Study Guide

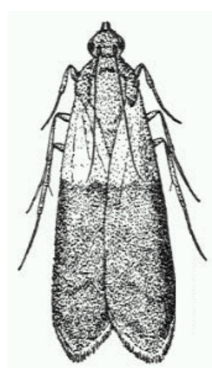
for the

EcoWise Certified IPM Practitioner Exam

Written by
Tanya Drlik & Terry Byrnes
Bio-Integral Resource Center

May 2006
(Revised February 2011)

Table of Contents



Study Guide for the EcoWise Certified IPM Practitioner Exam

Note that this Study Guide does not cover all the points listed in the Knowledge Requirements in the EcoWise Certification *Standards*. There are many websites and reference books to help you study for the exam. We have listed a sampling of these at the end of and throughout the document.

Knowledge Expectations for Certified IPM Practitioner

I. Knowledge of the Branch 2 Structural IPM Standards

1. **Be familiar with the EcoWise *Standards*** and be able to answer questions using a copy of the Standards

II. General Pest Knowledge

1. **Scientific classification of animals**

   <u>Animals (and plants) are divided into Kingdom, Phylum, Class, Order, Family, Genus, and Species.</u>

   - Kingdom is the broadest classification, or grouping. The other classifications get more specific as they go down to Species. Insects and humans are in the Animal Kingdom. As you move down through the other groupings (phylum, class, order, etc.) you get more specific about the identity of the creature.
   - Species is the most specific classification. *Homo sapiens*, or modern day humans, belong to the species "*sapiens*", meaning "wise", in the genus *Homo* that includes some other ancient humans who, being less wise, did not survive to the present day.
   - A way to remember the order of these classifications is the phrase: *Kings play chess on finely grained sand.* The first letter of each word in the phrase corresponds to the first letter in each of the classifications: <u>K</u>ingdom, <u>P</u>hylum, <u>C</u>lass, <u>O</u>rder, <u>F</u>amily, <u>G</u>enus, <u>S</u>pecies

   <u>How Latin Names are Written</u>

   The Latin names of pests are written with the name of the genus first and the name of the species following, for example, *Rattus rattus* (roof rat) or *Rattus norvegicus* (Norway rat). They are always written in italics (or they are underlined if you're writing by hand). The Genus Name is always Capitalized, and the species name is never capitalized.

   <u>Know the Genus and Species</u>

   The most important classifications for a pest manager to know are the genus and species of a creature so you can look up information about pest biology.

Common Name vs. Latin Name
The benefit of knowing the common name of a pest is that you can talk to other people about it without sounding superior; however, you may not always be talking about the same creature, since there are many common names for the same animal, especially for insects. There is only one Latin name for every species known to science, so there is no confusion when you use the Latin name. That is why pest management literature and scientific papers use the Latin names of pests.

2. **Proper Pest Identification**
It is very important to identify your pest properly. You cannot manage a pest whose identity is uncertain. Pest management strategies often differ profoundly from one species to another (think of ants) and you will be unable to control the pest if you are trying to control the wrong one.

3. **Symptoms Are Not Reliable for Identifying a Pest.**
Sometimes the symptoms and signs of one pest may mimic another.

4. **Basic Classification of Animals Encountered in Urban Pest Management**
The creatures encountered in urban pest management are all in the Animal Kingdom, and they belong to 2 main groups: arthropods and vertebrates.

Arthropods are "invertebrates", animals without a backbone or internal skeleton like ours. These creatures have their skeleton on the outside of their bodies. This is a more or less hard covering called an "exoskeleton". There are more different kinds of arthropods in the world than all of the other animals *and* plants put together! And there are more species of insects, by a huge number, than all the other species of arthropods.

Vertebrates have a backbone and an internal skeleton, and they come in many shapes, sizes, and lifestyles.

Phylum	**Class**	**Common Names of Organisms in the Class**
Arthropoda (this mean "jointed feet" in Greek)	Class Insecta	Insects
	Class Arachnida	Spiders, ticks and mites
	Class Diplopoda	Millipedes
	Class Chilopoda	Centipedes
Chordata (includes vertebrates and other animals with a "notochord")	Class Aves	Birds
	Class Mammalia	Mammals

5. **Identify Listed Pests**
Know how to identify the pests listed below (see page 6 for the Pest List) to class and order when given a name, specimen or photo of the adult or immature form.

Note: There are many websites and reference books that can help you with identification. Some useful websites are

UC IPM Pest Notes: http://www.ipm.ucdavis.edu/
A great resource on identification (there is a wonderful ant key), biology, and management.

UC Riverside wasp pages: http://wasps.ucr.edu/waspid.html
This information is for Southern California, but the same species occur in the Bay Area.

UC Riverside spider pages: http://spiders.ucr.edu/index.html
This site debunks the myth of the brown recluse, as well as some other spider myths.

University of Florida's Featured Creatures:
http://entnemdept.ufl.edu/creatures/
This site has many creatures that are of greater interest to Floridians than Californians, but many of the urban pests are the same. This site also includes identification, biology, and management.

Purdue University's spider web site list:
http://www.entm.purdue.edu/entomology/courses/110/websites1.fall.html
If you are interested in spiders, this page is for you! It is an exhaustive (and perhaps also exhausting) list of websites about everything you might want to know about spiders.

In the pest list below, you will find the class and order for all but the Arachnids and the birds. On the exam, you will not be asked to identify orders within those classes.

6. **Basic biology for the Listed Pests**
This includes food requirements, life cycle, habitat, reproduction, and damage symptoms.

Note: There are many websites and reference books that can help you with biology, including the websites listed above.

7. **Pest Status for the Listed Pests**
You will need to know why the creatures listed below are considered pests.

Note: If you are not familiar with the kinds of damage the listed pests can cause, the websites listed above can help you.

8. **Components of IPM Programs for the Listed Pests <u>with Asterisks</u>**
You must be able to describe the major components of an IPM program, in given sites or situations, for each listed pest with an asterisk.

See page 23 for an example of an IPM program for the Argentine ant.

9. **Where to Find Information on Pest ID and Biology**
   The websites listed above along with the books and websites listed at the end of this document will help you with biology and ID. For difficult or unusual problems, you can always stop by your County Agricultural Commissioner's office. Each County Agriculture Department has personnel who are skilled in identifying pests and know where to go for help, if they cannot identify the creature. Because there are always new pests arriving from foreign shores and even other states, it is important for you to take unusual or new things you find to the Ag Department.

Pest List

The Certified IPM Practitioner must be familiar with the following pests (class, order, basic biology, pest status). **NOTE: for those with asterisks (*)**, be familiar with the major components of an IPM program for the pest:

Biting and Stinging Pests

Class Insecta

1. Bed bug* (Order Hemiptera, *Cimex* spp.)
2. Cat flea, (Order Siphonaptera, *Ctenocephalides felis*)
3. Social wasps and bees (Order Hymenoptera)
   a. Honey bee, *Apis mellifera*
   b. Yellowjacket wasps, *Vespula* and *Dolichovespula* spp.
   c. Paper wasps, *Polistes* spp.

Class Arachnida

4. Tropical rat mite (*Ornithonyssus bacoti*)
5. Black widow (hourglass) spiders (*Latrodectus* spp.)
6. Brown dog tick (*Rhipicephalus sanguineus*)

Flies (class Insecta, order Diptera)

7. Drain (moth, filter, sewer) flies (family Psychodidae)
8. Fungus gnats (families Fungivoridae and Sciaridae)
9. Blow flies (family Calliphoridae)
10. Cluster fly (*Pollenia rudis*)

Ants (class Insecta, order Hymenoptera, family Formicidae)

11. Argentine ant* (*Linepithema humile*)
12. Pharaoh ant* (*Monomorium pharaonis*)
13. Carpenter ant (*Camponotus* spp.)

