
Vertebrate Pest Management

A Guide for Commercial Applicators Category 7D



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INTRODUCTION

How to Use This Manual

This manual contains the information needed to become a certified commercial applicator in Category 7D, Vertebrate Pest Management. This manual is intended for use in combination with the Pesticide Applicator Core Training Manual (Extension bulletin E-2195), available through the Michigan State University Bulletin Office. However, this manual would also be useful to anyone interested in learning more about vertebrate pest management.

Category 7D, Vertebrate Pest Management, covers the management and control of vertebrate pests that become problems in and around buildings, and in lawns, gardens, fields, backyards, etc. The chapters contain basic scientific information as well as guidelines for practical solutions to pest control problems.

The Category 7D certification exam will be based on information found in this booklet. Each chapter begins with a set of learning objectives that will help you focus on what you should get out of each chapter. The table of contents will help you identify important topics and understand how they relate to one another through the organization of headings and subheadings. As you prepare for the exam, read each chapter and answer the

review questions located at the end. These questions are not on the certification exam. They are provided to help you prepare for the exam. Questions on the exam will pertain directly to the learning objectives.

The appendices and glossary, including an answer key (Appendix A), at the end of this manual provide supplemental information that will help you understand the topics covered in the chapters. Terms throughout the manual text that are bold and italicized can also be found in the glossary.

This certification manual benefits the applicator and the general public. By learning how to handle pesticides correctly, applicators will be able to protect themselves, others, and the environment from pesticide misuse. For more specific information on how to become a certified applicator in Michigan, refer to the beginning of the core manual (E-2195) or to the Michigan Department of Agriculture's Web site at:
<<http://www.mda.state.mi.us>>.



CHAPTER 1

Legalities of Vertebrate Pest Management

LEARNING OBJECTIVES

After completely studying this chapter, you should:

- Understand the various state and federal laws that govern pesticide use and handling, record-keeping requirements, worker protection, and wildlife protection.
- Be able to explain the legal responsibilities of a pesticide applicator according to the rules of Regulation 637.
- Be familiar with the Wildlife Conservation Order and understand the rules regarding control (pesticide use, hunting and trapping, etc.) of wildlife pests.
- Know under what circumstances a state and/or federal permit is required to control vertebrate pests.
- Know the accepted methods for euthanization of vertebrate pests and for the disposal of animal carcasses.
- Know the rules regarding retaining and/or selling live or dead animals or their parts.

In this chapter, you will learn about the state and federal laws that regulate pesticide applicators with a particular focus on commercial pesticide applicators certified in Category 7D, Vertebrate Pest Management. **Vertebrates** are any animals with a backbone or spinal column. Humans, dogs, snakes, and birds are examples of vertebrates; insects, worms, jellyfish, and snails are not. A few vertebrates, such as rats and mice, are common pests in urban and industrial sites. Others are not pests in their normal habitats but may occasionally become pests when they conflict with humans. A skunk in the woods is a beneficial part of nature; a skunk nesting in the crawlspace of a home is an entirely different matter.

Simply defined, a **pest** is any unwanted organism. Applicators certified in Category 7D are responsible for vertebrate pest management in places where the activity of these animals is undesirable. This often occurs where vertebrate pests invade structures—homes, schools, businesses, warehouses, etc.; where they become pests of lawns, gardens, crops, etc.; and also where they pose a human health risk.

Some vertebrates that are serious pests in particular situations are never considered pests by certain people. Pigeons, for example, can cause human health problems when roosting in large numbers. Commonly, their droppings foul sidewalks, contaminate food, and damage automobile paint. But pigeons are seen as pets and friends by many city dwellers who feed them. These people may react angrily to any attempt to poison or trap pigeons. Many people today are involved emotionally in protecting the welfare of animals, particularly vertebrates. Control of vertebrates other than rats and mice is often more of a public relations problem than a pest problem. Wherever possible and practical, a non-lethal method of pest control should be used.

Public concern for the welfare of animals and the risk to people, pets, and other non-targets from poisons used to kill vertebrates have made rules governing vertebrate pest control particularly strict. Laws and regulations at the state and local levels may be much more restrictive than federal regulations. For these reasons, among others, it is important that Category 7D applicators understand and keep up-to-date with federal, state, and local laws that affect pesticide application for control of vertebrates.

STATE AND FEDERAL LAWS

The Pesticide Applicator Core Training Manual (E-2195) discusses federal and state laws that govern the handling and use of pesticides. Review the core manual and understand how laws and regulations affect pesticide practices and use. These laws include federal laws such as the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), the Occupational Safety and Health Act (OSHA), the Endangered Species Act, and the Federal Migratory Bird Treaty Act. State laws include the Natural Resources and Environmental Protection Act, Regulation 636, Regulation 637, the Michigan Occupational Safety and Health Act (MIOSHA), and the Wildlife Conservation Act. These are just some of the laws that affect commercial pesticide applicators. They are briefly described below. Refer to the core manual to learn more about other laws affecting pesticide use and

for further details on laws discussed in this chapter. Pesticide technicians should keep up-to-date copies of the laws and review their contents periodically. Copies of these laws can be obtained from MDA regional offices.



FEDERAL LAWS

FIFRA

This is the basic federal law administered by the Environmental Protection Agency (EPA) that regulates pesticides (their use, handling, storage, transportation, sale, disposal, etc.). The Michigan Department of Agriculture (MDA) has a cooperative agreement with the EPA to enforce some provisions of FIFRA in Michigan. Some of the provisions of FIFRA are that the EPA must register all pesticides before they can be sold or used. The pesticides must be classified as either “*general use*” or “*restricted use*.” General-use pesticides are those that can be purchased without restriction. Restricted-use pesticides are those that can be used only by or under the direct supervision of a certified applicator. FIFRA also stipulates that persons who misuse pesticides (in a way that is “inconsistent with the pesticide labeling”) are subject to penalties.

OSHA

OSHA is administered by the U.S. Department of Labor (DOL). OSHA governs the record-keeping and reporting requirements of all work-related deaths, injuries, and illnesses of businesses with 10 or more workers.

Endangered Species Act

This act requires the U.S. EPA to ensure that endangered or threatened plant and animal species are protected from pesticides. This act requires each pesticide label to limit its use in areas where these species could be harmed. Category 7D applicators must consider the possibility that endangered or threatened species may be affected by the pesticides they apply. The Michigan Department of Natural Resources (MDNR) Wildlife and Fisheries Management divisions administer the Michigan

Endangered Species Act (Act 451, Part 365) and maintains the federal and state endangered or threatened species lists. Michigan applicators who want to be sure they are complying with the act must take the initiative and consult with the MDNR to be sure that there are no endangered or threatened species in their area. One of the goals of pest management is to protect off-target plants and animals from pesticides, whether they are endangered or not.

Federal Migratory Bird Treaty Act

The federal Migratory Bird Treaty Act protects all birds except pigeons, house sparrows, and starlings. However, local ordinances may protect bird species not protected by the federal act and/or specify the types of treatments that can be used. Always check local and state laws before attempting to control any bird species.



Other than pigeons, house sparrows, and starlings, special federal permits (50 CFR) are required to control all other migratory bird species. In particular, the federal **Depredation Permit** allows the permittee to control migratory birds that are clearly shown to cause or about to cause serious damage to agricultural, horticultural, or fish cultural interests. The act also specifies the manner by which the birds may be killed. However, one exception in the Migratory Bird Treaty Act states: “A federal permit shall not be required to control red-winged, rusty, and Brewer’s blackbirds, cowbirds, all grackles, crows, and magpies when found committing or about to commit depredations upon ornamental or shade trees, agricultural crops, livestock, or wildlife, or when concentrated in such numbers and manner as to constitute a health hazard or other nuisance....” In these situations, first consult local and state laws before attempting control.

