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

A curriculum for grade 5

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

2005

CONTENTS

Discovering IPM: An Inquiry Approach to Learning Integrated Pest Management

Curriculum Introduction

Integrated Pest Management (IPM) is a decision-making process that uses applied ecology, knowledge-based applications, and a compatible integration of tactics to manage pest populations below economic injury levels. Using this curriculum, teachers are able to teach science through meaningful and useful real-life scenarios. *Discovering IPM* offers a step-by-step approach for students to discover and learn about science in "everyday" situations. It teaches IPM through inquiry. Students discover IPM by engaging in the steps of the IPM process through the activities outlined in each lesson.

IPM relies on ecological relationships and concepts for the integration of pest management tactics. As such, students must have a general concept of ecology and what the relationships are within an ecosystem in order to understand and utilize integrated pest management. This curriculum is based on the assumption that the students have some knowledge of basic ecology. When that is not the case, preliminary ecology lessons are available at http://www.clemson.edu/scg/ipm/schoolipm_discovering.htm and can be completed before beginning IPM Lesson 1.

The IPM lessons in this curriculum occur in environments in which students are familiar (i.e., school and home) and for which teachers have resources. The lessons lead the students through the steps of IPM as an informed knowledge-based decision-making process. Students 1) discover the pest problem; 2) identify and learn more about the biology of the pest; 3) develop a monitoring program; 4) use gathered information about various management tactics to make informed decisions about control; and 5) evaluate their plan and educate others. In the last lesson, they put together what they have learned to define IPM.

Each lesson represents a step in the process of IPM and includes an introduction that explains how the lesson relates to the previous one as well as its importance as a step in an IPM program. Appropriate South Carolina science standards, credible Internet resources, a materials list, the approximate time required for the lesson, objectives, and a vocabulary list are included for each lesson. Following each lesson is a teacher resource section that includes student worksheets and background information sheets. In addition, this curriculum was designed to be integrated across disciplines, and as such, the resource section includes language arts, math and social studies extensions where appropriate.

The purpose of these lessons is to provide a foundation for awareness and implementation of IPM. They are designed to increase awareness about the environment and our role in the use of pesticides. Throughout the lessons students build valuable observation, reading, writing, and decision-making skills. These lessons can be used as building blocks for further lessons in IPM, life science, language arts, social studies, art, and mathematics. The possibilities are endless.

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

Introduction

If students are familiar with basic ecology and some of the fundamental components of an ecosystem, they will have a clearer concept of integrated pest management (IPM) as a form of applied ecology. If needed, a review of these concepts is available by clicking on the Preliminary Lessons link at: http://www.clemson.edu/scg/ipm/schoolipm_discovering.htm.

This lesson starts with what the students know. It enables students to start investigating in familiar environments, such as school and home. 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 (*see Preliminary Lessons at link above*) 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 5:

- I. Inquiry
  A. Process Skills – 1a, 2ab, 4a
  B. Inquiry – 1abcdef

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.

Duration 2.5 – 3 hours

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
Mirrors
Tape recorders & cassettes

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. Who 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?
- 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 unwanted? Are they harmful?
- Yes because they 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 diseases.

Activity 1
Note: *For the first two activities, be sure to inform appropriate administrative staff and parents of your students' mission.*

School Scavenger Hunt:
Send your students around the school in search of pests. Have them fill out the scavenger hunt worksheet. Explain that it should 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.

Activity 2
Home Scavenger Hunt:
The next part of this activity is to expand what they have learned about pests in school, into the home. In most areas there will be similar pests inside the home as there are in the school, so you may choose:

- not to do a second scavenger hunt
- to change the pests that they were searching for in school to different pests at home
- to see if they can find the same pests
- to compare what they found at home to what they found in school

Variation of Scavenger Hunt:
You may choose to give students a mixture of hints along with the pest name (see Scavenger Hunt worksheet version 1) for a less challenging variation.

You may choose to give students a blank scavenger sheet (see Scavenger Hunt worksheet version 2) and have them completely fill in the boxes.

Enrichment
The following websites contain activities that will correspond to this lesson. You may choose to use these lessons as enrichment or assessment.

"What's a Pest?" Minnesota Department of Agriculture (Page 1 of *Join Our Pest Patrol*)
http://www.mda.state.mn.us/IPM/IPMPubs.html#PestPatrol

Pest World for Kids (http://www.pestworldforkids.org) is a wonderful resource, developed by the National Pest Management Association (http://www.pestworld.org). It begins with an animated introduction explaining what a pest is and then continues with links to "Amazing Pests," "Threats & Prevention," "Send a PestCard," and "Learning Games" (designed for students in the 3rd through 5th grades).

Activity 3 Follow-Up
After students have investigated their school and 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 IPM practices that are used in school and at home. They may interview parents, teachers, custodians, and administrators. Help them to formulate questions such as:

- Which pests have you discovered?
- Where have you discovered them?
- How have they been monitored?
- How have they been controlled?
- When do you control them?
- How many of a particular pest must you see before you control it?

After your students have conducted the interviews in school have them continue practicing their new knowledge at home.

This lesson, "Inspect and Investigate – Interviewing," is 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

Name_____

School/Home Scavenger Hunt (Version 1)

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

Name_____

School/Home Scavenger Hunt (Version 2)

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.

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 (a nuisance), 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 left over 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.

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, eggs laid by insects, cast skins or shed skins from insects, hairs, whiskers, 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.

Lesson 1 - Discovering Pests
Teacher Information Sheet: Ants

Photo courtesy of DR creations.net

Ants are members of the insect order Hymenoptera. Other members of this order are bees and wasps. They are social insects, and there are several thousand species of ants in existence. Being social insects, they dwell in colonies and often two or more generations inhabit one colony at the same time. Adult ants are divided into three categories, or castes. There are reproductive kings and queens, non-reproductive worker ants, and soldiers. Adult ants provide some care in young. Ant colonies are generally stable, worker ants have a life expectancy of 4-7 years and queens can live up to 15 years.

Ants fulfill important niches in the ecosystem. Living in the soil and ground litter habitat they can serve as predators, parasites, carnivores, and herbivores. Some of the carnivorous ants hunt smaller insects and other animals also living in the soil environment. Several ant species feed on honeydew that is produced by other insects such as aphids and leafhoppers, while others feed on the internal juices of fly larvae.

Pest Status: Ants are considered pests in homes and other structural dwellings because of their ability to compete for human resources by nesting and foraging inside. They can also cause serious economic damage to some field and orchard crops. Ants are visible during daylight, and often appear in large numbers. They are usually seen following each other to some food source or congregating around some other nourishment source. Indoors they are almost always found in kitchens attracted to human food. In metropolitan areas, ants have been the cause of major sidewalk cracking and settling because of their soil excavation under these structures. This can result in economic costs for city governments. Some ants are considered pests because of their aggressive biting and stinging behaviors. One example of this is the red imported fire ant in the southern United States. Because of their ability to bite, ants can also be considered vectors of pathogenic bacteria, especially in hospital environments.

Food: There are several thousand species of ants and they feed on a wide variety of sources. Worker ants, the primary food gatherers, do not eat dry foods; instead they crush the food with their large mandibles and suck the juices. These juices are later regurgitated for other worker ants, and the queen. This method of feeding is important for control. Ants do not have a single diet but feed on various organic matter including plant and animal materials, and foods rich in, oils, sugars, carbohydrates, and proteins. This non-specific diet makes them a rather unusual insect. They gain nourishment from small insects, animals, honeydew, and larval nectars. Ants that invade our homes are often in search of some type of food that is scarce in their normal habitat. Those ants have adjusted their food resources to the limited supply provided by humans.

Other ants, such as carpenter ants often inhabit the human environment in wood used for home heating, cooking, or construction.

Biology: There are three categories of ants in every colony, workers, males, and females. Workers are the largest caste in the colony. They are non-reproductive females and perform a variety of different tasks, such as gathering food feeding and caring for the immature ants, nest sanitation, and defense. The reproductive caste is composed of queens and males. The queen mates only one time and continues to lay eggs her entire life. The workers care her for. They clean and feed her for her entire life. The colony is not limited to one queen. Depending on the ant species, there could be 1-30 queens in a colony. The queen lays eggs continuously, the workers take the eggs to various parts of the colony where they will develop into legless grub-like larvae and pupae (immature life stages) and finally into adults. If there are threats to the colony the worker ants will remove the immature forms to safer areas of the colony.

Shelter: Colonies can exist under the soil surface, in logs, or in other wooden structures that provide shelter and space that ants need to carry out their daily activities. The queen starts colonies. After mating in flight she drops to the ground, sheds her large wings, and burrows a chamber into the soil, under a rock, or into tree bark and begins to lay eggs. The queen nourishes the first group of larvae by reabsorbing the muscle tissue that was used for operating her large wings. She reabsorbs and regurgitates this tissue and feeds it to her young. This first brood of ants then takes care of the queen and subsequent young. The queen will produce further generations that will yield more queens, males, and workers.

Behavior: Ants communicate through the release of pheromones in combination with touch and sound production. Being social insects they recruit nest mates for food retrieval, nest construction, colony defense and emigration to new nests through the release of pheromones (chemicals), their most effective use of communication. Ants create trails to food and other resources through the release of pheromones from glands at the posterior end of their abdomen near the stinger.

Control: Control methods are difficult for ants since their nests are very secluded. It is important to practice measures of sanitation in homes and schools. Keeping floors swept and table tops clean of crumbs and other debris will deter ants from alternate food sources. If infestations are intolerable, locate the nest and apply an insecticide liquid, dust or granular formation. Since ants are capable of adapting to several environments, biological control is difficult.

