Lesson 4 – Making Decisions (management)

Introduction

This set of activities will guide your students through the decision making process. Making knowledge-based decisions for effective and environmentally safe management practices is a critical step in an IPM program. In this lesson students will use their knowledge about pest status, biology, habitat, habits, pest density (from scouting), and tolerance to make decisions about which management strategies to use on a pest population. It is likely that most of the 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). But these lessons will help them apply their knowledge to effectively manage pests without the use of pesticides. They will learn how to change certain components of the pest tetrahedron, and they will learn more about pesticides and their safety. This lesson also introduces students to a variety of management practices implemented in an IPM program.

Appropriate SC Science Standards for the Following Outlined lessons

Grade 2:

- I. Inquiry

A – Process Skills, 2a – Classify, B – Inquiry, 1abd

- II. Life Science

A – Characteristics of Organisms, 2ab
B – Life Cycles of Organisms, 1abc
C – Organisms and their Environments, 1a

Grade 3:

- I. Inquiry

A – Process Skills, 2ab – Classify, 4a – Communicate
B – Inquiry, 1abe
C – Organisms and Their Environment, 1abaef

Grade 4:

- I. Inquiry

A – Process Skills, 5a – Infer, 6a – Predict
B – Inquiry, 1a

- II. Life Science, A – Characteristics of Organisms, c

B – Organisms and Their Environment, 1b, 2ab, 3abcd

Grade 5:

- Inquiry,

A – Process Skills, 2ab – Classify, 4a – Communicate, 5ab – Infer 6a, 7a – Hypothesize
B – Inquiry, 1abcdef

- IV. Physical Science

A – Properties of Matter, 1c, 2ef

Grade 6:

- I. Inquiry

A – Abilities to do Scientific Inquiry

1 – Identify process skills that can be used in scientific investigations, d1, e1
2 – Design and conduct a scientific investigation, c
5 – Think critically and logically to make relationships between evidence and explanations
6 – Recognize and analyze alternative explanations and predictions, a

- IV. Physical Science

A – Properties and changes of Properties in Matter, 3b

Grade 7:

- I. Inquiry

A – Abilities Necessary to do Scientific Inquiry
1 – Identify process skills that can be used in scientific investigations d1; e1
2 – Design and conduct a scientific investigation, c
5 – Think critically and logically to make relationships between evidence and explanations, a
6 – Recognize and analyze alternative explanations and predictions, a

- II. Life Science

B – Regulation and Behavior, 1a, 3b

- III. Earth Science

A – Structure of the Earth's systems 4d

Resources for the following Activities

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

Crop Life America Organization – Fact sheet about decision making
http://www.croplifeamerica.org/public/issues/child/pdfs/chinfokitpestgrid.pdf

University of Georgia
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/kidfs.pdf – Kid's guide to pesticides
http://www.spcpweb.org/school_ipm.html

Australian Biological Control – goodbugs.org
http://www.goodbugs.org.au/IPMnotes.htm

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

Duration 2-3 hours for all of the following lessons

Objectives
Students will:

- Review information they have learned about their problem pests
- Review the pest tetrahedron
- Understand that management tactics 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
- Find pesticides in their environment and discuss them in class
- IPM objective – to learn about management practices implemented in an IPM program

Vocabulary

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

Discussion/Review
If a University extension pest management professional visited your students begin this lesson by discussing what they 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 may 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 that they now know a great deal about. 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' (*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 kind of ideas they formulate. Ask more specific questions that will lead them to different methods of management. You may want to use examples to help phrase your questions. It is important in this activity that students understand that management should be thought of as a way to regulate populations below tolerable levels.

Example Questions and explanations:

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

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

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

- **Ask**: 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 Answer: We can seal up cracks along windows and doors.
    - Expected Answer: Be sure all windows and doors are closed tightly.
    - Explanation: Sealing windows and doors is another type of cultural control, called *prevention*. Another way to rid the home of an annoying beetle population is to simply vacuum them up and dispose of the vacuum bag. This type of control is a form of *physical control*.

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

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

Physical, cultural, biological, and chemical controls must be practiced with a certain amount of effort. Discuss with students the most efficient way to manage a pest population. Is it more efficient to practice good, consistent cultural controls such as sanitiatation 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
Markers
Paper
Construction paper

Activity 2 – "What happens if…" game
Methods of play:

1. For grades 5-7: 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 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 must sit down, and the game will resume with the third and fourth students in line.

2. Grades 2-7: Divide students into 2 (3 or 4 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.

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.

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

Materials
Teams of students
Game cards
Podium for game show host
Central desk or table for face-off
Black board
Chalk

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 to consider any problems they may encounter with their management plan; 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 if he or she would practice the students' management tactics, or ask the custodial staff what measures are being done to management pest populations. Ask the custodian 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 further information and enrichment about the dangers of pesticides, see the resources listed at the start of the lesson.

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

- What are pesticides?
- Where are pesticides found?
- What are pesticides used for?
- Who uses pesticides?
- Are pesticides helpful for managing pests?
- Are pesticides good for people and pets to be around?
- What kind of harm do pesticides cause?

Be sure to talk in depth about the dangers of pesticides, and about pesticides in the environment.

Parents should help their child with this exercise. Students must find a pesticide label and copy, or draw it. They must note: what kind of pesticide it is, e.g. insecticide, fungicide, rodenticide etc., the name of the pesticide, the signal word (i.e. Danger, Caution, Warning, etc.), precautionary statements, environmental hazards, directions for use and safety. You may also wish for students to draw the target pest on their label. Have them present their labels to the class.

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

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

Materials
Black board
Chalk
Paper – white or construction
Markers
Crayons
Colored pencils

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 enough 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 other elements 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 penetrate its host in order to consume the pesticide, essentially the pest eats 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://www.okstate.edu/OSU_Ag/agedcm4h/ pearl/hort/ornament/f-6432.pdf

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

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

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

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

- Can manage some pests that other management strategies cannot.
- Are inexpensive
- 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 a detriment to the future of the manageable 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 or those pesticides 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 (though they are currently economically efficient).
- 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 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 animals.
- Many 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 more applications at higher rates may be necessary, which leads to resistance, resurgence, and replacement (by secondary pests), which leads to more applications at higher rates and so on. Relief from pesticides never occurs.

Pesticides have several advantages and disadvantages, for their use in managing 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. Historical 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.

Source:
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
Corresponding Activity – 2
"What happens if…." game
Control Options Game cards
Resources:
University of Illinois
http://www.pestweb.com/ipca/contents.html

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