragraph). You may then want to issue an open invitation to anyone who evaluates their home pest management plan to speak to the class at a later date.

If you decide to assign the evaluation, ask students to re-scout their homes for their pest and fill out their scouting worksheet again. This time they will make specific notes about the management practices that were used and try to determine if these practices are working. Questions they should be thinking about:

- Are there symptoms and signs of the pest?
- Are there any pests? How many?
- Are there greater or fewer symptoms and signs than previously observed?

Have students compare the results from their first scouting mission (Lesson 3) with the results from their second (evaluation) scouting. Talk about the differences they found. Have them present their findings to the class. Items they should tell the class:

- Explain again what management tactic they used and why.
- Have them explain if they feel it worked or not and why.
- How could this pest problem be prevented?

Follow-up
Help students understand that while the school and home are two different environments, people and pests are a part of both. Just as they applied IPM to their homes, many of the same tactics will work on pest problems at school.

Materials
Lesson 5, Activity 2 Worksheets
Lesson 5, Activity 2 transparency

Activity 3 – Educate
Students should, once again, return to their groups and begin preparing presentations on the pest that they were assigned or chose in Lesson 4, Activity 2 (Management Decisions). Have each group create a brochure on the management of their pest. They should include information about what the pests eat, ways they get into the house, environments that they favor, and methods that can be used to make conditions less conducive for the pests. When finished, print off all of the brochures and then post them on a hall bulletin board or in the main office. Also, let each student have a copy to take home to share with his/her parents.

Another option is for students to present their information with posters, overheads, a puppet show, or any other creative measures. You may want to invite parents, administrative, custodial, and teaching staff to your class for a student-taught IPM lesson. If you choose to invite observers to your class, below is a list of topics that you may want your students to explain to your audience.

- What does IPM mean?
- What are the steps in IPM?
- How have the students used IPM?
- What pests did they find?
- What did they learn about these pests?
- What kinds of management tactics they used instead of pesticides, and why?
- How did they decide which options to use?
- Did their management tactics work?
- Things everyone can do to prevent pest problems.
- What are some of the concerns about the misuse and overuse of pesticides?
- Have the class explain what they have learned about IPM both in school and at home.

Enrichment Activity – Super Sleuth
In addition to the online scavenger hunt that the students experienced in Lesson 1, Activity 3, the IPM Institute of North America has put together a variety of games and puzzles that address the concept and steps of an IPM program. At this point these games can help cement your students' understanding of IPM. They are available at:
http://www.ipminstitute.org/Super_Sleuth/homework_briefing.htm.

Materials
Construction paper
Markers
Colored pencils
Scissors
Glue

Name_____

Lesson 5 -Activity 1
Discovering IPM

Integrated Means:_____

_____.

A Pest Is:_____

_____.

Management Means:_____

_____.

Integrated Pest Management (IPM) is_____

_____.

Steps in a successful IPM program are:

1. Observe the pest or problem
2. Identify the pest and learn about its biology
3. Scout and Monitor for symptoms and signs of the pest
4. Make decisions about control
5. Implement control options
6. Evaluate the control practices and educate about the pest and preventative measures

What have you done that is associated with each step? (The way we have practiced these steps is…)

1._____

2._____

3._____

4._____

5._____

6._____

Lesson 5
Corresponding Activity - 1
The Big Picture
Teacher Information Sheet - IPM defined

Integrated Pest Management (IPM) is a form of applied ecology. It uses, influences, and impacts the relationships of an ecosystem through biotic and abiotic means. IPM is a knowledge-based system that relies on correct and adequate information for decision making about management practices in both the present and future. Integrated Pest management integrates several compatible tactics for controlling pest populations through environmentally-conscious and economical methods.