Sources:
Robinson, W.H., Urban Entomology: Insect and Mite Pests in the Human Environment. London: Chapman & Hall, 1996.
Interesting Facts about Ants: http://www.lingolex.com/ants.htm

Lesson 1 - Discovering Pests
Teacher Information Sheet: Cockroaches

Photo courtesy of University of Nebraska
(http://entomology.unl.edu/images/cockroaches/cockroaches.htm)

Cockroaches are pests to humans in every part of the world. They require a very general diet, which means they are able to use a wide variety of plant and animal materials as food. They are considered to be a pest simply by their presence, which disturbs a sense of well being and aesthetics, their ability to carry pathogens, and the general phobia many humans have towards them. Cockroaches are sometimes associated with unsanitary conditions. The majority of cockroach species live in natural habitats in the tropics and subtropics and are not associated with people. There are only about 10 species that have adapted to the human environment. The human environment is often high in relative humidity but rich in carbohydrate and protein food sources, which cockroaches prefer. The most common cockroaches found in human habitats are the German cockroach, the American cockroach, and the oriental cockroach.

For about 280 million years, cockroaches have remained virtually unchanged. Today's household pests have similar body structures and wing shapes as those found in fossils of carboniferous rock. From these fossil records, scientists have been able to hypothesize about the foraging habits of prehistoric cockroaches and compare them to today's cockroach behavioral patterns.

Even though cockroaches are pests, in some areas of the world they may have useful functions. There are some reports of cockroaches being used for medicinal purposes. A first century Greek naturalist advised mixing the intestines of cockroaches with oil as a cure for ulcers, tumors, itching, and earache. In some areas of the world, such as China and Southeast Asia, cockroaches are still used to treat illnesses and diseases.

Pest Status: Cockroaches are most often associated with disease and illness. They can be carriers of fungi, viruses, protozoa, and bacteria. They also serve as hosts for several species of flatworms. Even though they may be carriers of these pathogens there is little evidence that cockroaches transfer these pathogens to humans.

The pathogens that naturally infect cockroaches can carry a variety of diseases, some examples of these are: leprosy, bubonic plague, dysentery and diarrhea in children, urinary tract infections, boils and abscesses, intestinal tract infections, typhoid fever and food poisoning. Another very important illness associated with cockroaches is asthma. Sensitive adults and children can

exhibit harsh allergic reactions when exposed to cockroach secretions, feces, body parts or cast skins. Allergic reactions to cockroaches have been reported to be as high as 79 percent.

Emotional responses to cockroaches have been another reason for their pest status. Cockroaches are often associated with uncleanness, poor house keeping, and low socioeconomic status. They are most often found in areas that are difficult to keep sanitary and free of water, such as kitchens and bathrooms. Control for cockroaches is difficult and can be very expensive. Therefore, those people with lower incomes can spend a great deal of their economic income on control, which gives reason for the association between low economic status and cockroaches.

Food: Cockroaches are not specific in their diet. They have chewing mouthparts that enable them to be generalist (non-specific) feeders. They feed on a range of plant and animal material and prefer foods that are rich in carbohydrates, lipids and proteins. In human habitats adults and nymphs will also feed on starch and sugar-based foods. If these preferred foods are not available, cockroaches will feed on dead insects, excrement, glue, paper, and other materials. They are nocturnal animals and will forage for food and water in cracks and crevices. Cockroaches prefer habitats with a continuous water source and high relative humidity. If their food resources are dry they will search for a water source, such as leaky faucets, condensation under refrigerators, condensation on water pipes, bathtubs, and sinks.

Biology: The female cockroach emits a volatile chemical, or pheromone to attract a mate. This compound is sensed on the antenna of the male and the pair begins mating behavior. For the German cockroach, the male contacts the female through pheromones and a period of antenna-to-antenna contact is made. Soon after this behavior copulation begins. Once the female's eggs are fertilized, she begins the production of an egg case. During the protection of the egg case, eggs are produced in groups of 10-40. The female may deposit the egg case in a protected location, which she created with her mouthparts, or keep it with her until the first stage nymphs are ready to hatch. The egg case is very sturdy and able to protect the developing nymphs from desiccation and harmful environmental compounds.

The cockroach has a gradual metamorphosis, in which each life stage resembles an adult. The first-stage nymphs may remain close to the egg case after hatching, but soon go in search of food. Nymphs will pass through five to six instars (juvenile stages), each time shedding skin and growing larger before reaching adulthood. After the final molt, for both male and female, the wings and reproductive organs are fully developed and functional, though in some species, the wings may be reduced or absent. Adults have a flattened body, and a sensitive cuticle that requires moisture to prevent desiccation.

Shelter: Because cockroaches are nocturnal animals they will remain inactive in dark cracks, crevices and other protected areas during the day. The adult German cockroach can fit its flattened body in crevices as small as 1.6 mm, and nymphs only need cracks as large as 0.5 to 1.6mm wide. They prefer humid areas where temperature and water vapor can directly influence the level of infestations. Low temperatures and humidity promote inactivity, whereas high temperatures and high humidity promote activity.

Behavior: Cockroaches are active at night with two specific periods of foraging activity; the first is a few hours after sunset and the other at an hour before dawn. During these hours, males, nymphs, and females (without egg cases) will leave their safe harborages (dwellings) to forage for food resources and to mate.

Control: Cockroaches are successful in human habitats because they can find adequate amounts of food, water, and shelter. Eliminating one or more of these necessities will inhibit cockroach populations in the home.

Reducing water availability and high humidity are some of the most effective ways to control cockroach infestations. Making sure faucets of bathtubs and sinks are tightly closed, and sealing potential leaks can decrease the possibility of cockroaches from inhabiting our homes.

Another way to limit cockroach infestations is to limit their food supply. They are generalist feeders and can live easily on scraps and crumbs of humans. To prevent these pests from invading your homes and schools, availability of food to the cockroaches should be reduced. Sanitation is the best way to reduce the food supply; sweeping, mopping, washing counters, and properly disposing of trash will limit food for these pests.

Eliminating shelter for cockroaches is another effective control measure. During construction fittings should be tight, and proper sealing of openings can prevent entrance of cockroaches into the home. Identifying, sealing, and treating any openings can also prevent and deter cockroaches.

There are several insect species that are valuable to the biological control of cockroaches. The house centipede and a pholcid spider are two predators that feed on early instar cockroaches. Some parasitic wasps exist that will seek a vulnerable egg case, and deposit an egg within it. As the young parasitic wasp develops, it consumes the eggs of the cockroach. Those that it does not consume, fail to develop.

Insecticides are a final method for control of cockroaches. Proper identification of the insect's harborage is necessary. Using care and other precautions, injecting liquid or dust into or near infested cracks and crevices prior to active hours in uniform and proper quantities will provide effective results. Insecticides should be used as an alternative means of pest control and in conjunction with other control practices.

Sources:

Robinson, W.H., Urban Entomology: Insect and Mite Pests in the Human Environment. London: Chapman & Hall, 1996

UC IPM Online: Cockroaches: http://www.ipm.ucdavis.edu/PMG/PESTNOTES/pn7467.html

University of South Carolina Roach Camera:
http://cricket.biol.sc.edu/usc-roach-cam.html

Asthma and Indoor environments: http://www.epa.gov/asthma/triggers.html

Entomology Websites – Cockroaches: http://www.isis.vt.edu/~fanjun/text/Link_specc01.html

Lesson 1- Discovering Pests
Teacher Information Sheet: House Flies

Photo courtesy of Do It Yourself. Com

Flies are members of the insect order Diptera. Other members of this order are biting midges, horse flies, and mosquitoes. The housefly, *Musca domestica* is a dipteran that is seen in human environments all around the world, from the equator to the poles, including some of the most extreme environments.

They are soft-bodied insects with two pair of wings that are very adept for long flights. Flies have large, well adapted eyes and a keen sense of smell. They have varying mouthparts, depending on the species. These mouthparts range from piercing-sucking types to sponging-lapping types to intermediate-cutting type. All of these morphological features make flies very successful at adapting to human environments.

Flies have been associated with human environments since the domestication of animals in early agriculture. Flies prefer the feces of pigs, humans, and horses to that of large grazing animals. When these animals became an important part of the human environment, flies also became more common. Some changes in fly biology occurred during this adaptation to the human environment. Egg laying females strayed away from their natural habitat and found more suitable conditions within the human environment.

Flies are considered pests in the human environment because of their association with disease. The housefly and its relatives breed in human feces, and other animal dung, where they acquire a range of pathogens. Significant diseases carried by flies worldwide are malaria, yellow fever, and encephalitis. Other diseases are indirectly associated with flies are typhoid fever and dysentery.

Pest Status: The primary reason for flies' pest status is their ability to transmit disease. They are most commonly associated with human garbage and animal feces. These two waste items are perfect breeding sites for flies. They can acquire several types of bacteria, including *Salmonella* and *Shigella*, as well as other pathogens. In these feeding sites habits of flies are rather disgusting to humans. Flies land on their food source, namely rotting flesh or excrement, where they defecate and regurgitate some fluids from their stomach onto their food. Flies then move into a human environment and repeat the process. This can result in bacteria transmission resulting in sickness.

Flies have the ability to be a great nuisance. Some types of flies will swarm and enter homes, schools, hospitals and other buildings in great numbers. Some flies, such as horse flies and mosquitoes, bite and feed on human blood. This is often very much a nuisance as well as painful for a human host.

Food: Flies feed on the waste products of humans. They feed on human and animal feces, garbage, crumbs, and decaying vegetation. They feed two or three times per day on food and water during the hottest and driest daylight hours, and ingest foods that are soluble through their salivary glands and sponging mouthparts. Biting flies feed on the blood of humans and animals. Feeding sites also serve as the breeding areas for flies.

