UTAH STATE UNIVERSITY EXTENSION

CATEGORY 7

Structural and Health-Related Pesticide Safety Study Guide

EXTENSION
UtahStateUniversity

UDAF

Contents

CHAPTER 1
INTRODUCTION

Forward 1
Introduction 1

CHAPTER 2
LAWS AND REGULATION

Learning Objectives 5
Federal Laws 5
Emergency Exemptions (Fifra, Section 18) 7
Special Local Need 24(C) Registration 8
State Laws 8
Maintain Pesticide Application Records for Two Years 11

CHAPTER 3
PESTICIDES IN THE ENVIRONMENT

Learning Objectives 13
Where Do Pesticides Go? 13
Pesticide Characteristics 15
Pesticide Accumulation In Animals 17
Groundwater 18
Surface Water 18

CHAPTER 4
INTEGRATED PEST MANAGEMENT

Learning Objectives 21
A Systematic Approach 21
Pest Identification 22
Pest Life Cycles 22
Site Inspection And Monitoring 22
Action Thresholds 23
Pesticide Use 24

CHAPTER 5
UNDERSTANDING ARTHROPOD PESTS

Learning Objectives 27
Introduction 27
Anthropod Pest Biology 28
Damage Caused By Arthropods 30

CHAPTER 6
COCKROACHES

Learning Objectives 31
General Biology 31
Major Cockroach Species In Utah 33
Cockroach Management 35

CHAPTER 7
ANTS

Learning Objectives 41
General Biology 41
The Ant Colony 42
Major Ant Pests 43
Ant Management 44
Special Management Considerations 47

CHAPTER 8
NUISANCE FLIES

Learning Objectives 49
General Biology 49
Fly Management 50

CHAPTER 9
STORED PRODUCT PESTS

Learning Objectives 53
Food Pantry Pests 53
Fabric Pests 54
Paper Pests 54
Managing Stored Product Pests 54

CHAPTER 10
ACCIDENTAL INVADERS

Learning Objectives 57
Overview 57
Managing Accidental Invaders 58

CHAPTER 11
BLOOD-FEEDING PESTS

Learning Objectives 61
Overview 61
Ticks 62
Tick Management 62
Fleas 63
Flea Management 64
Bed Bugs 66
Bed Bug Management 67
Lice 69
Human Lice Management 70
Mosquitoes 70
Mosquito Management 70

CHAPTER 12
STINGING PESTS

Forward 73
Bees 73
Wasps 75
Managing Stinging Pests 79

CHAPTER 13
SPIDERS

Learning Objectives 81
Overview 81
Poisonous Species 82
Spider Management 84

CHAPTER 14
RODENTS

Learning Objectives 85
Overview 86
Major Rodent Pests 86
Capabilities 88
Senses 88
Abilities 89
Behavior 90
Signs of Infestation 91
Managing Rodents 94
Secondary Hazards of Rodenticides 103

CHAPTER 15
OTHER VERTEBRATE PESTS

Learning Objectives 105
Overview 105
Birds 106
Bats 109
Tree Squirrels 111
Snakes 112
Skunks 112
Raccoons 113
Opossums 114
Managing Skunks,
Raccoons,and Opossums 114

Preface

This Category 7: Structural and Health-Related Pesticide Safety Study Guide is designed for individuals preparing to take the Utah commercial and non-commercial Category 7: Structural and Health-Related exam.

For more information regarding certification and licensing of pesticide applicators in Utah, see the Utah Department of Agriculture and Food website.

This edition of the Category 7 Study Guide is a major rewrite of the previous manual. It represents a close cooperation with leaders in the green industries of Utah, Utah State University (USU) Extension, and the Utah Department of Agriculture and Food (UDAF), as well as with the Pesticide Safety Education Program (PSEP) from other states. This cooperative effort expands our access to a broader array of expertise and resources.

This project is facilitated by the PSEP, part of the Utah State University Extension. USU PSEP neither endorses nor opposes the use of pesticides. USU PSEP's two primary goals include helping pest managers (1) determine when to use a pesticide, and (2) develop knowledge and skills to handle pesticides legally, safely, and responsibly.

Discard the old study guide materials for this category and off them for paper recycling. We plan to revise and update this study guide in future years. Feedback from manual users is the most valuable source of information for improving the manual as a training, education, and reference tool. We welcome comments from users of this manual, both what you have found useful and suggestions for improvement. Send comments about this manual to:

Michael R. Wierda Ph.D.

Utah State University, Extension Assistant Professor, Pesticide Safety Education Program Director

Davis County Extension, 80 E. 725 S. Sego Lily Dr., Suite B, Kaysville, UT 84037

michael.wierda@usu.edu

Office: 435-919-1270

Authors

Michael R Wierda, Ph.D., Extension Assistant Professor, Pesticide Safety Education Program Director

Marion Murray, Professional Practice Extension Assistant Professor

Ryan Davis, M.S., Entomologist

Sheriden Hansen, Extension Assistant Professor, Horticulture

Taun Beddes, Extension Assistant Professor, Horticulture

Major Sources

Arling, M., Bauer, E., & Black, C. (2014). National Pesticide Applicator Certification Manual, 2nd ed. National Association of State Departments of Agriculture (NASDA) Foundation.

Shour, Mark. (2013, July). "General and household pest management." Category 7A commerical pesticide applicator manual. Iowa State University Extension. https://store.extension.iastate.edu/product/Category-7A-General-and-Household-Pest-Management-Iowa-Commercial-Pesticide-Applicator-Manual

Tomasko, S., Nice, G., Liesch, Drake, D., Snyder, T. (2017-2022). Structural Pest Control, Commercial Cat. 7.1, University of Wisconsin Pesticide Applicator Training Program, 8th ed. https://fyi.extension.wisc.edu/pat/files/2017/07/Structrual-small-cover.jpg

CHAPTER 1

INTRODUCTION

FORWARD

Category 7: "Structural and Health-Related" is the second-largest pesticide license category in Utah. This category covers pesticide applications in, on, or around food handling establishments, human dwellings, institutions such as schools, hospitals, industrial establishments, warehouses, storage units, and any other related public or private areas. It is not for termites or structural wood-infesting pests.

Whether you are a new or experienced applicator, you can take pride in your contributions to the quality of life enjoyed in Utah. Your efforts help protect our homes, institutions, restaurants, industrial establishments, and more from public health and structural threats posed by pests.

INTRODUCTION

Household pests cause damage to our food, health, and property, with management costs exceeding billions of dollars annually. Losses resulting from insect and rodent damage to stored food alone exceed $1 billion each year. Pests may also transmit diseases that cause human illnesses, such as bacteria and viruses. Other pests bite or sting, or may cause allergic reactions in indoor or outdoor environments. Lastly, some pests living in and around buildings can be a nuisance to people by their presence, detracting from their overall quality of life.

Purpose of the Study Guide

Public concern over the use of pesticides continues to grow, and professionals who handle pesticides must prove themselves capable of using these chemicals responsibly.

This study guide contains materials to help you prepare for the Category 7: Structural and Health-Related pesticide applicator exam. To obtain a pesticide license, Utah requires you to demonstrate your competency by passing the exam. Occasionally, material presented in this study guide is also covered in the National Core Manual, but is presented here as it applies to applicators in Category 7.

If this is your first license under Category 7, or you are retesting, you are expected to study available materials. Once you think you are ready:

1. Pay for your license.
2. Find a proctoring center and schedule your test time.
   a. There will be a fee for testing.
3. Go to the testing location to take the exam. NOTE: You MUST bring your license receipt and a valid government ID (EPA requirement).
4. Pass the exam at 70% or better.

You must also pass a separate exam for the Core. All exams are closed book. Find testing center locations on the Utah Department of Agriculture and Food (UDAF) webpage at https://bit.ly/3fSvaVU. If retesting is necessary due to not attaining 70% or better, you are limited to two attempts per day. Depending on the testing center, there may be a charge to retake the exam.

This study guide was adapted from manuals and guides from multiple states. Iowa State University and the University of Wisconsin graciously granted copyright permission to use their materials. UDAF and Utah State University (USU) Extension experts modified the content to provide pesticide information relevant to Utah.

Because website links change, weblinks referred to in this study guide will be maintained online at https://bit.ly/3fSvaVU.

Study Guide Limitations

This study guide is not a training for techniques and products used to control pests. It is intended to provide information so that pesticide applicators can use any product safely and legally. This study guide does not:

- Contain product-specific directions for use. Always read and follow the pesticide product label, which is a legally binding document. Note that some Utah laws may be more restrictive than label directions.
- Advocate pesticide use over other means of pest management. Rather, it focuses on the safe and proper use of pesticides by people who have already determined that pesticides are necessary for a given situation.

Study Tips

Everything in this study guide is considered testable. You will need to learn the study guide concepts to pass the closed-book, multiple-choice exam.

Each individual learns in different ways. If you remember things better by writing them down, take notes and review and rewrite them. If you prefer visual learning, highlight the information. If you learn better by hearing things, read and repeat passages to yourself aloud.

Repetition is key. Consider making flashcards of important information. Study with a coworker and test each other on key information and terms. There are several online options to set up flashcards for studying. This website has some pre-made pesticide flashcards at https://bit.ly/3fSvaVU.

Once you've completed a chapter, go back and review the learning objectives and make sure you understand each concept.

CHAPTER 2

Laws and Regulation

LEARNING OBJECTIVES

After studying this chapter, you will able to:

1. Recognize the key elements of the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA).
2. Describe the Endangered Species Act and know how it applies to a pesticide application.
3. Understand the Utah Pesticide Control Act, with special attention to the unlawful acts.
4. Identify who needs to have a Utah commercial or Non-Commercial applicator license with the Structural and Health-Related category.
5. Identify what type of applications the license with the Structural and Health-Related category will allow you to complete.
6. Identify what type of applications the license with the Structural and Health-Related category will allow you to complete.
7. Describe what application records to keep, what information to include, and how long to keep them.

FEDERAL LAWS

Federal Insecticide, Fungicide, and Rodenticide Act

The Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) was enacted in 1947 to protect consumers from fraudulent pesticide products by requiring manufacturers to register their pesticide and provide label information about the contents, directions for use, and antidotes if the chemical is ingested by humans. Although herbicides are not included in the title, they are included under this regulation.

The United States Department of Agriculture (USDA) had responsibility for the implementation and enforcement of FIFRA until the Environmental Protection Agency (EPA) was formed in 1970. At that time, responsibility for FIFRA transferred to the Office of Pesticide Programs (OPP) at the EPA. Amended several times since first enacted, one of FIFRA's most important amendments passed in 1972, which led to more active regulation of product safety and an emphasis on the protection of public health and the environment. Today, registration decisions are based on data which demonstrates that the pesticide will not result in "unreasonable human health or environmental effects."

3 Utah Pesticide Applicator Licenses

- Commercial
- Non-commercial
- Private

KEY ELEMENTS OF FIFRA

- EPA reviews all pesticides and their uses, and approves the product label. All pesticides must be registered as "unclassified"/"general use" (GUP), or "restricted use" (RUP). A pesticide is classified as a RUP if it poses a risk to the environment and/or if it can harm the user even when used as directed. States may classify a federally registered general use pesticide as restricted use if additional concerns exist, especially to protect the environment. However, a RUP cannot be classified as a GUP by a state.
- FIFRA requires that anyone using RUPs must be certified as, or act under the direct supervision of a private applicator.
    - Utah has three types of pesticide applicator licenses: private, commercial, and non-commercial. One of these licenses must be obtained to purchase or use RUPs. Non-commercial and commercial applicators shall not supervise the application of any RUP by unlicensed individuals.
- It is illegal to store or dispose of pesticides or containers in a manner other than described by regulations.
- There are penalties for "use inconsistent with the labeling" of the pesticide and "illegal handling of containers."
- FIFRA provides civil penalties when a violation of a regulation is unintentional, and criminal penalties for knowingly violating regulations.

Endangered Species Act of 1973

Administered by the U.S. Fish and Wildlife Service (USFWS), the Endangered Species Act (ESA) protects endangered species and their habitat. Under ESA, it is a violation of federal law to use a pesticide in any manner that may kill or otherwise harm an endangered species or adversely modify their habitat. Some pesticide labels now include an "Endangered Species Restrictions" statement under the ENVIRONMENTAL HAZARDS section of the label.

The responsibility of protecting endangered species ultimately falls to the applicator. If the label contains an "Endangered Species Restrictions" statement, applicators must check the EPA Endangered Species Bulletins online to determine if the county (or counties) where the application will be made has any restrictions. These restrictions may be for a specific active ingredient, product, or time of application. Bulletins may be accessed online up to six months before the intended application. For example, when making an application in June, you can access Bulletins as far as six months before that application, or by January at the earliest. Access links for any state's Endangered Species Bulletin at https://bit.ly/3fSvaVU.

If indicated by the product label, pesticide applicators and their companies (if applicable) must check bulletins and related information on endangered plants and animals in the area where pesticides are applied. The USFWS website provides information on threatened and endangered species in Utah at https://bit.ly/3fSvaVU. Consider EPA Bulletins to determine pesticide use limitations in the application area.

If an active Endangered Species Bulletin exists, applicators MUST print a copy and keep it as part of the application record, though they don't need to possess it during the application. Endangered Species Bulletins can be reviewed by UDAF during an inspection, and violations could result in federal investigation.

Pesticide applicators and their companies (if applicable) are responsible for checking bulletins and related information on endangered plants and animals prior to applications.

EMERGENCY EXEMPTIONS (FIFRA, SECTION 18)

Section 18 of FIFRA authorizes EPA to grant a temporary emergency use permit to individual states, allowing for an additional use (not specified by the pesticide's label). The uses are requested by the state for a limited time to address the emergency situation only, typically for a maximum of one year. In addition to the EPA-registered label, applicators must also maintain a copy of the Section 18 use directions when applying a pesticide with a Section 18 exemption.

When no registered pesticide will alleviate an identified pest situation, the types of exemptions that may occur for pest control include:

- Specific—to avoid a significant economic loss.
- Quarantine—to control the introduction or spread of an invasive pest species.

SPECIAL LOCAL NEED 24(C) REGISTRATION

Section 24 of FIFRA allows states to register additional uses of a federally registered pesticide to meet a "special local need" (SLN). The official request for a 24(c) registration comes from a pesticide manufacturer or formulator. The pesticide may be needed to treat a pest infestation problematic in Utah but which is not widespread enough to warrant the expense or difficulties of adding a use to federal registration. SLNs add a state use to the federal registration and stay active as long as the registrant pays the maintenance fee and does not request cancellation. An applicator must have the 24(c) supplemental label in their possession to apply SLN products.

STATE LAWS

Rules and Policies for the Utah Pesticide Control Act (Utah Code 4-14-101); (Utah Administrative Code R68-7-14)

The UDAF Pesticide Program administers the laws, rules, and policies associated with pesticides in Utah. UDAF issues four types of pesticide licenses: (1) private, (2) non-commercial, (3) commercial, and (4) commercial pesticide business.

UDAF License Key Points

1. UDAF will not issue a Utah commercial pesticide business license until at least one licensed Utah commercial pesticide applicator is assigned to that business.
2. No Utah commercial pesticide applicator will receive their license without first being associated with a licensed pesticide business.
3. As of 1/1/2019 no Utah commercial pesticide business License will be issued until a new licensee has demonstrated that they have a qualifying party associated with the business who has been a certified licensee for qualifying party associated with the business who has been a certified licensee for at least to two years.

UDAF only issues new Utah commercial pesticide business licenses to businesses demonstrating that they employ a responsible individual who has maintained a valid Utah or out-of-state pesticide license for two years or that has an associate degree or higher in a related field. Some mowing businesses only spot treating with herbicides with the signal word "WARNING" or "CAUTION" may be exempt from this two-year rule. Conversely, individuals who apply for a Utah commercial pesticide applicator license must be associated with a commercial pesticide business.

One reason to obtain a pesticide applicator license in Utah is to apply RUPs. Although not all pesticides used in Category 7 are restricted use, the predominant reason to obtain a license is to apply commercially (for hire or compensation) for management of pests in various types of structures.
It is important that pesticide applicators understand the Unlawful Acts section of the Utah Pesticide

Control Rule. UDAF requests applicators review the full document to understand how the rules concern their use of pesticides. For the complete list with comments on how unlawful acts may affect the Category 7: Structural and Health-Related applicator, see https://bit.ly/3fSvaVU. Below is the list of unlawful acts.

Any person committing any of the following acts violates Utah Pesticide Control Act or rules promulgated thereunder. These can be found under R68-7-14.

1. Made false, fictitious, or fraudulent claims, written or spoken misrepresenting the use, effect of pesticides, certification of applicator, or methods to be utilized;
2. Applied known ineffective or improper pesticides;
3. Operated in a faulty, careless, or negligent manner;
4. Neglected or, after notice, refused to comply with the provisions of the Act, these rules or of any lawful order of the department;
5. Refused or neglected to keep and maintain records required by these rules, or to make reports when and as required;
6. Made false or fraudulent records, invoices, or reports;
7. Engaged in the business of, advertised for, or held self out as applying a pesticide for hire or compensation on the lands of another without having a valid commercial applicator's license;
8. Purchased, used, or supervised the use of, a pesticide which is restricted to use by "certified applicators" without having qualified as a certified applicator or designated as a certified private applicators agent;
9. Used fraud or misrepresentation in making application for, or renewal of, a registration, license, permit, or recertification.
10. Refused or neglected to comply with any limitations or restrictions on or in a duly issued license or permit;
11. Used or caused to be used any pesticide in a manner inconsistent with its labeling or rules of the department if those rules further restrict the uses provided on the labeling;
12. Aided or abetted a licensed or an unlicensed person to evade the provisions of the Act; conspired with such a licensed or an unlicensed person to evade the provisions of the Act; or allowed one's license or permit to be used by another person;
13. Impersonated any federal, state, county, or other government official;

14. Distributed any pesticide labeled for restricted use to any person unless such person or his/her agent has a valid license, or permit to use, supervise the use, or distribute restricted-use pesticide;
15. Applied pesticides onto any land without the consent of the owner or person in possession thereof, except, for governmental agencies which must abate a public health problem.
16. For an applicator to apply a termiticide at less than label rate.
17. For an employer of a commercial or non-commercial applicator to allow an employee to apply pesticide(s) before that individual has successfully completed the prescribed pesticide certification procedures.
18. For a pesticide applicator not to have his/her current license in his/her immediate possession at all times when making a pesticide application.
19. To allow an application of pesticide to run off, or drift from the target area to cause plant, animal, human, or property damage.
20. Refused or neglected to register a pesticide applicator business with the Utah Department of Agriculture and Food or follow the rules set forth in section R68-7-8 for licensing of a commercial business.
21. To handle or apply any registered pesticide for which the person does not have an appropriate, complete, or legible label at hand.
22. Refused or neglected to comply with the Federal Container and Containment regulations.
23. Failure to perform fumigation applications according to the standards required by this rule.
24. Failed to display business license numbers in accordance with this rule.
25. Refused or neglected to notify the customer of the application of a restricted-use pesticide and the information detailed in R68-7-10.
26. Failure of a qualifying party of the business licensee to train or prepare the applicator to comply fully with the Utah Pesticide statutes and rules and label and labeling directions.
27. Failure to fully respond in a timely way to requests by the commissioner's designated agent for information relating to training and equipping of applicators.
28. Transported, stored, handled, used, or disposed of a pesticide or pesticides container inconsistent with rules specified in section R68 7-13.

MAINTAIN PESTICIDE APPLICATION RECORDS FOR TWO YEARS

Applicators' records should contain the following:

- Reason for the application.
- Customer and business identification.
- Treatment site.
- Time and date of application.
- Product brand name and EPA registration number.
- Application rate and total applied.

Find an example records form at https://bit.ly/3fSvaVU. Application records must be maintained and made available for inspection upon request by the commissioner's designee. A suggested business practice is to keep the application record where the applicator's license is located.

Individual commercial pesticide applicators must record all applications (GUP and RUP) within 24 hours of application and maintain the records for two years.

Non-commercial pesticide applicators must record RUP applications within 24 hours of application and maintain records for two years. It is HIGHLY recommended as the best business practice to record GUP applications also. Non-commercial pesticide applicators can choose to store application records anywhere, and all parties must know their location.

Private applicators must record RUP applications within 14 days and maintain the records for two years. Records can be stored as the applicator sees fit but must be accessible within 48 hours if requested.

Pesticide labels must also be stored with the application records. Note that some products have more than one label. The label version must match the product used. The EPA hosts a webpage of pesticide labeling questions and answers at https://bit.ly/3fSvaVU.

Non-commercial applicators must keep records of RUP applications, but are strongly encouraged to keep records of all applications.

Utah commercial pesticide business licensees must keep records of each and every pesticide application (not just RUP).

R68-7-10. "Responsibilities of Business and Applicator" specifies that a business licensee must:

1. Ensure that applicators receive the training necessary to comply with Utah Pesticide statutes, labels, rules, and law.
2. Keep records that the employee was trained, by whom, and dates and length of time of the training.
3. Include the appropriate business license numbers on invoices, reports, records, service vehicles, and so forth.

4. Notify the customer before the time of each restricted use pesticide (RUP) application that has the Danger/Poison signal word on the label
    a. Provide a written statement with the following:
        - Business name and telephone number of the licensed business.
        - Name and license number of the licensed applicator who will make/has made the application.
        - Date and time of application.
        - Type of pesticide application service and brand names of the products used.
        - Instructions to the customer to contact the business telephone number if more specific information is desired regarding the pesticide product applied.
    b. The notice must be provided to the customer by:
        - Leaving it at the residence.
        - Leaving it with a property manager in the case of multiple residences.
        - Mailing it to the property manager if the authorized representative is not on site within seven calendar days before the application.

Though the majority of the responsibility for these specific rules lies with the business, owner or principal of the entity, the individual applicator needs to know about the provisions of R-68-7-10 (B) (1): A business licensee, qualifying party and/or applicator may be held responsible for the acts or omissions of another person who is employed by the business licensee.

CHAPTER 3

Pesticides in the Environment

LEARNING OBJECTIVES

After studying this chapter, you will be able to:

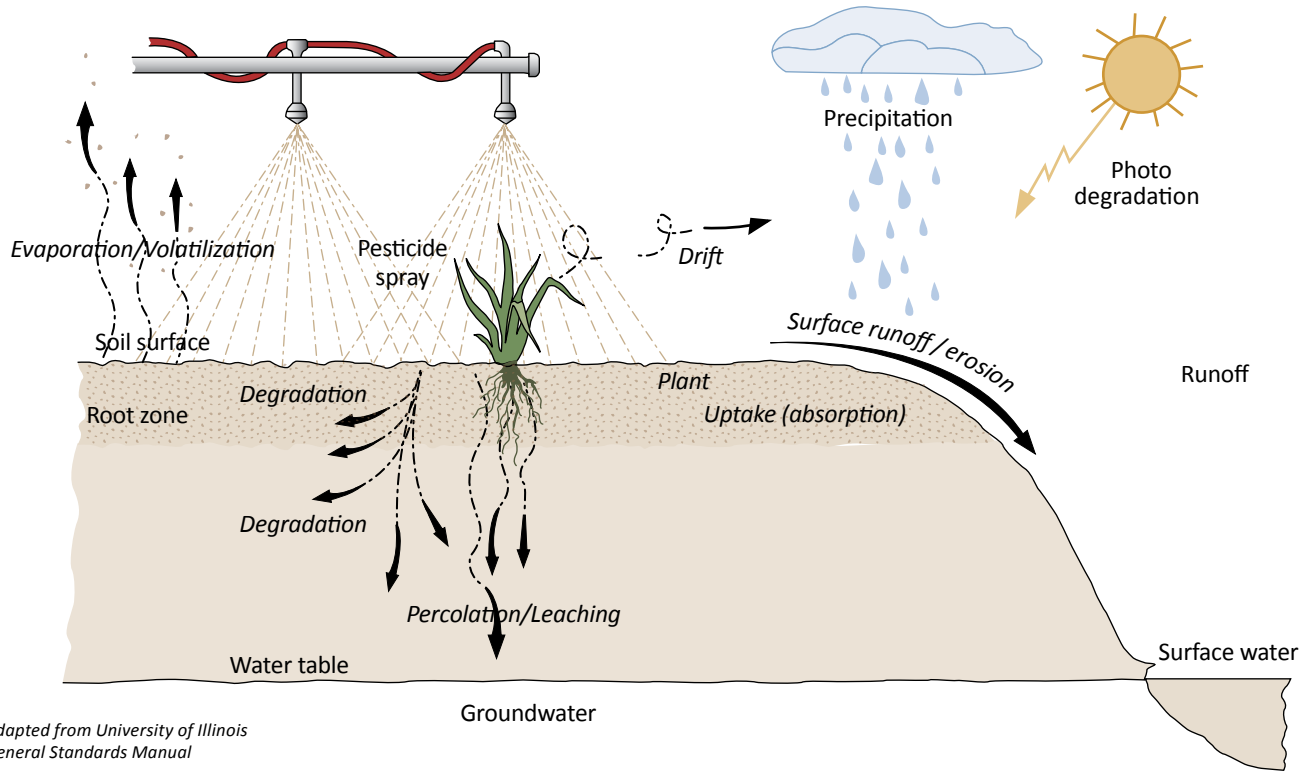
1. List ways that a pesticide can move from the site of application.
2. Define overspray, drift, and runoff.
3. Describe how different characteristics of pesticides can affect the movement of a pesticide from a target site.
4. Explain ways that pesticides can end up in animals (including humans).
5. Explain how pesticides can get into surface or groundwater and define the terms point and nonpoint source pollution.
6. Understand how pesticide characteristics and site conditions affect the movement of pesticides.
7. List ways to prevent contamination of surface and groundwater.

WHERE DO PESTICIDES GO?

Any off-target pesticide is a pollutant and can harm animals and/or the environment (Figure 1). Many pesticide labels list environmental effects such as contamination of groundwater or toxicity to pollinators, birds, or aquatic organisms as reasons for restrictions.