Cockroaches (class Insecta, order Blattaria)

13. German cockroach* (*Blattella germanica*)
14. Field cockroach (*Blattella vaga*)
15. American cockroach* (*Periplaneta americana*)
16. Oriental cockroach (*Blatta orientalis*)*

Stored product and fabric pests

Class Insecta, order Coleoptera

17. Carpet beetles (*Anthrenus* and *Attagenus* species)
18. Cigarette and drugstore beetle (*Lasioderma serricorne* and *Stegobium paniceum*)

Class Insecta, order Lepidoptera

19. Indian meal moth (*Plodia interpunctella*)
20. Angoumois meal moth (*Sitotroga cerealella*)

Other common commensal pests (non-arthropod)

1. Rodents (class Mammalia, order Rodentia)
    a. Roof rat* (*Rattus rattus*)
    b. Norway rat* (*Rattus norvegicus*)
    c. House mouse* (*Mus musculus*)
2. Birds (class Aves)
    a. Pigeon (rock dove) (*Columba livia*)
    b. Cliff swallows (*Hirundo pyrrhonota*)

III. Insect Biology and Morphology

1. The following characteristics set insects apart from other closely related animals:
    - Insects have 3 body regions: Head, Thorax, and Abdomen
    - Insects are the only invertebrates that fly (though not <u>all</u> insects fly)
    - Adult insects have 3 pairs of legs attached to the thorax and 1 pair of antennae attached to the head.

2. Insect Development

    Knowing the type of development a pest goes through can be an important tool for its effective control.

    <u>Types of Metamorphosis</u>

    Most urban insect pests can be grouped into 3 categories of metamorphosis:

    - *No Metamorphosis* (ametabolous)
        - Examples: silverfish and firebrats
        - These insects gradually change into adults. Adults look like larger versions of the young
        - Adult insects are sexually mature but continue to molt throughout their lifetime, sometimes as many as 50 or 60 times
        - Adults and young share similar food, environmental, and habitat preferences, meaning that all stages of development will be found together in a structure.
    - *Gradual Metamorphosis* (hemimetabolous)
        - Examples: cockroaches, termites, earwigs, crickets, bedbugs, lice
        - These insects also gradually change into adults, but they do not molt after adulthood.
        - Adults and young share similar food preferences and habitat, but the differences in body form, between adults and young, are more distinct.
        - The young are called nymphs and go through a set number of molts (the number varies depending on the insect) before they become adults.
        - The stages the nymph goes through are called instars.

    - The reproductive organs and wingbuds do not appear until the later instars (older nymphal stages), and do not become functional until adulthood.
    - A variation of gradual metamorphosis occurs in mayflies, dragonflies, and damselflies and is called incomplete metamorphosis. Their nymphs are aquatic and are called naiads. Adults and young do not share the same habitat and the naiads look quite a bit different from the adults.
- *Complete Metamorphosis* (holometabolous)
    - Examples: fleas, flies, beetles, moths, ants, wasps, mosquitoes
    - These insects have 4 distinct stages: egg, larva (with several instars), pupa, and adult.
    - The larva hatches from the egg and looks completely different from the adult insect. It may have different appendages for movement, different types of eyes (or none at all), and different mouthparts. It may also have completely different habitat and food requirements.
    - When the larva matures, it makes a pupal case or cocoon around its body and stops eating. At this point a truly *miraculous* transformation occurs in its body. Tissues are rearranged and after a time, out of the pupa comes an adult that is nothing like the larva.
    - Some insects are less vulnerable to pesticides and adverse environmental conditions in their pupal stage, and this may hamper efforts to control them.
    - Other insects may have a delayed emergence from their pupal stage creating the potential for the beginning of a new infestation long after you thought you had them under control. Fleas can wait in their pupal stage for months until they sense warmth and vibrations that signal the approach of a warm-blooded body and then emerge instantly, all together.

Adapted from Purdue University's Intermediate Level IPM Correspondence Course

3. Morphological Features of Insects (Class Insecta) and Spiders (Class Arachnida)

To be able to identify insects or spiders, you will need to be familiar with what their body parts look like and what they are called.

<u>Insect Morphology</u>

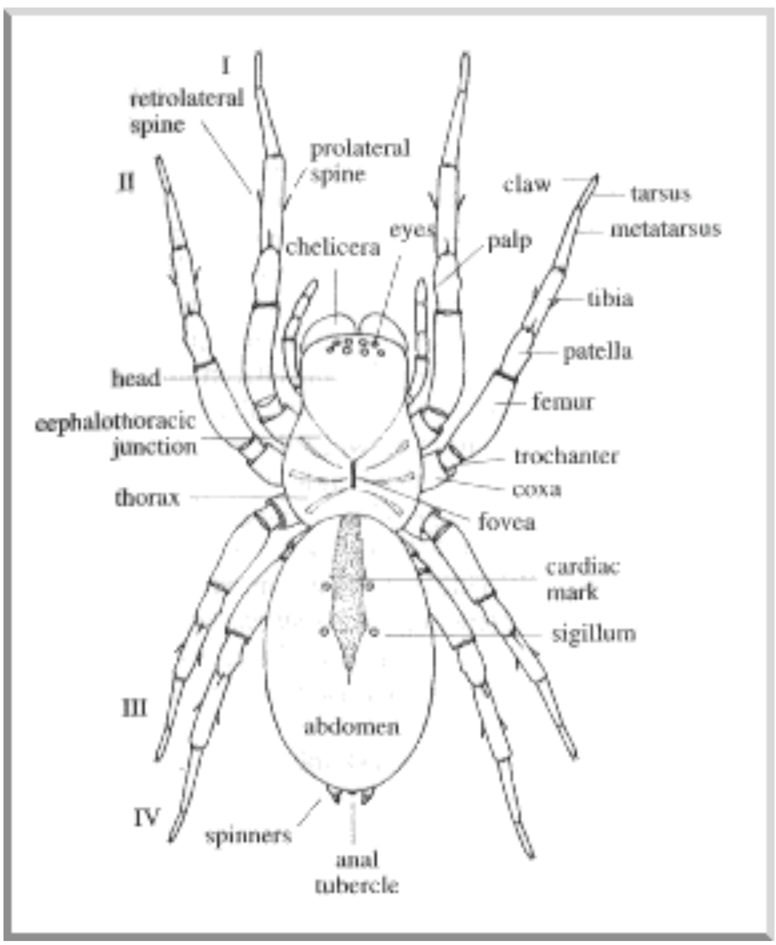
- Insects have 6 legs and 3 body regions called the head, thorax and abdomen.
- The chief structural parts of the <u>Head</u>:
    - Vertex = top of the head
    - Compound eyes
    - Ocellus (singular); Ocelli (plural) = simple eye(s)
    - Frons or Front = the front, uppermost part of the head
    - Clypeus = shield-like plate on the front of the head
    - Genae (plural); gena (singular) = cheek(s)
- The appendages on the Head are:
    - Anntennae
    - The mouthparts

- The Thorax is divided into 3 parts:
    - Prothorax
    - Mesothorax
    - Metathorax
- The Abdomen has few distinguishing characteristics. The male and female genitalia are located on the abdomen.
- The Legs are divided into 5 regions
    - Coxa = the piece of the leg closest to the body
    - Trochanter
    - Femur
    - Tibia
    - Tarsus = the tip of the leg

An excellent web page with clear illustrations for learning the names of insect body parts along with detailed information about insect morphology is on the University of Minnesota's website at: http://www.entomology.umn.edu/cues/4015/morpology/

Spider Morphology

- Spiders have 8 legs and 2 body regions called a cephalothorax and abdomen.