STATE LAWS

Natural Resources and Environmental Protection Act, Act No. 451, Part 83, Pesticide Control

This legislation gives the director of the MDA authority to register or certify private and commercial applicators and to prescribe standards for certification and registration. Category 7D applicators are considered commercial applicators. Commercial applicators can be divided into two subclasses:

Subclass A—Any person (including homeowners) who uses or supervises the use of restricted-use pesticides (RUPs) for a non-agricultural purpose.

Subclass B—Any person who either (1) applies pesticides other than ready-to-use pesticides in the course of his or her employment, or (2) applies a pesticide for a commercial purpose (for hire).

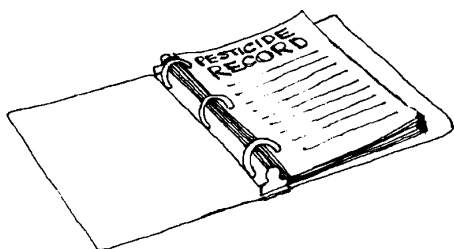
Ready-to-use pesticides are those used from the manufacturer's original container (aerosols, pump sprays, strips, baits) with no need to mix or load into application equipment.

Regulation 636 (Pesticide Applicators)

This establishes the types of certified applicators and expands the pesticide record-keeping requirements. All commercial applicators shall maintain records of pesticide use for a time period not less than the following:

General-use pesticides: One year following application.

Restricted-use pesticides: Three years following application.



All records shall contain the following:

- The name and concentration of the pesticide applied.
- The amount of pesticide applied.
- The target pest or purpose.
- The date the pesticide was applied.
- The address or location of pesticide application.
- Where applicable, the method and rate of application.

The records must be made available to the MDA upon request.

Michigan Occupational Safety and Health Act (MIOSHA)

The MIOSHA Right-to-Know act requires employers to:

- Obtain and retain material safety data sheets (MSDS) on all hazardous chemicals (including pesticides) for employee review.
- Develop and implement a written employee training program.
- Ensure that all containers of hazardous materials are properly labeled.

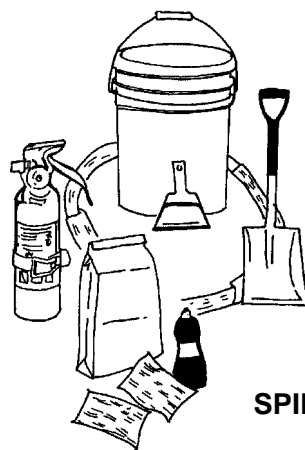
Regulation 637 (Pesticide Use) Requirements

One of the pertinent state laws that Category 7D applicators must be familiar with and understand is Regulation 637, Pesticide Use. Regulation 637 establishes

several legal standards for pesticide use. It requires that pesticides be used in a manner consistent with their labels, that applications be made in a manner that prevents off-target discharges of pesticides, and that pesticide application equipment be properly calibrated and in sound mechanical condition. Obtain a copy of the entire regulation to understand the components of each rule and how your pest management business and practices must comply.

Some of the rules of Regulation 637 surrounding the safe and legal use of pesticides are as follows:

- A pesticide must be used in a manner consistent with its label.
- Applications must be made so that off-target direct discharges are prevented.
- Pesticide application equipment will be in sound mechanical condition and be free of leaks and other defects that might cause a pesticide to be deposited off-target or in a way inconsistent with its label.
- Application equipment must be properly calibrated.
- Pesticide application or loading equipment that is designed to draw water must have an antisiphoning device.
- Applications shall not occur when conditions favor off-target drift of pesticides or prevent the proper deposition of pesticide to the target area.
- Before applying a pesticide, the applicator will identify any sensitive areas that are located adjacent to the target area and will use appropriate precautionary measures to prevent the direct discharge of pesticides to those areas.
- Each vehicle that is used to transport pesticides must have the following information printed on its exterior:
 - Name of the pesticide applicator firm.
 - Business telephone number, address, or U.S. Department of Transportation census number of the applicator firm.



SPILL KIT

- Any person who mixes, loads, or otherwise uses pesticides must have immediate access to a spill kit. The spill kit requirement does not apply to a person using single containers of use-dilution pesticides in a quantity less than 16 ounces.

Regulation 637 also discusses the most acceptable manner in which to handle excess pesticides and pesticide-containing material. Pesticide-containing materials are any materials that contain a mixture of active (pest-controlling) and inactive (non-pest-controlling) ingredi-



ents. To be in compliance with the label directions, the pesticide or pesticide-containing material should be applied to a site that is specified on the label and in a manner so that the total rate of application of the active ingredient is not more than the rate allowed on the label.

Regulation 637 also requires the applicator to follow label directions regarding **personal protective equipment (PPE)**. The regulation sets the minimum PPE requirements for commercial applicators. Unless otherwise directed by the pesticide product label, while performing pesticide tasks, applicators must wear:

- Long pants.
- Protective footwear.
- Long-sleeved clothing (short-sleeved clothing may be worn if wash water or waterless soap is immediately available).
- Gloves impervious to the pesticide being used when the applicator's hands are likely to come in contact with the pesticide, unless a program is in place that offers comparable applicator protection.

Regulation 637, requires commercial applicators to enter into oral or written **applicator service agreements** with the customer or authorized agent. The agreement must specify:

1. The customer's consent to services.
2. The name, address, and telephone number of the company that provides the pesticide application services.
3. The approximate schedule and frequency of anticipated services.

Further, according to the regulation, not later than at the time of each pesticide application, the commercial

pesticide applicator must provide all of the following **written information** to the customer:

1. The name, address, and telephone number of the company providing the pesticide application service.
2. The full name of the applicator who is making the pesticide application.
3. A general description of the target pest or pests to be controlled.
4. A list of pesticides applied, including the common name of the active ingredient.
5. The time and date of the application.
6. Precautionary warnings that are pertinent to the protection of humans, animals, or the environment at the application site and that appear on the label(s) of the pesticide(s) applied.

In addition, not later than at the time of the initial pesticide application, a commercial applicator must provide **risk and benefit information** to the customer. Risk and benefit information contains but is not limited to:

1. Definition of a pesticide.
2. A general description of how a pesticide works.
3. Why pesticides are used.
4. General toxicity information related to the following:
 - The type of compound used.
 - The environment where the pesticide is applied.
 - General exposure information.
 - The amount or rate of pesticide applied.
 - Proper pesticide applications in compliance with the label.
5. Common-sense precautionary measures to the customer regarding pesticides.
6. General information on the environmental fate of pesticides.
7. Instructions to the customer to discuss site preparation and precautionary measures with the pesticide applicator.
8. Instructions to the customer to consult with a physician if an unusual reaction occurs.

The regulation also specifies that the duration of a service contract cannot exceed 12 months unless either written notification of continuation of service is provided annually or unless the service agreement is a signed contract that specifies a definite period of time during which the contract is valid. The written notification of continuation of service must provide information to the customer on how to discontinue service.

Further, Regulation 637 requires a commercial applicator to provide all of the following documents to the customer, if requested:

- Pesticide product labels.
- **Material safety data sheets (MSDS)**.