The environment comprises everything around us. It includes not only the natural elements that the word "environment" most often brings to mind but also people and the manufactured components of our world. The environment is also not limited to the outdoors—it also includes the indoor areas in which we live and work.

Figure 1
Pesticides end up off the target application site in many different ways.



Adapted from University of Illinois General Standards Manual

Anyone who uses a pesticide must consider how that pesticide affects the environment. The applicator must ask two questions:

1. Where will the pesticide go in the environment after it leaves its container or application equipment?
2. What effects can this pesticide have on nontarget sites, plants, and animals it may reach in the environment?

A spilled or mishandled pesticide may enter the environment without ever being applied to a target site, while pesticides that are applied properly can enter the nontarget environment in a variety of ways, such as:

- Volatilize (turn into a gas) from treated surfaces.
- Rinse off a treated surface and enter the soil.
- Be carried laterally by runoff or soil erosion.
- Leach laterally or horizontally through the soil.

Overspray

Overspray is the application of a pesticide beyond the boundaries of the target area. Overspray can occur indoors and outdoors.

Drift

Drift is the movement of a pesticide in air currents or by diffusion onto property beyond the boundaries of the target area. Drift may occur either as solid or liquid particles or as vapors. Pesticide drift, like overspray, often implies a lack of due care on the part of the applicator. You are responsible for confining pesticide applications to the target area, and for taking precautions to prevent unwanted exposure to persons or property of others.

Runoff

Runoff and/or leaching can occur when pesticides are carried off the application site into water such as rivers, lakes and streams, wells, storm sewers, or into groundwater. Runoff occurs on the surface while leaching occurs below the surface. Leaching can occur vertically and horizontally.

Utah State Pesticide Control Rule R68-7-13 specifically states: "No person shall apply pesticides if weather conditions are such that physical drift or volatilization may cause damage to adjacent land, injure humans, other nontarget species, or the environment."

PESTICIDE CHARACTERISTICS

To understand how pesticides move in the environment, you must first understand certain physical and chemical characteristics of pesticides and how they determine a pesticide's interaction with the environment. These characteristics are solubility, adsorption, volatility, and persistence. Understanding these factors will help you determine not only the risk a pesticide application poses to the environment, but whether or not the pesticide will remain at the site of application long enough to be effective.

Always read the label carefully before each and every use. Pay particular attention to the Environmental Hazards section of the label.

Solubility

Solubility is a measure of how easily a chemical will dissolve in a solvent, usually water. Pesticides that are highly soluble in water dissolve easily. These pesticides are more likely to move with water in surface runoff—leaving the application site quickly and possibly contaminating nearby areas. Highly soluble pesticides can also leach downward through the soil, potentially contaminating groundwater.

Adsorption

Pesticides may settle or attach to surfaces such as soil, called adsorption. They vary in their degree of attachment. Strongly adsorbed pesticides are less likely to be carried from the treated area by water runoff

In understanding how pesticides interact with soil, it is important to recognize the difference between "adsorb" and "absorb." These terms are often confused.

Adsorb refers to refers to something getting stuck onto another surface. In this case, a pesticide molecule sticks on a soil particle.

Absorb refers to refers to something taken into a medium, like when an herbicide is taken into plant tissue.

or to leach through the soil into the groundwater. They may, however, move readily by soil erosion.

Volatility

Some pesticides are volatile. The volatility of a pesticide is a measure of its tendency to turn into a vapor or gas. Volatility increases as the temperature and wind increase and humidity decreases. As a pesticide turns into a vapor, it can drift and cause problems downwind.

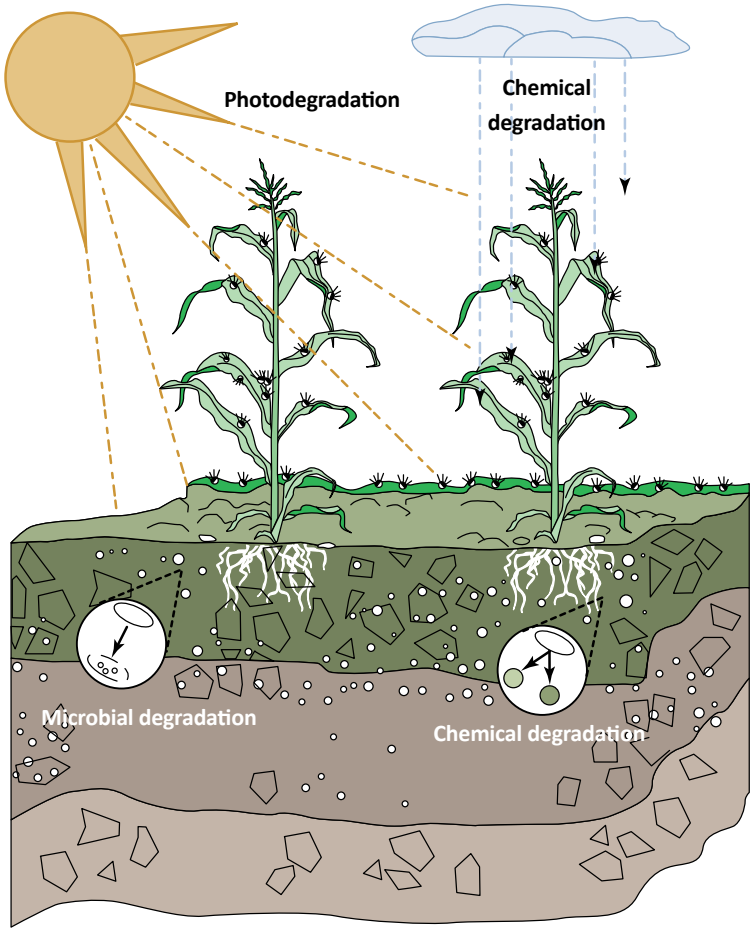
Persistence

Persistence is the ability of a pesticide to remain in an active form in the environment. Persistence may be either desirable or undesirable. Where the objective is long-term control, a persistent pesticide with residual activity may be desirable—persistence and residual activity are often used interchangeably. Persistence beyond the time it is needed, however, is undesirable and the remaining pesticide is usually referred to as residue. The longer a pesticide persists, the more chance it will have to remain active when it moves from the target site.

Degradation

Degradation is the process of pesticides breaking down into simpler, and often less toxic, compounds. Pesticides vary substantially in their susceptibility to degradation and are broken down by the environment in different ways (Figure 2).

Figure 2
Degradation of pesticides may be chemical, physical, biological, or any combination of the three. Biological breakdown results from attack by fungi, bacteria, and other microorganisms. Photodegradation is when sunlight causes chemicals to degrade.



OSU Pesticides and Groundwater Contamination

PESTICIDE ACCUMULATION IN ANIMALS

Pesticides that end up offsite can cause harm to people, plants, and animals in various ways. The following section discusses how pesticides get into animals and water sources, even when neither appears to be present at the site of the application.

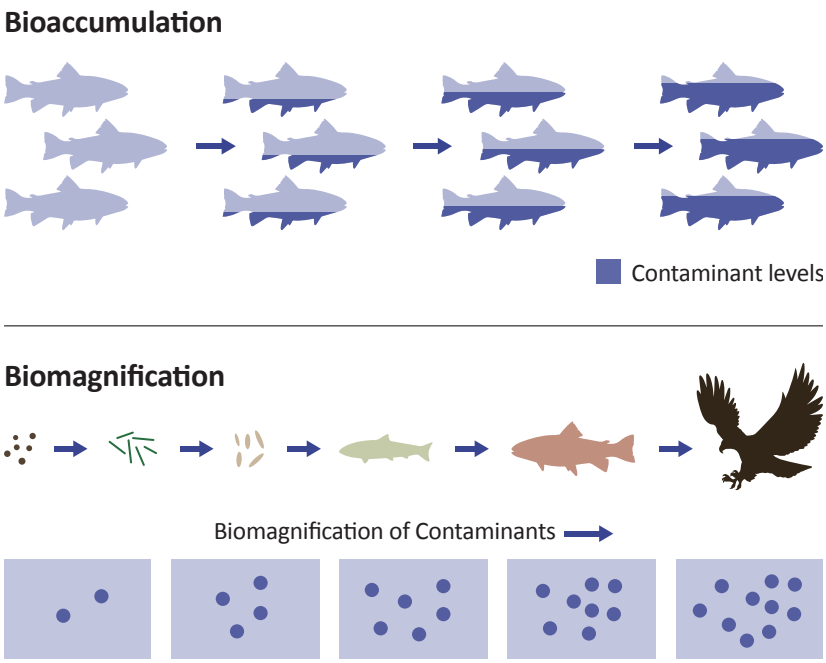
Bioaccumulation

Some pesticides can accumulate in the bodies of animals (including humans), particularly in fat tissue. Instead of the body getting rid of the chemicals as waste, they are stored in fat tissue and build up, or accumulate, over time. This process is called bioaccumulation. Because of this long-term accumulation, these pesticides can sometimes reach harmful levels, even though the animal or person only ingests a small amount at a time.

Biomagnification

Biomagnification occurs when the pesticide moves up through the food chain. A food chain is the sequence of plants and animals that feed on each other. For example, microscopic plants and animals in water take up a pesticide. Small animals eat those plants and fish eat the smaller animals. Larger fish eat the smaller fish, and a bird of prey (or human) eats the big fish. At each level of the chain, the organism eats many of those below it (e.g., a largemouth bass will eat many minnows). This is how a pesticide becomes increasingly concentrated as it moves up the food chain, with each level up getting a larger dose, magnifying the effect. With this process, an animal at a higher level (e.g., a bird of prey or a human) can become poisoned without ever directly being near the pesticide application (Figure 3).

Figure 3
Depiction of bioaccumulation within individual fish over time and biomagnification across species through predator-prey relationships.



To summarize, bioaccumulation occurs when a pollutant builds in concentration within a species, usually by absorption from surroundings (air, water, or soil). Biomagnification occurs when pollutants are magnified through the consumption of food, starting with lower food sources to higher-level organisms.

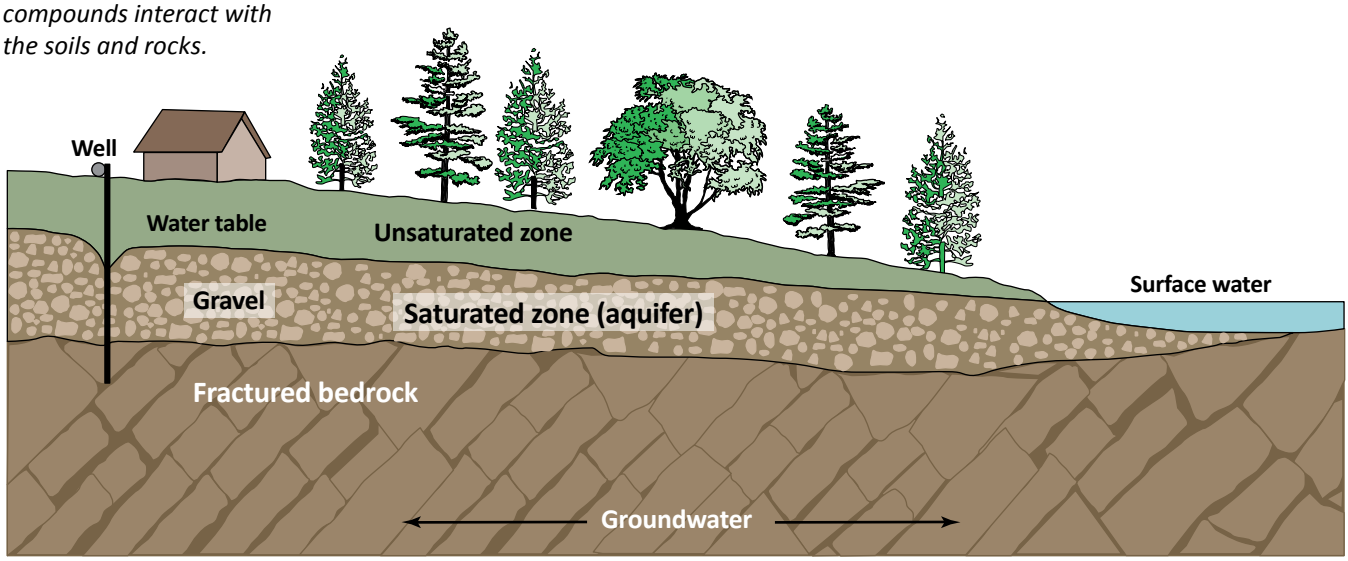
Biomagnification occurs between species and is closely related to predator-prey relationships. A tenfold increase in contaminant concentrations has been noted in tissues from prey to predator.

GROUNDWATER

Protecting groundwater from pesticide contamination is a concern in Utah. Everyone who uses water from a well uses groundwater. Groundwater is water contained in the cracks and pores of rocks and the space between sand grains and mineral particles underground (Figure 4).

Once groundwater becomes contaminated, it is difficult, if not impossible, to do anything about it other than to stop the source of contamination and allow enough time for the level of contamination to decrease. The best solution is to prevent contamination in the first place.

Figure 4
Spilled pesticides can be carried or leached down to groundwater along with water moving through the soil. Once a contaminant reaches the water table, it will flow with the groundwater, although not necessarily at the same rate because some compounds interact with the soils and rocks.



Adapted from Penn State Pesticide Education Manual

SURFACE WATER

Pesticides can reach surface water through sewers, in runoff, or in contaminated groundwater that is discharging to surface water. Most Utah city and secondary irrigation water are from surface water.

Be aware that conditions that reduce the threat of groundwater contamination may increase the threat of surface water contamination. For example, pesticides that strongly adsorb to soil particles may not leach downward into groundwater but may be carried into surface water if runoff causes soil erosion. Runoff into surface water is likely if the soil is crusted, compacted, or frozen—particularly on sloping sites or applying on or near pavement that may drain to a sewer.

Sources of Water Contamination

Surface or groundwater contamination results from either point source or nonpoint source pollution.

Point source pollution comes from a specific, identifiable place such as:

- Pesticide spills entering a storm sewer.
- Back-siphoning.
- Repeated spilling of pesticides at mixing and loading sites.
- Careless spilling of wash water at equipment cleanup sites.
- Improper handling of spills and leaks at storage sites.
- Improper disposal of containers, rinsate, and excess pesticides.

Nonpoint source pollution comes from a widespread area. Runoff, seepage, and leaching from areas of application take the pesticide into areas it should not occur.

Health and Economic Costs of Water Contamination

The human health impact of pesticides in water sources depends on the chemical present, the amount that is in the water, and the amount of water that a person drinks or comes in contact with over time. To avoid health problems, federal and state drinking water guidelines for pesticide residues set limits on the amount of contamination that may be present in drinking water.

The costs to society of pesticide-contaminated water are difficult to quantify. Losses of pesticide chemicals through leaching represent lost investments by the applicator. Contaminated groundwater can be very costly to the communities and families that rely on it for drinking water. For example, when household well water has levels of pesticides exceeding health standards, the family must get water from another source.

Factors Affecting Ground and Surface Water Contamination

The factors that influence whether a pesticide will reach groundwater or surface water after normal use include the characteristics of the pesticide itself, conditions at the pesticide handling site, and application practices.

To prevent spills or poor pesticide handling, follow the label guidelines regarding the proper transport, storage, mixing, and disposal of pesticides. Some key steps include:

- Securing pesticide containers in the back of a vehicle to prevent spills during transport.
- Storing pesticides over an impermeable floor and checking frequently for damaged containers.

- Storing bulk pesticides in secondary containment.
- Mixing or loading pesticides only over an impermeable pad.
- Using an air gap or backflow protection device when mixing pesticides.
- Disposing of pesticide waste properly.

Negligent behavior is a violation of Utah R-68-7-13 and can lead to regulatory action.

CHAPTER 4

Integrated Pest Management

LEARNING OBJECTIVES

After studying this chapter, you will able to:

1. Define integrated pest management (IPM).
2. Understand the importance of inspecting for evidence of pest activity.
3. Understand the tools needed for a facility inspection.
4. List several monitoring techniques used in pest management.
5. Give examples of food handling establishments requiring pest control

A SYSTEMATIC APPROACH

Successful implementation of Integrated Pest Management (IPM) requires the applicator to understand:

- Pests that are likely to occur in the setting.
- Pest life cycles and habits.
- How to conduct an inspection and monitor for pests.
- Action thresholds for each pest.
- Effective and legal methods to manage pests.

Steps of an IPM plan

1. Identify the pest; learn about the pest.
2. Determine the extent and distribution of pests and their damage; locate harborage.
3. Determine pest-conducive conditions or conditions that are contributing to the pest problem.
4. For nonchemical actions: use improved sanitation, exclusion, education, communication with residents, mechanical/physical controls (i.e., traps, vacuums, or other devices), and cultural controls.
5. For chemical control: use the most effective and safest chemicals and products for the specific site and situation.
6. Continue to monitor for pests after management; monitoring should also be part of an IPM program from the beginning even if no pests are present.

PEST IDENTIFICATION

Proper pest identification is key to successful pest management. If you cannot readily identify a pest, preserve the pest (if possible) in a container, take pictures, and/or take specific notes. Make an initial identification using reference books or online tools. Find links to multiple identification resources at https://bit.ly/3fSvaVU. Contact the Utah Plant Pest Diagnostic Lab (UPPDL) for assistance in positive identification.

If further help is needed, your local Utah State University (USU) county Extension office can help you or direct the information to a university specialist. The UPPDL at USU provides pest identification services for a fee. Find links to UPPDL sample submission instructions and a list of USU Extension offices at https://bit.ly/3fSvaVU.

PEST LIFE CYCLES

It is important to understand the target pest life cycle for management at the appropriate time. With insects, for example, different tactics may be used on the egg stage, intermediate stages, or adult stage. Other pests, such as rodents, may be active only certain times of the year.

Most insects have four wings as adults and some may lack wings as adults (e.g., bed bugs), while others have one pair of wings reduced (e.g., flies). Immature insects do not have wings (e.g., bed bugs, cockroaches, stink bugs, seed bugs). Insects with incomplete metamorphosis typically use the same food source (e.g., beetles, flies, moths, ants, termites). Often, insects with complete metamorphosis will feed on different food sources when they are larvae versus their adult food sources. More information on insect life cycles can be found in Chapter 5.

SITE INSPECTION AND MONITORING

A site inspection will form the basis for customizing a management program. The inspection should contain detailed notes, including maps of the structure layout, signs of pests and their damage, presence of food, water, harborage, and other conditions needed by the pest (pest-conducive conditions), and routes of pest access to those life-supporting needs.

Keep pest behavior in mind during an inspection. For example, rodents and cockroaches normally hide. Check cracks and crevices, behind/under appliances, in cluttered areas, along utility lines (electric, water, gas, phone/cable, etc.), and where pests penetrate structure exteriors or interior walls.

Inspect both indoor and bordering outdoor areas. Night inspections may help understand additional pest activity. Although the initial visit to the account requires time, follow-up visits are generally faster and allow you to focus on known problem areas, discover new problems, and see that your recommendations are implemented.

Customer relations are critical during the inspection process. Inspections of private spaces (e.g., cabinets, dressers, desks) may make occupants feel uncomfortable. Take the time to explain what an inspection involves, what you look for, and why you need complete access to the site.

Tools you may want to consider for a site inspection include:

- Powerful flashlight.
- Ultraviolet (black) light.
- Magnifying glass or hand lens.
- Long-handled mirror (purchased at an auto parts store).
- Putty knife or spatula.
- Access tools (e.g., screwdrivers, pliers).
- Protective equipment (e.g., safety glasses, knee pads, bump hat, gloves, respirator).
- Vacuum with HEPA filter.
- Clipboard with paper, pen, and inspection checklist.
- Floor plan or map of the structure.
- Vials containing 70% ethanol for collecting insect pests.
- A device to take pictures with

Following a detailed site inspection, regular monitoring will allow you to record continuous information on the facility. Monitoring will help identify the pest species, estimate population sizes, pinpoint areas of pest activity, and identify human behavior attributing to the pest problem.

Many monitoring techniques and tools are available to the pest control industry, including general and pest-specific tools and techniques. Examples include flushing agents, product inspection, and sticky, pheromone, mechanical, or light traps.

Nonchemical options are discussed throughout the study guide. In keeping with the IPM approach, use the most appropriate methods for the situation to solve the pest problem and to meet the client's expectations.

ACTION THRESHOLDS

An action threshold represents a pest concentration or density level that requires treatment to prevent a nuisance or damage to structures or human health. In many cases, the action threshold for pests affecting structures or human health is very low-often just a single insect or rodent-because their presence indicates additional unseen pests. Therefore, pest management in these situations requires almost complete elimination.

PESTICIDE USE

Pesticides are used as part of IPM. Select a product that has the site and pest on the label and matches the intended purpose. Important pesticide and site characteristics include:

- Mode of action (https://bit.ly/3fSvaVU).
- Pest resistance.
- Chemical characteristics.
- Formulation.
- Treatment surface (porous or nonporous, staining potential, alkalinity).
- Residual life expectancy.
- Recommended application and personal protection equipment.
- Visual objectionable residue.
- Safety profile for nontargets.

Terms for Pesticide Use

Some terms that appear on pesticide labels concerning use in food-handling establishments, commercial accounts, and other structural pest sites include:

- **Application sites** – Many labels will list areas to which the pesticide can be applied. You must be aware of labeled sites and those sites that are not listed.
- **Structural** – A pesticide application applied on, in, or around (within 3 feet) of a man-made structure. These applications are sometimes referred to as foundation or exterior treatments.
- **Food-handling establishments** – These are areas or places other than a private residence where food is processed, prepared, served, and/or held (including food displayed for sale as well as stored). Some places "other than a private residence" include restaurants, lunchrooms, caterers, cafeterias, bars and taverns, private clubs, military mess halls and clubs, food contractors in plants and office buildings, mobile caterers, airlines, ships, drug stores, confectionery stores, dairy product stores, bakeries, concession stands, school lunchrooms, colleges and universities, hospitals, homes for orphans, the aged and handicapped, federal and state prisons, and jails.
- **Nonfood areas** – These include garbage rooms, lavatories, floor drains (to sewers), entries and vestibules, offices, locker rooms, machine rooms, boiler rooms, garages, mop closets, and storage (after canning or bottling).
- **Food areas** – These include spaces for receiving, serving, storage, packaging (canning, wrapping, bottling, boxing), preparing (cleaning, slicing, grinding, cooking), and edible waste storage and enclosed processing systems (oils, dairies, edible oils, syrups).

- **Residual insecticides** – These products are applied to obtain effects that last several hours or longer.
- **General application** – This is made to broad expanses of surfaces such as walls, floors, and ceilings or as an outside treatment. This is permitted only in areas labeled on the insecticide.
- **Spot application** – This is made to target areas where workers will not ordinarily come into contact with the pest. These areas may occur on floors, walls, and bases or undersides of equipment. For this purpose, a "spot" often does not exceed two square feet. A spot may be round or long and narrow. To justify spot treatments, insects should likely occur on a surface.
- **Crack and crevice application** – This means applying small amounts of insecticides into cracks and crevices where insects hide or through which they may enter a building. Such openings commonly occur at expansion joints, between different elements of construction, and between equipment and floors. These openings may lead to voids such as hollow walls, equipment legs and bases, conduits, motor housings, junctions, or switch boxes. Crack and crevice treatments include sprays, dusts, or baits, and are sometimes referred to as baseboard treatments.
- **Barrier application** – A band of insecticides is applied on the lower portion of a building, around the building perimeter, and/or near doorways or windows. This treatment is designed to kill insects before they can enter a structure and is also known as perimeter treatment.
- **Insect growth regulator (IGR)** – Synthetic chemicals that mimic insect hormones are known as insect growth regulators (IGR), and these products tend to have low mammalian toxicity and are less likely to develop resistance in an insect population compared to conventional insecticides.
- **Void application** – This delivers an insecticide into an empty space inside a wall or ceiling, behind a kick plate, inside a table leg, or in any other void providing harborage for pests. The application is usually done by injecting liquid, dust, aerosol, fog, or ultra-low volume formulations into a void.
- **Baiting** – A management technique by placing insecticide bait (an attractive and/or palatable matrix mixed with pesticide or used in a trapping device) into cracks and crevices or voids, or those packaged as bait stations, typically placed inside cabinets, equipment, and other infested sites. Wear chemical-resistant gloves when placing baits, not only to protect you from the active ingredients but also to prevent accidental contamination of the bait with unacceptable odors (e.g., cigarette smoke, soap fragrances).
    - Advantages: Pesticide enclosed inside a plastic or metal casing; less product used; longer bait life; high effectiveness; precise placement; lowered exposure to humans; and ease of use.
    - Disadvantages: Visibility and casing may serve as harborage for pests if not removed after consumption or deterioration.

- Pastes, gels, and other injectable baits may be packaged inside tubes or syringes that you squeeze to apply, or designed to be applied from various types of bait "guns" or with a small spatula or putty knife.

- **Space treatment** – A space treatment is the application of a fine pressurized aerosol mist of insecticide into any sized, open area with the intent of providing a rapid knockdown and death of the pest, with little or no residual effects. A space treatment can be "fogging," or "directed," and sometimes "flushing" to chase pests from their hiding places. Space treatments are less effective in cluttered and dirty spaces.

Pesticide Shelf Life

A pesticide's shelf life is the amount of time that a product can be stored and remain effective for pest management activities. Check stored pesticides regularly for signs of deterioration, such as caking/clumping of wettable powders, excessive lumping of granules or dusts, stronger-than-normal odors coming from an opened container, failure of an emulsifiable concentrate to form an emulsion, or release of gas when the container is opened. Improper storage conditions accelerate the breakdown of the active ingredient(s) and reduce shelf life.

Store pesticides no more than two years. To reduce the amount of pesticide stored, purchase only the amount needed for scheduled work. When delivered, write the purchase date on the container and use older pesticides first.