4. **Biological Definitions**

Arthropod: a large phylum of animals, all of which have jointed legs and a body covered by hard cuticle

Exoskeleton: a skeleton on the outside of the body as in arthropods (insects, spiders, crabs); muscles are attached to the inside of the exoskeleton

Invertebrate: an animal without a backbone

Larva: the immature stage of an insect that undergoes complete metamorphosis

Metamorphosis: the transformation from immature form to adult form

Molt: to cast off the old, outgrown cuticle (the outer part of the exoskeleton) and form a new one; this is the way insects and spiders increase in size

Nymph: the immature stage of an insect that undergoes gradual metamorphosis

Pupa: the resting stage between the larval and adult stages in insects that undergo complete metamorphosis; the pupa does not eat and usually does not move, although mosquito pupae can move to transport themselves through the water

Vertebrate: an animal with a backbone

IV. The Integrated Pest Management Concept

1. **What Is Integrated Pest Management?**

Definition of Integrated Pest Management

The following is the EcoWise Certified Program definition of IPM:

IPM is a science-based strategy and decision-making process that provides effective, long-term pest control while emphasizing pest prevention and the use of non-chemical pest management practices. At its core, IPM includes the following activities:

- Inspection, monitoring and record-keeping are used to determine if thresholds for acceptable pest levels have been exceeded and to select the location, timing, and type of management strategies needed to successfully manage pests.
- A partnership is formed with the customer to facilitate management of pests.
- Appropriate and site-specific treatments are selected from educational, cultural, manual, mechanical, physical, biological, and chemical strategies. They are used within an integrated program to achieve long-term solutions that minimize hazards to human health and the environment.
- Reduced-risk chemical controls are included in the treatment program when non-chemical methods are insufficient to solve the pest problem in an effective and affordable manner.

Compare/contrast traditional pest control with IPM

- Pest control has traditionally involved a one-dimensional emphasis on pesticides.
- IPM uses as many different strategies to control the pest as are possible and practical.
- IPM is a decision-making process that helps you decide if and when you should apply a pesticide, or any other form of treatment.
- Pest control has traditionally relied on the reactive strategy of using a pesticide to solve a pest problem, whereas IPM tries to determine the complex causes of the problem and remedy that to prevent future infestations.

- IPM uses tolerance and action thresholds as a guide to decide whether or not to take action against a pest.
- IPM involves monitoring and evaluating the success of the treatment to fine tune or correct the process, something that has not traditionally been a part of pest control.

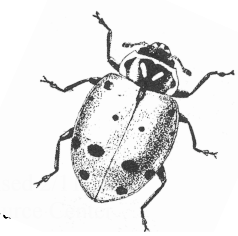
<u>Major categories of control strategies in IPM</u>

The categories of cultural, physical, biological and chemical control were adopted from agriculture when we began to think about applying IPM to structural pests. Habitat modification has been added for structural IPM, and is sometimes included under physical controls, but here we present it as a separate category. Pest prevention is also included as a separate category sometimes. These categories do not work as well for structural IPM as they do for IPM in agriculture or the landscape. This is especially true for cultural control, which in agriculture and landscaping refers to how plants are selected, planted, and maintained.

These categories are not meant to be precise and they can overlap. Sometimes it may be hard to decide where a particular tactic fits. However, the point is not to stick tactics in categories. These categories are just a way to organize your thoughts and help you keep in mind the many different ways there are to manage a pest.

- Habitat modification—reduction or elimination of food, water, and shelter/hiding places and alterations in the environment to reduce or eliminate conducive conditions. Examples include:
    - Eliminating clutter to reduce habitat for roaches and rats and using proper sanitation and food storage to reduce pest access to food
    - Structural design changes to eliminate or change the angle of surfaces where pigeons like to roost or loaf
    - Altering air flow to eliminate fly activity
    - Altering environmental conditions such as temperature and humidity to control pantry and museum pests
- Cultural control—modification of the activities of building occupants, groundskeepers, or custodians to eliminate or reduce conducive conditions and access to food. Examples include:
    - Emptying garbage or tying a knot in plastic liners at the end of the day, rather than allowing garbage to remain accessible overnight
    - Restricting human and pet food consumption to certain areas
    - Changing irrigation practices to prevent excessive moisture next to a structure or to prevent continual wetting of the structure
    - Removing plants near structures that are harboring honeydew producing insects, or not planting them there in the first place
- Physical/mechanical control—controlling pests with barriers, traps, physical removal; this includes pest proofing and exclusion
- Biological control—using parasites, predators, and pathogens to control pests

    Biological control has been used very successfully for insect control in agriculture and for weed control on rangeland.



Biological control is occurring outside, unnoticed everyday, but it has had limited success in structural pest management. However, one successful application is using tiny wasps to parasitize the eggs of cockroaches. Also, by selecting treatment methods that are the least disruptive to beneficial insects outdoors near a structure will help suppress honeydew-producing insects that attract ants and yellowjackets.

- Chemical controls—using pesticides to kill pests
  A pesticide is any substance that kills a pest (this includes herbicides). Note that IPM does not prohibit chemical controls, but they are used judiciously, only where and when they are needed and are selected to be least disruptive to the environment and least hazardous to people and pets.

The Relationship between Pest Population Levels and Damage

Because people are involved in structural IPM, the relationship between damage and pest population level is not always straightforward. The presence of a very few pests may equate to a high level of damage for an entomophobic (fearful of insects) customer. Conversely, a cat lover may not perceive large numbers of feral cats as a problem.

Knowing when the damage occurred is also important. Just because you see evidence of rats or termites does not mean there is a current infestation.

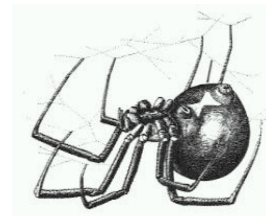
Injury and Action Level

It is important to understand that in urban IPM, these levels are very much dependent on the kind of pest, the customer, and the site or situation you are dealing with. Often the tolerance level is 0. In agriculture and in the landscape, plants and the people cultivating those plants can often withstand considerable numbers of pests without suffering. In agriculture, many injury and action levels have been well researched, but this is not true in urban IPM, and may not even be possible.

Injury level (or tolerance level/tolerance threshold) is the number of pests or amount of pest-related damage that can be tolerated without suffering an unacceptable level of aesthetic, economic, or medical loss.
Action level is the number of pests or amount of damage that triggers an action to control the problem.

- Determine the injury level first
  Before you can determine the action level, you must determine the injury level because you want to take action before the injury level is reached.
- The 3 types of injury levels
  - Aesthetic injury is the nuisance or fear factor of a pest that otherwise causes no health or economic damage. In urban settings this is probably the most common type of “injury”.
  - Economic injury refers to pest damage that causes monetary loss.
  - Medical injury refers to human and/or public health problems caused by pests such as rats, flies, yellowjackets, and mosquitoes.
- Determine action levels based on injury levels
  The number of pests that trigger action should be below the level that causes injury so you can catch the problem early and avoid reaching the injury level.