- Environmental Protection Agency fact sheets, if available.
- A document that specifies the rate of application of the active ingredients of the products applied.

The misrepresentation of pesticide safety is prohibited by Regulation 637. Such claims or statements that would imply that the pesticide is recommended or endorsed by a federal or state agency, that the pesticide is “absolutely safe,” or comparative statements of pesticide safety such as “contains all natural ingredients,” “among the least toxic chemicals known,” and “pollution approved” are strictly prohibited.

Regulation 637 also requires commercial applicator training in *integrated pest management (IPM)*. To make certain types of pesticide applications in schools, health care facilities, and public buildings, Category 7D applicators must participate in a training program that includes the following IPM elements:

- Site evaluation, description, inspection, and monitoring.
- The concept of threshold levels.
- The relationship between pest biology and pest management methods.
- Pest population reduction (including mechanical, biological, and chemical techniques) and pest prevention (including habitat modification).
- The development and implementation of an IPM program with consideration for reducing the possible impact of pesticide use on human health and the environment.
- The evaluation of an IPM program to determine its effectiveness.
- The record-keeping requirements of the IPM program.

Part 401 of Act 451—Wildlife Conservation:

Wildlife Damage and Nuisance Control

Regulations

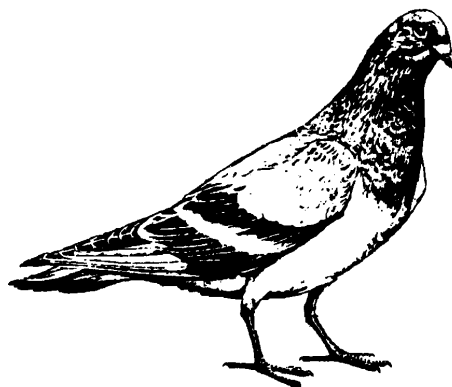
Under the authority of **Part 401 of Act 451, the Wildlife Conservation Order (WCO)**, the Michigan Department of Natural Resources Wildlife Division administers a permit system for control of wildlife that are creating unreasonable property, crop, or livestock damage. Many nuisance situations are the result of high populations of a particular wildlife species. An annual, regulated harvest during the hunting and trapping seasons is the preferred and most practical method of reducing populations to alleviate animal-caused damage. However, trapping and hunting during the regular season may not be adequate to control wildlife damage that occurs at other times. Extensive damage may be occurring outside of the regular hunting season, either by an individual animal or by an overabundance of a particular species. In some cases, the damage may be caused by animals that are normally not harvested during the hunting and trapping seasons (for example, red squirrels and

skunks), or the problems may be occurring in urbanized areas where hunting and/or trapping is not practical or permitted. The permit system allows nuisance wild animals causing damage to private property to be taken during times of the year and by methods not normally allowed under the regular hunting and trapping rules.

Under the damage and nuisance control system, four types of permits may be issued. Three of these permits may be issued to licensed commercial applicators:

A General Wildlife Damage and Nuisance Control Permit—This permit (also referred to as a general permit) is issued by the MDNR Wildlife Division office to nuisance animal control businesses, agencies, and organizations with licensed commercial applicators certified by the Michigan Department of Agriculture in Category 7A (General Pest Control) or 7D (Vertebrate Pest Control). (See Appendix C.)

A Project Control Permit—This is a specialized permit issued only to licensed pesticide applicators when pesticides are being proposed for use outside of buildings in areas that are not recognized industrial areas for the control of feral pigeons, starlings, and English sparrows (see Appendix C). Further details on regulations pertaining to the Project Control Permit are discussed in the chapter on bird control (Chapter 2).



A Wildlife Damage Investigation and Control Permit is issued by a conservation officer or a wildlife biologist to landowners, lessees, or their agents (e.g., certified applicators) on a case-by-case basis.

The fourth permit, the **Restricted Wildlife Damage and Nuisance Control Permit**, is issued to businesses, agencies, and organizations that are not licensed by the Michigan Department of Agriculture as commercial pesticide applicators.

The major difference between permits issued to landowners and those issued to businesses, agencies, and organizations is that the latter group is preauthorized to undertake control measures on specific species in certain areas and at certain times upon complaint of the person suffering damage without individual inspections and individual permits being issued by DNR personnel.

To obtain a restricted or general **Wildlife Damage and Nuisance Control Permit**, a Wildlife Damage and Nuisance Control Application and Permit form (PR2004) must be obtained from the DNR Wildlife Division office.