Biology: A female housefly is attracted to warm and moist substrates that will provide nourishment for her offspring. A female normally mates only once during her life. She has an internal structure that allows her to store sperm, and when she is ready will fertilize her eggs and lay several batches of eggs. Flies exhibit complete metamorphosis (life transformation) in which each life stage is different from the adult. Flies begin their life stage as an egg, which has been deposited in excrement or garbage. Next they transform into a larva. The larvae are wingless and legless. Their mouths are internal at the posterior portion of their bodies. At this stage they will go through four molts. Following the final or third molt, the larva becomes inactive, stops feeding and begins to form a pupa. After the pupal stage the adult emerges and unfolds its wings to dry and harden. The life cycle can take up to 10 days to complete and there can be as many as 12 generations in one summer.

Shelter: Flies have adapted to the human environment. They do not require any distinct protection for shelter. They live and breed among the interactions of humans and the human environment. They require warm, moist materials in which to lay their eggs and to allow their offspring to complete a metamorphosis.

Behavior: Flies are very strong and mobile insects, and can travel long distances. Adults generally follow an odor stimulus, and are active fliers when temperatures are between 11°C and 32°C (51.8°F and 89.6°F). They are inactive at temperatures below 7°C (44.6°F), and temperatures below 0°C (32°F) are lethal to adults. They rapidly and frequently fly between food sources. Flies have become resistant to most modern insecticides.

Control: Since flies have become very resistant to many insecticides, the best methods of control are those that make the environment unfavorable for the pest. Potential fly feeding or breeding sources should be removed. Household garbage should be sealed and disposal should be handled properly. Inside and outside debris should also be cleaned up. Other methods of control include traps that attract flies away from the human environment. An example of this is an electronic device that has a fluorescent light source (for some flies), that will draw the fly's attention and kill it upon contact. Other traps, including sticky traps and flypaper, help in reducing pest populations in the human environment.

Source:
Robinson, W.H., Urban Entomology: Insect and Mite Pests in the Human Environment. London: Chapman & Hall, 1996

Clemson University Entomology – Fact Sheet
http://entweb.clemson.edu/cuentres/eiis/pdfs/hs16.pdf

Virginia Tech – Virginia Cooperative Extension – Fact Sheet
http://www.ext.vt.edu/departments/entomology/factsheets/housemag.html

Lesson 1 - Discovering Pests
Teacher Information Sheet: Spiders

Photo courtesy of the Clifford W. Estes Company
(http://www.estesco.com/projects/oct02/oct02.html)

Spiders are Arachnids that are commonly mistaken for some type of insect. Spiders are not insects, and their most distinguishing characteristic is four pairs of legs. They are among the most common insectivores in a natural ecosystem and are predatory and can be beneficial. Spiders have easily adapted to any ecosystem that provides a sufficient food supply. They are primarily insectivores that prey on both beneficial insects and insect pests. Spiders are able to easily transition from natural ecosystems to agricultural and urban ecosystems by their swift ability to move across plant surfaces and by ballooning, or sailing on wind currents attached to a thin line of silk. Spiders are well camouflaged to their surroundings and prey on a multitude of insect species. They are solitary animals that often remain hidden in dark, protected corners on or near our homes and schools. Spiders and their prey enter our homes and schools through openings of unsealed doors and windows. Spiders that have adapted to our homes and other dwellings are those who prefer to forage at night and have limited interactions with humans. They often occur in undisturbed areas of our homes where relative humidity and temperature is ideal for both spiders and their prey, such as storage areas, cellars, and basements.

Pest Status: The pest status associated with spiders is the fear of being bitten. People have taught their children over time that spiders are dangerous. Children have learned that spiders are unpredictable, due to their quick and unexpected movements. Children have also learned that the bite of a spider can be deadly. These teachings have benefited both these beneficial arthropods and children. Spiders may bite humans but their bite is rarely harmful. Some spiders have mouthparts that are capable of penetrating human skin or produce venom that is not toxic to people but mildly irritating. In general, a spider bite may be painful, and cause skin irritations, welts, and swellings but is not associated with any long-term health problems. Both the widow (black and brown) and the brown recluse spiders are poisonous. A bite from a black widow spider is painful, but a bite from a brown recluse spider is often not noticed until symptoms appear.


The Brown Recluse

The Black Widow

Food: Spiders are predators that feed on insects and to some degree on other arthropods. They have powerful jaws (chelicerae) that they use to restrain their prey. These jaws are equipped with venom glands that aid in the immobilization of their prey. Spiders can also bind their prey with strong threads of silk. They cannot consume large prey; instead they secrete venom-rich enzymes into their prey's body that dissolves the internal organs. The spider can then feed on this degraded material.

Biology: Copulation for spiders can be very difficult. Male spiders have a pair of specially developed first pair of legs that aid in reproduction. The male uses these unique pair of legs to transfer sperm to the female genital orifice. Females briefly disengage their predatory instincts during copulation and then quickly resume them following the act. Reproduction can be very dangerous for male spiders because the female often consumes them after copulation. The female's body size determines the number of eggs she will produce. Eggs are placed in a silken sac and the female will raise her young until they are fully-grown. Spiders produce several generations per year.

Silk is a protein that is exuded from spinnerets at the abdomen of the spider. It is very elastic and is able to stretch five times its length without breaking. Silk is composed of one or more strands of silk and is specific to use, such as egg sacs, webs or nests. All spiders, with the exception of a few species, produce silk.

Shelter: Spiders prefer dark, protected, undisturbed areas, rich in prey for their web spinning and nest building. Spiders will abandon webs that are in areas that do not yield a sufficient amount of prey.

Behavior: Spiders are predatory nocturnal animals who catch and devour their prey in solitude. They will consume large amounts of prey, and then because of their slow metabolism, will not feed for a considerable amount of time. Spiders are also very unpredictable in their movements and are well camouflaged into their surroundings.

Control: Control for spiders is generally not necessary because they are beneficial arthropods. However, because they are nocturnal hunters, they may be found on the outside of human dwellings at night feeding on insects that are attracted to our outside lights. Removal of those lights or changing the color of the light bulb will reduce the attraction of spiders' prey. Removing and destroying egg sacs will also reduce the number of spiders in the environment.

Sources:
Robinson, W.H., Urban Entomology: Insect and Mite Pests in the Human Environment. London: Chapman & Hall, 1996

Texas Agricultural Extension Service, Texas A&M University:
http://insects.tamu.edu/extension/bulletins/l-1787.html

Photos courtesy of Conservation Commission of Missouri:
http://www.conservation.state.mo.us/nathis/arthopo/mospider/kinds.htm

Lesson 1 - Discovering Pests
Teacher Information Sheet: Wasps, Yellowjackets, and Hornets

Photo courtesy of Keith Edkins' insect photo collection (http://www.gwydir.demon.co.uk/insects/index.htm)

Wasps, yellowjackets, and hornets are members of the order Hymenoptera, and of the family Vespidae. They are social insects that live in colonies with one or more queens. They often form their nests out of paper-like material. These animals can be seasonal pests to humans. They are strong fliers, and skillful foragers.

These vespids seasonally establish their nests in the soil, trees, shrubs, and in the eaves and rafters of our homes and schools. The nests often have a great amount of worker activity, which attracts the attention of people, and when people's attention is drawn, fear develops because of the possibility of being stung. Despite the fear many people have of these insects, they are also beneficial, fulfilling the niche as predators and parasites feeding on other insects. They are also important in the pollination of some plants and flowers.

Vespids were originally found in the tropical regions of the world, but are now found in more temperate zones. This change from tropical to temperate climate is most likely due to the changes in their biology, and from limitations of their resources.

Pest Status: People often consider wasps, yellowjackets, and hornets as pests because of their threatening behavior and ability to inflict a painful sting. The stinger of most of these insects contains venom that causes a severe allergic reaction to sensitive people. Although the venom is designed to immobilize the prey and not kill it, it can result in death to people who are highly allergic to it.

The swarming and unpredictable behavior of these insects also causes alarm. When present in great numbers, economic damage can occur when outdoor recreation areas, dumps, and landfills are closed. Vespids are scavenger insects that often forage for food on animal dung, and in garbage dumps. These feeding habits can result in them carrying harmful bacteria such as *Escherichia* and *Salmonella,* transmitting disease when they visit human food.

Food: In natural environments, vespids serve as predators and parasites when they feed on other live arthropods. They also scavenge on decaying flesh of dead animals, visit flowers for sweet nectars, pollinating their host. In the human environment where there may not be a large numbers of insect prey, vespids forage in garbage dumps, on animal dung, in trash cans, and on beverage cans to supplement a lack of protein and carbohydrates.

Biology: In the early spring a female wasp will emerge from a protected burrow, usually from under a rock, in an attic, or some other type of wall void. This female will then create a small embryo nest that contains 40-60 cells. This founding queen will produce the first brood of workers. She will care for them until they are mature. After the first brood, the workers will care for future generations. Worker wasps forage during the day, capturing prey, and collecting decaying tissue to bring back to the developing larvae. The maximum number of workers will occur in the colony about three months after colony establishment. After this peak period, there will be a shift in activities from producing worker wasps to producing reproductive wasps. Males and new queens will emerge. They remain with their colony until they are strong and nourished enough to leave and mate, a period of about 7-10 days. After mating, fertilized queens will look for protected sites to overwinter.

Shelter: Vespids create their own shelter. Their hives are generally made from paper-like material, such as the bark of trees. Hives contain combs in the inside for laying eggs and rearing new vespids. Hives are usually formed in trees, bushes, under eaves, in the corners of doors, under bridges and in other undisturbed and protected areas.

Behavior: Wasps, yellowjackets, and hornets are social insects. They communicate with each other through pheromones (chemical signals) and body movements. They will invade inhabited areas in search of food but rarely attack humans.

Control: Wasps, yellowjackets, and hornets are beneficial insects that regulate detrimental insects in gardens and on farms. Unless populations become very problematic, no control is recommended. When they impede on a human environment, control may be necessary. For example, when they are seen in public places in relatively large numbers, they create a nuisance and cause concern for human health.