- The following are some of the factors that might affect aesthetic/nuisance injury levels:
    - The pest species and its appearance and/or the damage it causes
    - The customer and their personal preferences
    - Individual pest tolerance
    - The specific urban environment
    - The type of business
    - The type of structure
    - The specific area within the structure



Monitoring Techniques:

- Explain the importance of a thorough site inspection
- List the information that should be recorded on a site inspection
- Explain the importance of a written IPM plan for the site
- Differentiate between site inspection and monitoring and explain the importance of monitoring in an IPM approach
- List the main objectives for monitoring in a pest management program
- Explain the importance of recordkeeping in an IPM approach
- List the information that should be recorded when monitoring a site after the initial inspection

2. Treatment Strategies in IPM

- Explain why integrating a number of treatment strategies into a comprehensive IPM program can be more effective than relying on a single treatment
- Define and describe the principles behind the following non-chemical IPM tactics:
    - Sanitation
    - Exclusion or pest proofing
    - Denial/removal of harborage
    - Environmental manipulation
    - Trapping
    - Monitoring
    - Vacuuming
- List factors of the physical environment that impact pest populations
- Describe prevention methods for each pest listed with an asterisk on pages 6 & 7
- Biological control
    - Understand that biological control has, to date, had limited application in structural IPM, but is used extensively in agricultural IPM and is a natural phenomenon occurring outside every day
    - Define: natural enemies, parasitoid, predator
    - Understand the importance of conserving or enhancing the activities of beneficial arthropods, especially those that feed on honeydew producing insects

        - Describe how the following practices can be used to conserve or enhance the activities of beneficial insects (bees and insect natural enemies):
            - Selection of pesticide
            - Timing of application of pesticide
            - Placement of pesticides
            - Ant control
- Mechanical and Physical control
    - Explain the appropriate uses and advantages and disadvantages of the following traps for rats and mice:
        - Snap traps
        - Glue boards
        - Live traps
    - Describe the uses of a vacuum in pest management
    - Describe the uses of barriers in managing pests
- Chemical control
    - Understand that in IPM, chemical controls are applied
        - Only after visual inspection or monitoring devices indicate the presence of pests in that specific area, the pest numbers have exceeded the action threshold, and adequate control cannot be achieved with non-chemical methods within a reasonable time and for a reasonable cost; and
        - With the most precise application technique, in the smallest area, and using the minimum quantity of pesticide necessary to achieve control.
    - Understand that regular, calendar scheduled perimeter treatments are not a part of IPM
    - List the information you may need when making a pesticide recommendation that may not be found on the label.
- Describe how the following can help reduce your potential liability: using IPM strategies, the pesticide label; the MSDS, back-up documentation; knowledge of hazards around the property; local regulations and restrictions; state and federal regulations

V. Pesticides and Water Quality

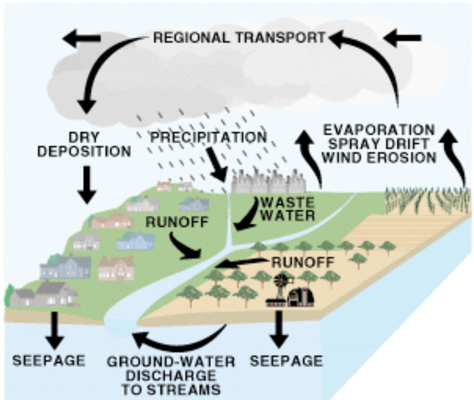
Introduction

Pesticides are potentially harmful to humans and other living organisms, and these chemicals have been found to contribute to toxicity in our water environment. Streams and reservoirs supply approximately 50 percent of the nation's drinking water, primarily in urban areas. Streams, reservoirs, lakes, and downstream estuaries are also vital aquatic ecosystems that provide important environmental and economic benefits.

Low levels of pesticides have been widespread in the nation's surface waters for several decades. Surface waters are particularly vulnerable to pesticide contamination because runoff from most of the agricultural and urban areas where pesticides are applied drains into streams.

Pesticides may also enter streams through wastewater discharges, atmospheric deposition, spills, and ground water inflow.

It is particularly important to understand the extent and significance of pesticides in this component of the hydrologic system because of the uses and ecological significance of surface water, combined with its vulnerability to contamination.



Text and Illustrations from: http://www.centralsan.org/education/ipm/intro.html#attention and from http://ca.water.usgs.gov/pnsp/rep/fs97039

1. The effects of pesticides on humans and on other creatures and the environment can be completely different. Substances that are relatively non-toxic to humans can be quite toxic to aquatic organisms.

Aquatic toxicology is the study of the effects of environmental contaminants on aquatic organisms, such as the effect of pesticides on the health of fish or the creatures they feed on. A pesticide's capacity to harm fish and aquatic animals is largely a function of its (1) toxicity, (2) exposure time, (3) dose rate, and (4) persistence in the environment.

Toxicity of the pesticide refers to how poisonous it is. Some pesticides are extremely toxic, whereas others are relatively nontoxic. Exposure refers to the length of time the animal is in contact with the pesticide. A brief exposure to some chemicals may have little effect on fish, whereas longer exposure may cause harm.

The dose rate refers to the quantity of pesticide to which an animal is subjected (orally, dermally, or through inhalation). A small dose of a more toxic chemical may be more damaging than a large dose of a less toxic chemical. Dosages can be measured as the weight of toxicant per unit of body weight (commonly expressed as milligrams of pesticide/kilograms of body weight), or as the concentration of toxicant in the water or food supply (usually expressed as parts per million, ppm or parts per billion, ppb).

A lethal dose is the amount of pesticide necessary to cause death. Because not all animals of a species die at the same dose (some are more tolerant than others), a standard toxicity dose measurement, called an LD_{50}, which stands for lethal dose, 50%, is used. This is the dose at which 50% of a test population of animals die. The higher the LD_{50}, the less toxic the chemical. LC_{50}, or lethal concentration 50%, is usually used for aquatic animals. This is the concentration of a pesticide that kills 50% of the test animals within a set period of time, usually 24 to 96 hours.

Exposure of fish and other aquatic animals to a pesticide also depends on its biological availability (bioavailablility), bioconcentration, biomagnification, and persistence in the environment.

Bioavailability refers to the amount of pesticide in the environment available to fish and other wildlife. Some pesticides rapidly breakdown after application. Some bind tightly to soil particles suspended in the water column or in stream bottoms, thereby reducing the availability. Some are quickly diluted in water or rapidly volatize into the air and are less available to aquatic life.

Bioconcentration is the accumulation of pesticides in animal tissue at levels greater than those in the water or soil to which they were applied. Some fish may concentrate certain pesticides in their body tissues and organs (especially fats) at levels 10 million times greater than in the water.

Biomagnification is the accumulation of pesticides at each successive level of the food chain. Some pesticides bioaccumulate (buildup) in the food chain. For example, if a pesticide is present in small amounts in water, it can be absorbed by water plants, which are, in turn, eaten by insects and minnows. These also become contaminated. At each step in the food chain the concentration of pesticide increases. When sport fish such as bass or trout repeatedly consume contaminated animals, they bioconcentrate high levels in their body fat. Fish can pass these poisons on to humans.

From: http://www.ext.vt.edu/pubs/waterquality/420-013/420-013.html#L4

2. Testing in streams around the country and in California have consistently found pesticides in water, sediment, or both and frequently in amounts toxic to aquatic life.

A study by the National Water Quality Assessment (NAWQA) Program of the United States Geologic Survey (USGS) has provided the most comprehensive information so far about pesticide contamination in US streams and groundwater. Drawing on data collected at 178 sampling sites nationwide from 1992-2001, the study concluded that more than 97% of the streams sampled contained at least one pesticide. Concentrations were seldom high enough to be a threat to human health, but more than half (56%) of streams with substantial agricultural or urban areas in their watersheds had concentrations high enough to potentially affect aquatic life or fish eating wildlife. The figure jumps to 83% when only urban streams are included in the analysis. The type of pesticides detected most frequently in streams and ground water were among those used most heavily during the study or in the past.

While the NAWQA Program states that pesticides may have effects on aquatic life, further testing in California has eliminated any uncertainty. Of the 992 tests of streams and other water bodies in California, 473 (48%) had at least one sample in which toxicity to the test species was measured in either water or sediment. Of these, 129 (13%) were classified as high toxicity sites.

Dozens of studies have identified the causes of toxicity in water and sediment samples from California sites from 1991 to the present. All of the studies, except for one, implicated pesticides, primarily organophosphates, and more recently pyrethroids, as the cause of the toxicity. It is important to note that pesticides are implicated as causing toxicity in streams draining residential and urban areas, as well as agricultural land.