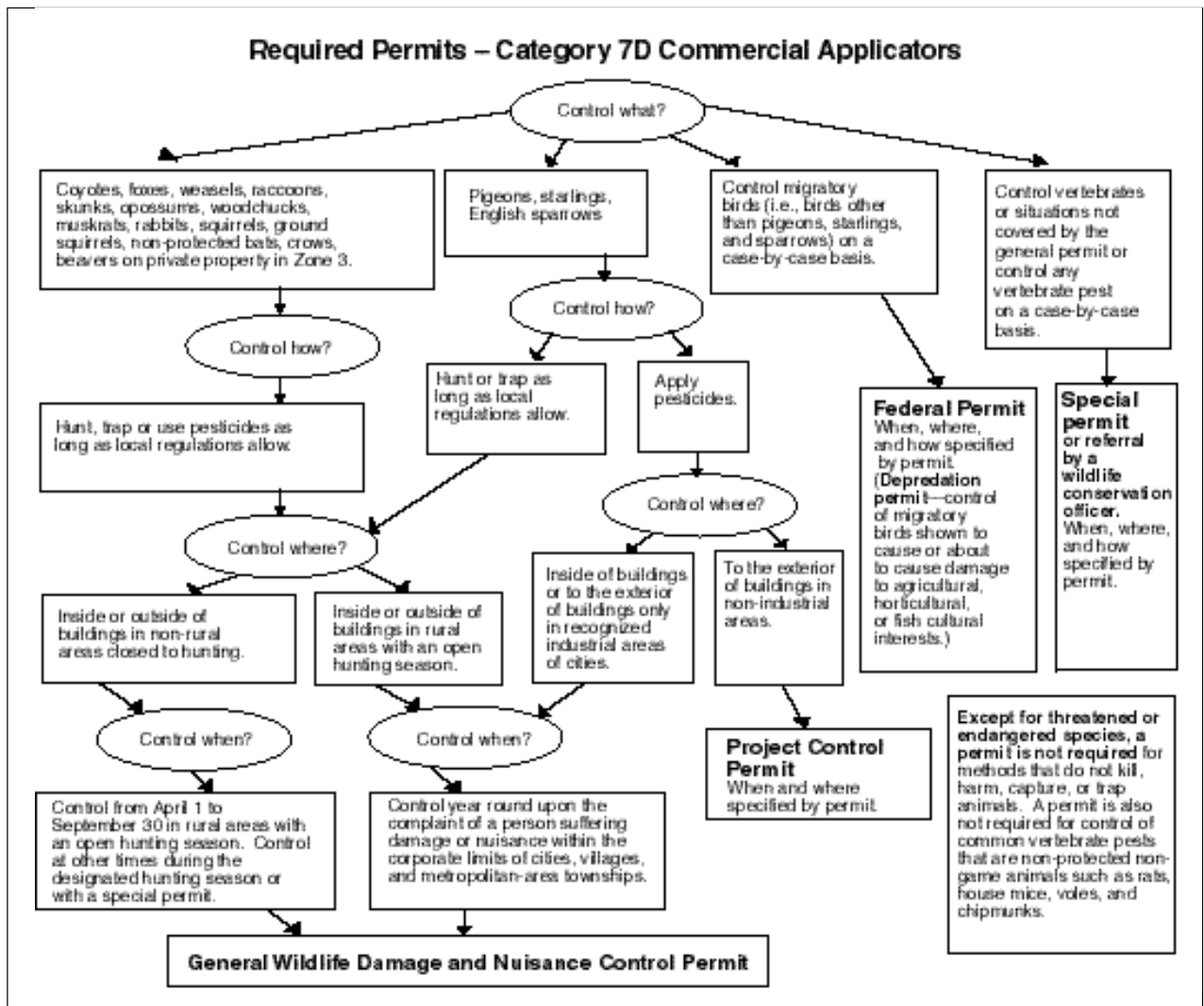


Figure 1.1. Flowchart of permits needed for Category 7D pest control operations

New applicants must obtain a “Certificate of Persons Conducting Business Under an Assumed Name” (DBA) from the county clerk of the county the business is located in and attach a copy to the application. Applicants for general permits (i.e., commercial applicators licensed in Categories 7A and/or 7D) must also attach a copy of their pesticide applicator’s license when submitting the form to the DNR. Permits must be renewed every three years. Applicants for renewal permits must attach a copy of their commercial applicator’s license and a copy of their three-year activity report (see “Record-keeping Requirements” below). See Appendix C for a sample permit application form (PR2004) and an activity report form (PR2004-1).

Wildlife Damage Control Rules and Regulations

Regulations related to these permits are found in Sections 5.50 to 5.55 of the WCO. According to the WCO,

the general permit allows commercial applicators to take action at any time in controlling certain animals upon complaint of any person suffering damage or nuisance within the corporate limits of cities, villages, and metropolitan-area townships that are closed to hunting. In other areas (non-urban areas open to hunting), the control measures may be initiated upon the complaint of a person suffering damage or nuisance from April 1 to September 30. Complaints that occur outside of these dates in areas that are open to hunting may be initiated by the *permittees* (in this case, 7D applicators who have been issued permits) if referred to by a conservation officer.

Wild Animal Species. The wild animals that permittees are authorized to take control measures on are coyotes, foxes, weasels, raccoons, skunks, opossums, woodchucks, muskrats, rabbits, squirrels, ground squirrels, non-protected bats, English sparrows, feral pigeons, starlings, and crows. Beavers on private property may be

controlled only in Zone 3 (southern Lower Michigan) upon complaint during the closed season. However, beaver shall not be live trapped and relocated or translocated without authorization of the DNR Wildlife Division management unit supervisor. Control of damage by game animals other than those listed above may be taken only if authorized by a conservation officer. A federal permit is required for control of damage caused by protected migratory birds (see Federal Migratory Bird Treaty Act).



A permit is not required when means other than hunting, trapping, or pesticide use are used to deter or prevent animal damage. These methods include frightening devices such as noisemakers and scarecrows; exclusion devices such as fences or screening; and other recognized and recommended means of preventing damage that do not kill, harm, capture, or trap animals. A permit is also not required for control of common vertebrate pests that are not protected by any federal or state laws. These are non-game animals such as rats, house mice, voles, and chipmunks.

Some further stipulations of the WCO are:

- Permittees may, unless otherwise instructed by a conservation officer, use steel and live traps, and firearms in those municipalities permitting the discharge of firearms, in control operations.
- All wild animals that the permittee is authorized to take shall be taken and disposed of in a manner to ensure humane handling or killing. Traps shall be checked daily. Captured wild animals shall not be held longer than 24 hours unless required by a physician or DNR representative for public health reasons.
- Captured animals shall not be released from or upon a public roadway or right-of-way. Captured animals shall not be released upon the lands of another person without the written consent of the landowner.
- Captured animals shall not be euthanized except by methods recommended and approved by the DNR.

Use of pesticides. The WCO also specifies that licensed commercial applicators in Categories 7A and 7D may use pesticides for nuisance animal control. Some of the rules for pesticide use under the WCO are:

- Prior to the initial use of pesticides by any permittee, the operator shall contact the Michigan representative of the U.S. Department of Agriculture to obtain general guidance and technical advice regarding methods of controlling nuisance birds without threatening protected species.
- Pesticides may be used inside buildings to control the depredations of the authorized bird and animal species (listed above under "Wild Animal Species").
- Pesticides may be used on the exterior of buildings and other structures only in recognized industrial areas of cities to control damage by English sparrows, feral pigeons, and starlings. Placement of pesticides outside of buildings in areas other than such recognized industrial areas shall not be made except under a Project Control Permit issued for each project. (See the WCO, Section 5.53, for details on what information should be included in the Project Control Permit.)

Record-keeping Requirements. Under Section 5.54 of the WCO, a person issued a Wildlife Damage and Nuisance Control Permit must keep records of all nuisance animal control operations, documenting the complainant's name, address, date of service, service technician, species of nuisance animal, number of each species taken, and the disposition of all animals taken. These records and any animals in the permittee's possession shall be available for inspection by a conservation officer or other representative of the DNR at any reasonable time. Prior to a permit being renewed, the permittee shall submit a completed renewal application and accurate summary of activities conducted under the previous permit furnished by the DNR. The renewal permit application forms and activity reports are submitted every three years (see Appendix C).

Permit Suspension/Revocation. Section 5.55 of the WCO provides the legal basis for permit suspension or revocation. Permittees should be aware that any conviction for a violation of Part 401 of Act 451 or the Wildlife Conservation Act, including a violation of a condition of the permit, shall result in the revocation of the permit upon action by the DNR.

Special Permits

No animals protected by federal or state laws may be trapped or killed with a general permit other than those listed above. To control animal damage by species not covered under the general permit, it is necessary to obtain a special permit or special authorization from the DNR. These permits may be applied for at local DNR district offices (Appendix F). In general, the species that require special permits cause relatively few damage or nuisance problems that cannot be addressed during the regular hunting and trapping seasons, or are species of particular management interest.

On the permit, the DNR representative or conservation officer will specify which methods, if any, may be used to control damage caused by the animal. In some cases, the DNR representative will require a visit to the site with the permittee before issuing a special permit. Problems caused by certain species (for example, black bear, deer) or migratory birds (for example, ducks, Canada geese) will be handled on a case-by-case basis. Specific regulations are currently in place that govern the DNR's deer damage control policy.

Endangered or threatened species are provided special protection under the law and may not be taken, harmed, pursued, or harassed. Though both federal and state laws make certain exceptions for the control of these species, rarely, if ever, would issuance of a control permit be justified.

Euthanasia of Animals

Section 5.52 of the WCO prohibits the euthanasia of animals except by methods recommended and approved by the DNR. When euthanasia is required, the DNR recommends the American Veterinary Medical Association (AVMA) methods. These methods include but are not limited to:

Sodium pentobarbital—An injection of sodium pentobarbital is considered by many to be the most humane method of euthanasia. Acquiring, possessing, and using this drug is strictly regulated by state and federal laws. For this reason, it is necessary to seek the assistance of a veterinarian or a specially licensed dog pound or animal shelter when using this method to euthanize an animal. The carcasses of animals euthanized by drugs, except for the hide when it may be legally sold, must be disposed of by burial, incineration, or disposal in a landfill. These carcasses cannot be sold or given away.