A method of control to be considered first is sanitation for the prevention of invading vespids. Proper disposal of trash, cleaning, and maintaining the inside and outside of our homes and school will deter these insects from searching our areas for food.

Another very effective method of control is baiting. Sometimes it is difficult to locate the hive, or dangerous to destroy it, so injecting an insecticide into high protein baits such as tuna fish, salmon, beef, or poultry is very effective. The slow acting insecticide allows the workers to continuously visit the meat product and return to the hive, thus infiltrating the hive with the poison until the entire hive is eliminated.

Sources:
Robinson, W.H., Urban Entomology: Insect and Mite Pests in the Human Environment. London: Chapman & Hall, 1996

University of Kentucky Entomology:
http://www.uky.edu/Agriculture/Entomology/entfacts/trees/ef411.htm

UC IPM Online – Yellowjackets and other social wasps:
http://www.ipm.ucdavis.edu/PMG/PESTNOTES/pn7450.html

Lesson 1 – Discovering Pests
Teacher Information Sheet: Gray Mold

Photo courtesy of: University of Florida

Gray mold is a very common disease that is found on vegetables, fruits, ornamental plants, and agricultural crops. It is a common pathogen that thrives in greenhouse and grocery store environments. Gray mold is caused by the fungus *Botrytis cinerea*, and is called gray mold because of the gray, fuzzy sporulation that is found on decaying plant material. *Botrytis* commonly invades plant material that has been broken, cut, or somehow damaged, though it can also infect healthy material.

Symptoms: The symptoms of gray mold include spots and brown or tan lesions on stems and leaves. Some plants may even produce cankers in response to the pathogen. Other symptoms include water-soaked lesions, and necrotic areas. Pictures of symptoms can be seen at the following websites:

- University of Guelph
  http://www.uoguelph.ca/~gbarron/MISCELLANEOUS/botrytis.htm
- University of Toronto
  http://www.botany.utoronto.ca/ResearchLabs/MallochLab/Malloch/Moulds/Botrytis.html

Biology: *Botrytis* overwinters in the soil in decaying plant debris. Botrytis does not generally infect the plant as the plant emerges. *Botrytis* can infect most any plant part under the right environmental conditions. The pathogen does not often infect seeds, but it can infect bulbs, corms, tubers, roots, petals, stems, leaves, and fruits. Cool and damp weather are optimal conditions for growth, sporulation, spore release and germination, and infection. Small conidia germinate on the plant surface, and then mycelia grow into plant tissues. Mycelia enter plant tissues through wounds. The pathogen produces enzymes which degrade plant tissue. *Botrytis* continues to grow by spreading more mycelia throughout the plant tissues. The mycelia then produce conidiophores, which produce balloon-like conidia. The gray branching conidiophores with conidia are easily seen on rotting fruit, such as strawberries. The presence of these conidia is a detectable sign of infection.

Control: Management for *Botrytis* is easy without the use of chemicals. If symptoms or signs of this pathogen are observed, removal of the infected material is necessary. Prevention of *Botrytis* can be practiced by monitoring the environmental conditions, such as warm

temperatures that will prevent moisture, and proper spacing of plants that allow for ample air flow for drying. Plants that are wounded can be protected with fungicides or removed from the environment.

Experiment: Study the development of *Botrytis* conidia by obtaining over ripe and mushy strawberries. Place them in a plastic bag for a few days. Observe the development of the mold as the strawberry breaks down, after a few days use a microscope to view spores or conidia.

Sources:

University of Guelph - http://www.uoguelph.ca/~gbarron/MISCELLANEOUS/botrytis.htm

Ohio State University Extension Fact Sheet – http://ohioline.osu.edu/hyg-fact/3000/3070.html

Agrios, George N. Plant Pathology 4th Edition. San Diego: Academic Press 1997.

Daughtrey, Margery, L., Robert L. Wick, and Joseph L. Peterson. Compendium of Flowering Potted Plant Diseases. APS Press, 1995.

Lesson 1 – Discovering Pests
Teacher Information Sheet: House Mouse

Photo Courtesy of: Bugbustersgsy.com

The house mouse is a common household pest. It originally arrived in North America on ships traveling from Central Asia, and has been able to adapt to a variety of environments. They are found around homes, commercial structures, in agricultural lands and in open fields. They are usually active at night and give off a distinct musky odor, which can assist in their detection. The house mouse has not been found to be a carrier of Hantavirus, though other mice have. Its relatives, the deer mouse and white-footed mouse, have been documented as carriers of the virus.

Pest Status: The house mouse is considered a pest because it lives in close association with people, pets, and livestock and consumes and contaminates food and dwellings. It can cause considerable damage to structures and property. The house mouse has been documented as a carrier of disease causing pathogens such as *Salmonella*. They often emit a very pungent musty odor, and leave behind fecal pellets, which can be bothersome. They are very difficult to control because of their abundance, rapid adaptation and rapid reproductive rates.

Food: The house mouse is a "nibbler." It prefers cereal and grain foods, but will eat almost any food available. They will also eat structural components such as wood materials and will chew through cable and telephone wires.

Biology: The house mouse is a small rodent with very large ears and small dark eyes. It weighs approximately ½ ounce and is usually light brown to gray in color. Adults are about 5½ to 7½ inches long, including a 3- to 4- inch tail. The house mouse has very keen senses of taste, hearing, smell, and touch. Females can have 5 to 10 litters of 5-6 young per year. Young are born 19 to 21 days after mating and reach reproductive maturity in 6 to 10 weeks. The life span of a mouse is 9 to 12 months.

Shelter: The house mouse is a very adaptable organism and will seek shelter almost anywhere. It creates its nest from fine shredded paper or other fibrous materials. It can create nests in home attics, in insulation materials, and between walls. The house mouse also can be found in open fields and in agricultural lands.

Behavior: The house mouse is most active at night, but can sometimes be seen during daylight hours. They are proficient climbers and can run up any vertical surface. They are capable of

running horizontally along wire cables or ropes and can jump up to 12 inches from the ground up onto a flat surface. They can fit through openings that are slightly larger than ¼ inch across.

Control: There are a variety of control options for the mouse pest problem. Preventative tactics are always the best option. Sanitation is the first option for preventing mice in the home. Remove mouse food and shelter sources whenever possible. Any dropped or left food items should be cleaned up and fibrous materials that could be a good source for a nest should be removed. Any holes, cracks, or gaps that are ¼ inch or larger should be sealed. Steel wool is a good temporary sealant option. Cracks or openings around pipes, vents, and utility cables should be sealed. Doors and windows should fit tightly. If a population already exists, traps are an option. Wood-based traps and live traps can be purchased at a local hardware store. Traps should be placed along walls, in dark corners, and places where there have been signs of mouse activity. Predators such as cats and dogs are also effective methods of keeping rodent populations down. A final option of rodent control is the use of baits. These usually consist of an attractant such as a food and a rodenticide, and can be purchased at hardware stores. These baits can be harmful to household pets and small children, so product labels must be followed.

Sources:
University of California, UC IPM Online
http://www.ipm.ucdavis.edu/PMG/PESTNOTES/pn7483.html

Bosley Jenkins, Erica. Exploring Urban Integrated Pest Management. Michigan State University Pesticide Education. http://www.pested.msu.edu

IPM Lesson 1: Learning Extensions

Science

1. Collect data from Lesson 1, Activities 1 and 2, (school and home scavenger hunts, i.e. which pests – or signs or symptoms of them – were found and where, i.e. kitchen, library, classroom)? This data will be taken to language arts class to be organized using charts, graphic organizers and/or pictures. The data will also be taken to math class to be graphed. How does the school pest (and sign/symptoms) data compare to the data collected during the home scavenger hunts in terms of kinds of pests found? Why might there be differences? Similarities? What advantages and disadvantages do the different methods of organization have when compared to each other?

2. In Lesson 1, Activity 3, students interview people at school and home (teachers, custodians, administrators and parents). The information collected during the interviews will be organized using graphic representations such as charts, pictures, and graphic organizers in language arts and graphs in math class. Review conclusions drawn by students after utilizing graphic organizers, etc. developed in Lang. Arts and graphs from math class. Do any patterns exist? Is there greater tolerance for some kinds of pests compared to others?

Language Arts

In conjunction with Lesson 1, Activities 1 and 2, students will bring data collected to language arts class to organize using charts, graphic organizers and/or pictures.

In conjunction with "Activity 3 – 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: 5-C1.12, 5-C2.3-2.5)

After students conduct interviews with teachers, administrators, custodians, and parents in Lesson 1, Activity 3, use graphic representations such as charts, pictures, and graphic organizers as a means of organizing the information collected. (5-R1.14, 5-R1.17)

Math

In conjunction with Lesson 1, Activities 1 and 2, students will bring collected data to math class to organize using graphs. (Math Standards: 5-DA&P-I-B1, 5-DA&P-I-C1-3, 5-DA&P-I-D1)

After students conduct interviews with teachers, administrators, custodians, and parents in Lesson 1, Activity 3, they will take collected data to math class to organize using graphs. (5-DA&P.I-B1, I-C1-3, I-D1)

Social Studies

The following activity should take place when students are studying westward expansion in their social studies class.