From: Pesticides in the Nation's Streams and Groundwater, 1992-2001—A Summary
http://pubs.usgs.gov/fs/2006/3028/

From: Summary of Toxicity in California Waters: 2001-2009
http://www.waterboards.ca.gov/water_issues/programs/swamp/docs/reports/tox_rpt.pdf

3. **Pyrethroids are the most commonly used pesticides in urban areas, and reported professional use of these pesticides appears to be a major cause of aquatic toxicity.**

   Pyrethroids continue to be the most commonly applied insecticides in California urban areas. The pyrethroids most heavily used in urban areas are bifenthrin, cyfluthrin, cypermethrin, deltamethrin, esfenvalerate, gamma-cyhalothrin, lambda-cyhalothrin, permethrin, and tralomethrin. They are commonly applied outdoors around buildings or on landscaping via broadcast treatments.

   Reported professional use remains the vast majority (nearly 90%) of all estimated pyrethroid use, when adjusted for toxicity. Two pyrethroids, cypermethrin and bifenthrin, accounted for almost 80% of the pyrethroids used in California urban areas in 2007/08, when adjusted for toxicity. These two pyrethroids are the two that most often appear in California creeks at levels sufficient to cause toxicity to sediment dwelling organisms.

   Pyrethroid use has declined somewhat since 2006, but increasing use of fipronil suggests that it may be starting to replace pyrethroids in the urban marketplace. Fipronil use almost doubled from 2003 to 2008. As is the case for diazinon and pyrethroids, fipronil is highly toxic to aquatic species. Almost all fipronil reported used in 2004 and 2005 was for structural pest control.

   A 2009 study of pest control operator (PCO) practices confirmed that outdoor perimeter sprays at residential addresses are the most common use pattern for pyrethroids and fipronil, the two pesticides currently of most concern to surface water quality in California. The survey found that PCOs generally power spray these pesticides in a continuous band an average of two feet high on a structure and five feet wide on the soil surface, which often includes some impervious surface such as a driveway or sidewalk. Eighty percent of applications are repeated regularly (monthly or every other month).

   Pesticides applied by do-it-yourselfers around the home also contain pesticides of concern for water quality, as shown by recent retail pesticide shelf surveys: bifenthrin, permethrin, and lamda-cyhalothrin are all readily available for purchase. Pyrethroids represented 46% of the insecticides sold over the counter.

   From: Annual Pesticide Use Report
   http://www.up3project.org/documents/UP3Use2010_Final.pdf

   From: California 2009 Urban Pesticide Use Pattern Study Presentation to UPC
   http://gallery.mailchimp.com/833eb84fe7dd41b66f23e407c/files/PyrethroidUsageSurvey2010_PW3.pdf

   From: Surveys of Pesticide Products Sold in Retail Stores in Northern and Southern California, 2010.
   http://www.cdpr.ca.gov/docs/emon/surfwtr/swanalysismemo/retail_memo_final.pdf

4. **The nature of the surface to which the pesticide is applied affects how much pesticide washes off when it rains. If all factors are equal, the amount that can wash off a solid "impervious" surface, like a sidewalk or driveway, is substantially greater than the amount that can wash off a landscaped area or farm field.**
   The porous and varied terrain of natural landscapes like forests, wetlands, and grasslands trap rainwater and snowmelt and allow it to slowly filter into the ground. Runoff tends to reach streams, rivers, lakes, and bays gradually. By moving slowly through organic matter and soil, many of the contaminants the water has picked up are filtered out or decomposed. In contrast,

nonporous urban landscapes like roads, bridges, parking lots, and buildings don't let runoff slowly percolate into the ground. Water remains above the surface, accumulates, and runs off in large amounts. An impervious surface is any surface that does not allow water to be absorbed into the ground.

From: http://www.epa.gov/owow/nps/facts/point7.htm

5. **Water quality problems can be caused by only a tiny fraction of pesticide washing off into creeks or storm drains or contaminating water that flows into sewage treatment plants.**

   For certain organisms, it may take only a tiny amount of a certain pesticide or combination of pesticides to severely impact them. For example, tiny water fleas, similar to those at the base of the food web in the Bay/Delta ecosystem, have been found to be very sensitive to minute amounts of some pesticides that remain in Central Contra Costa Sanitary District's treated wastewater that is discharged into Suisun Bay. It takes just one drop of a diazinon in the volume of two backyard swimming pools to kill this sensitive water flea.

   From: http://www.centralsan.org/education/ipm/intro.html#attention

6. **The formulation of a pesticide affects how much washes off with irrigation or rain.**

   The active ingredient in a pesticide is combined with other inert ingredients (carriers, solvents, propellants) to make the formulated pesticide product.

   Pesticides come in several physical forms or formulations that make them easy to store, transport and apply. Common formulations include water dispersable granules, wettable powders, dusts, aerosols, solid or liquid baits, granules, emulsifiable and flowable concentrates and solutions. There are other less common formulations designed to give special properties to the pesticide mixture or to take advantage of properties of active ingredients or to protect the environment. These include microcapsules, plastic beads, plastic membranes, plastic ropes, controlled release dispensers, and others.

   While most environmental hazards come from the active ingredient in a pesticide, the way its formulation interacts with the environment determines the overall hazard of a pesticide. In some cases the inert ingredients may cause concern for aquatic life. Common pesticide formulations are often designed to disperse readily in water, increasing their potential to run off and end up in our waterways.

   Spray formulations can drift with the wind or vaporize into the air. Other formulations can leach into ground water or be carried into surface water by rainfall or irrigation runoff. Even pesticides in formulations that bind to soil particles can find their way into surface waters if soil is eroded by wind or water.

   From: http://insects.tamu.edu/extension/bulletins/b-6050.html and http://www.ext.vt.edu/pubs/waterquality/420-013/420-013.html#L4

7. **The location of the application affects how much pesticide washes off.**

   Where a pesticide is applied can affect how much pesticide washes off. Considerations such as whether the surface area is impervious or not, where the area drains to, the slope of the area, and if it is near a downspout, driveway or street gutter should be considered. For example, pesticides applied outdoors to an impervious area that drains into the street will send much more pesticide contamination down into the storm drain and waterways than if it were applied to an impervious area that drains into a flowerbed where the runoff can soak into the ground.

Weather conditions may affect the amount of pesticide that moves off site. Pesticides should not be applied when rain is likely or when wind can cause drift.

8. Water that enters a storm drain untimately flows into creeks, rivers and the Bay.

Storm drains are frequently located outside along streets near curbs and gutters. Rain and runoff from garden and lawn irrigation moves off the property, into street gutters, and then on into storm drains. The runoff flows through pipes, which, in most locations in California, empty directly into our creeks, lakes, rivers and bays.

Adapted from http://www.ipm.ucdavis.edu/WATER/U/stormdrain.html

9. Water that enters a sewer also eventually flows into rivers and the Bay.

Sewer pipes run from inside drains within a home or building and carry the wastewater from sinks, toilets, showers, washing machines, etc. to wastewater treatment plants.

After the wastewater is treated, it is discharged into a river or the Bay.

Pesticides can get into sewers from application, cleanup, and washing of treated surfaces inside.

Pesticides applied in homes or other buildings can find their way down drains and into sewers from:

1. airborne particles that drift during application;
2. direct application of a pesticide around a drain;
3. cleaning up equipment at a sink or drain;
4. rags, towels or sponges used to wipe up an area that has pesticide residual that are then rinsed, or washed out, in a sink or washing machine; or
5. clothes contaminated with pesticides washed in a washing machine or sink.

Adapted from http://www.ipm.ucdavis.edu/WATER/U/stormdrain.html

10. Sewage treatment plants are not designed to treat pesticides.

Sewage treatment plants do not detoxify pesticides. Even though wastewater treatment plants send the incoming wastewater through a thorough treatment and disinfection process before releasing water into a river or the Bay, the process does not actually filter out, or detoxify, pesticides. Thus, pesticides in wastewater can enter our waterways.