Customer Safety

Safe application of pesticides requires a careful, thorough reading and understanding of the pesticide labeling. The labeling includes the label, supplemental labels, safety data sheets, bulletins, and so on. Take extra care in storing, measuring, and applying pesticides where children are present. Check the product label to see if people, pets, or specific items must be removed before application. This also includes covering aquariums and turning off the filter. Be specific in instructing customers when they are permitted to re-enter the premises and what precautions to take; written precautions are preferable. Labeling may include re-entry times. At the minimum, people and pets should not return to treated areas until the spray dries and the area has been ventilated.

Use special care in sensitive areas such as kitchens and food-handling establishments. Do not contaminate food, feed, and food-handling surfaces and equipment with pesticides. If the areas must be fogged, wash food-handling equipment and surfaces before food preparation resumes.

CHAPTER 5

Understanding Arthropod Pests

LEARNING OBJECTIVES

After studying this chapter, you will be able to:

1. Explain how to distinguish insects from other arthropods.
2. Describe the structural features of arthropods.
3. Describe the differences between incomplete and complete metamorphosis.
4. Describe the kinds of damage arthropod pests can cause.

INTRODUCTION

Insects and their relatives (arthropods) constitute one of the most important groups of pests. A pest is any organism that competes with people for food, fiber, or space, or that presents a threat to the health of people or domestic animals. Additionally, what constitutes a pest may vary by the person. Remember, that less than 1% of the 1 million described species of insects, in addition to some spiders, mites, ticks, etc., are considered pests. Most arthropod species provide direct or indirect benefits to humans and our environment.

Because many insects can reproduce quickly (short generation times), they can produce large numbers of offspring. This is why some pest species can cause significant damage. These characteristics also allow them to change and adapt to altered conditions, meaning any change in the pest's environment, in relatively short periods of time. These changes can be environmental (e.g., changing climate) or changes brought about while trying to control pests. Chief among control tactics is the use of pesticides. In particular, the overuse of chemicals that belong to the same chemical group, or that have the same mode of action, can lead to chemical resistance in some arthropod populations. Too much reliance on pesticides can lead to

some pest populations developing pesticide resistance. A key example of insecticide resistance includes bed bugs and their resistance to the pyrethroid group of insecticides. The Insecticide Resistance Action Committee (IRAC) was formed to promote and facilitate the development and implementation of resistance management strategies to maintain efficacy and support sustainable agriculture and improved public health. Find more information about IRAC and its resources at https://bit.ly/3fSvaVU.

In this chapter, we provide an overview of the general biology of arthropod pests and the damage they cause.

ANTHROPOD PEST BIOLOGY

You should learn to recognize the common pest arthropods that cause problems in and around structures. Basic knowledge of the biology of insects and their relatives will, at the very least, help you identify particular groups and understand the nature and development of pest problems.

Arthropod Form and Structure

Insects and their relatives belong to a group of animals called arthropods. All arthropods are invertebrates — meaning "no backbone." They have a segmented external covering (called an exoskeleton), paired, jointed legs, and other appendages. The exoskeleton is rigid and provides both protective covering and support. Examples of arthropods other than insects include arachnids (mites, scorpions, spiders, ticks), chilopods (centipedes), diplopods (millipedes), isopods (rollie pollies), and decapods (lobsters and crabs).

Scientists divide arthropods into several groups, including "insects" (the true insects) and "arachnids" (mites, ticks, spiders, etc.). You can distinguish these two groups by comparing a few important characteristics of the adult forms (Table 1).

Table 1
Comparisons of Adult Forms of Insects and Arachnids

Characteristic	Insect	Arachnids
Body form	3 regions: head, thorax, abdomen	2 regions: cephalothorax (fused head and thorax) and abdomen
Legs	3 pairs attached to thorax	Usually 4 pairs attached to cephalothorax
Wings	0, 1, or 2 pairs attached to thorax	None
Antennae	1 pair attached to head	None, though similar structures may be present

Note. You can find numerous articles and videos online comparing insects and arachnids.

An arthropod's head bears some of the sensory organs (eyes and antennae) and the mouthparts. While most adult insects have one or two pairs of wings, some have none (e.g., lice, fleas, bed bugs).

Different insects have different kinds of mouthparts. Chewing and piercing-sucking mouthparts are most common for structural pests. Because mouthparts largely determine the type of damage a pest can cause, recognizing damage can give you a clue as to which pest is causing the problem.

Insects with chewing mouthparts (e.g., many beetles) have toothed jaws that bite or tear at food. Insects with piercing-sucking mouthparts (e.g., bed bugs) have either a siphon-like tube for sucking secretions or needle-like structures capable of penetrating flesh and sucking blood. Mouthparts are sometimes different in the juvenile (or immature) and adult forms of the same species. An example of this is the chewing mouthparts of the Indianmeal moth caterpillar versus the coiled, straw-like proboscis of the Indianmeal moth adult.

Insect Development

Insects change in shape, form, and size during their lives. This change is called metamorphosis. It may be a gradual change, involving little more than an increase in size, or it may be a very dramatic one in which the adult looks nothing like the young. More information on insect development can be found at https://bit.ly/3fSvaVU. The principal function of the adult insect is to reproduce; that of the young is to feed and grow and become an adult.

INCOMPLETE METAMORPHOSIS

There are three stages to hemimetabolism (usually referred to as "incomplete metamorphosis"): egg, nymph, and adult (Figure 5). The juvenile, or immature forms, are called nymphs, which often look much like the adult, except for size and presence of wings (only adult insects have wings). As the nymphs feed and grow, they shed their external covering, a process called molting. A nymph must molt because the exoskeleton cannot enlarge as the insect grows. Nymphs have either no wings or only partially formed wings. Nymphs usually have the same kind of mouthparts as adults, and therefore, often (but not always) feed on similar things.

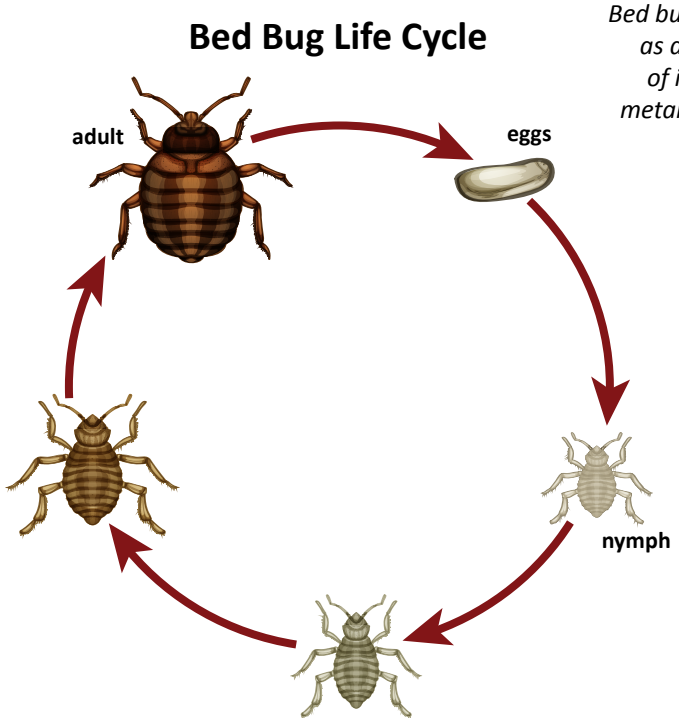


Figure 5
Bed bug life cycle as an example of incomplete metamorphosis.

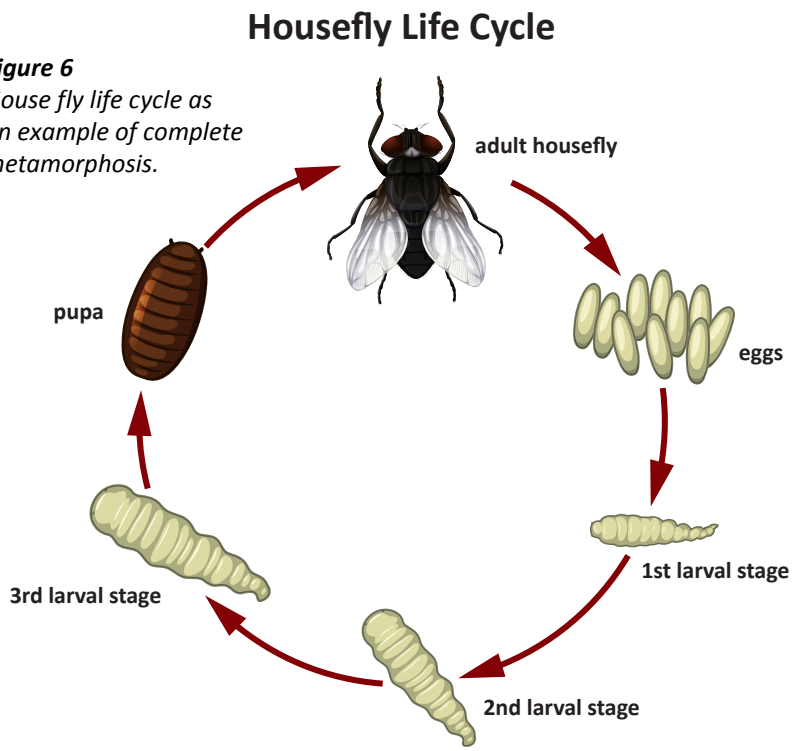


Figure 6
House fly life cycle as an example of complete metamorphosis.

COMPLETE METAMORPHOSIS

Some insects go through holometabolism (complete metamorphosis), which involves four stages: egg, larva, pupa, and adult (Figure 6). The immature stage is called a larva (plural: larvae). Larvae often have different mouthparts than adults and feed on different things and can live in different environments. As the larva grows, it molts several times (a range of 3 to 12 times, depending on the species) and finally changes into an intermediate form called a pupa (plural: pupae). The pupa may be exposed or contained in a capsule or a silken cocoon. The pupa is stationary and pupae do not feed. During this stage, some profound changes occur, and when completed, the adult insect emerges from the pupal shell.

DAMAGE CAUSED BY ARTHROPODS

Pest arthropods are responsible for an array of problems against human health or in structures. For example, they can:

- Feed on stored products.
- Contaminate raw and processed commodities.
- Weaken structural timbers.
- Damage furniture, carpeting, and clothing.
- Carry pathogens that cause disease in people and animals.
- Create a nuisance.
- Cause anxiety and reduce the quality of life.

Recognizing damage, and what caused the damage, is an important part of diagnosing a problem.

CHAPTER 6

COCKROACHES

LEARNING OBJECTIVES

After studying this chapter, you will be able to:

1. Define ootheca, thigmotactic, and gregarious.
2. Explain the health concerns associated with cockroach infestations.
3. Explain the relationship between conducive conditions and cockroach population levels.
4. Recognize the signs of cockroach infestation in the structure.
5. State environmental conditions required by cockroaches to survive in a structure.
6. Describe the nonchemical control tools used against cockroaches.
7. Categorize where (site) chemical products are used against cockroaches.
8. Explain how insecticide repellency will affect cockroach management.
9. Discuss the primary reason for bait failure.

GENERAL BIOLOGY

Cockroaches are among the most common insect pests found in buildings and homes. They are especially troublesome where food is prepared and sanitation is lacking. They may contaminate food, food preparation areas, kitchen utensils and other items, and they leave an unpleasant odor. Because cockroaches move freely between filth and food, they can transfer microorganisms that cause food poisoning and other illnesses. Many people are allergic to shed cockroach skins and their excrement.

Cockroaches are flattened, brownish, oval insects. Their head is flexed downward at rest and is concealed by a large shield-like plate called the pronotum. They have very long, threadlike antennae, large compound eyes, chewing mouthparts, and long, slender legs for running.

Cockroaches undergo incomplete metamorphosis. The female cockroach produces small, bean-shaped egg cases (called an ootheca or plural: oothecae) that are deposited (sometimes glued) in out-of-the-way places, but always near a food source. Nymphs emerge simultaneously from an egg case and as many as 50 nymphs may emerge, depending on the roach species. Nymphs resemble adults except they are smaller and lack wings. The nymphs molt several times and gradually become larger, inhabiting the same places as the adults. Cockroaches are prolific breeders, with some species capable of producing several hundred offspring in a year.

Cockroaches are nocturnal (most active at night) and stay in the dark whenever possible. They hide during the day hours and are thigmotactic, which means touch loving. They prefer the, bodily contact of gaps, crevices, other tight places, or each other. At night, they leave their hiding places in search of food.

Cockroaches are general feeders and will survive on a variety of foods, eating anything consumed by people. Their preferred foods have high starch and carbohydrate content. They will also feed on glue, hair, leather, soap, fabric, bookbinding, wallpaper, dead or living plant material, and filth.

These insects are gregarious (preferring to aggregate and harbor in groups) and large numbers may live in a small space. When cockroaches move from their harborage areas, they travel mainly along intersections, “structural lines,” and edges, such as along the back edge of a shelf or the juncture of the wall and floor or ceiling. Cockroaches commonly use plumbing and electrical lines to move from one room to another. This is a special concern in multiunit dwellings because attempts to control cockroaches in one unit may send them traveling to the next unit.

Entry into buildings can occur in various ways. They can be introduced in produce boxes, beverage cartons, grocery bags, or on furniture. Some species gain entry through cracks and openings around windows, through sewer lines, or on houseplants or firewood moved in for the winter. While cockroaches thrive where sanitation is poor, even the cleanest home or restaurant can become infested. Ways for pests to move into and around a structure, the sanitation level, and available water, food, and harborage are collectively called conducive conditions. These conditions promote the buildup of cockroaches (and other pests) in a structure.

MAJOR COCKROACH SPECIES IN UTAH

There are approximately 3,500 cockroach species worldwide and 50 species in the United States. Most of these are tropical insects. Only four are commonly found inside buildings in Utah. All life stages, including ootheca (egg case), can be used for identification. You need to know which species you are dealing with before you can prepare an effective management plan. More information on cockroach identification and IPM recommendations can be found at https://bit.ly/3fSvaVU.

German Cockroach *(Blatella germanica)*

The German cockroach is by far the most common and important cockroach species from the public health viewpoint.

Identification

- Adults are ½ to 5⁄8 inch (13 to 16 millimeters) long.
- They are tan with two dark stripes lengthwise on the pronotum.
- Their wings cover the entire abdomen; these insects do not fly.
- Nymphs are smaller and darker in color, with a tan stripe running down the middle of their back.

Life Cycle

- This species has high reproductive potential: 4 to 8 oothecae/female with 30 to 50 eggs in each egg case.
- The ootheca is carried by the female until the eggs are ready to hatch.
- A single mated female and the offspring she produces can produce an infestation of several thousand new roaches in less than a year.
- Three to four generations per year is common for this species.

Oriental Cockroach *(Blatta orientalis)*

The Oriental cockroach may be the filthiest of its type based on where it lives and what it feeds on.

Identification

- Adult males are 1 inch (25 millimeters) long; females are 1¼ inches (32 millimeters) long.
- Insects are shiny black or very dark brown.
- Females have very small wings; males have wings that cover ¾ of the abdomen; these insects do not fly.
- Nymphs are smaller, lack wings, and are similar in color.

Life Cycle

- This species has a lower reproductive potential: 8 oothecae/female with 16 eggs in each case.
- The ootheca is placed in a protected location within a day of completion.
- Eggs hatch within 60 days; the entire life cycle can take up to two years.

Brown-banded Cockroach
(Supella longipalpa)

Although similar in size to the German cockroach, this species is far less common in restaurants and other food-handling facilities but can be problematic in homes and apartments.

Identification

- Adults are ½ to 5⁄8 inches (13 to 16 millimeters) long.
- They are brown with two lighter bands across the base of the wings and the abdomen; wings commonly are golden in color.
- Males are narrow-bodied with wings covering abdomen; females have a broader abdomen and wings shorter than the abdomen.
- Males fly quite well and are attracted to lights; females do not fly.
- Nymphs are smaller and light brown; light bands run across the top of the abdomen, where a golden oval area is often seen.

Life Cycle

- This species has a moderate reproductive potential: 14 oothecae/female with 13 to 18 eggs/ootheca.
- An ootheca is carried by the female for up to 36 hours before she attaches it to an object (e.g., side or underside of a shelf or piece of furniture).
- Eggs hatch in 50 to 75 days; six months or longer are required to complete development from egg to adult.

American Cockroach
(Periplaneta americana)

The American cockroach is the largest and the longest-lived of the domestic species in the United States.

Identification

- Adults grow to 1½ inches (38 millimeters) long.
- Insect color is reddish-brown to brown with a pale, yellow band around the margins of the pronotum.
- Wings cover the abdomen; males are territorial and can exhibit gliding flight from a higher to a lower area.
- Nymphs are smaller and reddish-brown.

Life Cycle

- This species has a lower reproductive potential: 9 to 10 oothecae/female with 14 to 16 eggs/ootheca.
- Females drop an ootheca within a day of being formed and may attach the capsule to surfaces with secretions from her mouth.
- Eggs hatch within 55 days; the complete life cycle can take more than two years.

COCKROACH MANAGEMENT

The tolerance for cockroaches at any site is essentially zero, so any sign of their presence is unwelcome. If a customer reports seeing a single cockroach, ask where it was sighted. If the roach was far from a potential harborage site or appeared soon after items were brought into the building, there is a good chance the insect was hitchhiking. Advise the person to kill any cockroach seen and search any items for other roaches or oothecae. Monitor for cockroaches using pest monitors to verify their presence and species (i.e., sticky traps).

Some signs point to an infestation. For example, you can assume there is an active German cockroach infestation if the customer sees:

- 5 to 10 adults on countertops at night.
- Females carrying oothecae.
- Many small, dark nymphs.
- A mixture of adults and various size nymphs.
- Roach fecal spots, ootheca, or shed skins.

Also, an experienced applicator can identify an infestation by the distinctive odor these pests produce.

Inspection

Since cockroaches may hide in many places, a thorough inspection is essential to locate as many of these areas as possible. A great place to start is to conduct a client interview, which will provide insight into where the insects were seen and what items could be suspect in bringing roaches into the facility.

In addition to site inspection tools listed in Chapter 4, a flushing agent might be considered for conducting an inspection. The flushing agent irritates cockroaches and forces them into the open, thus revealing hiding places. This agent can be compressed air (such as used to clean computer keyboards) or aerosol pyrethrins. However, the pyrethrins may complicate control efforts by repelling roaches, causing them to move to new, previously uninfested areas. Have a vacuum (with HEPA filter) available to collect roaches that come out in response to the flushing agent.

Look for the following when inspecting a site for cockroaches:

- Live cockroaches.
- Dead roaches, including body parts.
- Shed skins.
- Ootheca.
- Dry fecal material (looks like dark grains of sand).
- Fecal spotting in corners (tiny dark spots).

When inspecting, don't overlook the possibility of there being more than one cockroach species present, especially in large buildings such as schools, hospitals, shopping centers, and multi-family dwellings. These sites provide environments that different species prefer.

Perform cockroach inspections in an organized, methodical manner because the countless cracks and crevices in a structure can harbor roaches. A systematic way to inspect a facility or home is to begin at a door and inspect one "zone" (3 to 5 feet; 1 to 1.5 meters) at a time, extending from floor to ceiling. Continue this procedure around the perimeter of each room, inspecting each piece of equipment or furniture encountered. Before leaving a room, inspect any items in the center.

Take notes and keep records of each inspection. Problem areas should be identified on the service record and building floor plan as a way to follow pest population levels over time and for clearer communication with clients.

Cockroach populations and locations can also be determined by using pest monitors, or sticky traps. Sticky traps placed every few feet along the baseboard or in other areas with suspected activity can give the pest control operator good information as to where roach populations are located, the species of roaches present, and the types of individuals present (i.e., adults vs. nymphs). Pest monitors can be used throughout a cockroach management program to track the progress of management techniques and also to catch and kill a small proportion of the roach population. Accounts treated for cockroaches would benefit from long-term monitoring with pest monitors to quickly recognize rebounding roach populations so that management action can occur swiftly. Accounts in food handling, manufacturing, processing, storage areas, etc. should always be monitored for the presence of cockroaches, even if they are not present. Catching cockroach populations early will make management easier.

Monitoring

Traps are also an important part of cockroach pest management. Consider traps monitoring tools to indicate species present, general locations in a structure, and population size and makeup (e.g., nymphs and adults vs. only adults).

Place sticky traps and glue boards at strategic locations, such as beneath sinks or behind refrigerators, and positioned flush against walls, corners, or at the junction of two or more construction elements.

Purchase monitoring traps with or without baits or lures. It is important to remember that these baits or lures are only attractive for 3 inches or less. Maximum activity occurs when cockroaches are presented with new environmental situations. Therefore, if an environment never changes (e.g., stored items left in one place for a long time), the cockroaches will explore less and spend as much as 90% of their time resting in harborages.

Sanitation

Good sanitation is extremely important for effective, long-term management of cockroaches. It is best to involve the customer whenever possible. Removing

available food and water stresses roaches and makes them forage over greater distances, which increases the chances of detection.

Clean up crumbs, grease, spills, and other food debris from floors, walls, furniture, and equipment. Wash all soiled dishes and kitchen utensils after use. Discard uneaten pet food after feeding. Store loose food in tight-fitting containers, and do not allow garbage, cardboard boxes and paper bags to accumulate. Remove items in food storage areas from cardboard boxes and store off the floor on stainless steel racks. Repair and routinely sanitize moisture leaks and floor drains.

Practical habitat alterations also are very important to cockroach management. This includes repairing defects such as loose baseboards and moldings; using copper wool and sealants around pipes and other wall penetrations to prevent access to wall voids; sealing cracks and crevices near food and water sources; and sealing around door frames, electrical outlets, and openings to hollow doors and table or equipment legs. Door sweeps can help keep out summer populations of American and Oriental cockroaches that emerge from sewer systems, outside drains, and so forth.

Remember that a cockroach infestation does not necessarily indicate poor sanitation or building upkeep. Once a population becomes established in a facility, sanitation and exclusion techniques will not eradicate it. Cockroaches are very adaptable and will find food and harborage, though the population size will be smaller.

Other Nonchemical Control Tools

Besides sanitation, there are a few other nonchemical options for cockroach management.

A temperature of 120° will kill roaches if exposed for several hours, while cockroaches held at 0° will die in an hour if the temperature drop is sudden. This approach can be useful for dealing with roaches brought into a site in boxes, sacks, or other small items.

A vacuum can remove roaches once their harborage is detected. Combining vacuuming with a flushing agent may let you remove more individuals. Make sure the vacuum is equipped with a HEPA filter so that allergens (e.g., shed skins and feces) are trapped rather than becoming airborne.

Although not a complete control tool, vacuuming is very useful because it:

- Reduces the population immediately, also reducing the total amount of other control measures.
- Removes pesticide-resistant individuals (an alternate method).
- Eliminates the need to remove people from the work area.
- Reduces the number of cockroaches (live or dead) that the customer encounters.
- Removes harmful allergens.

Chemical Control Tools

Wide varieties of insecticide active ingredients and formulations are available for cockroach control. Coordinate insecticide applications with other integrated pest management procedures. Insecticides placed directly into or near cockroach harborages will produce the best results. You will need to select insecticide formulations and products that are labeled for crack and crevice, spot, general, and structural applications. Always read the label to ensure the approved uses are completely consistent with the application.

Structures may have steamy areas, wet floors, or areas that are regularly washed down. Expect very little residual insecticide action in these locations, and consider using nonresidual products. Voids that remain dry, however, may most effectively be treated with dusts or residual aerosols with crack-and-crevice tips. Place bait applications near harborages and in areas where cockroaches are expected to forage. Greasy surfaces decrease the effectiveness of insecticide applications.

BAITS

Cockroach baits have revolutionized the pest control industry. These products incorporate small amounts of slow-acting insecticides in an attractive food substrate. Common active ingredients include abamectin, disodium octaborate tetrahydrate, fipronil, hydramethylnon, imidacloprid, indoxacarb, and orthoboric acid. Pastes and gels are applied in small dabs or spots close to harborage sites or injected into cracks and crevices, while dusts can be applied to places where roaches hide or travel. Plastic bait stations are also placed near cockroach activity, preferably near edges and corners. Smaller droplets of baits are more effective than large droplets in an area. However, you must set out baits in many prime locations when large populations are found.

Store baits away from other pesticides so that the baits do not pick up odors that will reduce their attractiveness to cockroaches. Likewise, it is best to use baits alone in a small area, so that a conventional insecticide does not interfere with the bait's effectiveness. If planning to bait and use a conventional residual insecticide, bait the roaches for a few weeks before applying a residual spray to maximize effectiveness.

BAIT FAILURES

As effective as baits are, you may still encounter situations in which they do not provide the expected control. The most common reasons for bait failures are poor sanitation, inadequate bait placement, immigration into the site, and bait aversion. Good sanitation ensures that roaches are drawn to baits rather than other food sources. Improper bait placement is often a result of inadequate inspection and/or time taken to place enough baits. Don't overlook the possibility that new roaches are being brought into the account, overwhelming the amount of bait previously placed.

Another cause of bait failures with German cockroaches is bait aversion, also called behavioral resistance. When this occurs, roaches actually move away from baits, especially when formulated as a gel. Cockroaches that avoid bait will survive and pass on that tendency to their offspring. You should suspect a problem with bait aversion if all of the following apply in the management site:

- Cockroach infestation has been continuous and longstanding despite the baiting.
- Roaches are not being introduced from outside the account.
- Sanitation is satisfactory.
- Bait was properly placed (e.g., correct location, amount, and number of placements).
- Baits have not been contaminated with cleaners or pesticides.
- Roaches are living in baited harborages.

INSECT GROWTH REGULATORS

Insect growth regulators (IGRs) can complement conventional insecticides in cockroach management programs. Properly timed applications will cause abnormal development (deformed wings and/or sterile adults) and provide effective control. Hydroprene is the most common IGR active ingredient.