Carbon dioxide—This is the method commonly used for the euthanasia of laboratory research animals. Using this method requires a chamber in which the heavier-than-air carbon dioxide is used to replace available oxygen in a container. To minimize stress to the animal, the chamber should be large enough to hold the live trap without removing the animal. The opportunity to euthanize the animal without injection, handling, or transfer is a definite advantage of this method.

Shooting—Shooting can be the most painless and is sometimes the only available method to humanely dispose of an animal. Local laws and regulations regarding the transportation and discharge of firearms must be complied with. It is the responsibility of the permittee and employee(s) to ensure the safe handling and use of firearms. If shooting is used, the operator and firearm must be capable of producing a quick death by a shot to the brain of the animal. The careless, negligent, or reckless use of firearms is a violation of state law. The carcasses of animals killed by shooting may be sold if sale is otherwise lawful. ***Animals that have bitten a person must not be shot in the head.***

Commercial operators interested in more information on euthanasia methods are encouraged to contact their local veterinarian. In addition, the report of the AVMA

panel on euthanasia (1993 Report of the AVMA Panel on Euthanasia, J Am Vet Med Assoc 188:252-268) should be available through the local public library. It is the responsibility of the commercial operator to employ safe and effective euthanasia practices.

Animals That Have Bitten a Person

Any person who is bitten by a wild animal should seek medical advice from his/her health care provider or physician. Under such conditions, the animal should be maintained in confinement until disposal instructions are provided by the health care professional. This same precaution applies if a person has handled an obviously sick animal that may be harboring a contagious disease. Children are particularly inclined to handle lethargic small mammals. If the animal cannot be restrained safely, it should be destroyed and the carcass temporarily kept for possible testing.

Under no circumstances should an animal that has bitten someone or is needed for rabies examination be shot in the head or subject to head trauma.

Disposal of Carcasses

The carcasses of all dead nuisance animals must be disposed of properly (Bodies of Dead Animals, Act No. 239 of 1982). Proper disposal methods include 1) above-ground, 2) belowground, 3) incineration, 4) disposal in a licensed landfill, or 5) disposal with a dead animal dealer. Ecologically, aboveground disposal, burial, or disposal via a licensed dead animal dealer is preferred and encouraged over incineration or landfill disposal methods.

Aboveground disposal is not recommended for the carcasses of sick (or suspected of being sick) animals. Below are some guidelines to follow for proper disposal of carcasses.

Aboveground—All of these conditions must be met:

- The carcass must be placed in a remote area that is at least 1,000 feet from any neighboring resident, or at a greater distance as necessary to prevent a nuisance odor condition.
- The carcass should not be placed within 20 feet of another carcass.
- The owner of the land must authorize placement of the carcass.
- The carcass must not come into contact with surface or groundwater.

Belowground, individual grave—All of these conditions must be met:

- The carcass must be covered by at least 2 feet of soil within 24 hours after burial.
- The carcass must not come into contact with surface or groundwater.
- The number of individual graves must not exceed 100 graves per acre.
- The grave must be located at least 200 feet from any

groundwater well that is used to supply potable drinking water.

Belowground, common grave—All of these conditions must be met:

- The number of carcasses in a common grave should not exceed 250.
- Each individual carcass should be covered with at least 12 inches of soil within 24 hours after burial.
- The common grave should not remain open for more than 30 days and should have at least 4 feet of soil as final cover.
- The number of common graves should not exceed five graves per acre.
- The carcasses must not come into contact with surface or groundwater and must not be disposed of in a 100-year floodplain or wetland area as defined by the Solid Waste Management Act.
- The common grave must be located at least 200 feet from any groundwater well that is used to supply potable drinking water.

Incineration—The incinerator must be approved by state and local authorities to burn pathological waste.

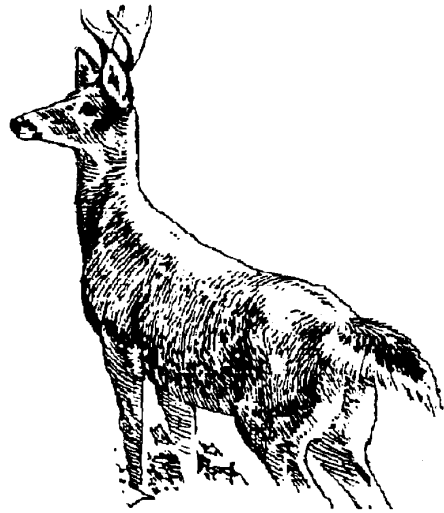
Landfill—The carcass must be securely enclosed in a plastic bag or other suitable air-tight container to prevent noxious odors and disposed of at a Type II licensed solid waste disposal facility (standard landfill) or at an out-of-state facility in accordance with that state's solid waste disposal regulations.

Dead animal dealer—The carcass may be taken with or without fee but generally not sold to a dealer licensed pursuant to the Bodies of Dead Animal Act, 1982 PA 239. Dead animal dealers are licensed by the Michigan Department of Agriculture.

Live Animals and Sale of Animals

The statewide wildlife regulations clearly prohibit any person from removing game or protected animals alive from the wild (Part 401 of Act 451). One of the few exceptions provided is that a person issued a Damage and Nuisance Animal Control Permit may hold an animal in captivity for no more than 24 hours specifically for release or disposal. Under the authority of a physician's request for legitimate public health concerns or a DNR request, captured animals may be temporarily held for a longer period of time (refer to Section 5.52 of WCO).

The sale of wild animals, dead or alive, and their parts is also regulated in Michigan (WCO, Sections 4.1, 4.3, etc.). Except for the specific provisions applying to live trapped feral pigeons and dead game taken during the open hunting and trapping season by licensed persons, no animals or their parts may be bought, sold, given away, or bartered by a permittee. In addition, these animals, whether dead or alive, cannot be retained.



SUMMARY

A number of state and federal laws are designed to protect the public and the environment from the improper use of pesticides. It is the pest control technician's responsibility to understand and to comply with these laws. Category 7D applicators must be particularly sensitive about preventing contact between pesticides and non-target organisms, including people. Category 7D technicians should be trained in IPM and other methods that limit the use of pesticides while still achieving pest management goals. Regulation 637 outlines the details of this training along with other details pertaining to the safe and legal use of pesticides. Proper communication, notification, representation, and record-keeping are essential whenever pesticides are used.

Category 7D applicators must also be aware of the several federal and state laws that protect Michigan's wildlife and know under what circumstances a federal and/or state permit is required. This will depend on several factors, such as the animal species causing the damage, nuisance, or health risk; the time of year (whether or not during the open hunting season); the location where the problem is occurring (rural or non-rural); and the pest control technique that is used (pesticides, hunting, or trapping vs. exclusion or frightening devices). Pest control technicians must carefully examine each pest control situation and use good judgment in deciding upon a course of action that will control the pest problem effectively and humanely.