Westward Expansion – The Rocky Mountain locust was considered by some to be the single greatest impediment to westward expansion in the 1800s in the United States. Have students read (individually or as groups who then present the information from their article to the rest of the class) one or more of the following articles: http://www.denver-rmn.com/millennium/0622mile.shtml, http://www.sciencecases.org/locusts/locusts.asp, http://www.nationalhistoryday.com/03_educators/teacher/doc1.htm, http://www.nationalhistoryday.com/03_educators/teacher/doc2.htm, http://www.nationalhistoryday.com/03_educators/teacher/doc4.htm, http://www.nationalhistoryday.com/03_educators/teacher/doc5.htm, http://www.nationalhistoryday.com/03_educators/teacher/doc6.htm. When finished have them imagine themselves as setters who are writing to family or writing in a journal telling about the arrival of the locusts and including details from the various sources. (Social Studies Standards: 5-2.1, 5-2.2)

Lesson 2 – Learning More about Pests

Introduction

In the previous lesson, your students interviewed individuals at home and school 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 Outlined lessons

Grade 5:

- I. Inquiry
  A. Process Skills – 2ab, 4a, 5ab, 6ab
  B. Inquiry – 1abcdef
- II. Life Science
  B – Populations and Ecosystems – 1ab, 2ab, 4cde

Resources for the following lesson

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

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

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

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

Duration 2.5 hours

Objectives
The Students will:

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

Vocabulary
Environment
Time
Symptoms
Signs
Complete metamorphosis
Hosts
Pest
Incomplete metamorphosis

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 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). 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 – Wanted: Pests
"Wanted Dead or Alive"
(http://www.pested.msu.edu/CommunitySchoolIpm/curriculumpdf/lesson6.pdf)
from Exploring Urban Integrated Pest Management by Jenkins.

In this activity students (individually or as part of a group) select a pest to research. You may want to limit their selection to a few choices, such as the most important pests at school, or you may want to provide many choices so that each student studies a different pest. The kinds of information that students should find for their pests include: identifying characteristics, reason(s) for pest status, habitats, eating habits, signs, symptoms, life cycle, means of communication and skills of the pest. Once they have researched their pests, students create "Wanted Dead or Alive" posters for the pests that include the information they have learned. Encourage students to use their creativity by including a drawing of their pest or by adding a picture of their pest on their poster. They should include pest information on their posters that they learned in their research, interviews and observations. If possible, post wanted posters in a public area of the school where other people will see them.

Materials
Poster board
Crayons
Markers
Colored pencils
Reading materials containing insect or pest information (see printed resources from Lesson 1 and websites)

Activity 2 – The Pest Tetrahedron
After the students have researched their pests and created their wanted posters, discuss the components of the pest tetrahedron (see teacher resources in binder) with them. Ask them questions such as:

- What will happen if the pest food supply is made less available, or less nutritious?
- What will happen to the pest if we change its habitat or environment by making it unsuitable?
- In what other ways can we affect the pest without using pesticides?

You may want to use your class pests as specific examples for the questions above. Draw a triangle or tetrahedron on the board and then, using the questions above, see if your students can piece together the important components of the pest tetrahedron. Pests become problems when all of the sides of the tetrahedron are equal (tetrahedron = an equilateral triangle with a fourth point for time). Pests, hosts, appropriate environment, and time are the important components of a pest tetrahedron. When there is a suitable host, a viable pest (with the ability to cause damage), a favorable environment and enough time pests easily become a problem.

Team Problem Solvers

Divide the students into groups, and give each group a problem to solve (see Teacher Resources for pest problem descriptions, answers and worksheet). Each problem consists of a situation in which some part of the pest tetrahedron must be manipulated to create a situation that is unfavorable for the pest, thus managing the pest problem. Each team must write an answer to the question(s), and develop a strategy for managing the pest population.

Activity 2 Follow-Up

After students complete this activity using the pest problems provided in the Teacher Resouces section, you may want to ask the teams to develop pest problems for their classmates to solve using the pests about which your students have been learning. Help students create pest situations using what they have learned about the pest tetrahedron.

Materials

Paper
A pest problem for each group
Pest problem worksheet
Answers to pest problems

Lesson 2
Corresponding Activity - 2
Learning More about Pests
Teacher Information Sheet: The Pest Tetrahedron (disease triangle)

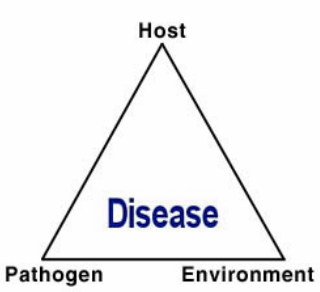


Photo courtesy of APS Education Center (apsnet.org)

The pest tetrahedron is the triangular representation of the relationship that occurs between the pest, its host, and the environment over time. On an equilateral triangle, one side represents the pest or pathogen, the adjacent side represents the host, and the last side represents the environment. The length of each side is proportional to the sum total of the characteristics of each component that favor diseases or pests. For example, if plants (the host) are resistant, the wrong age, or widely spaced then the total would be small or zero. If the three components could be quantified, the area of the triangle would represent the amount of disease or pests in a plant or plant population. If any of these three components is missing (or zero) then there can be no disease or pest infestation (Agrios 1997). Thus, for problems to occur the host must be susceptible or vulnerable. The pest or pathogen must be virulent and in contact with the host. The environment must be favorable and finally, enough time must have passed to allow for an interaction between pest/pathogen and host.

The Pest (or pathogen): The pathogen or animal pest must be in a virulent life stage or present in great quantities. Considering insects have several developmental stages in their life, some stages will cause more damage than other stages, for example, the egg stage of a beetle does not cause any damage. However, the larval and adult stages can cause severe damage. In their interactions with plants, they can reduce plant vigor, cause defoliation and transmit disease organisms. Pathogens require two components to cause damage, they must come in contact with a host and the pathogen and host must interact. If conditions are unfavorable, the pathogen may not be able to attack, or the host may be resistant to the attack. Pathogens also have ranges of virulence (more or less virulent depending on life stage). They may also be present in small or large quantities, may be in a dormant state or may require a film of water or specific vector to potentially be problematic.

The Host: The host must be susceptible. It must be in a stage of development that is vulnerable to a pest/pathogen, and it must come in contact with the pest/pathogen. For example, some pests prefer to eat only the foliage of trees, thus when the trees are dormant or the leaves have fallen that particular pest will not be able to feed because its host is not vulnerable. There are also

certain pests that prefer to eat the fruit of certain plants. If the fruit are not yet growing, then that host is not vulnerable to the pest.

The Environment: The environment must be favorable to the pest or pathogen. The temperature, humidity, and light all must be in favorable conditions for the pest to invade its host. For example, spider mites prefer dry conditions, so when there are humid conditions, such as in a greenhouse, that particular spider mite will not be a problem.

Time: Nothing happens immediately. Pest problems and pathogens may take weeks or months to develop. It takes time for the pest to develop to an active life stage and the host to develop into a vulnerable life stage. Oftentimes Mother Nature plays a very important role in regulating environmental conditions.

The purpose of understanding the pest or disease triangle is to be able to use it as a tool in pest management. Knowing how to manipulate the triangle and knowing some of the pest and disease biology is the key to effective management. If the pest manager can create an unfavorable condition for the pest or pathogen by altering one of the sides of the triangle, then the pest problem can be managed. For example, someone having a problem with cockroaches may alter the environment portion of the disease triangle by washing countertops and stopping leaks. Scouting and monitoring help to alter the pest portion of the pest tetrahedron. Scouts look for all stages of the pest. If it is early in the season and the scout discovers eggs of the key pest, they may consider some physical control to eliminate the pest in its vulnerable stage before it becomes a problem. Lastly, hosts can play a very significant role in altering the disease triangle. Using host plants that are resistant to a particular pest or pathogen problem in a garden, crop, or greenhouse is the most effective way to alter the pest tetrahedron, making conditions unfavorable for pest or disease development.

Sources:

Agrios, George N. Plant Pathology 4th Edition. Academic Press: San Diego 1997.

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

American Phytopathological Society - APS.net
http://www.apsnet.org/education/InstructorCommunication/TeachingArticles/Francl/Top.html

Lesson 2 – Team Problem Solvers
Corresponding Activity – 2 The Pest Tetrahedron
Learning More About Pests

Introduction: Students have learned the four components of the pest or disease tetrahedron. For each situation students should identify the pest, host, environment, and symptoms and signs. All problems occur with time, so it is not necessary to identify that factor. However, encourage students to think about plant, pest or disease life cycles. Next, have students decide on and investigate recommendations for managing the problem. Encourage students to determine alternatives to pesticides. Have them suggest as many ways possible to manage the problem. Lastly, have students explain how their situation manages the problem and why.

Problem A In the summer time, your grandmother grows beautiful flowers in her garden. She loves her daylilies but grows tired every day of seeing so many weeds like crabgrass and oxalis.

www.extension.umn.edu/

Problem B. One summer day when you opened the door to the house several flies flew in. All day long they were pestering you, landing on your food and buzzing in your ears. When you went outside, you smelled a rotting, dirty smell. You decided to follow the odor, which took you to your neighbor's garbage. He has not taken it out for weeks.

Problem C. This morning your little brother made a peanut butter sandwich for breakfast. He was in a hurry to meet the school bus and on his way out of the house he tripped on the bowl of dog food and knocked some of it out of the bowl. When you returned home, you found mouse droppings on the kitchen counter and along the wall near the dog food.

http://www.scarafaggio.com/images/mouse_droppings_drawer.jpg

Problem D. Grandfather planted a young rose bush in his yard early in the spring. It is now nearly late summer and the leaves are glistening as if it had just rained. You touch the leaves and they are sticky and have black specks. Curious as to where this sticky material is coming from, you look under the leaves. You find small pear shaped insects. You also notice that the roses are looking a little wilted. You decide to take a few of these bugs and some rose leaves to your science teacher. He tells you these insects are aphids and they produce a sugary waste called honeydew, and the black specks are a fungus called sooty mold.

http://www.sactorose.org/ipm/84whiteflies.htm

Problem E. It is spring and you are helping your parents with their garden. Things are going along great and the vegetables look good. About mid summer you notice big pieces of the lettuce leaves are missing. It looks as if something has been eating them. The leaves are chewed and some of the other vegetables have portions whre something has eaten them.