REPELLENCY

Many insecticides repel cockroaches, including some dusts. This behavioral characteristic is strongly exhibited by German, American, Oriental, and brown-banded cockroaches. Because repellency causes avoidance by cockroaches, the entire building may need treatment at the same time. Cockroaches repelled from an infested area may seek harborage in previously uninfested areas, thus monitoring throughout the entire structure is essential. Recent studies have shown that many insecticide dusts are repellent. Even food-grade flour and sugar can repel cockroaches. Boric acid was the least repellent powder tested. Most commonly used liquid insecticides also repel roaches, while microencapsulated formulations are less repellent.

RESIDUAL TREATMENTS

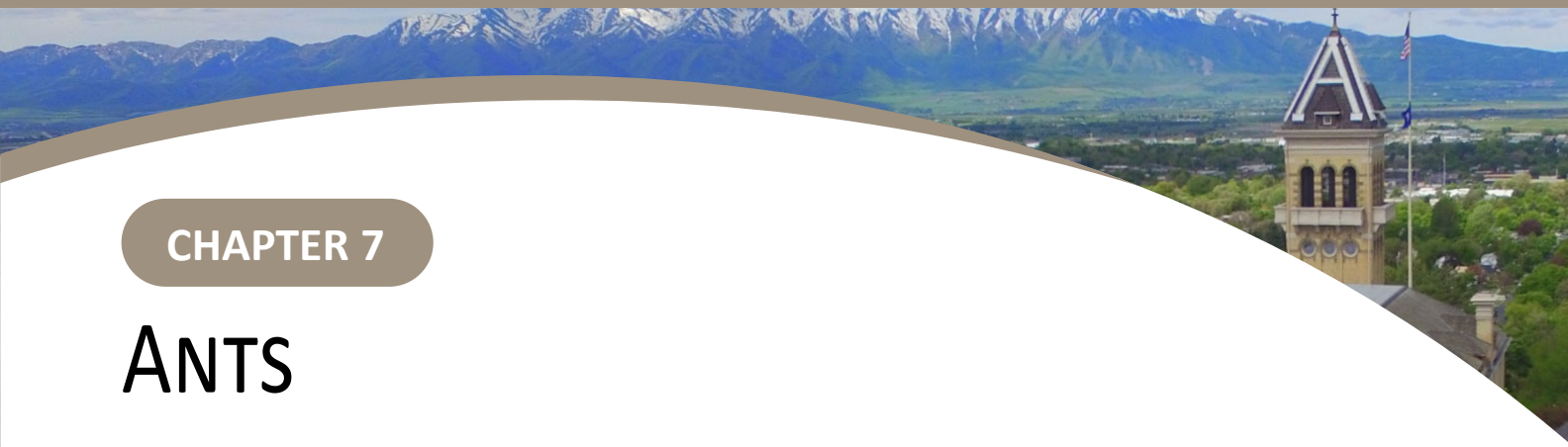
Crack and crevice treatment is a standard approach for all species because cockroaches like to hide in small spaces. This type of application has the advantages of using little product, placing the pesticide where it is needed, and minimizing the exposure to people. Common active ingredients applied in cracks and crevices include acephate, bifenthrin, chlorfenapyr, cyfluthrin, cypermethrin, imidacloprid, lambda-cyhalothrin, permethrin, prallethrin, and pyrethrins.

Dusts are preferred for treating wall voids. You need very little dust to effectively coat the interior surfaces of the void (heavy dusting is wasteful and repellent). Dusts have the advantages of residual action and are safer to use around electrical lines and outlets. Common dust active ingredients include boric acid, deltamethrin, orthoboric acid, pyrethrins, and silica.

Residual insecticides are also labeled for spot treatments where roaches forage, as well as for barrier treatments, to prevent cockroaches from entering an area or building.

NONRESIDUAL TREATMENTS

Nonresidual insecticides are those products applied to obtain control of roaches only during the time of application. These products are often applied with aerosol or ultralow volume equipment, directed into areas of suspected cockroach harborage. Avoid indiscriminate dispersal of nonresidual insecticides into the air (e.g., fogging or space treatment) in kitchens, dining rooms, storage areas, etc., because it will only drive cockroaches deeper into wall voids or other protected locations. Common active ingredients of nonresidual insecticides include hydroprene, prallethrin, and pyrethrins with piperonyl butoxide.



CHAPTER 7

Ants

LEARNING OBJECTIVES

After studying this chapter, you will be able to:

1. Define swarm, budding, trophallaxis, petiole, gaster, trail pheromones.
2. Describe the social order within ant colonies.
3. State the key body characteristics used to identify ant species.
4. Distinguish winged ants from termites.
5. List the four approaches for managing ant infestations.
6. Discuss how baiting controls ant colonies.
7. Name three ant bait formulations.
8. Discuss the choice of insecticide and application site for ant management.

GENERAL BIOLOGY

Ants are among the most common pests in and around buildings. They may build nests in the soil, under concrete slabs, stones, or boards adjacent to foundation walls, in the walls of a structure, or in decaying wood. The activities of most ants are more annoying than harmful, especially when they enter buildings in search of food. On occasion, ants will contaminate food and can mechanically transfer disease-causing organisms, but they are generally not considered a public health pest.

Ants undergo complete metamorphosis. Larvae are white, legless, and grub-like. Most clients only encounter adult ants, as the "brood" (eggs, larvae, and pupae) are protected and tended in the ant colony. Find more information on ant identification and IPM recommendations at https://bit.ly/3fSvaVU.

THE ANT COLONY

Ants are social insects and live in colonies of hundreds or many thousands of individuals. There are three distinct adult castes in their social order: queens, workers, and males.

- Queen ants are responsible for laying eggs. Some ant species maintain more than one active queen in the colony.
- Worker ants are wingless, sterile, female ants that comprise most of the members of the colony. This caste is responsible for foraging for food, tending the queen, caring for brood, building and repairing the nest, and protecting the colony. Commonly, different individual ants specialize in a particular task.
- Male ants are only produced before reproductive activity in the colony. They have fully formed wings. Along with winged, reproductive females, these individuals leave the nest, swarm in a "nuptial flight," and mate. Winged reproductive ants are called swarmers. Some ant species will mate within the nest before leaving to start a new colony.

Swarms can involve thousands of individuals leaving the nest within an hour. Often, ant swarms are brought on by environmental conditions such as rain events. The winged swarmers are often confused with swarming termites, but they can be distinguished by differences in wings, antennae, and petiole (the "waist" between the thorax and the large part of the abdomen called the gaster). Ants have elbowed antennae, a narrow petiole, and unequal wing length (front wings longer than hind wings). Termites have thread-like antennae, a broad waist, and wings of equal length. Find more information on how to tell winged ants from termites at https://bit.ly/3fSvaVU.

Starting a New Colony

After the winged reproductive ants finish mating, the males die. Each winged female will search for a suitable nest site, tear off (or perhaps eat off) her wings, and begin a new colony. The female will lay eggs and tend the young, feeding them with secretions from her mouth. Once the young develop into workers, they will assume colony responsibilities and the queen will continue egg-laying. Approximately 90% of new queens fail.

Ant species with multiple queens can start new colonies by budding. A queen mates within the nest (without swarming) and, with workers and some brood, leaves the parent colony to start a new colony at another location. This type of colony formation is more successful because it already contains workers.

Colonies can live for several years and move from place to place. If a nest site becomes too small, dry, or otherwise unsatisfactory, the workers move the queen and brood to a

new site. This type of behavior and budding can be a response to pest management control efforts, so it is important to realize how quickly an ant colony can establish a new nest site.

Foraging and Feeding

Ants eat a wide variety of foods. Common foods include other insects, seeds, nectar, greases, sugars, and honeydew (excretion of plant sap-feeding insects such as aphids and soft scales). Even within a species, preferences will change over the year and may depend largely on what foods are available. Food is gathered by foraging workers and carried to the nest for sharing with other members of the colony. This food-sharing behavior is called trophallaxis.

At any given time, only a small percentage of workers will leave a colony to forage. It is this behavior that most frequently brings ants inside a structure. The foraging workers will leave chemical trails (called trail pheromones) when they find food so that other foragers can find the food source and bring it back to the colony. This explains why a client will see lines of ants coming and going from a food source, such as unrinsed dinner dishes in the kitchen sink.

MAJOR ANT PESTS

Each ant species will have its peculiar traits. Knowing where ants prefer to nest, how they forage, what they eat, and when and how they set up new colonies is essential to every step of the pest management process, from initial inspection through the implementation of a management plan.

Collect worker ants at the job site for identification. If necessary, set out honey or peanut butter on an index card and wait for ants to arrive. Check the card within the hour. Once ants arrive at the bait, pick up the card with ants on it, place in a Ziploc plastic bag, and hold in a freezer.

Later, look at the ants under the microscope and preserve some in alcohol as a record. Ant identification to species can be difficult and may require the help of a qualified entomologist. Ant identification is based on workers and involves looking for traits such as:

- Shape of the thorax.
- Number of nodes making up the petiole.
- Spines on the thorax.
- Antennal segments and clubs.
- Color and size.
- Distinctive odors when crushed.

ANT MANAGEMENT

There are four approaches for managing ant infestations:

1. Pest-proofing and sanitation.
2. Using baits to deliver pesticide into the nest.
3. Treating the nest directly.
4. Barrier treatments.

The management approach will depend on the species present, the results of your initial site inspection, and any previous management efforts.

Inspection

The ant colony is the source of all the individual ants that your clients will encounter, whether they are workers foraging for food or swarmers flying in the structure. Finding the nest, or at least determining that it is not in the building, is the primary goal of your inspection. Follow foraging ants carrying bits of food as they return to the colony.

Indications of an indoor nest site include consistent ant foraging over a long period, nest materials (e.g., wood shavings) observed inside, ant foraging during the winter, foragers in a high-rise building, or swarming of winged ants. Using sticky traps may prove helpful. Outside nesting is indicated by worker trails that lead outside and nesting sites (e.g., soil mounds or wood shavings) next to the foundation.

Sometimes locating the nest is not possible. Alternatively, you can learn more about the ant activity by identifying foraging trails. Are ants coming from outside a building, from under a slab, or from somewhere in a wall? Taking the time to assess foraging activity is a crucial part of the inspection.

Note site conditions that are attractive to ants. Poor sanitation, insufficient seals around doors and windows, water-damaged wood, or cracks in the foundation are among the items to look for.

Pest-proofing and Sanitation

Ants will explore much of their surroundings to find food, water, and new nest sites. One way to prevent ants from foraging or nesting indoors is to exclude them. Sealing around doors and window frames, pipes penetrating the building envelope, and cracks in the foundation go a long way to keeping ants outside. Other methods include having tightly fitting doors and window screens, repairing siding or shingles, and draining water away from buildings.

Sanitation is especially important in accounts where pest-proofing is difficult to achieve (e.g., poorly maintained older homes, public schools, and commercial buildings built on slabs). Ants will stop foraging in an area when their efforts are

fruitless. One achievable sanitation goal is for the building occupants to keep the kitchen and break areas extra tidy and clean in the spring and summer when many ants seek out food sources and establish trails.

Baiting

Use nontoxic ant baits to determine the focus of an infestation or to locate small, isolated colonies. This baiting can also help you determine what type of food (e.g., sweet, protein, grease) the foragers are taking back to the colony.

Foragers take ant baits containing slow-acting insecticides back to the colony. The products have to be slow-acting to give the ants time to return to the nest and share the bait with other workers, brood, and the queen(s). Baits allow for the elimination of the colony without having to find and treat the nest directly.

The key to bait success is acceptance. Avoid any actions that will prevent ants from accepting the bait and taking it back to the colony. For example, using a repellent, residual insecticide when baiting may act as a repellent or kill the foragers directly.

Sanitation is also important for bait acceptance. If ants have plentiful food sources available, they will choose those foods over the bait. Sanitation, though, does not remove natural food sources (e.g., honeydew, carrion, dead insects) that will always compete with baits.

Place baits as close to foraging trails as possible to increase the chance ants will take the bait. If pre-baiting reveals ants are taking two types of foods, set out different baits (even side by side) along trails or near nest sites. Be sure to place enough baits, both to increase the chance ants will find the bait and ensure that enough bait is returned to the nest to provide control.

Baits come in several formulations. Liquid and gel baits are sugar baits. Granules, pastes, and liver baits offer protein to ants. Yellow, oily baits provide lipids.

- Liquid baits. Liquids come pre-baited or can be added to stations. These require maintenance due to evaporation, which increases the concentration of the toxicant and chances that the bait will kill the foragers before they return to the nest. One improvement is to use covered stations or stations with foam tops. Ants can feed through the foam without the risk of falling into the bait and dying. A similar strategy would be to put bait in a vial and plug it with a piece of a cellulose kitchen sponge.
- Gel baits. Gels come in tubes for injections into stations or placement directly on surfaces. These baits require less maintenance than liquids and are easy to use, which makes them popular among pest management professionals.
- Granular baits. Granules are used for ants that nest in the soil, leaf litter, or mulch. Place bait around

active mounds or near ant trails. Avoid placing granules directly on the mounds, as this will alarm the ants and lead to bait rejection. If you are unsure of colony locations or if there are a large number of colonies in an area, you can apply granules as a broadcast treatment. Make sure this equipment is dedicated to this purpose, as equipment used to apply other chemicals will impart odors and lead to bait rejection.

Barrier Treatments

A barrier treatment is an alternative if pest-proofing and sanitation have not solved the problem and the nest cannot be located. Although some worker ants will be killed by the residual insecticide treatment, this method mostly serves as a repellent. Properly applied, it should even stop ants from using well-established foraging trails. In other situations, a nonrepellent insecticide may be used as a perimeter application. The goal of this type of application is to allow ants to travel over the chemical band and transfer it mechanically around the nest.

To successfully complete a barrier treatment, the product label will provide valuable information such as:

- Distance from the foundation outward (commonly 4 to 10 feet).
- Height up the foundation the treatment should be made (commonly 3 feet).
- Possible need to treat shrubs, mulch, and perennial plants within the treatment zone.
- Possible requirement to water in a granular insecticide.
- Specific sites for treatment, including under siding where it overlaps the foundation, under doorjambs, sill plate in the crawlspace, and any visible cracks or crevices.

Effective formulations include wettable powder, suspension concentrate, and microencapsulation, especially on brick veneer homes.

Barrier treatments are temporary solutions and may need to be repeated (as per label directions) when ants appear in the treated area. This need to repeat the application, as well as the relatively large area treated and the amount of insecticide required, explains why barrier treatments are NOT the first choice for ant control.

If ants problems continue indoors after a barrier treatment, then either the colony is nesting indoors or the ants are getting access to the building from above (e.g., telephone wires, overhanging tree branches) or below the ground (e.g., tree roots, pipes, utilities, structural cracks). Re-examine the possible nesting sites or access points to the structure.

Treating the Ant Nest

Once located, use a residual insecticide to treat a nest. Outdoors, you can use liquid or granular products. If you use a liquid, be sure to use enough water to thoroughly drench the material into the nest. To treat a carpenter ant nest in a tree cavity, you may need to drill an access point at the top of the nest and then apply the liquid. Under a Category 7: Structural and Health-Related license, you are permitted by Utah state law to treat nests only if located within 3 feet of the structure unless the label states otherwise.

Indoors, aerosols and dusts are the preferred formulations. Use aerosols if you uncover the nest during an inspection. Spray all of the ants before they get a chance to disperse. Choose dusts when nests are located in voids and areas involving electrical wiring. Dusts provide a long residual effect, so not only current ants but also future ants are killed. Aerosols may distribute better within insulated walls. You may need to drill holes in floors, walls, or ceilings to gain access to the void where the nest is located. Use wood putty to plug these holes after treatment.

State law permits Category 7: Structural and Health-Related applicators to treat up to 3 feet away from the structure unless the label states otherwise. Treatment beyond state or label limits will require possession of a different license.

SPECIAL MANAGEMENT CONSIDERATIONS

Two pestiferous ant species require special considerations to achieve complete control.

Pharaoh Ants

Proper identification of pharaoh ants is crucial, and management must be done with care to avoid making the problem worse. Applying the wrong pesticides, or even the wrong formulation, may potentially cause the colony to bud into several colonies; this results in the ants infesting several new locations. Before applying a direct application, pre-bait with nontoxic mint jelly. Otherwise, the ants will disappear and give the impression that the colony has been destroyed. However, 7 to 10 days later, new colonies reorganize and the ants will continue their foraging activities.

Baiting is the most reliable method for controlling this species. Place one bait station per foraging trail, near the entry/exit point of the wall or nest area. Do not disturb or agitate the ants because they may move the nest.

Carpenter Ants

Dust treatment of the nest best controls carpenter ants. Baits can also control this species if the nest cannot be located or is inaccessible (e.g., high in a tree). Baiting will likely take more time and more frequent visits, so discuss this with your client. When baiting for carpenter ants, place baits near the base of a tree from which foragers emerge. This will reduce foraging pressure on the structure and will also result in foraging trails away from the structure. Gel

baits can be very effective against worker ants found indoors in the winter. Note that a Category 15: Wood-Destroying Organisms license is required for controlling carpenter ants, wood-boring or tunneling insects, bees, wasps, wood-decaying fungi, and any other pests destroying wood products.

CHAPTER 8

Nuisance Flies

LEARNING OBJECTIVES

After studying this chapter, you will be able to:

1. Explain the human health concerns from nuisance flies.
2. Describe the general life cycle of flies.
3. Understand the importance of sanitation.
4. Discuss the two types of traps used in fly pest management.
5. Explain the role of chemical products in fly management.

GENERAL BIOLOGY

Several types of flies exist in and around homes. Most of these are invaders from outdoors while a few are produced indoors in specific situations. The flies discussed in this chapter are considered an annoyance and a possible indication of unsanitary or unpleasant conditions. There is a slight possibility that flies can mechanically transfer disease-causing organisms. These flies do not bite or sting humans, nor do they feed on furnishings or structural elements in a facility.

Flies under complete metamorphosis. They have very specific requirements for egg-laying sites where larvae will develop. Maggots (fly larvae) have chewing mouthparts, are legless, and usually white or off-white. Pupae are usually encased in a brown, capsule-like structure. Adults have one pair of wings and are highly mobile. Adult flies have sucking or sponging mouthparts that project downward from the head. Solid food must be liquefied with saliva secreted from the mouthparts before ingestion. Find more information on fly identification and IPM recommendations at https://bit.ly/3fSvaVU.

FLY MANAGEMENT

Inspection

A detailed facility and site inspection must occur to find and eliminate all fly breeding sources. These investigations should begin inside a building and then move to the exterior foundation, landscaping, and neighboring properties. Adult flies will typically lead you to the breeding sites, as these insects are highly attracted to odors associated with breeding materials. Failure to eliminate breeding sources will negate any other attempted control methods.

Traps

Once flies are inside a building, electric light traps can be used to capture winged adults. These traps usually employ ultraviolet light as an attractant and kill either by electrocution or entrapment on replaceable glue boards. Carefully follow the manufacturer's directions for trap use and maintenance. For these traps to be effective, properly position them along routes of fly entry and movement. Install traps at the proper height (usually within 5 feet of the floor) and away from windows and other competing light sources. The glow of the light trap should not be visible from outside the structure; otherwise, the trap will attract insects into the building when doorways are open.

Use bottle or jar traps to capture adult flies for identification purposes. Bottle traps are especially useful for trapping vinegar flies and humpback flies once the breeding source is eliminated. You can make a simple jar trap by placing a paper funnel into a jar containing a few cotton balls (to reduce evaporation) and then adding a few ounces of cider vinegar or fermenting substance as the bait.

Sanitation

Sanitation is the single most important step in controlling flies because it removes both food and breeding sites. It is best to involve the customer whenever possible. Small amounts of garbage or organic waste can support hundreds of developing flies. Regular cleaning of the facility and deep cleaning of the kitchen and break rooms is very important in decreasing food for fly development. Pay attention to edges and corners of a room and under equipment, as food debris builds up in these areas. Clean out floor drains regularly using a stiff brush and/or a biological product formulated for this purpose. Fix plumbing leaks as discovered.

Also, sanitation includes disposal of excrement, garbage, animal carcasses, proper storage of waste materials, and adequate drainage (interior and exterior). "Gray" wastewater is highly attractive to flies. Clean garbage cans and dumpsters regularly with steam cleaning or pressure washing, or have them replaced by the sanitation company. Move garbage cans and dumpsters as far away from the exterior of the building as practical. It is best to keep these containers covered to prevent them from

attracting flies. Remove trash from the site weekly from residences and nonfood businesses, and daily from restaurants and similar businesses. Open sewage pits and wastes from food-based industries are sources of heavy fly breeding and can cause more problems in nearby residential areas. Broken septic or sewer lines require soil excavation, removal of all the leaked sewage, and repair.

Exclusion

Another very important nonchemical method of preventing fly problems in buildings is exclusion. Exterior doors and windows should be tight-fitting, properly screened, and kept closed whenever practical. Plastic strip curtains, air doors, and self-closing doors can deter fly entry into a structure. Seal and tighten around all openings such as doors and windows, plumbing entries, ventilators, and eaves. Inspect around the soffit and wall junction and the soffit face board, and look for loose siding boards; seal gaps when discovered.

Chemical Control

Insecticide sprays may temporarily reduce the numbers of flies, but this method will not eradicate a problem. Space sprays provide very brief control. These nonresidual contact sprays provide quick knockdown of adult flies but do not affect developing maggots. Active ingredients include synergized pyrethrins and pyrethroids (e.g., allethrin and resmethrin). An application can be made with aerosol-type dispensers, ultralow volume, or fog-generating equipment. For optimum results indoors, apply the precise amount of material per cubic area specified on the pesticide label. Read the product label for the appropriate personal protective equipment. Put all food away and cover utensils and food preparation surfaces before spraying.

Residual sprays or dusts in resting sites or entry points can be helpful, especially outdoor sprays to prevent entry by cluster flies. Treatments should be applied as coarse, low-pressure sprays where flies rest and will most likely absorb a lethal dose (e.g., around garbage dumpsters or sun-exposed walls adjacent to a doorway). Wettable powder and microencapsulated formulations are very effective for this purpose. Pyrethroid insecticides (e.g., cypermethrin, cyfluthrin) are the most common active ingredients used for residual treatments.

Fly baits are a mixture of toxicant and attractant and are used primarily to control house flies. Most bait contains sugar and the house fly sex pheromone, musculature. This combination keeps the fly in contact with the toxicant for a longer time. Fly baits are typically formulated as granules that are placed in shallow trays or scattered around dumpsters and other fly-breeding areas. Their effect is short-lived unless the bait is reapplied.

CHAPTER 9

Stored Product Pests

LEARNING OBJECTIVES

After studying this chapter, you will be able to:

1. List when food pantry pests can infest food.
2. Name the protein that fabric pests can digest and use for food.
3. Discuss how source reduction and prevention affect stored product pest management.
4. List the pesticide formulations available to use against stored product pests and where to apply them.

FOOD PANTRY PESTS

Nearly all food products may be attacked by one or more of the many insects collectively referred to as pantry pests. They eat or contaminate the products and may make them unfit for human consumption.

Infestations can occur at every point between origin and final use. Insect pests can infest food while:

- In the field as crops.
- Stored by the producer or grain elevator.
- In the process of converting raw commodities into food.
- During some stage in transportation.
- Stored in a warehouse or a retail outlet.
- Stored before consumption.

Most commonly, insect pests become problems in foods stored for some time, often beyond their expiration date. Pantry pests can infest rooms other than the kitchen. When this occurs, they are likely feeding on ornamental seed or plant displays, dried flowers, ornamental corn, potpourri, or even rodent baits.

The common stored food pests are beetles and moths. Both groups of insects exhibit complete metamorphosis and can produce several generations each year. All stages are present in food pantries, though adults commonly leave the infested products and move about inside a structure. Beetles or moths may be seen a considerable distance from the infested food.

FABRIC PESTS

Fabric pests are unwelcome in homes, businesses, and museums because they will eat a variety of items (fur, feathers, piano felts, upholstery, clothes, animal collections, and carpeting). They are unique scavengers because they have the rare ability to digest keratin and use it for food. Keratin is a protein found in animal hair, fingernails, hooves, skin, wool, hide, and bird feathers.

Both beetles and moths undergo a complete metamorphosis. The larval stage causes the damage, but the first sign of an infestation is usually the presence of adults in an area.

PAPER PESTS

Some insects can feed on paper, wall coverings, paperboard, and books. They can cause problems in homes, business files, libraries, and museums.

MANAGING STORED PRODUCT PESTS

Managing stored product pests is somewhat dependent on the specific pest(s) present. The use of one or more of the following is recommended to properly manage the pest problem.

Inspection

Inspection is a major part of eliminating stored product pests because pests are often discovered when adults start moving around a structure. Detection is difficult because of their small size and hidden feeding sites.

- Check for pests, cast skins, and insect trails in spilled product dust or debris.
- Inspect under, around, and inside packaging for penetration and/or exit holes, as well as for insects in seams and folds.

- Investigate potential problem sites (e.g., areas where seasonal clothes are left in storage for several months).
- Seal any cracks and crevices discovered during an inspection.
- Take detailed notes as you inspect.

Sanitation

There are several things that the customer can do to reduce the food attracting stored product pests in their building. Securing client cooperation and participation will speed up management efforts.

- Dispose of any food, fabric, or other infested item. If the customer wants to keep something that has been fed upon by insects (e.g., birdseed), tell them to place the item in an oven at 130° for 30 minutes or put it into a freezer at 0° for three days. Either approach will kill all life stages present.
- Improve sanitation, which is very important in managing stored product pests. Most of these insects are small and can survive on very little food. Empty cabinets and storage closets, then thoroughly clean surfaces with soap and water. Use a vacuum cleaner to clean cracks and crevices, which can harbor both food and insects.
- Clean infested clothing by washing the item in hot water or dry cleaning. If wall-to-wall carpets or throw rugs are attacked, they may need to be removed or cleaned.
- Reduce high humidity and moisture within a building by repairing plumbing and increasing the ventilation.
- Use sticky traps that have food attractants or sex pheromones (chemicals released by females to attract males for mating) for some pantry pests. Use traps to monitor for the presence of these insects or to assist in population reduction.