Adapted from http://www.ipm.ucdavis.edu/WATER/U/stormdrain.html

11. How to find out if a pesticide is a concern for water quality.

A listing of pesticides that are of water quality concern can be found at the Urban Pesticide Pollution Prevention Project at http://www.up3project.org/.

A number of agencies are involved in pesticide regulation and water quality:

California Department of Pesticide Regulation

California State Water Resources Control Board

U.S. Environmental Protection Agency Water Programs

12. Water quality problems caused by pesticides.

When pesticides and other toxic substances enter lakes, streams, rivers, oceans, and other water bodies, they are dissolved or lie suspended in water, or deposited in sediment on the stream or lake bed. This results in pollution of the water and the deterioration of the water quality, which affects aquatic ecosystems. Pollutants can also seep down and affect groundwater aquifers.

The effects of water pollution can not only be devastating to people, but also to animals, fish, and birds. Polluted water is unsuitable for drinking, recreation, agriculture, and industry. It diminishes the aesthetic quality of lakes and rivers. Also, contaminated water destroys aquatic life and reduces its reproductive ability. Eventually, it may be a hazard to human health.

From: http://edugreen.teri.res.in/explore/water/pollu.htm

13. Gaps in EPA and state regulatory procedures allow pesticides to be registered that can cause water quality problems.

The U.S. Environmental Protection Agency (EPA) Office of Pesticide Programs and the California Department of Pesticide Regulation are the primary agencies that regulate pesticides.

Their pesticide regulations, however, do not ensure compliance with water quality laws and regulations overseen by the U.S. EPA Office of Water and the State and Regional Water Quality Control Boards.

The separation of these regulatory programs among different agencies has resulted in regulatory gaps that have allowed the impairment of many California urban creeks.

Municipalities are caught in the middle because they are responsible for pesticide discharges through their Regional Municipal Storm Water Permits (and liable for very large fines and other expensive regulatory action), but federal and state laws withhold authority from local governments to regulate pesticide sales or use.

From: http://www.krisweb.com/biblio/sfbay_scrwqcb_tmdl_diazinon_sum.htm

14. Court Ordered Buffers around Pacific Salmon-Supporting Waters

Most counties on the West Coast, including those in California, support threatened and endangered salmon or steelhead habitat. Pesticide use buffer zones have been ordered by the court to help protect these endangered species. If you plan to use any of the pesticides subject to the court order (see list below) in these counties, special buffer zones may be required.

Background

A citizen suit was filed under the Endangered Species Act against EPA. In response, the United States District Court for the Western District of Washington, on January 22, 2004, **issued an order that establishes pesticide buffer zones adjacent to streams, rivers, lakes, estuaries and other water bodies** (this court order applies to most counties in California, Washington and Oregon). The court ordered certain pesticides not be used in these buffer zones. Generally, the **buffer zones are 20 yards for ground application and 100 yards for aerial application** and the restrictions apply to any product containing one or more of the pesticides subject to the court order.

Pesticides Subject to the Court Order

1,3-dichloropropene	diflubenzuron	methyl parathion
2,4-D	dimethoate	metolachlor
azinphos-methyl	disulfoton	Metribuzin
bensulide	diuron - crop	naled
bromoxynil	diuron - non-crop	oxyflourfen
captan	ethoprop	pendimethalin
carbaryl	fenamiphos	phorate
carbofuran	fenbutatin oxide	prometryn
chlorothalonil	lindane	propargite
chlorpyrifos	malathion	tebuthiuron
coumaphos	methidathion	triclopyr BEE
diazinon	methomyl	trifluralin

Uses Where Buffer Zones Do Not Apply

No buffers apply for the following uses of any of the pesticides subject to the order:

- Use in a public health vector control program administered by a public entity
- Use to manufacture an end-use pesticide product
- Use in flea or tick collars for dogs or cats
- Indoor uses
- Use by tree injection
- Homeowner applications to household potted plants

Uses Where a One Yard Buffer Zone Applies

A one yard buffer applies for the following uses of any of the pesticides subject to the order:

- Localized spot treatments using hand-held, ready-to-use devices, as long as the area treated is limited to 10 percent of the treated right-of-way, roadside, pasture, lawn or forestry site
- Insect bait stations
- Spot treatments of wasp and hornet nests, as long as the area treated is limited to 10 percent of the treated right-of-way, roadside, pasture, lawn or forestry site
- Individual tree removal using cut stump applications
- Basal bark applications to individual plants

For additional information and to keep updated, go to: http://www.epa.gov/espp/litstatus/wtc/maps.htm

IPM Resources and Study Materials

Web Sites

IPM Institute
http://www.ipminstitute.org/school_biblio_buildings.htm
This web page lists useful articles about specific pests, and many of the articles are available online.

California Department of Pesticide Regulation School IPM Page
http://www.schoolipm.info/
This section of the DPR web site contains a wealth of information about school IPM.

University of California Statewide IPM Project
http://www.ipm.ucdavis.edu/
U.C. Pest Notes for pests of homes, structures, people and pets. A great resource for identification (there is a wonderful ant key), biology, and management.

University of California at Riverside Entomology Department
http://entmuseum.ucr.edu/bugfaq.html
On this page you will find short descriptions of lesser-known pests with links to sites with more information.

UC Riverside wasp pages
http://wasps.ucr.edu/waspid.html
This information is for Southern California, but the same species occur in the Bay Area.

UC Riverside spider pages
http://spiders.ucr.edu/index.html
This site debunks the myth of the brown recluse, as well as some other spider myths.

University of Florida Entomology Department
http://entnemdept.ufl.edu/creatures/
This site has many creatures that are of greater interest to Floridians than Californians, but many of the urban pests are the same. This site also includes identification, biology, and some management.

Bed Bug Central
http://www.bedbugcentral.com/
Although this is a commercial site, it has excellent information on bed bug biology, inspection, control, and research.

University of Florida School IPM
http://schoolipm.ifas.ufl.edu/
Useful information on school IPM.

Marin County Department of Agriculture Model School IPM Program
http://www.co.marin.ca.us/schoolIPM/schoolipmprogram.cfm
This site has fact sheets to help educate school staff, teachers and parents.

Correspondence and On Line Courses

Purdue University Correspondence Course
http://www.entm.purdue.edu/entomology/urban/Urban_Info/courses.html

Here you will find information on Purdue's IPM correspondence courses.

University of Minnesota IPM Education
http://www.cce.umn.edu/Integrated-Pest-Management-Education/index.html

There are a number of courses to choose from that are made available at certain times of the year. Fees are collected to view these courses.

Books and Manuals

Bennet, G., J. Owens, and R. Corrigan [eds.]. 1997.*Truman's Scientific Guide to Pest Management Operations*. 6th ed. Advanstar Publications, Cleveland, OH.

Doggett, S. 2010. Code of Practice for the Control of Bed Bug Infestations in Australia. University of Sydney Department of Medical Entomology.
http://medent.usyd.edu.au/bedbug/bedbug_cop.htm

Although this is written for Australia, it is an excellent set of best management practices that Dr. Doggett updates periodically; probably more useful in practice than the recently released BMPs from the National Pest Management Asssociation.

Gold, R. E., and S. C. Jones [eds.]. 2000. *Handbook of Household and Structural Insect Pests*. Entomological Society of America, Lanham, MD.

Hedges, S. A. 1996. *Field Guide for the Management of Structure Infesting Flies* G.I.E. Publishing, Cleveland, OH.

Hedges, S. A. 1998. *Field Guide for the Management of Structure-infesting Ants*. G.I.E. Publishing, Cleveland, OH.

Hedges, S. A., and M. S. Lacey. 1996. *Field Guide for the Management of Structure-infesting Beetles*. Vols. I (Hide and carpet beetles/ wood-boring beetles) and II (Stored product beetles/occasional and overwintering beetles). G.I.E. Publishing, Cleveland, OH.