Problem F. You are camping with your family and are being bitten by mosquitoes. You are unable to use insect repellent because of allergies.

Problem G. One day you are playing fetch with your dog and he stops and starts scratching his neck. You walk over to him and look through his fur and discover little black jumping fleas.

Problem H. Your family just returned from a two-week vacation and you are hungry. You run into the house to the refrigerator. When making your sandwich you notice bread crumbs on the floor, a bit of a leak from the refrigerator, and a dead cockroach in the corner. You also notice that the bread and cheese have a bit of green fuzz on them.

Problem I. You are having a family picnic in your back yard and as you enjoy your soft drink you notice a few bees buzzing around. When you get up to see where they are coming from you notice an open trash bag.

Problem J. It's fall and as the temperature gets cooler you notice that you prefer to be inside more where it is warmer. One day you notice you are not the only organism that wants to be in the warmth. You begin to notice little lady beetles wandering around inside your home along your ceiling; they sometimes fly into you and wander into your food.

http://www.ppdl.purdue.edu/ppdl/weeklypics/Weekly_Picture11-26-01-2.html

Team Problem Solvers: Teacher Answer Sheet
Corresponding Activity - 2

Your students may come up with alternative answers than the suggested answers provided here. If they are logical, then they are correct.

Problem A. Host: Daylily bed
Pest: Weeds – Crabgrass and oxalis
Environment: Summer time and space in the bed
Control: Hand pull; hoe; prevent by putting in plastic mulch or rock
Explanation: makes environment unfavorable

Problem B. Host: Neighbor's garbage, you
Pest: Flies
Environment: House, garbage
Control: Ask neighbor to dispose of trash by taking to disposal site; keep trash in closed cans; put screens on doors; swat flies
Explanation: Makes host unfavorable to pest

Problem C. Host: Peanut butter, dog food
Pest: Mouse
Environment: House
Signs: Mouse droppings
Control: Clean up peanut butter and dog food; keep food in closed plastic containers; set mouse traps along walls; patch up holes that could be related to mice; get a cat.
Explanation: Makes host and environment unfavorable

Problem D. Host: Rose bush
Pest: Aphids feeding on plant tissues, fungus feeding on honeydew
Environment: warm summer day in the garden
Signs: Honeydew, mold
Symptoms: Wilting
Control: Prune rose bushes; introduce ladybird beetles to eat aphids; transplant bush
Explanation: Makes environment and host unfavorable

Problem E. Host: Garden
Pest: Rabbits, beetles, or caterpillars
Environment: Garden - summertime
Control: Put up fence for rabbits; set traps; get a cat
Explanation: Makes environment unfavorable

Problem F. Host: You
Pest: Mosquitoes
Environment: Night, forest near a lake
Control: Use citronella candles; wear long pants and long sleeved shirts; light a fire
Explanation: Makes host unfavorable

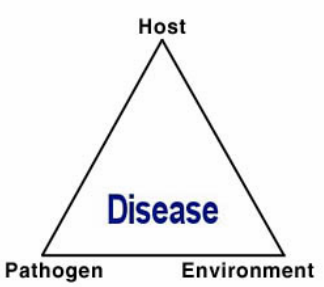
Problem G. Host: Dog
Pest: Fleas
Environment: Outside and in dog's fur
Symptoms: dog scratching
Control: Give a bath; comb and brush fur; vacuum your home; change and wash dog's bedding
Explanation: Makes host and environment unfavorable

Problem H. Host: Crumbs, water, bread, cheese
Pest: Cockroach, mold
Environment: Home, refrigerator, and kitchen
Sign: Dead cockroach
Control: Clean up crumbs; throw out cheese and bread; clean kitchen
Explanation: Makes environment unfavorable

Problem I. Host: Trash, you, sugary foods
Pest: Bees
Environment: Outside, backyard
Control: Close up trash bag and dispose; cover soda cans and food; go inside
Explanation: Makes host unfavorable

Problem J. Host: You, your food, home
Pest: Ladybird beetles
Environment: Warm house
Control: Sweep them and put them outside; vacuum them and dispose of vacuum bag
Explanation: Eliminates pest

IPM Lesson 2 – Learning more about pests
Activity 2 – The Pest Tetrahedron
Team Problem Solvers Worksheet



Name:_____

Problem:_____

Host:_____

Pest:_____

Symptoms and
signs:_____

Environment:_____

Control:_____

How can your solution manage the problem and why?

IPM Lesson 2: Learning Extensions

Science

Activity 1

May limit Wanted Posters to those pests found in school or home during the scavenger hunts or may want to include other common pests as well.
Student research resources include:
http://www.pested.msu.edu/CommunitySchoolIpm/curriculumpdf/lesson6.pdf
http://education.denniskunkel.com/MostWantedBugs.php

Activity 2

See pp. 32-33 for additional background information on the pest tetrahedron and pp. 34-39 for the team problem solvers and worksheets discussed on p. 31.

Language Arts

Each student takes on the persona of a particular pest and writes a creative "day-in-the-life" profile, telling about its behavior during one 24-hour period. For an example, visit http://yucky.kids.discovery.com/noflash/roaches/pg000095.html and http://yucky.kids.discovery.com/noflash/roaches/pg000213.html.
(5-R1.15, 5-R2.7, 5-W2.2, 5-RS2.1, 5-RS2.2, 5-RS3.2)

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

Introduction

In Lesson 1, students took a look around their school and 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 specific pests and what they require for survival. 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 look carefully (scout) for pests identified in Lesson 1. 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 by 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 5:

- I. Inquiry
  A. Process Skills – 1a, 2ab, 5ab, 6ab
  B – Inquiry – 1abcdef

Resources for the following lesson

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

"Inspecting the School" Exploring Urban Integrated Pest Management by Jenkins.
http://www.pested.msu.edu/CommunitySchoolIpm/curriculum.htm

Duration 5 – 6 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 the school for pests.
- Use communication and interviewing skills.
- Recognize situations that encourage pest infestations.
- Understand tolerance levels in relation to pests.
- Make decisions about when management tactics may be necessary.

Vocabulary
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 school or at home? (Animals, insects, fungi, etc.)
- Where did we discover them? (Ask for specific details, e.g. in the dark closet, near a crack in the wall, close to moisture)
- What do we know about them? Such as: 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 gain a better understanding of 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 school scavenger hunt and their notes from their interviews with the custodians and teachers. This will give them some background information for their scouting and monitoring activity. As a class, you may want to combine all of the students' pest information onto one large classroom chart (on the board, overhead, or as a poster). Discuss the charts, making sure that everyone has the same information.

Materials
Worksheets from their first scavenger hunt.
Overhead projector and sheets
Poster board
Markers

Activity 2 – The Hunt
Note: *Be sure to obtain permission from the proper individuals before beginning this activity. Explain that you and your students will be scouting the school for pests and their symptoms and signs.*

Give students copies of the Lesson 3, Activity 2 worksheet on page 47 for this activity. It will help students as they scout the school. Working in groups of two or three, students should scout the school 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 return to the classroom and present to the class all of the information they found on one pest.

- Each group should present their findings for a different pest. Again you may choose to make a classroom chart of these findings.
- Ask your students how often they believe they should scout the pest infested areas (How many times per week, month, year) and why?
- Be sure they understand that regular scouting is necessary to monitor pest populations.

Follow-Up
Depending on time available, have students repeat this activity at home. Discuss with students their findings at home. Review the classroom chart from the previous day. Up to this point students have learned a great deal about the environments in which they fulfill some role every day. They have learned that they are not the only living organisms in their school or their homes. 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.

Begin to talk with them 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. Ask them questions like:

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

Materials
Lesson 3, Activity 2 worksheets
Flashlights
Mirrors
Overhead projector and sheets
Poster board
Markers

Activity 3 – How many is too many?
In this activity your students will begin to understand what tolerance means, as far as pest populations are concerned, and begin to think about types of management tactics. Also, encourage students to think about how and which management tactics they could use simultaneously.

Have students interview each other in order to determine some pest threshold i.e. some level at which a pest population is no longer tolerable and must be managed. Some questions they may want to ask include:
- How many of a particular pest is too many?
- What has been done to manage the problem in the past?
- Why did you choose the threshold amounts that you did?
- How much control is necessary (i.e. how much impact is needed before you consider the pest population to be within tolerable limits)?
- What management tactic is easiest and most efficient to use?

After they have interviewed each other, 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 a pest population.

Enrichment
Contact your local University pest management extension specialist and ask him or her if they would be willing to visit your class for an interview. Have your class interview this person in the same manner as they previously interviewed the school officials and each other. Discuss with them any new information.

Materials
Student interview sheets (provided)
Tape recorders

Activity 4 – Using GPS to Monitor Fire Ant Mounds

Using GPS units, students will work in groups of three to measure off quadrants on the school grounds, marking the corners with pieces of aluminum flashing and a 3 inch nail pushed through the center until the marker is flush with the ground. Aluminum squares should be marked/numbered to facilitate future recognition. Once the quadrants are marked off, use the GPS units to mark fire ant mounds. Record numbers of mounds and their locations. Over time, students will return to determine if the number of mounds has increased or decreased. Depending on school resources, you may want to have the school's pest control operator apply different fire ant treatments as determined by the students. Then have the students regularly return to their quadrants to see what happens in terms of new mound development and amount of time before new mounds appear.

Name_____

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

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)

Lesson 3 – Activity 3
Student Interview: How Many Is Too Many?

Name of Interviewer_____

Name of Person Interviewed_____

Q: Recently you have been learning about pests in your school and 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 didn't 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

1. Students develop a list of questions for interviewing peers, parents, teachers, kitchen staff, custodians, and administration about how many of each kind of pest they can tolerate before action must be taken. See pp. 47-48 for a handout that can be used when students interview their peers.