Chemical Control

In certain situations, the proper use of a labeled insecticide complements pest management efforts. Keep in mind, though, that insecticides will not solve a problem if the source is not found and eliminated.

- Very few pesticides can be applied directly to food products. If using pesticides to control a stored product pest, remove food and follow the label directions to prevent food contamination.
- A residual crack and crevice or spot treatment may be required to kill wandering insects and to prevent reinfestation from wall or ceiling voids where adults have found harborage.
- Place traditional insecticide dusts in attics or structural voids to control fabric pests feeding on accumulated dead insects. Use inorganic dusts and microencapsulated pesticides in high-temperature sites.

- Follow labels on granular baits to control some stored product pests (e.g., silverfish).
- Baseboard spraying, fogging, and broad area treatments are generally ineffective and waste insecticide and the pest manager's time.
- Do not apply pesticides to clothing. Dry clean or launder these items instead.
- Common active ingredients for insecticides used to control stored product pests include pyrethroids (e.g., bifenthrin, cyfluthrin, deltamethrin, lambda-cyhalothrin, permethrin, pyrethrin), diatomaceous earth, and silica gel.

Prevention

Once a stored product pest has been eliminated, give the customer a list of instructions to prevent reinfestation, including:

- Inspect food packaging at the time of purchase and do not accept any ripped or damaged package.
- Check the date of expiration. If the contents cannot be used before expiring, choose another package with a longer expiration date.
- Keep food storage areas clean.
- Store dried foods in tightly fitting glass, metal, or plastic containers or the freezer (if appropriate).
- Label products with the date after purchase and use older products first.
- Regularly clean (or launder or dry clean, where appropriate) the facility or vulnerable items.
- Store valuable items (e.g., bridal gown, tuxedo, furs) in specialized storage containers after dry cleaning.
- Remove dead insects and nests (e.g., wasp, bird) that stored product pests may use as a food source.
- Use mothballs (naphthalene) or cedar wood as repellants when appropriate and permitted by the product label.

CHAPTER 10

Accidental Invaders

LEARNING OBJECTIVES

After studying this chapter, you will be able to:

1. Define accidental invader.
2. List three needs each pest species must have to survive in a site.
3. Identify common places that pests can enter a structure.
4. State the three methods used to manage accidental invaders.

OVERVIEW

The term "accidental invader" includes those pests that may occur in buildings at some stage of their life cycle, but that do not usually complete their entire life cycle within the structure. These are also called occasional invaders because they do not regularly occur inside. These pests are uniformly disliked even though they are generally harmless and cause no damage to buildings, furniture, or occupants. Some exceptions do occur; for example, multicolored Asian lady beetles can bite as well as cause strong allergic reactions in people.

"Invasion" is often triggered by migration from a nearby, heavily populated habitat, or by some environmental condition such as decreasing or increasing temperatures or changes in moisture. Their movement into a structure is merely accidental, often the result of foraging, but these structures provide all three items an organism needs to survive: food, water, and shelter.

MANAGING ACCIDENTAL INVADERS

Managing pests that accidentally wander into a building is somewhat dependent on the specific pest(s) present and how they entered the structure. Generally, nonchemical methods are the most successful in solving the problem.

Exclusion

Because these pests originate outdoors, exclusion techniques to prevent their entry are preferred.

- Seal cracks and gaps in foundations, siding, around chimneys, windows, doors, and any utility service (e.g., electric, gas, water) penetrating the outside building structure. Keep in mind that these pests can enter from ground level to the roofline.
- Use well-maintained and tightly fitting windows, doors, and screens. Adjusting or replacing door brushes or rubber door threshold seals may be required.
- Use nonattractive lights (e.g., yellow incandescent or sodium vapor) if security lights are present.
- Close curtains or window shades to minimize interior lighting that would draw arthropods near a structure.

Habitat Modification

Habitat modification is sometimes partially successful in managing accidental invaders. To decrease outdoor hiding and breeding places near a structure:

- Maintain a 2- to 3-foot wide vegetation and mulch-free border around the foundation.
- Mow lawns and remove clippings from around the building perimeter.
- Decrease lawn fertilizer in turfgrass near the building.
- Use less mulch in planting beds and rake piles of moist mulch so it can dry out.
- Weed planting beds regularly.
- Remove rotting wood and leaf litter from around entry doors.
- Prune back trees and shrubs away from the building.
- Move rock piles, firewood, equipment, and construction debris away from the building.
- Modify the downspouts and/or tile the site to drain water away from a structure if water accumulation is noted during the inspection.
- Revisit exterior lighting.

Ideas for modifying the habitat inside a structure include:

- Correct any moisture problems in the ground level or basement areas.
- Decrease clutter and thoroughly clean rooms with exterior doors to minimize hiding places for incoming pests.
- Vacuum any pests encountered and dispose of the debris in a plastic garbage bag.
- Place sticky traps (used for cockroach monitoring) near

exterior doors and windows, as these are effective in catching many structural invaders and will show where the pests are coming in.

Chemical Control

There are some situations in which a pesticide application to the outside of the building, surrounding landscape, and cracks and crevices helps control accidental invaders. A similar treatment inside the building, however, is generally not recommended.

- For effectiveness, make wide (4 to 10 feet) barrier treatments to the landscape surrounding a structure with a labeled, residual insecticide. Repeat applications may be required during periods of heavy migration. Note that a Category 3: Ornamental and Turf license is required to make applications more than 3 feet from a structure.
- Bait, granular, microencapsulated, and wettable powder formulations may sometimes prove more successful than other formulations.
- Timing of pesticide applications should coincide with the beginning of migration events, which is late summer or early fall for most accidental invaders; elm seed bugs prefer to invade in midsummer. Observing pests in nearby trees or shrubs (e.g., boxelder bug) may justifies a spot insecticide treatment.
- Examples of active ingredients used in barrier treatments include carbaryl, fipronil, indoxacarb, neonicotinoids (e.g., acetamiprid, clothianidin), and pyrethroids (e.g., beta-cyfluthrin, bifenthrin, deltamethrin, lambda-cyhalothrin, permethrin).
- Pyrethroid labels have special requirements for outside applications to reduce drift (wind-carried contamination) and runoff (storm water-carried contamination). Some of these requirements follow.
    - Limit spot and crack and crevice treatments to impervious surfaces (e.g., sidewalks, driveways, porches, and patios).
    - Apply bands up to 1 inch (2.5 centimeters) to cracks or other potential pest entry points.
    - Applications are permitted to the exterior of buildings, as the label allows, where the treated surfaces are underneath eaves, soffits, windows, or doors protected from rainfall by coverings, overhangs, awnings, or other structures.
    - Limit applications to crack and crevice or building foundations up to a height of 3 feet (1 meter) only if the exterior of a building is not protected from rainfall.
    - Make treatments using a coarse, low-pressure spray to portions of surfaces that are directly above bare soil, lawn, mulch, or other vegetation.
    - Find other limitations and applications permitted on product labels.

CHAPTER 11

Blood-feeding Pests

LEARNING OBJECTIVES

After studying this chapter, you will be able to:

1. Define ectoparasite, nit, pediculosis, and canine detection.
2. List three blood-sucking insects found in or around a structure.
3. Identify three signs of a bed bug infestation at a site.
4. State the activity period(s) of bed bugs.
5. Name ways bed bugs can move unassisted or assisted by humans.
6. Identify monitoring tool(s) for blood-feeding pests.
7. Understand issues in designing a management program for ticks, fleas, bed bugs, and lice.
8. Explain why delusional infestation may be encountered by a pest manager during business activities.

OVERVIEW

A few species of arthropods feed on the blood of specific animal hosts, with some intentionally or accidentally feeding on humans. These pests are called ectoparasites when they feed externally, taking blood from their hosts. In addition to the irritation of their bites, some of these pests may transmit serious disease-producing organisms.

Pest management approaches will be discussed for each type of pest because control methods vary. It is important to note, however, that you can treat the environment (e.g., structure and its perimeter) but you cannot treat pets, other animals, or humans. Chemical management of blood-feeding pests on animals or humans should come under the direction of a veterinarian.

TICKS

Ticks are small arthropods, more closely related to spiders and mites than to insects. Several ticks are parasites of animals, with humans serving as an alternate host. Their life cycle includes the egg stage, a six-legged larval stage, the nymph stage, and the adult stage; the nymphs and adults have eight legs. All life stages (after egg stage) suck blood through a specialized mouthpart called a hypostome. Find more information on ticks and tick-borne diseases in Utah can be found at https://bit.ly/3fSvaVU.

Ticks find a host by climbing vegetation and reaching out from this perch to grab onto a passing host. These arthropods locate hosts by the carbon dioxide, host odors, and/or heat coming from the host. After feeding, ticks drop to the ground for their next life stage (molting or laying eggs).

Ticks are most commonly found in woodland, mixed shrub, and overgrown areas. They are especially common along overgrown borders and paths since passing hosts frequent these areas. Ticks are seldom found in open areas of mowed yards.

Ticks generally resemble the shape of watermelon seeds. On the back of most common ticks is a shield called a scutum. This structure is often colored and textured and can help with species identification. The scutum covers the back of male ticks, but only covers the anterior portion of the back of females.

TICK MANAGEMENT

Integrating the following management methods in a short time period will have the greatest impact on controlling tick populations.

Indoors

Tick control indoors is limited to brown dog tick infestations, since the American dog tick and the Pacific blacklegged tick cannot complete their life cycles indoors.

Management of the brown dog tick in homes requires frequent inspection and removal of ticks from pets. Launder and routinely vacuum pet bedding, rugs, floors, and furniture, especially along baseboards and behind furniture. Insecticide treatment should focus on cracks and crevices along baseboards and molding, around door and window frames, underneath furniture, beneath the edges of carpeting, behind loose wallpaper, and in similar hiding areas. Pay special attention to where the dog spends time. Remind the homeowner to keep children and pets off treated surfaces until sprays have dried. Because the eggs and immatures may take several weeks to hatch or molt, retreatment may be necessary to eliminate all brown dog ticks in a structure.

Outdoors

While ticks are not common outdoors in the Salt Lake Valley, they are found in wooded state parks or forests. Ticks are sometimes a problem in yards, especially when pets live outdoors. Ticks also reside in parks, camps, picnic sites, and other unmowed recreational areas. One method of determining if ticks are present is to drag a 3 feet x 3 feet (1 meter x 1 meter) white flannel cloth through suspected areas. Ticks will attach and be visible against a white background. Reduce tick populations in these areas by mowing lawns and trimming other vegetation, thus creating a less favorable habitat for ticks and their wild hosts. Discourage wildlife by keeping lids on garbage cans and stopping the practice of feeding wild birds. Dropped birdseed encourages mice to live nearby. In some cases, wild birds may carry ticks to a new location.

Repellents are an important element in protecting people in the area. Apply these chemicals to clothing and areas of the body specified on the product label. Educate people to tuck in shirt and pant legs when walking in tick habitat. In addition, check clothing and skin after trips outdoors through these areas.

Insecticide sprays are most effective when directed into areas likely frequented by ticks and their animal hosts. Pay particular attention to border regions between wooded and grassy areas, around ornamental plantings, along footpaths, and around pet pens and runs. A single application in early to mid-May is often all that is required, although re-treatment may be necessary at the interval specified on the product label. Insecticide active ingredients include carbaryl, permethrin, and cyfluthrin.

Thoroughly wet the ground and vegetation up to a height of 3 feet (1 meter) with the insecticide mixture. Keep children and pets off treated areas until the vegetation is completely dry. Treating the entire lawn is not recommended since ticks avoid direct sunlight and normally do not infest areas that are well maintained.

FLEAS

Cat Flea
(Ctenocephalides felis)

Although there are several known flea species, the cat flea is the most commonly encountered in or around structures. Their vertically flattened body allows them to move between the hairs of an animal's coat. Fleas are well known for their ability to jump 6 inches or more.

IMPORTANT CONSIDERATIONS

- Fleas feed by biting and sucking blood. They inject saliva that results in irritation and subsequent scratching.
- Fleas will bite adult humans on their ankles and bite children as they crawl around or play on the floor.
- Some individuals are hypersensitive to flea bites, causing itching and irritation.
- Fleas can transmit serious diseases to humans, most notably plague and flea-borne typhus, which were initially acquired by feeding on infected rodents (e.g., Norway rat).
- Fleas can transmit tapeworms from pets to people.
- Severe cat flea infestations can cause sufficient blood loss to result in poor animal health.

FLEA MANAGEMENT

Managing fleas requires an integrated approach. Deal with the pets and the environment simultaneously to best remedy the situation.

Inspection

Flea management begins with an inspection of the environment and the insect identification. Ear mites (controlled solely by a veterinarian) can cause symptoms similar to a flea infestation. If the customer's pet is allowed to roam in woodland sites, it is possible for the pet to pick up fleas from wildlife. Check to see the specific identity of the insect captured, as most of the wildlife fleas cannot develop on dogs or cats.

Inspect the premises. Look for areas with flea dirt and high numbers of fleas. Wear white socks and take off your shoes while inside; walk around each room for two minutes. Fleas landing on your socks will be visible and allow you to make an estimate of the flea population size.

Check crawlspaces, kennels, under furniture, in closets, pet paths, and pet resting areas. Ask the customer about the pets and learn their favorite resting areas and where fleas were seen. Adult fleas are attracted to disposable glue boards illuminated by bright light; place boards close to the floor and turn off all other lights. Raking carpets will also stimulate adult flea activity.

You may sometimes find fleas in a home with pets; this may be a result of the pets owned by the previous occupant. It is also possible for fleas to be present that are not feeding on pets in the home. Check the chimney, attic, and crawlspace to see if wild

animals (e.g., raccoons) are living there. Removing any animals found is the first step in solving the flea problem.

Customer Involvement

Provide your clients with a flea fact sheet and a list of tasks they will be responsible for to solve the problem. Be certain to explain that the flea inside the pupal case cannot be killed. If you have applied a residual insecticide, control will occur within three weeks when fleas emerge from the pupal cases. A flea fact sheet can be found at: https://bit.ly/3fSvaVU.

In addition to treating the pet, the customer can follow several tactics to help get rid of the fleas.

- Launder intact (still usable) pet bedding and throw rugs.
- Vacuum carpeting in each room thoroughly and daily. Beater bars will improve removal of the larvae and eggs from carpets.
- Vacuum furniture, the pet bed, and wood floors using proper attachments.
- Dispose of debris from vacuuming and frayed/old/unusable pet bedding in a plastic trash bag, placed in an outside dumpster.
- Seal or repair floor cracks and crevices at the wall-floor junction.
- Remove all toys, clothing, and stored items from floors, under beds, and in closets to provide access for treatment.
- Remove pet food and water dishes, and cover fish tanks and disconnect their air pumps.
- Secure the pet in a kennel in a nontreatment area or have the veterinarian treat the animal while the home is treated. Pets and people can access treated areas once sprays have dried.

Educate the customer that flea collars are the least effective treatment method available to homeowners. Similarly, explain that fleas do not react to ultrasound, so ultrasonic devices are useless.

Chemical Control

Before you start treating the environment to control fleas, do the following:

- Communicate with the customer to learn what pesticide(s) have been used on the lawn (whether to control lawn pests or fleas) and any product used on the animal. If insecticides having the same mode of action are used on the pet, in the home, and in the yard, pets may suffer overexposure.
- Ensure the pesticide label allows you to make the intended application. Fleas can live on the pet as well as in the home, kennel, and lawn.
- Ventilate the structure following treatment and make sure the carpets dry before allowing pets or children on them. Power fans or dehumidifiers may help during humid weather when carpets dry slowly.

Surface and crack and crevice sprays are routinely applied for flea control. Both broadcast and spot

treatments kill larval and adult fleas that come in contact with the sprays. Thorough application is essential to reach concealed areas (e.g., under furniture). Apply sprays as an even, fine spray under low pressure. Do not treat hardwood and tile floors but vacuum and mop instead.

Several effective insecticides are available for adult flea control. Active ingredients include pyrethrins with piperonyl butoxide and several pyrethroids (e.g., bifenthrin, cyfluthrin, cyhalothrin, cypermethrin, deltamethrin, esfenvalerate, permethrin, phenothrin, prallethrin, and tetramethrin).

As a tank mix with conventional insecticides, insect growth regulators (IGRs) are very effective at long-term flea population reduction. These chemicals work by interrupting normal development from the larval to adult stages. IGRs have long residues (up to 120 days) but are nontoxic to people and pets, and thus work well in a residential IPM program.

Be aware that some pesticides may stain upholstery, carpets, or other finished surfaces. Dyes used in manufacturing some red fabrics and carpets will turn yellow or green when treated with acidic pesticides. Select a nonstaining product by carefully reading the product labels. It is wise to always test the pesticide in a small, hidden area first.

Total release aerosols ("flea bombs") have limited use because they do not penetrate areas in a structure well and are hard to place directly where needed. Also, they can cause explosions if you fail to turn off pilot lights before making the application.

Where inspection indicates fleas in outdoor areas, treat with a residual formulation of a labeled insecticide. Be especially aware of perimeter areas around the home, paths used by animals, kennels, and sleeping areas under decks and porches where fleas may be developing.

BED BUGS

Bed Bug *(Cimex lectularius)*

The bed bug is one of the top insects that applicators deal with on a regular basis.

IMPORTANT CONSIDERATIONS

- Bed bugs are not known to transmit any diseases.
- These human ectoparasites penetrate host skin with an elongated, sharp beak.
- Bite responses range from no reaction to red welts to intense itching.

- Possible negative outcomes include secondary infection, discomfort, anxiety, sleeplessness, embarrassment, loss of work, and financial burden.
- Masters at hitchhiking, bed bugs can hitch a ride in backpacks, suitcases, briefcases, purses, furniture, clothing, books, laundry, boxes, and wheelchairs.
- Bed bugs also will crawl along pipes, electrical wires, along room edges, and under doors to gain access to hosts.
- Bed bugs are most active between 2 a.m. and 5 a.m. However, they will come out to feed when the opportunity presents itself.

BED BUG MANAGEMENT

IPM methods are very important in controlling bed bug infestations. You can find many resources related to bed bug control and IPM methods at https://bit.ly/3fSvaVU.

Prevention

Tell customers the three basic ways to prevent getting bed bugs:

1. Inspect hotel or motel rooms before settling in.
2. Carefully check luggage after a trip, paying attention to seams and crevices; launder all clothing.
3. Avoid acquiring used furniture at garage sales, online, or off the curb.

Inspection

When confronted with a bed bug complaint, begin with a thorough inspection of the structure. Ask occupants where they think the problem is. You should pay attention to odors, as an infested apartment or bedroom may have a characteristic "obnoxious sweet" smell, sometimes likened to the odor of fresh red raspberries.

Beginning with the area(s) where people sleep, inspect all crevices where bed bugs could hide. Signs of an infestation include live bed bugs, dead bed bugs, shed skins, fecal/blood smears, and tiny white eggs. Places to check include:

- Under the bottoms of mattresses, in the coils or bed springs, and on the bed frame.
- Along edges of and in recessed screw holes of bedroom furniture, including nightstands, end tables, headboards, dressers, etc.
- Behind loosened wallpaper, calendars, or pictures.
- Inside pleats of draperies, electrical switch plate covers, upholstered furniture, and electronics (e.g., alarm clocks, radios).

During your inspection consider asking the following questions:

- When and where did you first notice the problem?
- Have you had any visitors recently? Sleepovers?

This information can help create a better management plan and determine the best method of treatment.

- In clothing, books, boxes, and other items left on the floor or under the bed.

Detection Methods

Three types of monitoring devices are available to confirm the presence of bed bugs. One type is a passive monitor that a bed bug crosses while seeking shelter. Passive monitoring is most effective in a room where people regularly sleep. This type of monitoring includes barrier tapes on bed legs, interceptor devices beneath bed legs, or a sticky surface sandwiched between small cardboard or plastic pieces. A second type is called an active monitor because there are host volatiles, carbon dioxide, and/or heat to attract bed bugs to the device. These monitors are most effective in vacant rooms. The third monitoring type is bed bug-sniffing dogs. Dog handlers must not mix or apply pesticides or other chemicals because these would interfere with the dog's performance.

Chemical Control

A properly labeled insecticide may be applied to bed bugs and their harborages. Take extra care when treating mattresses and box springs. Apply the pesticide lightly in seams, folds, and buttons. Allow the treatment time to dry thoroughly before allowing use. Do not treat beds used by infants, elderly, or sick people. Do not treat linens; instead, wash them in hot, soapy water and heat dry.

Apply the insecticide to cracks and crevices, under loose baseboards, around window and door casings, at the floor-wall and ceiling-wall junctures, and in and around electrical outlets. Furniture may also be infested and may need treatment with a registered insecticide. Do not use broadcast or fog treatments, as these have limited effectiveness.

There are several insecticide active ingredients registered to control bed bugs. Many populations of bed bugs in the U.S. have some level of resistance to the pyrethroid class of insecticides. Currently, the most effective products contain a mixture of pyrethroids (e.g., lambda-cyhalothrin, bifenthrin, beta-cyfluthrin, phenothrin) and a neonicotinoid (e.g., thiamethoxam; acetamiprid, imidacloprid, dinotefuran) active ingredient. Silicon dioxide (e.g., CimeXa) also shows great promise in both curative and preventive bed bug treatments.

Other Treatments

Encasements are zippered enclosures that cover bed components (e.g., mattress, box springs, upholstered furniture. They trap bed bugs inside (bugs cannot feed through this fabric). Their light color provides the contrast needed to spot bed bugs during reinfestations. You can suggest that the client purchase these to eliminate the need to discard this furniture.

Mattress liners, such as Active Guard, are fitted sheets impregnated with 1.64% permethrin and have a residual of two years. When used on a mattress or box spring, mattress liners can disrupt bed bug feeding and reproduction, aiding in control efforts. Liners can be used to help control an active infestation or preventively, such as in hotels. Liners will not eliminate an established bed bug population on their own but may kill introductions of one or a few bugs, such as in a hotel room.

Thorough vacuuming can be used in conjunction with other management strategies, but will not eliminate an infestation. To prevent bed bugs from getting into the vacuum cleaner, insert a knee-high nylon stocking in the end of the vacuum hose, then insert the crack and crevice attachment. Vacuum furniture, bed components, edges of flooring, and other possible harborage sites. When finished, immediately remove the stocking, tie a knot in the top, and place in a sealed plastic bag for disposal in an outside trash container.

Steam, when properly and directly applied, kills all life stages of bed bugs. Use this treatment on mattresses, upholstered furniture, and along edges of carpets and rugs. Move the steam cleaner nozzle slowly (20 seconds per linear foot) to maximize depth and time of exposure. Dry steam or low-vapor steamers are preferred because they leave behind less moisture.

Heat treatment of the entire house or apartment also has the advantage of killing all life stages. Whole unit heat treatments use a series of heat-generating units and fans to circulate super-heated air. If you are dealing with a multiple-unit dwelling, carefully inspect adjacent units to prevent bed bugs from reinfesting the heat-treated unit following the procedure.

The use of cold treatments is also used as a method to kill bed bugs. Cryonite is a rapid-freeze technology that uses carbon dioxide “snow” to treat cracks and crevices, in the same fashion as steam treatments.

LICE

Lice are ectoparasites of warm-blooded animals and people. Although several types of lice feed on various animals, only three must have a human host.

Lice undergo incomplete metamorphosis. A blood meal is required for nymphs to proceed to the next immature stage and to the adult stage; adults also feed exclusively on human blood. Eggs are referred to as nits once they have hatched. Eggs and nits are often mistaken as dandruff or shampoo residues to the untrained eye.

When lice feed, they inject saliva into the host, causing itching and discomfort. Scratching areas can

intensify the itching. Host distress also occurs from lice crawling on the scalp or other affected areas. Pediculosis is a skin condition resulting from continuous and severe infestation of lice. Scarred, hardened, oozing, and pigmented skin results from a continuous scratching of louse bites.

HUMAN LICE MANAGEMENT

Louse control is not a pest control operation because premise treatments are generally not required. Human lice cannot survive long off-host and most will die within one day. Most often louse control involves a medical treatment of the infested individual using over-the-counter or prescription insecticidal shampoos and rinses made specifically for lice control and by thoroughly combing and removing lice and eggs with a lice comb. Common active ingredients include malathion, pyrethrins, permethrin, ivermectin, and spinosad. Advise clients to contact their physician, pharmacist, or public health nurse. Treat all infested family members at the same time to prevent reinfestation from one person to another. Find more information at https://bit.ly/3fSvaVU.

Encourage clients to wash bedding (e.g., sheets, blankets, pillowcases), clothes, hats, scarves, and coats in hot, soapy water and use a clothes dryer set on high heat (140°). Discourage use of a common brush and comb, although most lice transfer is by direct body contact.

MOSQUITOES

Mosquitoes are well known biting pests found almost anywhere outdoors. They are generally small (< ½ inch) and fragile insects. Their most obvious characteristics include one pair of wings with scales on the wing veins and hind margin, and an elongated beak with piercing mouthparts. Mosquitoes are often confused with midges, gnats, and other flies. Beyond annoyance, mosquitoes threaten human health because of the diseases they potentially transmit, such as West Nile virus, Western equine encephalitis, and Saint Louis encephalitis.

Only adult female mosquitoes feed on blood; adult males feed on flower nectar. Mosquitoes have a complete life cycle. All life stages (except adults) are aquatic. Eggs are laid on water or in areas that are prone to flooding, depending on the species. Larvae feed on organic matter found in standing water.

MOSQUITO MANAGEMENT

Effective mosquito control requires community-wide efforts, including elimination of water-filled breeding sites. Larvicides, such as Bacillus thuringiensis subsp. Israelensis (Bti) can be used in aquatic, mosquito-breeding habitats. Adults are often managed using sprays, aerosols, or fogs (ultra-low volume applications).

Persons doing significant, area-wide mosquito control work should become certified in Category 8: Public Health. Contact UDAF for more information.