Kramer, R. 1998. *PCT Technician's Handbook*. G.I.E. Publishing, Cleveland, OH.

Mallis, A. 2004. *Handbook of Pest Control*, 9th edition. Pest Control Technology, Cleveland, OH.

O'Connor-Marer, Patrick J., M.L. Flint, M.K. Rust. 2006. *Residential, Industrial, and Institutional Pest Control.* 2nd. Edition. U.C. Statewide Integrated Pest Management Program. ANR Publication #3334. University of California Agriculture and Natural Resources Publications, Oakland, CA 1-800-944-8849

Pinto, L. J., R. J., Cooper, and S. K. Kraft, 2007. The Bed Bug Handbook. Pinto and Associates.
http://www.bedbugcentral.com/shop/products.cfm/bed-bug-handbook

Smith, Eric H. and Richard C. Whitman. 1992. *NPMA Field Guide to Structural Pests*. Published by the National Pest Management Association

Integrated Pest Management for Schools: A How-To Manual (written by BIRC staff)
Find the full text at http://www.epa.gov/pesticides/ipm/schoolipm/index.html. Hard copies are available from BIRC (see below).

Bio-Integral Resource Center (BIRC) publications
For a list of publications on pest management available from BIRC, go to http://www.birc.org or call 510-524-2567.

Example IPM Protocol for the Argentine Ant (*Linepithema humile*)

Note: This Argentine ant protocol was prepared by BIRC with input from two pest control companies. This is an example and not meant to be exhaustive. Other techniques and other pesticides that pass the EcoWise Screening Criteria may work just as well or better. The protocol is written as if it were being used by a "typical" EcoWise Certified company for a commercial account.

1. **Establish a partnership with the customer.** It is important for the success of our IPM service to establish a partnership with the customer (to the extent feasible—each customer will vary).
   a. Determine who your customer contact will be; record their name and phone number
   b. Determine who the decision-maker at the site will be; record their name and phone number
   c. At the appropriate time, advise the customer of their responsibilities:
      - Keeping dumpsters and areas around them clean, locating dumpsters away from the building, and making sure they are emptied at least once a week
      - Keeping inside trash receptacles clean, lined with plastic and emptied nightly—no trash left overnight without the bag knotted
      - Maintaining adequate sanitation in the building
      - Informing building occupants that all food in workspaces must either be in a refrigerator or sealed in an ant-proof container (screw top jar with rubber on the lid or plastic container with tight-fitting lid, such as Tupperware)
      - Distributing our company's Argentine Ant Fact Sheet to appropriate building occupants; distributing our Sanitation and Pest Management Fact Sheet to appropriate building staff/contractors
      - Refraining from spraying aerosol pesticides near or on bait stations that we set up
      - Following through on recommendations made by our company
   d. Determine with the decision-maker which pest management recommendations will be the responsibility of the customer and which will be the responsibility of our company.
   e. Suggest periodic meetings (by phone or in person) with the decision-maker to review pest management progress and any issues
   f. If the ant problem is very serious because of customer non-cooperation, suggest a short customer training/education session for an extra fee

2. **Record a detailed history about the problem.**
   Some of the following questions are appropriate for asking on the phone before you visit the site. Others can be asked on the phone or in person.
   a. Where is the site/structure?
   b. Type of building?
   c. Where do they see ants?
   d. How long have they had the problem?
   e. Have changes occurred that might relate to the ants being a problem now (e.g. potted plants brought inside, construction activity disturbing soil)?
   f. Have they or someone else treated the problem? How or with what?
   g. Are there children at the site? (crumbs, food in places other than kitchen) Pets? (dog food, cat food left out, people may be feeding feral cats)
   h. Do they have ants all year? If not, when do they see them?

3. **Biology of the pest.** This section contains important biological information related to effective ant management.

Argentine Ant Colonies

- Colonies are linked by tunnels; workers and queens move freely from nest to nest; each colony has many queens that live in harmony. Perhaps it is more accurate to think of Argentine ants as living in huge colonies with 1000's of entrances.
- Because of these huge "supercolonies," the concept of finding and killing "the" nest is not always valid.
- The energy that most other ant species use in defending the colony is used instead for reproduction.

Feeding Behavior

- Worker ants (all females) feed and care for the young, but also feed each other and the queens (called **trophallaxis**); this is the way baits are spread throughout a colony
- On average at any one time, a very small proportion of a colony is out foraging, so killing these ants will not eliminate the colony.
- These ants feed on just about anything from dead animals (including insects) to all kinds of human and pet food, to vomit, feces, and even human sputum.
- A favorite food is the honeydew produced by insects like aphids, mealybugs, scales, and whiteflies. Argentine ants protect these insects from their natural enemies.
    - Plants that harbor these pests and are growing near a structure will attract ants to the building.
    - If ants are excluded from plants with honeydew-producing insects, natural enemies will often eliminate the plant pests
- Liquid baits with sugar as the attractant are useful throughout the year, because adult ants will always feed on sugary liquids.
- Baits with a protein attractant may only be useful when the colony is expanding and ants are feeding a large number of young.

Nesting sites

- Argentine ants move their colonies within hours to take advantage of a food source or to escape inhospitable conditions. In winter they look for places that are warmer and drier, and in summer they seek cooler and moister sites.
- Their shallow nests are primarily in the ground, and they are not marked by significant soil mounds. They prefer moist, well-drained soil.

Outside, some places to find nests are

- near irrigated turf and other landscaping
- in planters and potted plants
- in the ground under trees, especially trees with honeydew producing insects,
- near faucets and irrigation valves
- under sidewalks, stones and patios
- in soil accumulated in the corners of a roof

Inside, nests can be found

- in potted plants
- inside cupboards and drawers
- under tiles on kitchen counters, behind wall tile and brick veneer
- in the insulation in dishwashers, washing machines, and refrigerators,
- in wall voids, in moist basements, and in vehicles
- in unusual places including inside metal curtain rods and inside a bathroom sink in the void that allows overflowing water to escape down the drain.

Seasonal Colony Development and Feeding Behavior

Winter (November thru January): many adults die, colony essentially stops breeding and ant population is small.

Liquid sugar baits are accepted better than other baits, and less is needed because of the low population.

Late winter/early spring: breeding increases and adult workers seek honeydew producing insects (aphids, scale) and protein to feed developing larvae.

Both solid protein and liquid sugar baits are accepted

Summer: honeydew producers decline (beginning in July/August) and ants start to look elsewhere for food, often in nearby buildings.

In early summer, solid protein baits are still accepted.
Liquid sugar baits are readily accepted all summer

Fall: the ant population has reached its maximum, honeydew food source has declined and foraging pressure results in more nearby building invasions.

Sugar baits readily accepted

4. **Thoroughly inspect the site.** Record information on inspection form.

   a. Verify the ant species.

   b. Inspect outdoors

   Begin your inspection around the perimeter of the building. If you don't find trails and entry points there, move farther out from the building.

   - Look for ant trails and follow back to a nest, if possible, and note nest site. Look along edges of foundation, paving, roof line, gutters; inspect pipes and wires near or leading into the building, inspect nearby trees and shrubs (especially if branches touch the building), hanging or potted plants, planters; inspect lumber piles, logs or other wooden elements in the landscape, inspect around garbage cans, dumpsters, recycling storage
   - Check for other obvious nests and note them. See above for nesting sites.
   - Note and record entry points where ants are currently entering structure & where ants could enter structure, such as
     - Holes where pipes, wires, conduit penetrate walls
     - Cracks, crevices, openings between window or door and sill or frame
     - Weep holes in doors or windows
     - Cracks in the foundation

- Note and record conducive conditions including lack of sanitation, plants with honeydew-producing insects or extra-floral nectaries (esp. citrus, roses, pines, birches, black acacia, bottlebrush, birches); ground covers and mulches; leaking irrigation; other areas of warmth and moisture or humidity
- Check garbage can/dumpster areas for cleanliness, tight lids and sealed bags

c. Inspect inside

- Look for ant trails and follow back to entry point, if possible. Follow into crawl space if necessary. Look along the edges of counters, cupboards, along and behind baseboards, under carpet along the tack strip (use needle-nosed pliers to pull up), along pipes and wires, in and around heating and air conditioning ducts, behind electrical switch plates, around windows and doors, around garbage and recycling storage, near food storage, in and around vending machines, in attics and basements in damp areas
- Note conducive conditions, such as improper food storage, substandard sanitation, holes, gaps to the outdoors, potted plants.