2. Invite a Clemson University pest management extension specialist or graduate student to come to the school to be interviewed by the students. Some questions that might be asked are included in the Discussion/Review section on p. 42.

3. Using GPS – Time includes learning to use GPS device. Using the GPS unit, students will divide the school yard area into quadrants and then map the fire ant mounds. In addition to the GPS readings, students should mark the mounds by pushing a 3-inch nail into a piece of aluminum flashing to make it flush with the ground. Mapping will continue at regular intervals (at least once again in the spring when fire ants become active). If control measures are implemented (Lesson 4), mapping will continue to determine the effect on the number of mounds over time.

Language Arts

2. Have the students read "The Mister Runtles' Bet" by Jennie Wright (30 copies and teacher's edition provided in Discovering IPM kit and at http://educ.queensu.ca/connectme/sharedresources/languagearts/RuntlesBet.pdf) and then fill in the worksheet provided in Lesson 3 Teacher Resources. When they finish, have them read the story again and answer the questions on the worksheet. Once they collect their fly data from the story, have them take the numbers to their math class so that they can graph them. (5-R1.3, 5-R1.5, 5-R1.9, 5-R1.12, 5-R1.14)

2. In conjunction with Lesson 3, Activity 3, utilize the information graphed in the math extension #2 below and compare and contrast the findings of pest tolerance in different groups. (5-R1.9, 5-R1.17)

Math

1. Graph the data that the students collect in their language arts class (see #1 above). Continue doubling the fly population until the population is greater than 1,000,000 flies. Graph that data as well. Theoretically, populations of many kinds of organisms have the potential to grow exponentially so long as there are resources available. Their population numbers, when graphed, form a J-shaped curve. In the real world, this kind of growth does not occur because eventually, they run out of resources (food, water, and space to live) in addition to death due to predators and disease. (5DA&PI.D2, 5DA&PII.C4, 5DA&PIII.A1)

2. In conjunction with Lesson 3, Activity 3, graph and compare number of each kind of pest that can be tolerated before individuals in different groups (i.e. teachers, kitchen staff, administrators, custodians, parents, and males vs. females) would want them controlled. (5-DA&PI.B1, 5-DA&PI.C1-3, 5-DA&PI.D1, 5-DA&PII.A1, 5-DA&PII.B1, 5-DA&PII.C1)

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 Lessons

Grade 5:

- I. Inquiry
  A. Process Skills – 2ab, 4a, 5ab, 6a, 7a
  B. Inquiry – 1abcdef
- IV. Physical Science
  A. Properties of Matter – 1c, 2ef

Resources for the following activities

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

Crop Life America Organization – decision making game
http://www.croplife.ca/foodforthought/farmer_frank/farmerFrank_content.html

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
http://www.epa.gov/pesticides/ipm/brochure/

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.

Australian Biological Control – goodbugs.org
http://www.goodbugs.org.au/IPMnotes.htm - Information on biological control

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

Crop Data Management Systems, Inc. provides a database of pesticide labels. It can be accessed by visiting: http://www.cdms.net/manuf/manuf.asp. First, click on a manufacturer's name and then on the label icon to the right of the pesticide name.

Household Products Database – Provides health and safety information on common household products. http://householdproducts.nlm.nih.gov

Duration 2-3 hours

Objectives
Students will:

- Review information they have learned about their problem pests
- Review the pest tetrahedron
- 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	Chemicals
Pest tetrahedron	Prevention
Host	Insecticide
Suitable environment	Fungicide
Time	Rodenticide
Cultural control	Physical controls
Biological control	Sanitation
Predator	Habitat modification
Prey	Pesticides
Resistant plants	

Discussion/Review
If a University extension pest management professional visited your students during Lesson 3, begin this lesson by discussing what students learned from this person. Ask students about the different pests with which that 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 pest manager give to manage the pest population, i.e. how was the pest population managed?

- You may find that your students report that the pest manager managed mostly insects.
- They were called to manage the problem when pest populations were very high, or rather 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. This is also a good opportunity for students to revisit the pest tetrahedron and their Team Problem Solvers. These materials will help them make educated pest management decisions.

Activity 1 - Brainstorming
Begin by drawing the pest tetrahedron on the board. Next to it list 'management methods' (see *italicized* words below). Under this category list ideas your students suggest for managing their pests.

Ask students several questions about pest management tactics. Begin with general questions to see what kinds of ideas they formulate. Next, ask more specific questions that will lead them to different methods of management. You may want to use specific pest 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.

<u>Sample Questions and Explanations:</u>

- **Question**: How many management methods can you think of?
  Expected Answers: Chemicals, predators, cleaning
  Explanation: Chemicals or *pesticides* are one way that many of us manage unwanted pests, and we will talk about pesticides later. However, there are many 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*.

- **Question**: Often in the winter ladybird beetles 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 Answers: Seal up cracks along windows and doors. Make 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*.

While the class has not thoroughly explored pest management outside of school and home, this is a good time to introduce a few new ideas.

- **Question**: 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? And if they are pests, how do we control weeds, other than by pesticides (herbicides)?

  Expected answers: Yes. Pull them out by hand or use a hoe to remove them.

  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? Or is it more efficient to allow the pest population to grow and then try some form of control? 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. 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.

Materials
Black board
Chalk
Overhead projector
Paper

Activity 2 – "What happens if…" game
This game is designed to give the students an opportunity to think through a problem, individually or in teams, and come up with some solutions. It is similar to Team Problem Solvers, but it strictly targets different control methods. Use this game as a method to start class discussions.

Two methods of play:

1. This game is played in a "around the world" fashion. The first student (challenger) in the front left corner desk stands next to the student behind him or her. Ask both students the question on a game card. The students must give an answer similar to answers listed on the game cards. The first student to raise his or her hand is allowed to answer the question. If

the student standing is the first to raise his or her hand and to correctly answer the question, then they may challenge the next student who is sitting. If the student standing is incorrect they must sit down. The sitting student is then allowed to answer. If that student is correct they may stand next to and challenge the next student. If that student is incorrect, he or she remains seated, and the game resumes with the third and fourth students in line.

2. Divide students into 2 (3 or 5 students to a team depending on class size) teams, and play this game in a "Family Feud" fashion. In this game each team will choose a captain, and the captains will face-off. You will ask the question on the game card, and the first student (captain) to raise his or hand may answer. Then the other student may answer. The captain with the best answer wins the face-off, and his or her team has the first chance to try and get the other answers to the question. That team is allowed to work together to come up with answers to the question. They are allowed three tries. If they answer the question with all correct answers, they win that round and are awarded points (to be determined by the teacher). However, if the team fails to answer the question in three tries, i.e. they get three strikes, then the opposing team may steal the round. In order to steal the round, the opposing team must work together to figure out the best answer to the question. They are allowed one try. If they succeed, they win the round. If they fail, the first team wins the round. The next round begins with a face-off of the next two students from each team.

Follow-Up
Review and discuss the different methods of control, with the exception of pesticides. Return to your brainstorming session and see how many more controls the students can list.

Materials
Teams of students
Game cards (see resources)
Podium (for the game show host)
Central desk or table for face-off

Activity 3 – Implement
Have students return to their scouting groups. They should revisit their scouting worksheets, and determine a method to manage their school pests. The class has just brainstormed and discussed several management methods that do not involve the use of 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 consider any problems the presenting students might encounter with their management plan (i.e., could the tactics be reasonably implemented?). With the help of the school custodial and administrative staff, students should implement their controls.

If students are not able to implement their management measures, ask the custodian and administrative staff if they would practice the students' management tactics, or ask the custodial and administrative staffs what measures are being done to manage pest populations. Ask the custodial/administrative staff to report his or her management plan to the class. Have students take detailed notes about the management practices being done to regulate particular pests.

Assessment:
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. Ask students to report back to the class, and have them turn in a paragraph about what management practices they decided to use and why.

Materials
Paper
Pencils
Materials for implementing controls

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 U.S. 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.

- 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.

Pesticide Labels
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, hazards to humans and domestic animals, 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 one another and fill in the chart for two more pesticides.

Suggestion: As an additional emphasis on the safety of chemicals and pesticides, you may wish to contact your poison control center or a representative from your county cooperative extension service for additional information or for a representative that would be willing to speak to your class about pesticides.

Materials

EPA generic pesticide label (8 X 11 and poster)
30 sample pesticide labels from actual pesticides
Pesticide worksheet (transparency included)
Sample pesticide worksheet (transparency included)

Lesson 4
Corresponding 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 – 2
"What happens if…." game
Control Options Game cards
Resources:
University of Illinois
http://www.pestweb.com/

Cockroaches in the kitchen
Sanitation – clean up crumbs, food, and water Elimination – Seal up cracks and leaks Prevention – cover trash cans and other garbage places Physical control – traps and vacuuming Chemical – Pesticides

Beetles in the baking flour and cereal
Prevention – buy small amounts, store in sealed containers, store in refrigerator Sanitation – Clean up spilled flour, clean cabinets well, at least once a year Physical – Discard materials with infestation Chemical - pesticides

Spiders crawling along the window
Cultural – sticky traps Sanitation – cleaning and dusting unused areas Physical – locate webs, and nests and destroy egg masses Chemical – pesticides labeled for spiders

Flies in the House
Exclusion – Install screens, and tighten doors and windows Sanitation – Remove garbage from the home, keep covered Physical – sticky traps and fly swatters Chemical – pesticides

Ants in your home

Exclusion – caulk up or seal cracks, eliminate water leaks, tighten doors and windows
Cultural – trim bushes and hedges away from the house
Sanitation – remove food sources, clean up items stacked close to buildings that could encourage nests
Chemical – Pesticides

Whiteflies in the greenhouse

Prevention – Inspect regularly, keep infected plants out of the greenhouse
Biological control – predators such as green lace wings
Cultural – remove infested plants
Chemical - pesticides