DELUSIONS OF INFESTATION

It is common for clients to seek (more often demand) an insecticide treatment to cure bite-like skin reactions, itching, or skin irritations. The clients assert that these conditions have been caused by insects, but upon investigation, no insects or mites can be found. Delusions of infestation, illusory parasitosis, or Ekbom's syndrome are three of many names used to describe these extremely emotional and sensitive situations. Other names used for the nonexistent arthropods include "paper mite," "sand flea," and "cable mite." There are no such animals, and the use of these names by a client should be a warning of a difficult situation. The use of these names by a pest management professional is unethical and a flagrant breach of professional conduct.

There are only a few biting insects that produce skin reactions and these are all large enough to be seen and readily identified. Common biting pests include fleas, head/body lice, pubic lice, ticks, bed bugs, bird/rodent mites, and mosquitoes. Obscure or microscopic organisms exist that may bite (e.g., scabies mite, itch mite), but dermatologists can isolate and identify them.

One characteristic of delusional infestation is a client's recent history of seeking relief through excessive treatments or bizarre remedies (e.g., spraying sheets with insecticide, washing clothing in gasoline, bathing with disinfectants). Another characteristic is the client's contact with several specialists (e.g., physicians, dermatologists, psychiatrists, entomologists, public health departments) without remedy of the skin symptoms. Finally, an inspection of the sufferer's environment and alleged specimens affirms the absence of an infestation.

Several studies and articles on this topic exist, and you are encouraged to read more. Some of the most common causes of skin irritation are physical agents (e.g., dry air, detergents, cosmetics, fiberglass fibers), physiologic factors (e.g., allergy, disease), and psychological issues (e.g., anger, anxiety, stress).

When faced with this situation, advise clients to work closely with a dermatologist or physician. Remember that the skin irritation or itching sensations feel real to the client. Treat all clients with sensitivity and concern. Always be honest in answering questions. Do not agree with clients that you see pests that are not there. NEVER apply a pesticide unless biting arthropods have been confirmed and identified by you. This could reinforce the client's belief that stronger pesticides will solve the problem. Ironically, they could shift from a fictitious pest to blaming the pesticide application as the cause of their suffering.

Solving mystery bug problems is seldom easy; it will be, more likely, frustrating, and time-consuming. A thorough investigation and referral to another professional specialist (rather than a quick pesticide application) is the best course of action.

CHAPTER 12

Stinging Pests

FORWARD

After studying this chapter, you will be able to:

1. Distinguish between bees and wasps.
2. Determine the common food sources of wasps.
3. Name two generally nonaggressive wasp species.
4. Discuss how to manage bees and wasps.

BEES

Bees are beneficial insects (e.g., pollination, honey) but they can be problematic if nesting in or near dwellings due to the danger of stings. These insects have a complete life cycle. Bees have two pairs of wings, are hairy and fuzzy, and have a broad connection between the thorax and abdomen. Bees have chewing-lapping mouthparts and consume pollen and nectar.

Utah is home to nearly 1,200 different bee species, making Utah home to about 1/4 of all bee species known from the U.S. While the vast majority of Utah's bees are capable of stinging, most are very docile and will only sting if their life is in danger (for instance, grabbing one in your hands). Most of the bees native to Utah are solitary (they live alone rather than in a hive) and most of these bees nest in the ground in a hole the female bee digs herself. They do not make honey but they can be excellent pollinators of our gardens, orchards, and flowerbeds. Find more information on exotic bee identification and native Utah bees can be found at https://bit.ly/3fSvaVU.

The EPA acted on protecting bees from pesticide exposure in 2013 with the introduction of the Bee Advisory Box and icon. While these efforts target the protection of honey bees, the principles and practices described are applicable to all pollinators. More information on pollinator protection and the Bee Advisory Box can be found at https://bit.ly/3fSvaVU.

Honey Bees *(Apis mellifera)*

LIFE CYCLE, NESTING

- Honey bees are social and have three castes: queens (egg production), drones (males for mating only), and sterile workers (tend the young).
- There are 20,000 to 90,000 individual bees in a given nest.
- They construct their nests of wax combs in hollows (e.g., old trees, attics, soffits, wall voids, chimneys).

IMPORTANT CONSIDERATIONS

- Honey bees are beneficial insects because they pollinate many different crops and produce honey and beeswax.
- Stings (barbed stinger with poison sac attached) are used to defend themselves or the nest.
- If nests are built in structures, wax combs may melt and release honey, which may stain walls and attract secondary pests (e.g., larder beetles, carpet beetles).
- Honey bees may swarm, especially in spring, but often swarms are not dangerous and swarms will go away without intervention. If necessary, contact your local bee inspector to assist with the removal of bee swarms. Find more information at https://bit.ly/3fSvaVU.
- A qualified beekeeper can remove honey bees that accidentally nest within a wall or void of a structure, but the nest, wax, and honey will still need removal to prevent pantry pests from infesting.
- If working in the southern third of Utah, be aware of Africanized bees may be present. Take extra caution when working in these areas. Learn more at https://bit.ly/3fSvaVU.

Bumble Bees *(Bombus* species*)*

LIFE CYCLE, NESTING

Bumble bees are social insects that live in nests made in the ground, in mouse nests, old bird nests, clumps of dry grass or straw, or in soft materials (e.g., old mattresses, car cushions, rags).

IMPORTANT CONSIDERATIONS

- Bumble bees are important pollinators of many crops and other plants.

- Bumblebees sting when defending their nest. Their stingers, unlike those of honey bees, are not barbed, allowing for multiple stings from the same bee.
- Nests may rarely be located in or next to a building or along a walkway.

Carpenter Bee *(Xylocopa* species*)*

LIFE CYCLE, NESTING

- This solitary insect nests as a unit consisting of a female, male, and their offspring.
- Carpenter bees nest in unfinished softwoods (e.g., pine, cedar, redwood, cypress); wood is not consumed, but merely hollowed out. From the entrance hole, the tunnel turns 90˚ and extends up to 1 foot, following the wood grain.

IMPORTANT CONSIDERATIONS

- Carpenter bees are beneficial insects because they pollinate flowers.
- They drill ½ inch holes into exposed wood, causing damage to home, garage, or barn siding, fences, and other structures.
- They will reinfest the same wood year after year.
- Females can sting if aggressively handled.
- Behavior of males is the first indication of carpenter bees nesting in the area: they will hover around the nest entrance and chase off any intruders. Although aggressive, males are harmless since they lack a stinger.

WASPS

Like bees, wasps are considered beneficial insects because they cannot only pollinate flowers but are also predators of many different insects and spiders. However, hundreds of people die each year in the United States from allergic reactions to wasp venoms.

Wasps have a complete life cycle. Adults have two pairs of wings, are smooth or hairless, and have a

narrow petiole (waist). Wasps have chewing mouthparts and consume pollen and nectar.

Social wasp colonies start from the work of a single, mated, overwintering queen. She constructs a small, paper nest for a few eggs. Larvae are fed by the queen, develop through the pupal stage, and emerge as sterile adult female workers. The new workers increase the nest size, scavenge for food, and feed the next developing offspring. A colony may reach 4,000 individuals within a season. Males and new reproductive females develop in early fall. After mating, the colony dies off and only the newly fertilized queens overwinter in sheltered sites. Abandoned nests are not reused and disintegrate.

Solitary wasp species work alone to build a nest and provision it with food for offspring. Nests are much smaller than those of social wasps, producing no workers to care for the developing larvae.

Yellowjackets *(Vespula/Dolichovespula* species*)*

LIFE CYCLE, NESTING

Social insects build their nests in trees or shrubs, underground, in rock piles, in timber retaining walls, under eaves, or in structural voids (e.g., attics, walls). Yellowjacket nests die out every fall in Utah. Mated queens produced by the colony in late fall overwinter in the landscape. In spring, overwintered, mated, queen yellowjackets emerge and look for new places to establish a nest. Yellowjacket numbers are low in the spring and increase slowly until about midsummer when populations begin to rise rapidly, reaching a peak in late summer and early fall.

FOOD PREFERENCES

Yellowjackets prey upon other insects and arachnids but will scavenge heavily at dumpsters or garbage areas, picnics and BBQs, and other places where food, especially meat, is present. Scavenging, a habit particular to western yellowjackets, is worst in the fall.

IMPORTANT CONSIDERATIONS

- This species exhibits aggressive behavior in protecting the nest and securing food.
- Yellowjackets are considered the most dangerous stinging insect in the United States.
- Their nests in attics and wall voids attract dermestid beetles.
- Western yellowjackets scavenge for food, especially in the later summer and fall.

Bald-Faced Hornet *(Dolichovespula maculata)*

LIFE CYCLE, NESTING

Bald-faced hornets are not true hornets; they are considered aerial yellowjackets. The only true hornets in the United States are the introduced European hornet (*Vespa crabro*, in the eastern U.S., and the giant Asian hornet, *Vespa mandarinia*, which has only been detected in a small part of northwest Washington state). Utah is not home to any true hornets. Bald-faced hornets build gray, football-shaped paper nests that are attached to tree branches, shrubs, utility poles, or house siding. A nest consists of three to four internal tiers of combs housed within a thick, multilayered outer shell that has a single opening at the bottom; one nest may contain several hundred hornets. Another species of aerial yellowjacket, *Dolichovespula arenaria*, also builds similar nests in similar locations as the bald-faced hornet but looks nearly identical to the western yellowjacket.

FOOD PREFERENCES

The bald-faced hornet feeds on flower nectar, ripening fruits, plant sap, and insects.

IMPORTANT CONSIDERATIONS

- Hornets will aggressively defend their nest if disturbed.
- At night, remove nests on siding or near high-traffic areas.

Paper Wasps *(Polistes* species*)*

LIFE CYCLE, NESTING

- Paper wasps, especially the invasive European paper wasp (*Polistes dominula*), are social insects that build open comb nests (inverted umbrella) under eaves of houses, porches, or windows, in shrubs, and in other protective places. Nests can have 75 adults tending 200 cells.
- The queen and worker females work together to assure the success of the nest.

FOOD PREFERENCES

Paper wasp adults feed arthropods to their larvae, and adults feed on honeydew produced by aphids and overripe fruit.

IMPORTANT CONSIDERATIONS

- Nests may be built in high-traffic areas.
- Paper wasps will sting when defending a nest.
- Paper wasps do not scavenge for food like the western yellowjacket does.

Mud Daubers

LIFE CYCLE, NESTING

Mud daubers are solitary wasps that construct nests out of moistened soil in species-specific shapes. The mated female lays an egg in each cell and adds a paralyzed spider as food for the larva. She seals the cell with more mud. The types of spiders used to provision a nest are specific to the mud dauber species.

FOOD PREFERENCES

Mud dauber adults feed on flower nectar and larvae feed on spiders provisioned by the mother.

IMPORTANT CONSIDERATIONS

- Mud daubers are not aggressive and rarely sting.
- Sometimes, the presence of this wasp in garages, on home siding, and other high visibility areas is considered a nuisance to the property owner.

Cicada Killer Wasp *(Specius speciosus)*

LIFE CYCLE, NESTING

- This large, solitary wasp nests in soft, sandy soil, including in the cracks of patios and other places.
- Each nest tunnel is approximately 1 inch in diameter and extends 2 feet into the ground. Tunnels may branch and end in one or more globular cells. Each cell along this tunnel is provisioned with one egg and one or two paralyzed cicadas.

FOOD PREFERENCES

Cicada killer wasp adults feed on nectar and pollen.

IMPORTANT CONSIDERATIONS

- Large wasps flying around trees near homes are considered a nuisance.
- Adults are large and intimidating, but rarely sting.

MANAGING STINGING PESTS

It is best to locate the entrance(s) to the nest during the day and conduct necessary treatments at night (when bees or wasps are sheltering within their nest). For success, all adults must die or the nest will be rebuilt and the process will begin again. Always wear a protective bee veil and heavy clothes when controlling a stinging pest to prevent injury from stings.

Active ingredients of insecticides used to control stinging pests include acephate, carbaryl, dichlorvos, nylar, and pyrethroids (bifenthrin, cyfluthrin, cyhalothrin, cypermethrin, deltamethrin, esfenvalerate, permethrin, prallethrin, pyrethrin, tetramethrin). For ground- or void-nesting social wasps, inject insecticidal dusts into openings. These dusts are not designed as quick knockdown products. Wear protective clothing when attempting dust applications.

Bees

Honey bees may swarm in the spring. A swarm consists of thousands of workers and one queen. Although these massive accumulations of bees frighten people, honey bees are docile and nonaggressive at this time. It is best to call a beekeeper to collect the swarm for honey production.

For honey bees found nesting in a structural void, first contact a local bee inspector or a beekeeper to see if they will remove the bees. If the bees must be killed, blow a dust formulation into the nest entrance at night, but do not seal the nest opening. Dusts are effective because of the cleaning behavior of these insects. Once the bees die, open the wall and remove the nest to prevent wall staining and attraction of stored product pests. Seal the nest opening in the outside wall, as the void may be used by a future bee or wasp colony.

Carpenter bees are best controlled by applying insecticide dust into the entrance holes. You should plug the entrance hole with wood putty or a similar substance in the summer or fall to discourage use the next year.

Wasps

Manage yellowjackets, hornets, and wasps with similar procedures. Treatment of individual nests in structures and in the landscape may be required if located in high-traffic areas or if otherwise interfering with normal human activities.

After dark, apply a registered insecticide to the nest opening and a 6-inch band around it. For aerial nests, wet the paper material thoroughly so all members of the colony contact the treatment. For ground nests, apply a dust formulation to the nest opening. Pressurized aerosols are also effective for small and/or exposed nests.

Do not seal the nest opening after treatment. This is especially important in structural situations because agitated wasps may emerge elsewhere inside a structure. Once all the wasps die, seal the opening(s) or fill voids to prevent future problems. Such exclusion techniques are also needed when wasps nest in hollow tubes, such as playground equipment or metal fences.

Inspect sensitive areas for paper wasp nests twice monthly from spring through early summer. Remove small nests by simply knocking them down. This will greatly reduce the number of large nests in these areas later in the season. Remove nests using vacuums if you have a way to safely dispose of the trapped insects. Where nests have been removed, consider washing with soap and water to remove pheromones left behind.

If mud dauber wasp nests are problematic for a client, scrape and destroy the nest with a putty knife, which will encourage the wasp to seek out a new location for future nests. Pesticide control is not warranted for mud daubers.

Folk remedies, such as dousing nests with gasoline or a stream of water from a garden hose, seldom work and can result in multiple stings.

Parks, schools, supermarkets, and restaurants can use sanitation to minimize attractive food sources for foraging wasps. Equip trashcans with plastic liners and tightly fitting (self-closing) lids. People eating outdoors should keep food and beverages covered, and clean up spills and leftovers promptly. Whenever possible, locate trashcans and dumpsters away from serving tables, loading docks, concession stands, and other entrances. Maintaining high levels of sanitation earlier in the summer will make areas less attractive to foraging wasps later in the year.

Traps have shown only marginal benefits even though they will catch impressive numbers of yellowjackets when properly positioned and baited. Business establishments (e.g., outdoor cafes) may find yellowjacket traps baited with heptyl butyrate effective at pulling yellowjackets away from sensitive areas. Yellowjacket traps baited with heptyl butyrate only attract and capture yellowjackets; they do not work on paper wasps or other wasps. Various trapping methods have been attempted for European paper wasps, but with little success.

CHAPTER 13

Spiders

LEARNING OBJECTIVES

After studying this chapter, you will able to:

1. Define cephalothorax and ballooning.
2. State how spiders are different from insects.
3. Sight-identify Utah's spiders of human health concern.
4. Explain human health concerns associated with venomous spiders.
5. List nonchemical control tools used to manage spiders.

OVERVIEW

Spiders are not insects but are arthropods in the class Arachnida. They have eight legs, two body regions (cephalothorax and abdomen), no antennae, and no wings. Spiders are one of the most common arthropods seen by homeowners. They are considered beneficial because they eat many insects.

A spider develops from an egg into an immature spider that may molt several times before becoming an adult. Newly hatched spiderlings are lightweight and can be carried on winds, especially when a small silk "balloon" is made by the spiders (referred to as "ballooning"). Others crawl away from the egg case, seeking a site to feed and develop. Some spiders are active hunters while others are dependent upon silk webs to trap their prey. This important distinction when managing spiders can be made through proper identification of the spider by a professional entomologist or arachnologist.

Spiders are usually just a nuisance from their webbing and presence indoors. Common accidental invaders include wolf spiders, jumping spiders, woodlouse spiders, ground spiders, cellar spiders, and grass spiders.

While alarming or disagreeable, they do not threaten human health. In general, spiders will not attempt to bite humans unless held or accidentally trapped. However, two species in Utah are medically important because of their toxic bite.

POISONOUS SPECIES

Western Black Widow Spider *(Latrodectus hesperus)*

Widow spiders are considered the most venomous spider in North America, although human mortality is less than 1% from its bite. In Utah, the western black widow is the only *Latrodectus* species, with more occurrences in the southern part of the state.

IDENTIFICATION

- Adult spiders have a ½ inch (13 millimeter) body and 1½ inch (38 millimeter) legs.
- Adult females are shiny, jet black with an abdomen having two connected triangles on the underside that form its characteristic hourglass marking. The hourglass color varies from yellow to red to orange.
- Immature females are brown, white, and cream-colored and will have various striped markings, including a red stripe on the back. As they age, immature black widow spiders take on a darker and darker color until they reach adulthood.
- Male spiders are about one-third the size of adult females and resemble immature females.

NATURAL HABITAT, HOSTS

- A female constructs a web of crisscrossed silk threads with no recognizable pattern and suspends herself upside down at night and waits for prey.
- Webs are situated outdoors near the ground in a dark, sheltered site such as irrigation boxes, wood piles, rubble piles, under stones, in hollow stumps, rodent burrows, outbuildings, and window wells. Indoors, females prefer undisturbed basements and crawl spaces.

MEDICAL CONCERNS

- The bite is poisonous.
- Symptoms vary from no reaction to a short stabbing pain to serious complications. Other symptoms may include nausea, profuse perspiration, abdominal cramping, tremors, labored breathing, restlessness, increased blood pressure, and fever.
- Long-term complications and death are very rare.

Desert Recluse Spider *(Loxosceles deserta)*

The desert recluse spider only occurs in southern Washington County. Desert recluse spiders like to live in dark places, such as under rocks or in wood piles. They can also be found in the vents, attics, basements, closets, and crawl spaces of buildings. They are often confused with hobo spiders, which are common in Utah. More information on Hobo IPM can be found at https://bit.ly/3fSvaVU.

IDENTIFICATION

- Adult spiders are ¼ to ½ inch (6 to 13 millimeters) long.
- Desert recluse spider's cephalothorax has six eyes arranged as three pairs, colored light brown with a dark brown, violin-shaped marking on its top. It has four pairs of long legs, and the abdomen is uniformly colored light to dark brown.
- Immature spiders are light but gradually darken as they mature.

LIFE CYCLE

- A female places 50 yellow eggs in a white, silken sac. She will produce one to five egg sacs.
- This spider completes a single generation each year.
- Spiders can live up to two years.

NATURAL HABITAT, HOSTS

- Desert recluse spiders prefer to live outdoors, typically in low-lying vegetation around pack rat nests, etc.
- The desert recluse spider spins a loose, irregular web of very sticky, off-white to grayish threads to create a daytime retreat.
- The spider hunts at night for insects and other small arthropods and also will scavenge dead and dying insects.

MEDICAL CONCERNS

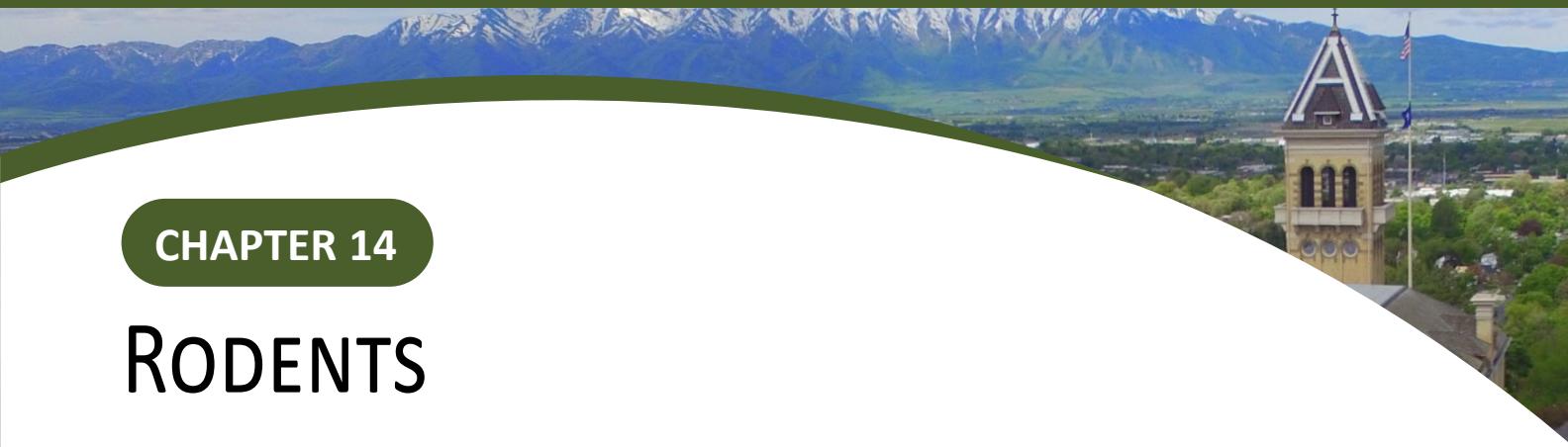
- The bite is venomous.
- Symptoms vary in severity and may include: no reaction; a small, red mark; a painful, slow-healing, deep wound; or tissue death at the site of the bite.
- Fatalities are extremely rare, but bites are dangerous to children, the elderly, and those in poor physical condition.

SPIDER MANAGEMENT

There are several nonchemical tools you can use to manage spiders in a facility, as follows:

- Remove webbing with a broom or vacuum; control the insects that serve as food within a structure.
- Clean and rearrange storage areas and basements regularly.
- Place sticky traps around the inside of basement and ground-level rooms to monitor spider activity.
- Exclusion. Install tight-fitting screens on doors and windows, and adjust door threshold seals to prevent entry.
- Install yellow incandescent or sodium vapor lights on a structure's exterior.
- Remove ivy or other heavy vegetation on the foundation or building walls.
- Avoid storing piles of lumber, firewood, or stones near a structure.
- Check boxes, furniture, and other storage items for egg cases and spiders before bringing these into a building.

Apply residual liquid sprays as a perimeter barrier or crack and crevice application to kill wandering spiders. Apply to webs to kill web-dwelling spiders. Focus applications on spider habitat to improve efficacy. Wettable powder and microencapsulated formulations work best for spider management. Use dusts to treat webs directly.



CHAPTER 14

RODENTS

LEARNING OBJECTIVES

After studying this chapter, you will be able to:

1. Define commensal, omnivores, kinesthetic sense, bait translocation, anticoagulant, paraffinized bait, and secondary hazard.
2. Describe the human health concerns from rodent infestations.
3. Identify the damage to human foods by mice and rats.
4. Give examples of structural damage done by rodents.
5. Identify four common places rodents can enter a structure.
6. Distinguish rodents that:
    a. Must have access to free water.
    b. Acquire water from their food.
7. State the normal activity periods of commensal rodents.
8. Name the two primary commensal rodents infesting a structure.
9. Recognize the capabilities of commensal rodents.
10. Name ways to determine if rodents have infested a structure.
11. Describe how landscaping affects pest management.
12. Compare:
    a. Anticoagulant and non-anticoagulant rodenticides.
    b. Food bait and water bait rodenticides.
    c. Detection blocks and tracking powders.

OVERVIEW

Domestic rodents constitute a major vertebrate pest problem due to adaptability, damage potential, and disease transmission. Rats and mice are remarkably well adjusted for living in close association with humans, thus being called commensal rodents. They live in granaries, fields, city sewers, attics, basements, street trees, and on top of multistory buildings. Rodents eat almost every food that humans, pets, and livestock eat.

The greatest economic loss is not how much rodents eat but what must be thrown out because of damage or contamination. Rats and mice also damage doors, walls, insulation, and other structural components by gnawing and burrowing. They also gnaw through utility pipes and electrical wiring, causing fires, indoor flooding, power outages, and equipment failure.

Rats and mice can also transmit diseases, most notably salmonellosis (bacterial food poisoning) when infected feces and urine contaminate food. Other rodent-borne diseases include plague, murine typhus, rat bite fever, rickettsialpox, Hantavirus, lymphocytic choriomeningitis, leptospirosis, scrub typhus, and tularemia.

MAJOR RODENT PESTS

Norway Rat
(Rattus norvegicus)

The most common rat encountered in Utah is the Norway rat. It is the largest domestic rodent species found and is described as robust, hardy, aggressive, and sly. It is also called the common rat, barn rat, gray rat, brown rat, house rat, sewer rat, wharf rat, and ship rat.

IDENTIFICATION

- Adult total length is 13 to 18 inches.
- Weight is 7 to 18 ounces.
- Snout is blunt.
- Tail is shorter than the head plus the body and measures 6 to 8.5 inches long.
- Ears are small, close set, and appear half buried in fur; they do not reach the eyes.
- Fur color is reddish-brown to gray-brown with the belly a yellowish-white.
- Droppings are ¾ inch long and blunt on each end.

LIFE CYCLE

- The rat's life span is 5 to 12 months.
- Females are sexually mature in two to three months and can produce 4 to 6 litters each year with 6 to 12 pups per litter.

Outdoors, Norway rats commonly nest in burrows alongside buildings, fences, sidewalks, and under bushes

or debris. Their ground burrow system consists of a central den, a primary entrance, and two or more escape holes. They follow the same routes daily causing a distinct, well-beaten path. Indoors, this species prefers to nest in the lower portions of a structure in wall voids, underneath floors, in crawl spaces, and beneath or inside equipment or stored items.