CHAPTER
1

Review Questions

Chapter 1: Legalities of Vertebrate Pest Management

1. Define a pest in simple terms. When are vertebrates considered pests?
2. Which Michigan regulation requires that pesticide applications be made in a manner that prevents off-target discharges of pesticides, and that pesticide application equipment be properly calibrated and in sound mechanical condition?
 - A. Regulation 636
 - B. Regulation 637
 - C. FIFRA
 - D. Natural Resources and Environmental Protection Act
 - E. OSHA
3. Which Michigan legislation gives the MDA authority to certify commercial applicators and to prescribe standards for certification?
 - A. Regulation 636
 - B. Regulation 637
 - C. FIFRA
 - D. Natural Resources and Environmental Protection Act
 - E. OSHA
4. Which federal legislation specifies that all pesticides be classified as either general-use or restricted use?
 - A. Regulation 636
 - B. Regulation 637
 - C. FIFRA
 - D. Natural Resources and Environmental Protection Act
 - E. OSHA
5. Which Michigan legislation establishes the types of certified applicators and expands the pesticide record-keeping requirements?
 - A. Regulation 636
 - B. Regulation 637
 - C. FIFRA
 - D. Natural Resources and Environmental Protection Act
 - E. OSHA
6. In Michigan, a vehicle used to transport pesticides for a pesticide application business must:
 - A. Be yellow or red.
 - B. Have the name of the pesticide(s) being carried posted in an appropriate location in the vehicle.
 - C. Name of the pesticide applicator firm and the business phone number printed on the exterior.
 - D. Be registered with the MDA and the MDEQ.
7. In Michigan, commercial pesticide applicators must provide their customer written information in the applicator service agreement including:
 - A. The time and date of application.
 - B. A general description of the target pest or pests to be controlled.
 - C. A list of pesticides applied.
 - D. All of the above.
8. Describe what type of pesticide information should be a part of the risk and benefit information provided to customers.
9. If requested, a commercial pesticide applicator must provide the customer with pesticide product labels and MSDS sheets.
 - A. True
 - B. False
10. List the minimum PPE requirements for commercial applicators.

11. Commercial pesticide applicators may represent pesticides as being endorsed by federal or state agencies
- True
 - False
12. List the elements that should be included in IPM training of commercial applicators.
- Use a distress-call frightening device to keep crows out of a farmer's field.
 - Trap and dispose of a coyote attacking livestock.
 - Trap and relocate a bear invading city dumpsters.
 - Use rat snap traps to catch chipmunks.
13. Under each situation described below, indicate which type of permit you would need and describe your reasoning (more than one answer may be possible for some).
- A general permit
 - A Project Control Permit
 - A special permit or referral by a wildlife conservation officer
 - None of the above
 - Build a fence to exclude deer from a farmer's field.
 - Control beaver damage on private property by trapping in Michigan's Upper Peninsula.
 - Use porcupine wire to prevent pigeons from roosting on a building.
 - Live trap pigeons roosting on a city building.
 - Control beaver damage on private property by trapping in southern lower Michigan.
 - Shoot deer during the non-hunting season to reduce crop damage.
 - Trap squirrels invading an attic.
 - Trap weasels in March to keep them out of a farmer's poultry house.
 - Trap weasels in April to keep them out of a farmer's poultry house.
14. Under each situation described below, indicate which type of permit you would need and describe your reasoning (more than one answer may be possible for some).
- A federal permit
 - A general permit
 - A special permit or referral by a wildlife conservation officer
 - A Project Control Permit
 - Shoot crows to keep them from destroying a farmer's crop.
 - Use poison baits to reduce a pigeon population in a city park.
 - Use poison baits to control starlings in an industrial area.
 - Trap owls attacking poultry.
 - Trap seagulls causing air-flight safety problems near airports.
15. After trapping a coyote that had been attacking livestock, which would be an approved and legal method for releasing or disposing of the animal?
- Within 24 hours, shoot the animal in the heart and dispose of the carcass in a nearby stream.
 - Within 48 hours, inject the animal with sodium pentobarbital and dispose of the carcass by an approved method.
 - Within 24 hours, have a veterinarian inject the animal with sodium pentobarbital and dispose of the carcass by an approved method.
 - Within 48 hours, shoot the animal in the heart and dispose of the carcass by an approved method.
 - Within 24 hours, take the animal home and make it a family pet.

16. Which is an accepted method of disposing of an animal that has bitten a person (assume local ordinance allows the discharge of firearms)?
- Shoot the animal in the head (brain) with a firearm capable of producing a quick death, retain carcass until examined by a veterinarian.
 - Hold the animal under observation for 24 hours; if the animal appears healthy release it; if not, consult a veterinarian.
 - Kill the animal by shooting through the heart, retain carcass until examined by a veterinarian.
 - Maintain the animal in confinement until instructions for disposal have been provided by a health care professional/veterinarian.
 - C & D
17. It is always legal for holders of general permits to sell animals or their parts.
- True
 - False
18. Which would be an approved method for disposing of a single animal carcass?
- Dispose of a sick animal in an aboveground grave at least 1,000 feet from a neighboring resident.
 - Dispose of a healthy animal in an aboveground grave at least 750 feet from a neighboring resident.
 - Dispose of a sick animal in a belowground grave at least 200 feet from any groundwater well, and cover with at least 2 feet of soil within 24 hours after burial.
 - Dispose of a healthy animal in a belowground grave at least 100 feet from any groundwater well, and cover with at least 2 feet of soil within 24 hours after burial.
 - Dispose of a healthy animal in a belowground grave at least 200 feet from any groundwater well, and cover with at least 1 foot of soil within 24 hours after burial.
19. What are the specifications for burying animals belowground in a common grave?
20. From an ecological standpoint, disposing of animal carcasses by incineration or landfill is preferred over burial aboveground or belowground, or disposal through a licensed dead animal dealer.
- True
 - False
21. For holders of general permits, which activity would NOT be a violation of the Wildlife Conservation Order?
- Checking set traps every two days.
 - Releasing a trapped animal on a public roadway or right-of-way.
 - Releasing an animal on private property with the property owner's written consent.
 - Releasing an animal after being held for 48 hours.
 - B & C
22. According to the Wildlife Conservation Order, what information must holders of general permits include in their records of nuisance animal control operations?

CHAPTER 2

BIRDS

LEARNING OBJECTIVES

After completely studying this chapter, you should:

- Be able to identify the common types of “pest” birds.
- Be able to describe the life cycles, habits, and habitats of common pest birds.
- Be able to identify situations in which birds are considered pests.
- Be able to describe the health hazards and property damage associated with bird pests.
- Know the chemical and non-chemical alternatives for bird control and management.
- Know techniques for managing pest birds in agricultural situations.
- Understand the legal considerations and know what precautions (protection of non-target birds, personal protective equipment, etc.) to take when managing bird pests.

Birds provide enjoyment and recreation while greatly enhancing the quality of life. These colorful components of natural ecosystems are studied, viewed, photographed, enjoyed, or hunted by most Americans. Bird watching as a sport and recreational activity involves more than 10 million people. For this reason, birds are strongly protected by laws, regulations, and public opinion.

Birds can become pests, however, when they feed on crops, create health hazards, roost in large numbers on buildings, contaminate food, or create a nuisance. No

particular species can be flatly categorized as good or bad. Whether birds are beneficial or harmful depends on time, location, and activity.

The three main pest birds not protected by the federal Migratory Bird Treaty Act (see Chapter 1) are pigeons, house sparrows, and starlings. The state of Michigan requires a **General Wildlife Damage and Nuisance Control Permit** or, under certain conditions, a **Project Control Permit** to control these birds. In addition, local ordinances may protect these birds and/or specify the types of treatments that can be used. Always check local and state laws before attempting control of these birds.

PIGEONS

The domestic pigeon (*Columba livia*) developed from the rock doves of Europe and Asia, was introduced into the United States as a domestic bird. Rock doves originally nested in caves and holes and under overhanging rocks on cliffs, so they comfortably adapted to window ledges, roofs, eaves, steeples, and other components of man-made structures.