5. Discuss inspection findings with the customer and provide them with information

a. Discuss inspection results, priorities and what we will do for the customer for no additional charge and where appropriate, our price for additional work.
b. Discuss the possible outcomes of the treatment methods, how long they might take to gain control and what to expect.
c. Discuss the emphasis of IPM while judging customer interest level (e.g., long term solutions, using knowledge of pest biology, monitoring, trapping, baiting, pest exclusion, all of which lead to effective pest control and minimal pesticide use).
d. For customers not on a bimonthly schedule, emphasize the importance of being on a scheduled service so baiting can begin early in the year and help prevent infestations in the future.
d. Provide written information to reinforce and supplement verbal discussion. At minimum, this should include a copy of the inspection report and IPM site plan.
e. Discuss the customer's role such as keeping things clean, not using sprays, etc.; provide them with our Ant Fact Sheet and our Sanitation and Pest Management Fact Sheet
f. Discuss pest tolerance levels and action levels that trigger treatment, and if applicable, the advantages of higher tolerance level but be careful about being too persistent on this subject.
g. Mention that substantial control can be achieved for ants outside but we can't guarantee ants will never again come into the structure.

6. Develop a written site-specific IPM plan

This is the written plan for how to manage the target pest at the particular site. Use our IPM Site Plan & Treatment Record Form. IPM strives for prevention and long-term solutions with the lowest risk to people, pets, and the environment. Integrating a number of the treatments options below will result in better control than using a single treatment. Specific options chosen will depend on the time of year, customer needs, and the situation at the site.

Treatment Options Outdoors

To limit availability of food

- Treat honeydew-producing insects on vegetation near the structure by washing with plain water or with insecticidal soap and water
- Use sticky barriers around trunks to exclude ants; be sure to trim branches that touch the building, the ground, other plants or structures to prevent ants from finding an alternative route into the plant
- Remove plants that regularly have large populations of honeydew-producing insects

BIRC Note: a DPR license may be necessary for some of the above work

To limit availability of shelter/habitat

- Reduce excessive moisture and irrigation leaks near structures
- Reduce areas outside covered with black plastic and decorative rock
- Cut back or eliminate ground covers next to the structure, especially to have access to the foundation.

To limit access to the structure (pest-proofing)

- Trim trees and bushes touching structure
- Caulk or otherwise seal accessible areas where ants are getting in or have been seen getting in

To directly suppress the pest by removal or killing

Use direct suppression alongside the preceding treatment options, not as a stand-alone treatment.

Baiting (For more information, see attached Notes on Baiting for Argentine Ants)

Winter (November thru January)

- Liquid sugar baits, such as Gourmet Ant Bait Liquid (borate), Terro Ant Killer II (borate)—use outside in bait station
- Maxforce FC Professional Ant Bait Gel (fipronil)—use outside in cracks and crevices

  Place in locations where ants are present or near where they are entering structure (out of sight).

Late winter/early spring

- Liquid sugar baits, such as Gourmet Ant Bait Liquid (borate), Terro Ant Killer II (borate)—use outside in bait station
- Protein baits such as Maxforce Professional Insect Control Granular Insect Bait, Niban FG

Early Summer

- Liquid sugar baits, such as Gourmet Ant Bait Liquid (borate), Terro Ant Killer II (borate)—use outside in bait station
- Protein baits such as Maxforce Professional Insect Control Granular Insect Bait, Niban FG

Late Summer and Fall

- Liquid sugar baits, such as Gourmet Ant Bait Liquid (borate), Terro Ant Killer II (borate)—use outside in bait station

Other Baiting Considerations

To attract ants outside of the house use MaxForce Ant Killer gel with fipronil or Gourmet Ant Bait Liquid with borate.

A 5% concentration of borate will kill ants quickly, usually before they get back to the nest, and is useful for getting rid of ants inside. Little if any borate will make it back to the nest so a high concentration (5%) of borate will have little effect on the ant colony. A lower concentration of borate (0.5% to 2%) can kill an entire colony, but may take several weeks.

To make a bait solution with a 1% concentration of borate from a 5% concentration, dilute one part ant bait with four parts sugar water (1 cup sugar in a quart of water will make a 25% sugar solution, the ideal for Argentine ants). Add a small amount of disodium benzoate food preservative for a 1% concentration to help prevent mold growth. Use either a PFT station (Rockwell Labs) or the KM AntPro station.

Spot treat trails and nests with a mixture of sodium lauryl sulfate and water; sodium lauryl sulfate and diatomaceous earth; rosemary oil

<u>Record actions taken, location of bait stations or bait placement, amount and kind of material used.</u>

Treatment Options Inside

To limit availability of food

- Remove and clean up food sources
- Discuss importance of sanitation with appropriate people
- Discuss importance of not feeding feral cats

To limit availability of shelter/habitat

- Look for attractive habitat—warmth and moisture—and discuss remedies with customer
- Discuss with customer about removing potted plants with nests
- Suggest using an Antser® (platform with soapy water moat underneath) to prevent ants from reaching potted plants, pet food, garbage
- Suggest placing potted plants in a dish of water with a drop of detergent as another option

To limit access to the structure (pest-proofing)

- Caulk or otherwise seal entry points that ants are currently using or are nearby
- Blow diatomaceous earth into cracks and wall voids

To directly suppress the pest by removal or killing

- Clean up ant trails with soap and water
- Vacuum up ant trails, or use a lint roller to pick them up
- Use baits temporarily to eliminate ant trails inside; remove after trails are gone

In general, it is preferable to bait ants outside because baiting inside can exacerbate the problem by drawing more ants into the structure; however, at various times, it may be necessary to bait inside briefly to eliminate trailing ants.

Record actions taken. Note locations of any bait stations.

7. **Evaluate and monitor the success of the treatment(s) for this pest and the satisfaction of the customer**

   Return in 7 to 10 days
   - Remove inside bait stations if ant trails have been eliminated
   - Check bait stations outside to ensure that bait is being accepted
   - Change bait if necessary
   - Refill bait stations outside, if necessary
   - Bait stations can be moved away from building toward fence/property line
   - Check for ants trailing into building; seal entry points.
   - Check on the progress of customer responsibilities to limit access, food, and habitat.

   Return in 7 to 10 days to check again, if necessary.

Sources:

Agurto, Luis Sr., Luis Agurto, Jr. & Carlos Agurto. 2005. Pestec IPM Provider, San Francisco, CA. Personal communication

Klotz, John. 2005. U.C. Riverside. Riverside, CA. Personnal communication.

Klotz, J., M. Rust & A. Soeprono. Why delay when you bait & spray? *Pest Control*. April 2004, pp 33-34.

Klotz, J., M. Rust, C. Amrhein & R. Krieger. In Search of the 'Sweet Spot'. *Pest Control*. September 2004, pp 49-51.

Reierson, D., M. Rust & J. Klotz. There's Safety in Numbers. *Pest Control*. March 2001, pp 50-52.

Slater, Arthur. 2006. Slater Pest Control. Sebastopol, CA. Personal communication.

Soeprono, A., M. Rust. Strategies for Controlling Argentine Ants (Hymenoptera: Formicidae). *Sociobiology*. 2004. Vol. 44, No. 3, pp 669-682.