As omnivores, Norway rats consume as many different types of foods as they encounter. In natural areas, rats eat cereal grains and various plants. In the urban environment, they eat meats, vegetables, and cereal grains, as well as garbage. Norway rats require 0.5 to 1.0 ounce of water each day when feeding on dry food. The average rat consumes 0.5 to 1.0 ounce of food per day. Their foraging range from the nest is 50 to 150 feet.

House Mouse
(Mus musculus)

One of the smallest, common domestic rodents, the house mouse is a delicate, agile rodent, labeled a mammalian weed because it so successfully adapts to changing human environments.

IDENTIFICATION

- Adult total length is 5 to 8 inches.
- Weight is 0.4 to 1 ounce.
- Snout is pointed.
- Tail is equal to or slightly longer than the head plus the body, measuring 3 to 4 inches long. It is scaly and sparsely haired.
- Ears are prominent and large for the animal's size.
- Eyes are inconspicuous.
- Fur color is dusky gray and silky.
- Droppings are to 1/8 to 1/4 inch long and pointed on at least one end.

LIFE CYCLE

- Life span is one to two years.
- Females are sexually mature in 6 to 10 weeks and can produce 6 to 10 litters in a lifetime with 5 to 6 pups per litter.

Outdoors, the house mouse lives among weeds and shrubbery or near building foundations, inside garages, crawl spaces, or outbuildings. When food becomes scarce in the fall, these mice move indoors. Inside buildings, house mice commonly nest in the wall, ceiling, or cabinet voids, in furniture, storage boxes, and in large appliances (e.g., stove, refrigerator, dishwasher).

Mice feed on a wide variety of food. Outdoors, they feed on seeds and cereal grains. Indoors, mice consume most human and pet food, as well as some common invertebrates found in buildings (e.g., cockroaches, slugs, snails). They are fond of foods high in fats, proteins, and sugars. House mice are nibblers and may make 20 to 30 visits to different food sites each night. House mice eat 0.05 to 0.10 ounce of food daily. Their foraging range from the nest is 10 to 30 feet.

Unlike other commensal rodents, the house mouse can conserve water and obtain water from its food when free water is scarce or unavailable.

CAPABILITIES

Rodents can sense and move in their environment with great efficiency. Learning how they do this and their limitations will help with management.

SENSES

The sense of touch is well developed in highly sensitive whiskers (vibrissae) and certain guard hairs. This enhances the rodent's ability to move rapidly in the dark. Rats and mice prefer to run along walls or between things where they can keep their sensory hairs in contact with side surfaces. An exception is the deer mouse that does not follow well-defined runways.

Kinesthetic sense refers to a rodent's process of exploring and learning about its environment as a way of ensuring survival. The animals explore their surroundings and remember the location of runways, food, water, harborage, and obstacles. Rodents even develop "muscle memory"—memorizing the muscular coordination needed to maneuver through their territory, sticking to frequently used routes.

Rodent vision is adapted to nocturnal life. Their vision is not sharp but is very sensitive to light. Rodents can also detect motion in dim light. The limit of their vision is 30 to 45 feet (9 to 14 meters). They are color blind, so any distinctive coloring of poison baits does not reduce their acceptance provided the dyes do not have an objectionable odor or taste.

The sense of smell is keenly developed in rats and mice. They will leave odor trails of urine or other secretions to mark trails, delineate territories, and detect sexually active mates. Commensal rodents have adapted to the smell of humans, so human odor on baits or traps does not repel them. However, the scent of cigarettes, strong soaps, or cologne will make baits less attractive. An attractive food odor can help draw rodents to bait, providing the odor is not too strong and does not detract from the taste of the bait.

Rodents also have a well-developed sense of taste. Taste is probably the most important factor in bait acceptance. Food preferences will vary among rodent species and even between different populations of the same species. Rats prefer fresh food to decayed food; keep baits fresh.

Rodents can detect sounds outside of the human range of hearing (ultrasonic sounds). They use these sounds for echolocation in darkness for nocturnal orientation, though not as well as bats do. Young rats emit ultrasonic distress signals to call the mother to the nest. Unusual noises cause rodents to attempt escape.

ABILITIES

Rodents gnaw almost anything they can bite. Because the incisor teeth grow 4 to 5 inches a year, rats must grind them against each other to keep their incisors filed down. Rodents rely on gnawing as a means of survival. They use their incisors to gain access to harborages, obtain daily resources (e.g., food, water, and nesting materials), assist in climbing, and for defense.

Gaining access to areas of a building or a food supply is another ability of rodents. A house mouse can squeeze through any opening larger than ¼ inch. A rat needs a ½ inch or larger hole. Rodents can make or expand holes by gnawing to obtain the food or shelter they need.

Rodents' ability to jump, climb, swim, and keep balance extends their territory and the range of areas they can reach in their environment. With a running start, Norway rats can jump vertically 3 feet and house mice can jump 1 foot. Rats and mice can climb any vertical surface where they can get a claw hold, and descend headfirst down a rough wall. Norway rats can climb inside vertical pipes with diameters between 1½ and 4 inches and along the outside of vertical pipes up to 3 inches thick.

These extreme feats of climbing and jumping are usually done when the rodent is under stress (e.g., hunger, in need of shelter). House mice are better climbers than Norway rats, which will climb when necessary. Deer mice are excellent climbers and will often enter a building through high access points.

Commensal rodents have excellent balance. Rodents can travel between rooms or buildings on plumbing and utility lines, can walk on narrow ledges, or crawl along ropes of various sizes.

All commensal rodents can swim, but the Norway rat is the best among them. They can dive and stay underwater for at least 30 seconds; this allows the rats to enter buildings through sewer lines, floor drains, and toilet bowl traps. These rats can also swim through open water for a half mile and tread water for three days.

Norway rats prefer to burrow in earth banks, along walls, under rubbish or concrete slabs, and in similar places for nesting and harborage. Nest burrows rarely go deeper than 18 inches. While individual burrows are usually shorter than 3 feet, established burrows may be longer and interconnected with several exit holes.

BEHAVIOR

Social Behavior of Rats

Rats are aggressive and competitive. They live in colonies with well-defined territories that they mark with urine and glandular secretions. The colony has a social hierarchy with a dominant male leader and a "pecking order" of less dominant males and ranking females. The strongest and most dominant animals occupy the best nest and resting sites and feed at their leisure. Weaker rats are pushed to less favorable sites or forced out of the territory completely. Social conflicts are most common at feeding sites, prime resting areas, and territorial boundaries. Females fiercely defend their nest and young from other rats.

Knowing the social hierarchy in rat populations will help you focus your management efforts. If you take time to locate the "choice" territories and focus on eliminating the dominant rats, the population will collapse into a smaller area. Then you need to remove the remaining rats (once kept on the fringe by social dominance) that migrate into the choice territories.

Confining control efforts to a smaller area can mean less time, less expense, and less risk of exposure among both people and nontarget organisms.

Activity Periods

Generally, commensal rodents are nocturnal animals, but they are highly adaptive. If food is readily available ONLY during the day, they will adjust their feeding/foraging schedules. Competition may also influence activity. When populations are high, some individuals may not be able to compete with the others at night and may be forced to forage during the day.

Dominant individuals are most active within two hours after sunset and again for a few hours before sunrise. Less dominant individuals are forced to forage between these times. The poorest competitors in a population have to look for food during the day, risking easier detection.

Response to Strange Objects

Rats are wary of any new object or sound that appears in their territory for three or more days. "New-object reaction" occurs whether you are placing a series of traps or with unintentional littering (e.g., a block of wood left from a construction project). This is a good example of how kinesthetic memory plays a protective role for the rodent. Rats notice anything new in their environment.

Mice tend to travel over their entire territory nightly, investigating each change or new object. Unlike rats, they show no fear of new objects or sounds. They dart from place to place, covering the same route over and over again. You will quickly learn that mice are more likely caught in newly set traps when compared to rats.

Rats may display less of the new-object reaction in environments where change is constant, as in warehouses or grocery stores with rapid turnover of inventory or when rodent populations build to the point of food scarcity. Still, the more cautious rats are the hardest to remove from a site and the more curious individuals usually succumb to trapping.

Feeding Behavior and Hoarding

Rats are less likely than mice to go after new food sources. They prefer the familiar but will feed on a range of sources available rather than restrict themselves to a single food source. This means that any other available sources will provide competition for even the most palatable baits. After overcoming their initial fear of a new food source, rats will still only sample the bait, taking small amounts. If they get sick, the rats will avoid the bait completely.

Rodents hoard food. They may take the food back to harborage to avoid predators, to keep the food from competing rodents, or to store in case the food supply diminishes or vanishes. Hoarding occurs with all foods of all different shapes or sizes, but large particles, pellets, or food packets are most susceptible to hoarding. House mice regularly move foods to nearby corners or other areas where they feel secure while eating.

The rodents may not be eating as much bait as you might think based on how much of it is disappearing from bait stations. Hoarding may also result in the bait being taken to places that could expose nontargets, such as into a food-processing area or room frequented by children and pets. This movement of bait from one area to another is referred to as bait translocation.

SIGNS OF INFESTATION

Because rodents are habitually nocturnal and secretive, it is necessary to interpret signs of their activities properly to plan management work. These signs are found in secluded places, such as along walls, under piles of rubbish, and behind or under boxes, boards, thick vegetation, or unused equipment. These signs can give you information about the species involved, the level of infestation, and if the infestation is still active.

Night inspection confirms rodent activity suspected during a daytime inspection.

Dead or Active Rodents

Dead rodent carcasses are an indication of a current or past infestation. If all that you find are old, dried carcasses and skeletons, it usually means an old infestation. A rodent population is still active (and likely at high levels) if you see rats

and mice during the day or if dead carcasses are still fresh.

Sounds

When a building is quiet, various rodent noises may be heard. These include squeaks, sounds of rodents fighting, clawing, scratching, gnawing, scrambling inside walls, and running across ceilings. Pets are often alarmed at these sounds before their human counterparts.

Droppings

Droppings are the most common sign of a rodent infestation. These pellets are durable and left wherever rodents travel or rest. The size and shape of the droppings indicate the species of rodent you are dealing with and the numbers give a general indication of the population size. A single rodent will produce 50 or more pellets each day. Fresh fecal pellets are usually moist, soft, shiny, and dark. Older droppings are dull, grayish, and crumble when pressed.

Urine Stains

Rodents use urine to mark trails and territory, so wherever they travel, they leave dribbles and spots of urine.

House mice tend to urinate in the same spots along their runways. Urine, dirt, and grease build up to form “urine pillars.” The discovery of such pillars is a reliable indication of heavy mouse activity.

Both wet and dry rodent urine stains will “glow” blue-white under an ultraviolet (“black”) light. Portable black lights are used in the food industry to identify rodent urine on food items. Other substances (e.g., cleaning solutions and detergents) may also glow under this light, so look for droplets and occasional pools symptomatic of rodent activity.

Runway and Rub Marks

Rodent runways alert the pest manager to food, water, and harborage locations. A key rule when inspecting for rodent travel corridors is: Rodents travel along lines. Outdoors, these lines could be ledges, sill plates, tree branches, utility lines, sewer lines, building perimeters, and edges of hard surfaces (e.g., sidewalks, parking areas, landscape stones). Smooth, well-packed, vegetation-free pathways are often indicative of Norway rats or meadow voles. Indoors, search for lines at junctures of walls, floors, and ceilings, as well as temporary lines made by pallets and various containers.

Grease marks (or rub marks) from the body oil and dirt of rats and mice often appear along walls next to runways. Rub marks may also be seen around the bottom of joists, along beams or sill plates, on stairways, on walls near garbage dumpsters, or around burrow openings in walls, floors, or ceilings. Norway rat rub marks are most common on ground-level areas, while the roof rat makes swing marks beneath beams and rafters at the point they connect to walls.

Fresh rub marks are soft and will smear if rubbed. Older rub marks flake off when scratched with a fingernail. Undisturbed spider webs and dust indicate a runway not currently in use.

Tracks

A rat's hind footprint is ¾ to 1½ inches long, while a house mouse hind footprint is 3⁄8 to 1/2 inch long. The number of toes on the hind footprint is five and the front footprint includes four. Typically, the rodent places the most weight on the hindfoot, making it the most visible print. In mud or food dust, the foot's toes and digits are visible and counted easily. Rats may also leave a tail drag line in the middle of their tracks.

Gnaw Marks

When rodent gnawing marks are fresh, they are lightly colored, have sharp edges, and show distinct teeth marks. Small chips of wood or other materials on the surface below also indicate recent gnawing. Mice will make gnaw marks that are 1⁄16 inch apart, appearing as scratch marks. Rat gnaw marks are 1⁄8 inch apart. With age, wood gnawing marks become dark and smooth from weathering and frequent contact with the rodent's body.

Burrows

Burrows indicate an obvious presence of Norway rats in outdoor infestations. Mice will sometimes burrow, but the openings are much smaller (1 inch) compared to rat burrows (3 to 4 inches).

If a burrow is in use, its entrance will be free of spider webs and dust, and you can see fresh rub marks on compacted soil. The presence of fresh food fragments, recent rodent droppings, and freshly dug earth (especially with tracks in it) at the burrow entrances will also indicate current use. To verify an active burrow, stuff a few wads of paper into the entrance or cave in the entrance; recheck these sites within two days.

Two common sites for rat burrows on private property are near bird feeders and by dog houses. Deer mice and meadow vole burrows are often seen around ornamental plantings and at the base of decorative or production fruit trees.

Odor

A distinctive, musky odor commonly accompanies rodents. Urine is a large contributor to this smell. With practice, the odor of rats can be distinguished from that of mice.

MANAGING RODENTS

Rodents must have adequate food, water, and harborage to live and multiply. It follows that anywhere with abundant resources can harbor an abundance of rodents. Removing or reducing available food and harborage with good sanitation and rodent-proofing will reduce the rodent population. Failure to combine these necessary elements will cause rodent management to fail despite other control tactics.

Sanitation

Sanitation (removal of food, water, and harborage) directly limits the growth of rodent populations and also enhances other management efforts. For example, removing other food sources increases the odds that rodents will feed on rodenticide baits. Even the best baits cannot compete with acceptable food sources.

Involving the client in rodent management to improve sanitation includes the following:

- Close or repair dumpsters and garbage containers. The tighter the lid fits on these devices, the less likely a rodent can access food and exit the container.
- Move garbage dumpsters as far away from a building entry door as possible; a minimum of 25 yards is recommended.
- Place food trash in plastic bags before placing in the dumpster.
- Clean up food spills (inside and outside buildings).
- Do not leave out pet foods overnight.
- Store bulk foods (e.g., flour, sugar) and pet foods (including birdseed) in rodent-proof containers.
- Stack packaged foods in orderly rows on pallets for easy inspection in warehouses, restaurants, schools, and food plants. Allow a minimum of 18 inches off the ground and the same distance from side walls.
- Place pallets in aisles for cleaning and inspection. Painting a 12 inch yellow or white band on the floor in commercial storage areas permits easier detection of rodent droppings.
- Eliminate clutter in rooms, closets, and other interior areas of a structure.
- Reorganize items in storage at least once a year. Donate or eliminate items not used in the previous year.
- Remove plant groundcovers (e.g., low-lying shrubs, vines) near buildings. A visual inspection zone of 2 feet is recommended.

- Remove high grass, weeds, wood piles, old equipment, and construction debris adjacent to a structure.
- Renovate or destroy abandoned buildings.
- Trim back tree branches at least 6 feet away from the building. Do not allow branches to extend over the roof of a structure.
- Trim back shrubs at least 2 feet away from the building.

Exclusion

The most successful form of rodent control is to keep them out. Also called rodent-proofing, this technique makes it impossible for rats and mice to enter a structure or a specific area within a building. Mice and rats can squeeze through small openings and jump vertically to amazing heights based on their body size. Look at possible access points at least 3 feet above and below ground level.

Suggestions for repairs to a structure to exclude rodents include the following:

- Seal spaces around doors to ensure a tight fit, especially between the door and floor threshold.
- Check door (personnel entry and overhead doors) brushes or rubber seals and/or thresholds quarterly and replace as needed. For swinging or sliding doors, seals can be heavy-duty brush, vinyl, or rubber strips. For larger overhead doors, install compression seals.
- Seal cracks, holes, and other unneeded openings in building foundations and exterior walls.
- Block openings around water, sewer, and gas pipes, and around dryer vents, telephone and electric lines where these penetrate walls.
- Use permanent sealants (e.g., cement, sheet metal, hardware cloth) whenever possible.
- Screen air vents and chimney openings.
- Screen floor drains and make sure covers fit tightly.
- Fit windows and screens tightly.
- Install rat guards in the water seals of toilet bowls. The rat guard is a 30 inch long, 8 inch diameter piece of pipe that is cut into the vertical 4-inch sewer pipe. A rat can climb inside the vertical 4-inch pipe but cannot span the 8-inch rat guard.
- Space the connecting hardware for utility lines that run along the outside of a building far enough apart that they do not form a ladder for rodents to follow into the building.

Because rodents can gnaw through all types of building materials, the following lists materials used to build rodents out (see Table 2).

Table 2
Materials Used for Rodent-Proofing Building Structures

Material	Specifications
Galvanized sheet metal	25 gauge or heavier
Galvanized or rust-proof expanded metal	28 gauge or heavier, mesh openings no larger than ¼ inch (6 mm)
Perforated metal	24 gauge or heavier; not perforations larger than ¼ inch (6 mm)
Galvanized or rust-proof hardware cloth	19 gauge or heavier; no opening greater than ¼ inch (6 mm)
Cement mortar	1:2:4 mixture or richer
Brick	regular size (3 ¾ inches; 9.5 cm) with mortared joints
Metal kick plate for door	12 inches (30 cm)

If a foundation cannot be sealed, consider building a curtain wall around the foundation. The wall can be made of hardware cloth (19 gauge or heavier) that extends 3 feet straight down into the soil. Alternatively, the hardware cloth can be "L-shaped" with the long part of the material going straight down and the lower part turning out away from the building. A rat that digs down would be diverted by the L turn away from the foundation.

You should also check roof areas (e.g., roofing, flashing, eaves, fascia boards) for signs of rodent entry. Concentrate your inspections where utility lines enter a building and where tree, shrub, or vine branches come near to the building. Repair or replace suspect areas.

Trapping

Trapping provides a very effective form of rodent control, especially when dealing with mice. Some advantages of trapping include the following:

- Traps are nontoxic and can be used in sensitive accounts.
- Their effects are most notable with a small rodent population.
- Results are seen directly.
- They trap bait-shy rodents.
- Trapped mice pinpoint areas of activity.
- Dead rodents are disposed of easily, thus eliminating odor problems.

The primary disadvantages are the time and labor required to put out and maintain traps with severe rodent infestations.

Check traps daily and dispose of dead rodents in plastic bags. Wear protective, disposable gloves (e.g., neoprene, nitrile) when handling rodent carcasses to prevent any chance of disease spread. Decomposing rodents attract flies, dermestid beetles, and other insects, which can lead to additional problems if not removed in a timely fashion. Keep records indicating

where and when rodents were trapped to modify management plans as needed.

SNAP TRAPS

This type of rodent trap is readily recognized, widely available, and easy to use. Successful traps once reset, are more effective at trapping rodents compared to new or cleaned traps. Orient snap traps perpendicular to the wall, with the trigger end against the vertical surface.

Traps must be set in the right places, in high numbers, and in the right position or rodents will miss them entirely.

- Set traps with bait (if food is in short supply) or without bait if food is plentiful.
- Bait traps with items that are more attractive than readily available food sources. When many rodents are present, offer different types of baits. Secure loose baits with string or floss.
    - Good mouse baits include small amounts of peanut butter, bacon, chocolate, gumdrops, nutmeats, vanilla extract, potato chips, snack cracker, and nesting materials (e.g., cotton ball, floss, a strip of paper).
    - Baits for Norway rats include peanut butter, hot dog slices, bacon, and nutmeats.
- Sprinkle oatmeal or other cereals around the traps to make them more attractive. Alternatively, dust the floor with talcum powder near the traps to show if rodents are traveling nearby.
- Take advantage of a rodent's behavior when trapping.
    - For rats, leave the traps unset for a few days to reduce the animal's fear of new objects in their environment.
    - For mice, rearrange a space or storage area before placing traps as they are curious and will explore the "new" area.
- Move boxes and other objects around to create narrow runways for trap placement.
- Set unbaited traps along runways, along walls, behind objects, or in dark corners where the rat travels through a narrow opening.
- When runways are located on rafters and pipes, set the expanded trigger models directly across these structures, fastening them to pipes with wire, heavy rubber bands, or hose clamps, and to rafters with nails.
- Place snap traps near observed signs of rodent activity. For mice, this means sites with large numbers of droppings where the animals congregate.
- Extend the trapping area in three dimensions from an area with active signs. Consider areas above or below food supplies, such as in suspended ceilings, attics, inside pipe runs, above walk-in coolers, in floor voids, under coolers, and in processing equipment.

- Use enough traps. More traps are better than fewer traps.
  - Use 10 to 20 for a house, and 100 for a small warehouse.
  - Place 5 to 10 traps in an active corner of a room.
- Avoid placing traps at equal distances around the interior perimeter even though the traps may look nice or orderly to the person placing them. Concentrating on active locations will result in a greater number of rodents trapped.
- In a rodent-active area, place traps for mice less than 10 feet apart and 15 feet for rats.
- Consider the jumping behavior of rodents when setting traps. A rodent can leap over a single trap.
  - Place two traps side by side with triggers next to the wall for mice or three traps side by side for rats.
  - Use two traps end to end along the wall with triggers facing outward.
- Set traps in a shallow pan of meal, sawdust, or grain when only a few rats remain, resisting capture to this point.
- Avoid spraying snap traps with an insecticide or storing traps with pest control application equipment. These odors, absorbed on the traps, will repel rats.
- Inspect traps frequently to remove dead rodents and change old bait.
- Replace warped traps since this is one way trap-shy mice are produced (the rocker arm misses the mouse and scares it away).
- Avoid handling or petting a dog or cat before setting traps because these odors repel rodents.

MULTIPLE-CATCH TRAPS

Multiple-catch traps are designed for mice. The curiosity of a mouse attracts it into the trap's small opening. Once inside the entryway, either a one-way door or a wind-up mechanism puts the mouse into the trap's holding area. Another type of multiple-catch trap operates on the principle of a trap door. Mice usually die from "capture stress" (a combination of confinement and food and water deprivation) or hypothermia (loss of body heat).

You may encounter live mice when checking traps.

Several advantages to using multiple-catch traps include the following:

- Very efficient, catching up to 15 mice in a single setting.
- Easy to set and place.
- Relatively safe for children and pets.
- No baits required.

- Sturdy and can withstand casual abuse.
- Usable in harsh environments (indoors or outside).
- Can be cleaned.
- Can place the entire trap in a bucket of soapy water or in carbon dioxide chamber to kill any live mice.

Actions to consider when using multiple-catch traps:

- Check traps regularly and make sure mechanisms function properly.
- Place the traps directly against a wall or object with the opening parallel to the runway, or point the entryway toward the wall and leave a 2-inch space between the wall and the trap.
- Consider placing a glue board on top of the trap, as mice will sometimes jump on the trap to investigate it.
- For maintenance trapping, position the traps at high-risk areas and potential mouse entry points (e.g., loading docks, near utility lines, at doorways).

GLUE BOARDS

Another way to trap rodents is with glue boards that use a sticky material spread over cardboard. The rodent becomes entangled in the glue when it runs over the board.

Glue Board Advantages

- Glue boards are preferred traps in homes and other sensitive accounts.
- Trapped rodent and glue board can be discarded in the trash.
- Glue board does not need to be baited for effectiveness.
- Mineral oil or vegetable oil will free the paw of a curious pet or the hand of a person temporarily trapped in the glue.
- Two sizes are readily available-a smaller one for mice and a larger one for rats. However, glue boards can be custom-made to fit the space available.
- Some glue boards are used inside multiple-catch traps.
- Ectoparasites (e.g., fleas, ticks, lice) have an excellent chance of being trapped in the glue, greatly reducing public health concerns.

Glue Board Disadvantages

- Glue boards are less effective in especially wet or dusty areas when the trap is unprotected.
- Glue can run off the cardboard in extremely hot weather.
- Glue hardens to an ineffective state in cold weather or sites.
- Captured animals die of suffocation; some clients will not want you to use the devices to service their accounts.

Suggestions for Using Glue Boards

- Place boards in the same locations as you would snap traps.
- Place boards lengthwise, flush against the wall, box, or other object that edges a runway.

- Avoid placing glue boards directly over food products or food preparation areas.
- Secure the glue board with a thin wire so a rat can't drag it away.
- Install a glue board in a bait station if:
  - children or pets could come in contact with the trap;
  - people might get upset observing a struggling rodent; or
  - the area has excessive dust or moisture.
- Add a few pieces of dry grain or seeds to the middle of the board. Do not use oily bait (e.g., peanut butter) because the oils will inactivate the glue and the trap will not hold a rodent.
- Check glue boards frequently and dispose of rodents when found.

Rodenticides

A rodenticide is a pesticide designed to kill rodents. Their toxic effects are not limited to rodents; they can harm people or other animals as well. You must know and understand the use of rodenticides and strictly follow label directions.