Pigeons give pleasure to many people. Along with house sparrows, they may be the only “friendly” wildlife observed by many people living in an inner city. Many park visitors have adopted special pigeons that they feed every day. Pigeons are also bred for racing, stunt flying, and meat production. Pigeon racing is a sport in Europe and in some parts of the United States, with birds racing distances of 10 to 1,000 miles (the record is 3,000 miles).

Pigeons are used for scientific research on heart disease in humans and diseases of domestic chickens. They are raised for food. The meat of pigeons, referred to as “squab,” is considered a delicacy.

Pigeons have become the most serious bird pest associated with buildings. They may congregate in flocks of a hundred or more. Though primarily seed or grain eaters, pigeons in urban areas feed on garbage, spilled grains, insects, food left out by outdoor diners, and food provided by bird lovers, who intentionally feed pigeons bread, peanuts, and cookie crumbs.



Figure 2.1. Pigeon, *Columba livia*

Habits of Pigeons

Pigeons are gregarious—they feed, roost, and loaf together whenever possible. Feeding, roosting, and loafing sites are usually separate. Roosting sites are protected from the elements and used for nesting, congregating at night, and shelter in bad weather. Loafing sites will be nearby and used by inactive birds during the daytime. Feeding sites may be several miles away. When pigeons are not feeding or mating, most of their day is spent cooing, preening, and sunbathing. Sunbathing is most common in the morning of cool days.

Pigeons prefer to rest and feed on flat and smooth surfaces. Unlike most birds, they will feed from rooftops, regardless of height, because they like open feeding areas that permit a speedy getaway. They also feed on open ground and occasionally on ledges. Typical roosting and loafing sites are building roofs and ledges, cooling towers, bridges, and signs. Typical feeding sites are parks, squares, food-loading docks, garbage areas, railroad sidings, food plants, and wherever people eat outdoors.

Male pigeons are sexually mature at 3 to 4 months of age; females at 6 months. Pigeons usually mate for life unless separated by death or accident. If one partner of a mated pair is lost, the survivor will re-mate within a few days. After pairing and mating, nest construction begins.

Pigeons nest on a frail platform of small twigs, straw, and debris in which they make a slight depression. Nests are usually located in protected openings in or on buildings and structures. The male usually selects the nest site, but both adults build the nest, with the male often bringing nest materials to the female.

One or two creamy-white eggs are laid 8 to 12 days after mating. Three or more eggs are sometimes found in a single nest, but this occurs when two or more hens

share one nest. Both parents incubate the eggs for roughly 18 days—the male from midmorning through afternoon, and the female the rest of the day and evening.

At birth, the young pigeons are naked and helpless. They are fed “pigeon milk,” a milky-white fatty substance regurgitated from the parents’ crops. After five days, the parents begin mixing grain and other foods with the pigeon milk, and after 10 days, they switch completely to whole grains.

During the first week or so, the young double in size daily and so are full grown in less than a month. They are fledged when they are 37 days old. Average flight speed is 36 mph. Adult birds can mate again while the young are still in the nest.

Pigeons nest during all seasons when conditions permit. City pigeons generally remain in one area year round and produce 10 young per year. Nests that are continually used become solid with droppings, feathers, debris, and, sometimes, dead birds.

Life span is highly variable, ranging from 3 to 15 years in urban roosts. Pigeons have lived for 30 years in captivity.

STARLINGS

European starlings (*Sturnis vulgaris*) were introduced into the United States in 1890, when 60 were brought to New York City. They rapidly expanded into new areas. Today, 140 million starlings range throughout North America.

Starlings are robin-sized birds that weigh about 3 ounces. Adults are dark with light speckles on their feathers in winter. The feathers turn glossy purplish black and green in summer. The bills of both sexes are yellow from January to June and dark at other times. Young birds are grayish.

Starlings have relatively short tails and appear somewhat chunky and humpbacked. The wings are triangular when stretched out in flight. Starling flight is direct and swift, not rising and falling like the flight of many other black birds.



Figure 2.2. European starling, *Sturnis vulgaris*

Habits of Starlings

Starlings nest in holes or cavities in trees or in rocks, or in urban areas on buildings, in birdhouses, on power stations and water towers, and in and on other structures. Starlings average two broods a year with four to seven young per brood. Both parents build the nest, incubate the eggs, and feed the young. The young birds leave the nest when they are about 3 weeks old.

Starlings migrate in some parts of the country. They begin forming large flocks when temperatures become cooler in the fall. The major sources of food shift from insects and fruits to grains, seeds, livestock rations, and food in garbage. Roosting areas may shift from rural and suburban areas into cities and towns. Each day, they may fly up to 30 miles to their feeding sites. Each starling eats about 1 ounce of food each day.

Leaving their evening roost at sunrise, they travel to feeding sites over well established flight lines. When they return to the roost just before sundown, they do not fly straight into their roost. They “stage” on high perches such as trees, power lines, bridges, and towers. The birds are quite social at these times and remain on pre-roost sites until after sunset, singing and calling to one another.

Starlings are pests because of their high numbers. Thousands or tens of thousands can roost at one site. Droppings at the roost site damage car finishes, tarnish buildings, drop on people below, and build up to such levels that they become a health hazard. Starlings have been responsible for outbreaks of a number of diseases.

When starlings roost in food processing plants or storage areas, they contaminate food. The birds consume large quantities of livestock feed and contaminate water at stockyards. The noise of a large flock can be irritating.

HOUSE SPARROWS

The house sparrow (*Passer domesticus*) also called the English sparrow, was introduced into the United States in the 1850s. Populations now flourish all over the continental United States except in heavy forests, mountains, and deserts. It seems to prefer human-altered habitats in cities and around farm buildings and houses. In fact, though it's still one of the most common birds, its numbers have fallen drastically since the 1920s when food and waste from horses furnished unlimited food.

The house sparrow is a brown, chunky bird 5 to 6 inches long. The male has a distinctive black bib, white cheeks, a chestnut mantle around a gray crown, and chestnut upper wing covers. The female and young birds have a gray breast, buffy eye stripe, and a streaked back.



Figure 2.3. Male house sparrow, *Passer domesticus*

Habits of House Sparrows

House sparrows average three broods per season with four to seven eggs per brood. Breeding can occur in any month; through much of the country, it is most common from March through August. Eggs are incubated for about two weeks, and the young stay in the nest another two weeks.

The male usually selects the nest site. Nests are bulky and roofed over; they are located in trees and shrubs, on building ledges, in signs, on light fixtures, and under bridges. Nests often plug rain gutters or jam power transformers.

Sparrows are aggressive and social birds, often out-competing native species. They have no recognized migration patterns and will stay in an area as long as food and nest sites are available. Young birds, however, move out of an area to establish new territories. Flocks of juvenile birds and non-breeding adults may sometimes travel 4 or 5 miles from nest sites to feeding areas. Sparrows are very tolerant of human activity and will not hesitate to set up housekeeping in high-traffic areas.

House sparrows prefer to feed on grain. They will also feed on fruits, seeds, and garbage.

House sparrows can be pests in many situations. Their droppings contaminate stored grain and bulk food. Droppings and feathers can make hazardous, unsanitary, and smelly messes inside and outside of buildings, on sidewalks, and under roosting sites. Sparrows can also become pests when one or a few begin nesting inside a food plant, warehouse, mall, or atrium.

The birds cause damage by pecking at rigid foam insulation in buildings and nesting inside traffic lights. They create a fire hazard by nesting in transformers and power stations.

They are a factor in the transmission of a number of diseases, internal parasites, and external parasites (i.e., ectoparasites). Most significantly, they are thought to be a major reservoir of St. Louis encephalitis.