Aphids on trees around the house

Do nothing
Prevention – avoid high nitrogen applications
Biological control – predators such as predatory wasps, and lady bugs
Chemical - horticultural oils, or insecticidal soaps

Mice in the Home

Sanitation – keep kitchens and food areas clean, stack food in cabinets neatly, put foods in protective containers
Prevention – in addition to sanitary techniques, keep stored materials away from walls and off floors
Physical – control population with traps
Chemical – rodenticides

Scale on house plants

Prevention – carefully inspect plants before bringing into the house
Physical – hand remove any scale
Monitor – use double sided sticky tape on either side of the scale, watch for crawlers (babies) and
Chemical – apply an insecticidal soap or horticultural oil

Bulging Galls on oak trees in the school yard

Do nothing – no harm is being done
Monitor for galls
Hand remove

S-shaped (serpentine) mines on the school holly bush

Monitor carefully
Do nothing
Keep isolated if possible
Chemical – pesticides

Mealybugs on house plants

Physical – hand remove
Cultural – prune off plant parts
Remove with alcohol swab

Woollybear caterpillar in the flower garden

Do nothing
Hand remove

Green – striped maple worm in the maple tree outside

Cultural – prune off webbing with caterpillars and burn
Do nothing if late in the year
Chemical – pesticides

Southern Pine beetle in the backyard pine tree

Physical – cut down trees and burn
Monitor – remove bark and check for s-shaped mines at right angles
Cultural – keep trees well watered and fertilized, promote resistance

Rotting roots on the petunias in the front yard flower bed

Prevention – use resistant plants
Cultural – clean tools before and after use
Cultural – remove infected plants

Mold on the Underside (downy mildew) of flowerbed plants

Monitor – watch for infection, pull out infected plants
Cultural – space plants for proper ventilation
Prevention – use resistant plants
Cultural – avoid over watering

Mold in the bathroom shower

Dry shower walls when finished
Wipe clean regularly
Clean often with soapy water
Use anti-bacterial cleaning agents

Lady beetles crawling on the living room ceiling

Do nothing
Vacuum and dispose of bag in outside trash
Chemical - insecticide

Brown and red angular spots on strawberry leaves (caused by bacteria)

Remove diseased plants
Clean tools before and after use
Check for adequate fertility
Chemical – pesticides

Rabbits eating vegetables in the garden

Exclusion - Put up a barrier, fence
Set traps
Chemicals – baits with rodenticides

Gray fuzzy mold on Mother's favorite lilies

Prevention – use resistant plants
Cultural – plant with enough spacing to allow air flow
Cultural – avoid over watering
Monitor often

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	Hazards to Humans and Domestic Animals	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	Hazards to Humans and Domestic Animals	Environmental Hazards
1. Clincher	**Herbicide – kills plants**	**Warning**	• **Causes substantial, but temporary eye injury.** • **Causes skin irritation** • **Harmful if swallowed.**	• **Toxic to fish and aquatic invertebrates.** • **Can contaminate surface water.** • **Can contaminate groundwater.**
2. Quintec	**Fungicide – kills fungi (molds, mildews)**	**Caution**	• **Harmful if swallowed.** • **Harmful if absorbed through the skin.**	• **Toxic to fish and aquatic invertebrates** • **Can contaminate water.**
3. Lock-On	**Insecticide – Kills insects**	**Caution**	• **Causes moderate eye irritation** • **Harmful if swallowed.** • **Prolonged or frequently repeated skin contact may cause allergic reactions in some persons.**	• **Toxic to fish, aquatic invertebrates, small mammals and birds.** • **Highly toxic to bees.** • **Can contaminate water.**

IPM Lesson 4: Learning Extensions

Science

Carry out biological control experiments

A. Look at the predator/prey relationship using praying mantids (i.e. how many prey can/does a predator eat in a specified time period?)

B. Look at predatory/prey relationship of aphids and ladybird beetles. Add different numbers of ladybird beetles to different cages and compare results.

(Amount of time required will vary depending on how much students participate in the set up of the experiments. Once the experiments are set up, time required will be minimal – mainly for making and recording observations.

Language Arts

1. After observing the predators and their prey (see 5th Grade IPM Curriculum Timeline/Outline – Science – Additional Information/Enrichment), write a poem or short story in which the student takes on the role of the predator or prey and describes their thoughts and concerns. (5-R2.7, 5-R2.9, 5-W1.3, 5-W2.2)

2. Have students imagine themselves as predators and then create posters to advertise themselves for solving particular pest problems. (5-R1.15, 5-R2.7, 5-W2.2)

Math

1. Graph the data from the biological control experiments (see 5th Grade IPM Curriculum Timeline/Outline – Science – Additional Information/Enrichment). Compare types of graphs that could be used to show data. (5-DA&P1.B1, 5-DA&P1.C1-3, 5-DA&P2.B1, 5-DA&P2.C1)

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, though they have not been formally introduced to the concept. 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, make control decisions. This segment of lessons will put the concept of IPM into focus for the students.

Appropriate SC Science Standards for the Following Outlined Lessons

Grade 5:

- I. Inquiry
  - A. Process Skills – 1a, 2ab, 4a, 6a
  - B. Inquiry – 1abcdef
- II. Life Science
  - B. Populations and Ecosystems – 1ab, 2ab, 4cde

Resources for the following activities

University of Florida
http://ipm.ifas.ufl.edu/

IPM institute of North America – IPM Super Sleuth
www.ipminstitute.org

Iowa State University
http://www.ipm.iastate.edu/ipm/

New York State Department of Law
http://www.oag.state.ny.us/environment/ipm3fold.html

Bio-Integral Resource Center
http://www.birc.org/

Michigan State University – Exploring Urban Integrated Pest Management
www.pested.msu.edu

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

Duration 4 hours

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 their control practices.
- Educate their peers and adults about IPM and preventative pest measures.

Vocabulary

Integrated	Educate
Pest	Prevention
Management	Environment
Evaluate	

Activity 1 – Discovering IPM
Write Integrated Pest Management on your black board. Underline the letters I, P, and M. Divide your class into three groups. Give each group a word, either integrated, pest, or management. Ask each group to take a three-step approach in order to figure out what their group's word means.

1. Have each group member write their meaning of their word.
2. Allow each group to interview other classmates or teachers about the meaning of their word
3. Have each group look up the meaning of their word in the dictionary.

Ask each group to present their word to the class. After each group has presented their word, lead a class discussion about these words. Talk about each word and its meaning individually and then talk with the class about what IPM means when all of the words are put together in the phrase. 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 their scouting groups again to complete the worksheet that 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 if there is anything left to do in their school and home IPM program. The students should realize they have not completed the last step of their program.

Materials
Lesson 5, Activity 1 worksheets
Lesson 5, Activity 1 worksheet (transparency)
What Does Integrated Pest Management Mean? (transparency and poster)
Dictionaries

Activity 2 – Evaluate
Ask students to join with their scouting groups. They will now re-scout their area of the school 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?

Once students return from their scouting mission, ask them to compare their first scouting mission with the second. Talk about the differences they found. Have them present their findings to the class. Items they should tell the class:

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

Assessment
Have the students repeat this procedure for their pests found at home. They should return to school with notes about what they found.

Follow-up
Review with your students all of the steps of an IPM program be sure to match their activities with the IPM steps they have taken both in school and at home. Ask them why they think they have also done IPM at home. Help them understand that school and home are two different environments, but that people and pests are a part of both. Pests can be in similar environments, therefore it is important for us to take care of all of our surroundings.

Materials
Lesson 5, Activity 2 worksheets
Lesson 5, Activity 2 transparency

Activity 3 – Educate
Students should, once again, return to their scouting groups and begin preparing presentations. Assign each group a different pest, either one they have been studying at school or one they have been studying at home. Half of the class should talk about school pests, and the other about home pests. Allow your students class time to work on their presentations. They can present with posters, overheads, a puppet show, or any other creative measures.

Invite parents, administrative, custodial, and teaching staff to your class for a student taught IPM lesson. Allow your students to explain to their audience:

- What does IPM mean?
- What are the steps in IPM?
- How they have used IPM.
- What pests did they find?
- What did they learn about these pests?
- What kind of management options they used other than pesticides, and why?
- How they decided which options to use.
- Did their management tactics work?
- What everybody can do to prevent pest problems.
- Have the class explain what they have learned about IPM both in school and at home.

Materials
Paper
Poster board
Construction paper
Markers
Colored pencils
Scissors
Glue
Overhead and transparencies

Activity 4 – Super Sleuth
The IPM Institute of North America (http://www.ipminstitute.org) has put together a variety of games and puzzles that address the concept and steps of and IPM program. At this point these games would help to cement your students' understanding of IPM. However, you may choose to use these helpful games and puzzles at any point during your IPM program.

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
4. Implement control options
5. 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

Language Arts

In conjunction with IPM Lesson 4, Activity 3, students will be divided into groups to create different educational products that answer bulleted questions on p. 73, as well as creating:

- A pesticide safety pamphlet for parents.
- A PowerPoint presentation, play or puppet show on IPM for grades 2-3 that includes what children in those grades can do to help solve pest problems in the school.
- A PowerPoint presentation on IPM (what it is; why it's important) for adults (PTA, School Board).
- A school IPM plan – While this is an ambitious project, there are many models on-line for creating a school IPM plan. In addition, the plan can be broken down into its component parts, and each part can be worked on by a different group of students.

(5-R1.4-1.6; 5-R1.13; 5-R1.15; 5-W1.1-1.6; 5-W1.6.1-1.6.4; 5-W2.1-2.2; 5-C1.1; 5-C1.3; 5-C1.5; 5-C1.7-1.8; 5-C1.14-1.15; 5-RS1.1-1.2; 5-RS2.1-2.2; 5-RS2.4-2.5; 5-RS3.2)