IPM does integrate the use of pesticides. They are often part of a successful program. However, the use of pesticides should be very specific for the situation that is being managed. Pesticides should only be used when necessary, and should target the major pest populations. Pesticides should not be harmful to beneficial organisms, and must be used in accordance with the label. It is necessary that individuals incorporating pesticides in their pest management program are knowledgeable about their use and safety. A successful IPM program uses additional methods to control pest problems and uses only those pesticides that are compatible with other management strategies. An IPM program aims to reduce the use and reliance on pesticides, and it includes a series of steps.

Step One: Organisms in the situation are correctly identified. Then determine if the organism is a major pest, a minor pest, or a beneficial organism. If it is minor pest, it may not be necessary to take further action. Likewise, if it is a beneficial organism, no action is necessary.

Step Two: Learn more about the pest. Identify the pest as the cause of a problem; research the pest and its biology. Know its life cycle and developmental habits, its behavioral and feeding habits, and understand its distribution, and potential damage to the resource.

Step Three: Establish a monitoring program. This is done through scouting and monitoring procedures. Determine the levels at which pest populations will cause severe loss to the yield, aesthetics, or monetary value.

Step Four: Make decisions about tactics that can be implemented in the situation. Which tactics are most available, effective, efficient, and cost beneficial to the situation? It is important at this step to think about how management strategies will influence the ecosystem to be managed. Examine all of the alternatives and choose the best option(s).

Step Five: Implement the tactics chosen to manage the pest situation. Then continue to monitor the pest population with respect to the chosen tactic. Are the tactics working? Does the situation need to be reevaluated and new tactics implemented? Was a decision really necessary? Was the population high enough to cause serious problems?

Step Six: Continue to evaluate the monitoring program and chosen management tactics. Consider if changes are needed in the monitoring program or management tactics. Then educate

individuals about IPM programs that were implemented. This can be considered a preventative measure to ensure against pests in the future. Taking preventative measures against pests can be the easiest and most effective pest management tactic.

Sources:

Norris, Robert F., Edward P. Caswell-Chen, and Marcos Kogan. Concepts in Integrated Pest Management. Pearson Education, Inc. Upper Saddle River: New Jersey 2003

University of California IPM online
http://www.ipm.ucdavis.edu/

Cooperative State Research, Education, and Extension Service
http://www.csrees.usda.gov/

IPM Institute
http://www.ipminstitute.org

Integrated Plant Protection Center – Directory of IPM Resources
http://www.ippc.orst.edu/DIR/

Name_____

Lesson 5 -Activity 2
Evaluate

School Pests (drawing or description)	**Pest Habitat** (where it was found)	**Pest Evidence** (Symptoms and signs)	**Pest Numbers**	**Monitoring** (how often and when)	**Manage-ment** (when, how, with what)

IPM Lesson 5: Learning Extensions

Science

Super Sleuth

In addition to the online scavenger hunt that the students experienced in Lesson 1, Activity 3, the IPM Institute of North America has put together a variety of games and puzzles that address the concept and steps of an IPM program. At this point these games can help cement your students' understanding of IPM. They are available at:
http://www.ipminstitute.org/Super_Sleuth/homework_briefing.htm

Language Arts

In conjunction with Lesson 5, Activity 3, have students create an educational presentation with puppets or PowerPoint that they will present to first grade students on the topics of their brochures. (See curriculum page 72.)
(Language Arts Standards: 4-C1.1, 4-C1.3, 4-C1.6, 4-C1.8, 4-C1.9)

Social Studies

This activity should be done when the students are studying the Civil War. Have them read excerpts from the "Insects and the Civil War" website at:
http://scarab.msu.montana.edu/historybug/civilwar2/taps.htm. After reading and discussing these excerpts, point out that the Civil War was one of the most documented wars in human history because so many Americans could read and write on some level. Many soldiers kept diaries and wrote letters describing their daily life. Many of these writings have been preserved. Have each student imagine the uncontrolled insect conditions the soldiers experienced. Have them 1) write letters or diary entries describing their day (with references to the insect situation) or 2) write lyrics to a song about the conditions in the war (including references to some aspects of insect pests) to entertain fellow soldiers. (4-6.6)