There are two major types of rodenticides, set apart by their toxic action on the rodent:

1. Anticoagulants—these act by damaging blood vessels and inhibiting blood-clotting mechanisms. The poisoned rodent dies from internal bleeding. The process takes several days and does not cause pain to the rodent.
2. Ingesting one dose of some active ingredients is sufficient, while multiple feedings are needed for other active ingredients. Examples of anticoagulant active ingredients include brodifacoum, bromadiolone, chlorophacinone, difethialone, diphacinone, and warfarin.
3. Non-anticoagulants—these toxicants have various modes of action but do not interfere with the animal's ability to clot blood. Some products are effective after a single feeding while others require multiple feedings. Examples of non-anticoagulant active ingredients include:
   - Bromethalin—kills rodents by disrupting energy production within body cells. The resulting fluid buildup, especially in the brain and spinal cord, leads to a decrease in nerve impulses and eventual paralysis and death. Slow action does not promote bait shyness and after consuming a lethal dose the rodent dies.
   - Cholecalciferol—a concentrated form of vitamin D3. It causes the body to release too much calcium from the bones into the bloodstream and the rodent dies from heart failure.
   - Zinc phosphide—a toxin with quick activity, this chemical reacts with water and acid in the rodent stomach to produce poisonous phosphine gas. Death results from heart paralysis, as well as gastrointestinal and liver damage. Zinc phosphide has a distinct garlic odor that is attractive to rodents.

Rodenticide Formulations

DETECTION BLOCKS

Although they do not contain a rodenticide active ingredient, detection blocks are available to determine if rodents are present in a location and to get a general sense of the number and type of rodents. Some detection blocks are formulated with luminous biomarkers that fluoresce green under ultraviolet light. These nontoxic blocks can then be replaced with their toxic counterparts to begin rodent management.

FOOD BAITS

Most rodenticides are formulated as food-based baits containing seeds or grain to attract the rodents. Commercial baits are available in place packs (bait within a small paper or cellophane sack), treated seed and grain, and paraffin pellets, cylinders, or blocks.

One serious disadvantage of food bait is that rodents can carry off pieces; this bait translocation results from normal hoarding behavior. Baits that were carefully placed out of the reach of children and pets may end up out in the open. This presents exposure risks to your customers and liability risks to you. The risk of bait translocation may dictate your choice of formulation.

A tamper-resistant bait box is designed so a child or pet (especially dogs) cannot get the bait inside, but the rodent can. These boxes, constructed of metal or noncrushable plastic, are lockable and usually secured to the floor, wall, ground, or a 12 x 12 concrete paver acting as an anchor. In addition, they have a specific internal design for confining the bait, such as a wire rod. Label each bait station with a precautionary statement from the product label and company contact information.

Rodenticide baits must be used within 100 feet of manmade structures that are vulnerable and attractive to commensal rodent invasions. Some bait can be applied to burrows beyond 100 feet.

Suggestions for Food Baiting

- Use small bait stations for mice and larger ones for rats.
- Offer enough bait; make as many placements as practical. Incomplete baiting can lead to bait shyness and interfere with control efforts.
- Place bait stations in active locations (e.g., runways with fresh fecal pellets) and to intercept incoming rodents (e.g., on both sides of busy personnel and overhead doors).
- Keep the distance between bait boxes at 10 to 20 feet for mice and 15 to 50 feet for rats.
- Check boxes periodically to ensure bait freshness and acceptance.
- Limit burrow baiting to sites where packs can be placed 6 inches or more into active rat burrows.
- Do not broadcast bait on the ground in rodent-infested areas.
- Use paraffinized baits if the bait will be regularly exposed to moisture.

According to state law, if a bait is placed more than 3 feet from the structure or beyond label-approved distances for rodent control, the applicator is required to have a Category 12: Vertebrate Animal Pest Management license.

- Keep a station in place as long as rodents take the bait; the animals now consider it as part of their normal surroundings.
- Number each bait station and map their locations on the property. In addition to speeding up service activities, the map will give you information on rodent activity and possible entry sites.

WATER BAITS

In some instances, liquid (water) baits are more successful than dry baits. Rats need a daily ration of water to survive. Although mice usually obtain their water requirements directly from their food sources, they will freely drink from a water bait station placed in their home range. Water baits are particularly effective in sites where water or food with high moisture content is scarce, such as a dry goods warehouse. Diphacinone is a common active ingredient for water baits.

Some disadvantages of water baits are increased installation and service times, risk of spills, and freezing temperatures. Use this formulation only where no other animals or children can access them.

TRACKING POWDERS

Tracking powders combine the active ingredient with talc or finely ground clay. The material is placed in rodent runways or active burrows. When the animal travels across the powder, some of it sticks to their feet, fur, and tail. The rodent will swallow the powder during grooming. Because small amounts of powder are consumed, the concentration of rodenticide is higher than in baits. Chlorophacinone, diphacinone, and zinc phosphide are examples of active ingredients formulated as tracking powders.

Placement of tracking powders to minimize nontarget exposure is very important. Keep in mind that the rodent will carry the powder on its body wherever it travels, including food preparation surfaces or on stored foods. Tracking powders are not recommended for use in and around homes because of the hazard to children and pets.

Suggestions for Using Tracking Powder

- Apply heavier than an insecticide but never deeper than 1⁄8 inch.
- Best application sites are inside dry, infested wall voids; around rub marks; along pipe and conduit runs; on active, discrete runways; and in dry burrows (when permitted by the product label).
- Placement in bait stations, in PVC pipe, cardboard tubes, or any other small, dark shelter area will minimize nontarget access.
- Application equipment could include a hand duster or a similar, properly labeled device.
- Do not use tracking powders in suspended ceilings, around air ventilation areas, or near food or food preparation areas.

FUMIGANTS

Certain rodenticides are also formulated as poisonous gases (fumigants). The most common use of these products is for burrow

gassing. Although this is a fast and effective way to control burrowing rodents (e.g., Norway rats), these products pose extreme danger if used improperly.

SECONDARY HAZARDS OF RODENTICIDES

Secondary hazard refers to the risk that a nontarget animal will consume rodents poisoned by rodenticides. These routes of exposure are a concern because rodenticides are toxic to nontarget animals that readily consume the bait and/or rodents. Possible animals impacted are pets, livestock, zoo animals, raptors (e.g., owls, hawks, eagles), and other wildlife.

Rodenticide secondary hazards can be classified as:

- Primary poisoning—when an animal directly consumes a rodenticide, usually occurring when bait is placed in an unprotected location.
- Secondary poisoning—when one animal is poisoned after consuming the flesh of another animal that digested the poison. Rodenticide poisoning has been documented in many birds of prey after ingestion of rodenticide-killed rodents.
- Secondary ingestion—when one animal (e.g., cat) consumes a rodent that still has undigested bait in its gut or mouth. Technically, the animal is directly (although unknowingly) consuming the rodenticide bait. The chance of an animal (e.g., dog, cat) being poisoned by consuming exposed rodents is extremely small. For one thing, the amount of toxicant needed to kill a mouse or rat is much smaller than the amount required to poison a cat or dog. The unsuspecting animal would have to consume a large number of exposed rodents to ingest a toxic dose of the rodenticide.

CHAPTER 15

Other Vertebrate Pests

LEARNING OBJECTIVES

After studying this chapter, you will be able to:

1. Define avicide.
2. Know a variety of bird management methods.
3. Discuss the daily and seasonal activity of bats.
4. State the best method to control bats in a structure.
5. Name five common entry sites for squirrels entering a structure.
6. State how rat glue boards can assist in managing snakes.
7. Explain how opossums can be household pests.
8. Discuss the human health concerns of birds, bats, raccoons, and skunks.
9. Outline four things a client can do to eliminate conducive conditions for birds, snakes, skunks, raccoons, and opossums.
10. Give examples of vertebrate pests that can be legally trapped.

OVERVIEW

It is your responsibility to be familiar with Utah laws, licensures, and/or certifications regarding nuisance wildlife control. In addition, you may need to review federal endangered and threatened species laws for certain protected, problematic species.

BIRDS

Birds can become pests when they feed on crops; create health hazards; roost in large numbers on buildings; deface buildings, sidewalks, and cars with droppings; plug downspouts and air vents with nests; contaminate food; or otherwise create a nuisance. Bird ectoparasites (e.g., mites, lice, swallow bugs) can invade living areas and bite humans. Birds can also transmit cryptococcosis and histoplasmosis, which are serious, systemic, fungal infections acquired by inhaling airborne spores that grow in bird droppings. No particular species can be flatly categorized as beneficial or harmful; these designations depend on time, location, and activity.

Daily removal and proper disposal of carcasses is required by most avicide labels.

Bird Management Procedures

With very few exceptions, federal laws and regulations protect all birds. Pigeons, starlings, and house sparrows are not directly protected at the federal level, but applications of avicides (pesticides targeting birds) must be according to label directions and under FIFRA restrictions and protect nontarget birds and other animals. State and local regulations may require permits or restrict actions against these three pest species.

Be aware of risks when dealing with birds. Dry, dusty droppings may contain fungal spores, which may lead to human disease. Workers cleaning such areas or involved in hand capture of birds should wear approved respirators, appropriate gloves, goggles, and coveralls. Do not eat, smoke, or drink anything until contaminated clothing is removed and you have washed thoroughly.

INSPECTION

The first step in controlling nuisance birds is to conduct a detailed and accurate survey. Do these assessments early in the morning, midday, and again in the evening to correspond to the different activity periods of the birds. Record information on pest and nontarget bird species. The surveys should answer the following questions:

- What bird species are present?
- Are there endangered species in the area?
- How many birds were seen?
- Are the birds living as residents or migrants?
- Are birds nesting, feeding, roosting, or loafing at a specific site?
- Where do they eat and drink?
- What is attracting them to the various sites?
- Is the presence of the birds a health risk?
- Are the birds causing property damage?
- If dispersed, where do the birds go?
- If poisoned, where would the birds die?
- What risk exists to nontarget species?

- What state and local regulations impact management activity?
- Could there be a public relations problem?
- What control methods appear to be practical?

HABITAT MODIFICATION

Modifying the habitat for bird management means to limit the food, water, and shelter in the problem sites. Although removal of all food and water for pigeons, starlings, and sparrows is not possible, limiting these necessities in urban sites is important.

- Handle garbage in a manner so that none is available to birds.
- Avoid or clean up spills of grain or other feed immediately.
- Mow vacant lots to reduce weed seed numbers.
- Nest destruction is ineffective against sparrows and starlings, but pruning trees, shrubs, and vines will sometimes deter birds from roosting.

EXCLUSION

Building out or preventing birds from roosting or nesting inside or near the doors of a building is good bird management. The best time to do this is before nests or roosts are well established.

Some building designs and conditions lend themselves to bird infestations. Flat ledges, openings in water towers and vents, unscreened windows, and similar attributes make a building an attractive location for nesting, roosting, and loafing. Typical solutions include:

- Replacing broken windows.
- Eliminating large crevices and holes.
- Adding screens to windows, vents, and rooftop equipment, using ¾-inch (19 millimeters) galvanized mesh or rustproof wire.
- Using plastic or woven bird netting to prevent access to building structures.

ROOST REPELLENTS

Roosting repellents force birds to move to other areas. A sticky substance (e.g. polybutene) can be used as roost repellents on ledges, beams, or other areas where birds roost. The tackiness of the sticky repellent discourages bird roosting without trapping or poisoning the animals. If the bird picks up enough of the substance, it may affect its flight.

Sticky roost repellents are initially very effective, but their tackiness is lost with time, usually due to the accumulation of dirt and debris. Some of these materials do not work under extremely hot or cold temperatures.

Methyl anthranilate is an irritant sprayed on roosts to repel birds and discourage roosting. This product is applied with a sprayer or fogger.

Porcupine wire or plastic spikes can effectively repel birds when installed properly on ledges and inspected periodically to remove debris.

Electric roosting repellents provide a weatherproof system. A cable or track is installed in a position to provide the birds with a desirable perch or roosting place. When birds perch on that track, an electric charge shocks them without killing them. Experienced contractors must install these.

Wood or sheet metal caps can be added to ledges at a 45° angle so that birds can no longer stand on the ledges.

Other repellents have been used, such as revolving lights, predator mimics (e.g., owl decoys, rubber snakes), noisemakers (e.g., blank guns, fireworks), high frequency sound vibrations, or recorded distress calls. These devices generally have only a temporary effect, if any, in bird management, reducing cost-effectiveness.

SUPPRESSION TECHNIQUES

Population reduction techniques must be performed in conjunction with habitat modification and exclusion. People often react more negatively to one dying bird than to accumulating pigeon droppings on sidewalks or potential risks of disease. The public's perception of bird management operations needs consideration. Regular communication and teamwork with clients will better prepare them for the various activities and dead birds that result from these activities.

TRAPPING

In the case of pigeons, small populations can often be controlled by capturing them in live traps placed near their roosting, loafing, or feeding sites. Enhance success of live trapping by prebaiting with corn or milo for several days before actual trapping begins. Supply traps with plenty of food and water and check them daily. Immediately free federally or state-protected birds if trapped accidentally.

SHOOTING

A possible alternative or supplemental method for eliminating birds is shooting with air-powered pellet guns if legally allowed. This method is most effective for killing scattered individuals or small flocks.

CHEMICAL MANAGEMENT

The use of avicides in certain situations may be the only means of effective management. These products repel and/or kill birds. Make decisions as to the need, type, and method of toxicant use carefully. Poisons may be prohibited or too risky to use because of the dangers to humans, pets, or desirable bird species.

TOXIC BAITS

Poison baits with the active ingredient 4-aminopyridine are restricted-use products. They are made with whole corn for pigeons, and smaller grains for sparrows and other birds. This avicide is both a repellent and toxin to birds. When eaten by pigeons, starlings, or sparrows, it produces distress reactions (e.g., erratic fluttering, flying into windows or structures,

Placement distance of the bait from the structure determines which applicator license is required. According to Utah law, if bait is placed over 3 feet or beyond label-approved distances, a Category 12: Vertebrate Animal Pest Management licenses is required.

convulsions) in some of the birds. Stress or other factors may cause the death of these birds. This reaction frightens the rest of the flock away from the area.

Another avicide used only to control starlings has the active ingredient 3-chloro-p-toluidine. It produces a slower, nonviolent death of birds eating the treated grain. Death usually occurs within 24 to 36 hours after feeding.

Premonitoring the area to determine the pest bird and nontarget bird populations is a necessary prerequisite to using avicide bait. Also, birds must usually be trained to feed on the bait and to establish proper feeding locations. Removal of all the prebait corn/small grain before switching to the treated material is important. Good bait acceptance usually results in quicker control of the flock.

CHEMOSTERILANTS

Products with the active ingredient nicarbazin serve as a type of chemosterilant, bringing about pigeon birth control. It interferes with egg hatch success and causes the treated bird population to decline. Products are formulated as ready-to-use baits.

BATS

Bats in the United States are almost always considered beneficial animals. Many bats feed on insects and can consume up to half their body weight in insects at one feeding. It is estimated that a colony of 500 bats could consume 500,000 insects nightly. They will also eat other animals, and some species eat fruits.

Occasionally, bats will roost in houses, barns, and upper sections of churches and public buildings. The odor from accumulated droppings and urine is unpleasant and will stain ceilings and walls. Noises of bats calling to each other and flying in a structure, as well as the danger of bites to humans, constitute a health hazard.

Bats can transmit histoplasmosis and rabies to humans. When working in a bat roost, always wear a respirator and protective clothing. Bats' role in rabies transmission has been exaggerated since only 4% of bats are infected with rabies. However, as a precaution, consider any bat found inside a structure infected and take the following steps:

- Wear heavy gloves when handling bats because most bats will try to bite when handled.
- NEVER handle a bat that is acting in a peculiar manner.
- Capture a bat without crushing its head if the bat has bitten someone. Refrigerate the animal (don't freeze) and contact the health department for rabies testing.

Habits of Bats

Bats are active in warm weather from late afternoon through early morning; they are not active during bright daylight. (If you see a bat during the day, it was either dislodged from its roost or it is sick.) When not hunting flying insects, bats rest upside down in dark, secluded areas (e.g., caves, hollow trees, attics of buildings). Bats can enter places of refuge through holes as small as 3/8 inch.

Bats migrate or hibernate when the weather turns cold. In some situations, they hibernate in hanging clusters inside buildings. Depending on the species and geographic location, bats breed from late spring to midsummer. Young bats grow rapidly, flying in as few as three weeks after birth.

Management of Bats

EXCLUSION

June and July are peak months for bat complaints. Unfortunately, this is the worst time of year for control because bats are rearing young. Bat-proofing should wait until after mid-August when the young bats can fly.

The best (and permanent) way of controlling bats is to exclude them from a building; this is often referred to as "bat-proofing" a structure. The goal is to close all openings ¼ inch or larger through which bats may enter or leave. Address all potential openings, and detect active openings by observing the structure at dusk; you will see bats flying out of these active openings.

Seal all openings but one with ¼-inch hardware cloth, screening, sheet metal, or steel wool and sealant. Wait three or four days for the bats to adjust to using the remaining opening. Then seal this opening after the bats have exited the roost for the evening, usually one-half hour after dark.

In certain situations, use bat valves. These are placed over the remaining opening and allow bats to leave but not return.

Plastic bird netting is another material that can be part of bat exclusion. This inexpensive material is easy to work with, tough yet flexible for shaping, and can be fastened over hard-to-seal areas. If needed, drape the bird netting over the entire roof to seal multiple openings due to poorly designed construction.

REPELLENTS

To force them out of a structure before it is bat-proofed, repel bats from their roosts. The only chemical registered for this purpose is naphthalene (commonly called mothballs). Spread the crystals or flakes on attic floors or place in voids, or place an open container in the bat roosting area. Make sure that the placement does not expose people to the fumes. This treatment is most effective in confined air spaces.

Blasts of air and bright lights have had some success in repelling bats. Ultrasonic devices do not repel bats.

When a single bat finds its way into a home, office, or store, it will usually find its way out again. When it cannot, capture the bat with an insect or fish net, a coffee can, or even a gloved hand. Take the bat outside for release.

TREE SQUIRRELS

Adult tree squirrels are small, rodent-like animals with long, bushy tails.

Tree Squirrel Management

EXCLUSION

The first step in eliminating a squirrel problem in a structure is to find out where the animal(s) are entering. Common points of entry include damaged attic louvers, ventilators, soffits, joints of siding, knot holes, openings where utility pipes or wires enter, chimneys, and flashing.

Use heavy gauge, ½-inch hardware cloth or sheet metal to seal most openings. Make other suitable repairs as for rat-proofing or bat-proofing.

REPELLENTS

Many repellent products on the market keep squirrels out of attics and other areas of structures, particularly in summer homes and camps that are unoccupied in the winter. Active ingredients include black pepper oils, capsaicin, garlic oil, mustard oil, piperine, putrescent egg solids, and thymol. These are formulated as single ingredients or combinations of two or more ingredients.

TRAPPING

Live trapping can be used to remove one or a few squirrels from a building. Leave traps open and unset for a few days, surrounded by attractive bait. Examples of baits include whole corn, sunflower seeds, peanuts, nutmeats, and rolled oats. Once the squirrels feed at the site, then set the trap for capture.

Handle trapped squirrels carefully. Always wear heavy gloves when moving the trap, as squirrels will readily bite you. Release captured squirrels at least 5 miles away in a wooded area.

Where lethal control is permitted, rat snap traps can be used to kill squirrels in attics. Tie the bait to the trigger and secure the trap with wire to a nearby wood rafter or beam. Check with local game conservation officers if you plan any kind of lethal control.

SNAKES

Most snakes are nonpoisonous, harmless, and beneficial, but few people want them in their homes.

If snakes are a regular problem, the best solution is to eliminate hiding places. Clean up brush piles, wood piles, rock piles, and other debris. Trim shrubbery away from foundations and cut tall grass.

Often, snake problems follow rodent populations. Eliminate the rodents and the snakes will move elsewhere seeking prey.

Snakes enter structures through broken block foundations, cracked mortar, damaged vents, or open crawl space covers. Repair or close these items.

Snake Management

REMOVAL

If a snake gets into a house or other building, it can be removed through several methods:

- Place damp burlap sacks on the floor and cover them with dry sacks. Check them every few hours to see if a snake has crawled underneath, seeking shelter. Lift the snake and bags with a shovel and take them outside to be released or killed.
- Use rat glue boards to capture all but the largest snakes. These boards should be tied down or attached to a plywood base. Place the glue boards along wall/floor junctions. Release captured snakes from the glue by pouring vegetable oil over the snake's body.
- Place expanded trigger rat traps in pairs along wall and floor junctions. Make sure these are set in out-of-reach places for children and pets.

REPELLENT

A granular snake repellent can keep some species away from homes, campsites, garages, and yards. The active ingredients are naphthalene and sulfur. Apply the granules in a narrow band around the area needing protection.

SKUNKS

There are two species of skunk in Utah: the common striped skunk (*Mephitis mephitis*) and the western spotted skunk (*Spilogale gracilis*). These animals usually live in underground burrows, hollow logs, or rock piles. In certain situations, however, they may decide to live under houses, sheds, cabins, or outbuildings.

The main problem with skunks is their odor. They become pests when they locate their habitat

closer to humans and change their dietary selections from rodents, insects, and wild fruit to garden crops, garbage, and lawn insects. In some areas of the country, skunks also transmit rabies.

If a skunk sprays a pet, mix ¼ cup baking soda, a fresh 1-quart bottle of hydrogen peroxide, and 1 to 2 teaspoons of liquid dish detergent. This solution must be used right away and cannot be stored. Thoroughly work the mixture into the fur/hair/skin, avoiding the eyes and mouth; leave on for five minutes. Rinse with fresh water and repeat.

Repellent

A repellent labeled for skunk control has the active ingredients capsaicin, black pepper oils, and piperine. Other products registered in some states include a smoke bomb (carbon, sulfur, and potassium nitrate) and the "Giant Destroyer" (carbon, sulfur, and sodium nitrate).

RACCOONS

Raccoons are common throughout North America. Their natural habitat includes streams, lakes, and swamps, and they have adapted very well to suburban areas and city parks. They den inside hollow trees or logs, rock crevices, deserted buildings, culverts, chimneys, attics, and crawl spaces. They may use more than one den.

Raccoons feed on animals and plants. In the spring and summer, these animals feed on crayfish, mussels, frogs, and fish. In the fall they switch to fruits, seeds, nuts, and grains. They will also eat mice, squirrels, birds, and garbage left by humans.

The raccoon can transmit rabies. This animal is the definitive host for a large intestinal roundworm, *Baylisacaris procyonis*, which has been documented in 68% to 82% of raccoons. Pets and humans can accidentally pick up this parasite if they contact the contaminated soil of raccoon latrines.

Repellent

As an example, raccoon repellents typically have one of four active ingredient combinations:

- Garlic oil + capsaicin.
- Meat meal + red pepper.
- Capsaicin, black pepper oil + piperine.
- Camphor oil, cornmint oil, eucalyptus oil + wintergreen oil.

OPOSSUMS

Opossums prefer to live near wooded areas with access to a stream or swamp. They den in the burrows of other large animals, in tree cavities, brush piles, and under sheds and buildings. Occasionally, they move into attics and garages.

These animals are omnivores, eating insects, carrion, fruits, grains, garbage, and pet food. As a pest, the main complaint with opossums is their habit of getting into garbage, bird feeders, and pet food left outside.

There are no chemicals registered to repel opossums.

MANAGING SKUNKS, RACCOONS, AND OPOSSUMS

Sanitation

Community involvement in keeping good sanitation levels in a neighborhood is the best preventive measure for skunks, raccoons, and opossums. Examples of good sanitation practices include:

- Using garbage containers with tight-fitting or latched lids.
- Securing cans so they cannot be tipped over.
- Picking up remaining pet food.
- Picking up and discarding fallen fruits on a regular schedule.
- Trimming back tree branches hanging over buildings.
- Eliminating long-standing brush piles.
- Removing old, hollow trees and logs on the property.

Exclusion

Prevent these animals from entering buildings by several methods, depending on where they are living:

- Repair breaks in foundations with appropriate materials.
- Screen crawl space vents with hardware cloth.
- Seal attic openings.
- Cap chimneys with a wire cage or other animal-proof cover.
- Seal all openings but one if an animal appears to be living under a building. Sprinkle talc powder at the last opening; examine the area after dark, and if the animal has left, close opening.
- Install an electric fence around garden areas if needed. A two-wire fence with one wire 6 inches off the ground and the second 12 inches high, will discourage hungry animals.

When excluding animals in spring or early summer, be aware that young also may be present. To prevent odors from dead animals, ensure that all animals have been removed before sealing the building.

Live Trapping

The best way to remove animals from structures is to trap them. Some guidelines include:

- Handle trapped animals with extreme care; always wear heavy gloves and a heavy jacket or coat.
- Release a trapped animal far away (10 miles) from human dwellings or nearby buildings. Check with state wildlife officers for the best possible release sites.
- Set traps as close to the den as possible or as close to the areas being damaged, such as at corners of gardens, breaks in stone walls, or along obvious animal trails.
    - Set multiple traps in a number of different locations.
    - Check traps at least each morning, or, if possible, twice a day. Release any nontarget animals trapped.
- Utah state law requires live-trapped raccoons be euthanized on-site.

For trapping skunks, it is very important to modify the site to prevent being sprayed. Cover all but the trap entrance with burlap sacks or canvas before placing the trap. Commercial skunk traps are available. When a skunk is trapped, approach the trap slowly and transport it gently. To release a live skunk, stand at least 20 feet away, and release the trap with string or fishing line.

The best baits for each animal are as follows:

- Skunk – chicken parts and entrails, fresh fish, cat food, sardines, eggs.
- Raccoon – chicken parts and entrails, corn, fresh fish, sardines.
- Opossum – apple slices, chicken parts and entrails, fresh fish, sardines.

Utah State University is committed to providing an environment free from harassment and other forms of illegal discrimination based on race, color, religion, sex, national origin, age (40 and older), disability, and veteran's status. USU's policy also prohibits discrimination on the basis of sexual orientation in employment and academic related practices and decisions. Utah State University employees and students cannot, because of race, color, religion, sex, national origin, age, disability, or veteran's status, refuse to hire; discharge; promote; demote; terminate; discriminate in compensation; or discriminate regarding terms, privileges, or conditions of employment, against any person otherwise qualified. Employees and students also cannot discriminate in the classroom, residence halls, or in on/off campus, USU-sponsored events and activities. This publication is issued in furtherance of Cooperative Extension work, acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture, Kenneth L. White, Vice President for Extension and Agriculture, Utah State University.