OTHER BIRDS

The three birds that most often become pests in the United States in urban areas are pigeons, starlings, and house sparrows. Other birds, from hawks to swallows, may occasionally cause unexpected and unusual pest problems. When blackbirds and crows roost in suburban areas, they become pests. Woodpeckers peck holes into house siding looking for insects. Seagulls can feed at food plants.

Many of these birds are more protected by laws and regulations than the three birds discussed above. Special permits may be required to trap them or to control them by lethal means. The best approach emphasizes exclusion or modification of buildings.

HEALTH HAZARDS ASSOCIATED WITH BIRDS

Though health risks from birds are often exaggerated, large populations of roosting birds may present risk of disease people nearby. The most serious health risks are from disease organisms growing in accumulations of bird droppings, feathers, and debris under a roost. If conditions are right, particularly if roosts have been active for years, disease organisms can grow in these rich nutrients.

Birds may contaminate food, but this risk is usually limited to food manufacturing or processing plants. When parasite-infested birds leave roosts or nests to invade buildings, some of their parasites can bite, irritate, or infest people.

Histoplasmosis

This systemic fungal disease is transmitted to humans by airborne mold spores from soil contaminated by pigeon and starling droppings (as well as the droppings of other birds and bats). The soil under a roost usually has to have been enriched by droppings for three years or more for the disease organism (*Histoplasma capsulatum*) increase to significant levels. Though it is almost always associated with soil, the fungus, in rare instances, has been found in droppings alone, such as in an attic. Infection is by inhalation of the spores, which can be carried by wind, particularly after a roost has been disturbed.

Most infections are mild and produce either no symptoms or a minor flulike illness. The disease can, on occasion, lead to high fever, blood abnormalities, pneumonia, and even death. Based on histoplasmin skin tests given to large numbers of people throughout the United States, it is thought that about 50 million people have had histoplasmosis or been exposed to it. Each year there are about 500,000 infections, 5,000 people hospitalized, and 800 deaths in the United States due to histoplasmosis.

The National Eye Institute (NEI) at the National Institutes of Health has reported a potentially blinding eye condition, called ocular histoplasmosis syndrome

(OHS), which results from infection by *Histoplasma capsulatum*. In this condition, the central part of the retina (the macula, used in straight-ahead vision) becomes inflamed and is damaged as blood vessels grow inside the affected area. The NEI estimates that 4 percent of those exposed to the disease have tiny scars that put them at risk of developing OHS. An estimated 100,000 people have OHS in the rapidly progressive form that can lead to blindness.

Cryptococcosis

Pigeon droppings appear to be the most important source of the disease fungus *Cryptococcus neoformans* in the environment. The fungus is typically found in accumulations of droppings in attics, cupolas, ledges, water towers, and other roosting and nesting sites on structures. It has been found in as many as 84 percent of samples taken from old roosts. Even when old and dry, bird droppings can be a significant source of infection. As many as 50 million colony-forming units have been found in a gram of pigeon manure.

The disease is acquired by inhaling the organism's yeastlike vegetative cells (2 to 3 microns in diameter). There are two forms of cryptococcosis present in humans. The cutaneous form is characterized by acne-like skin eruptions or ulcers with nodules just under the skin. The generalized form begins with a lung infection and spreads to other areas of the body, particularly the central nervous system. It can be fatal. Like histoplasmosis, outbreaks of this disease often occur after building renovation, roost cleanup, or other actions that disturb old droppings.

Other diseases carried or transmitted by birds affect humans to a lesser degree. Psittacosis, pigeon ornithosis, and toxoplasmosis are normally mild in humans. However, serious illness or death can occur in rare cases. Pigeons and sparrows have also been implicated (along with many other species of birds) in outbreaks of encephalitis.

Ectoparasites

Pigeons, starlings, and house sparrows harbor external parasites that can invade buildings. Some of these parasites can bite and irritate. A long list of mites infest pigeons, but the northern fowl mite and the chicken mite are usually the main culprits invading buildings from nesting and roosting sites. Other pigeon ectoparasites that may cause problems inside buildings are the pigeon nest bug (a type of bedbug), various species of biting lice, the pigeon tick, and the pigeon fly.

Droppings, feathers, food, and dead birds under a roosting or loafing area can also breed flies, carpet beetles, and other insects that may become major problems in the immediate area. These pests may fly or walk into windows, ventilators, cracks and crevices, and the like, and enter buildings.

Defacement and Damage to Structures and Equipment

Bird droppings under windowsills, “whitewashing” down a building face, or accumulating on sidewalks and steps are the most obvious problem associated with large roosts. Cleanup can be labor-intensive and expensive, particularly on high-rise buildings. Bird droppings are corrosive and will damage automobile finishes, many types of metal trim, electrical equipment, and machinery. Droppings, nest materials, and feathers also block downspouts and vents on buildings. This accumulation of debris can attract insect pests such as carpet beetles and other dermestids, spider beetles, and mealworms.



Figure 2.4. Defacement of building from pigeon droppings

LEGAL CONSIDERATIONS

Federal Laws

With very few exceptions, all birds are protected by one or more federal laws and regulations (see Chapter 1).

- Pigeons, starlings, and house sparrows are not directly protected at the federal level, but applications of toxicants or repellents must be made according to the product label and under the restrictions that apply under FIFRA.
- Other birds are regulated in some way at the federal level.
- Non-target birds in the treatment area are protected, and any actions that kill or damage protected birds or their habitats will violate various federal and state regulations.

State and Local Laws

Michigan requires applicators certified in Categories 7A or 7D to obtain a General Wildlife Damage and Nuisance Control Permit for control of pigeons, starlings, house sparrows, and crows. However, according to Section 5.53 of the Wildlife Conservation Order, pesticides may be used to control English sparrows, feral pigeons, and starlings only when applied to the exterior of buildings and other structures in recognized industrial areas of cities. Because of the risks of secondary poi-

soning to other bird species and/or direct poisoning of non-target bird species, state regulations are very restrictive in non-industrial areas—i.e., those areas where non-target species are likely to be present. When pesticides are being used to control these three pest birds in outside-of-building non-industrial areas, it is necessary to obtain a Project Control Permit from the DNR Wildlife Division for each project (see Appendix C).

According to Section 5.53 of the WCO, prior to the initial use of pesticides by any permittee, the commercial applicator must contact the Michigan representative of the U.S. Department of Agriculture (USDA) to obtain guidance and technical advice regarding the methods of controlling nuisance birds without threatening protected species. Bait-type pesticides used outside of buildings in non-industrial areas must be preceded by prebaiting, and the treated bait cannot be left unattended. This requires a person to be on the site monitoring the bait to ensure non-target species are not killed. The incidental taking of migratory birds by poison bait ingestion or the killing of hawks and owls or other predatory/scavenger bird species by secondary poisoning may result in severe fines for the unlawful killing. The prompt and proper disposal of target carcasses to ensure that secondary poisoning does not occur is the responsibility of the permittee. If secondary or non-target poisoning occurs, the permittee will be held responsible.

Migratory birds are protected by federal regulations. Therefore, a federal permit is required to control these birds. In addition, local laws concerning acceptable bird control methods must also be complied with. For example, in certain portions of Detroit, Lansing, and Grand Rapids, no pesticide use is permitted for bird control because of the possibility of secondary poisoning to peregrine falcons. When in doubt, contact local natural resource agencies, the state or district DNR Wildlife Division offices, and/or the U.S. Fish and Wildlife Service for further information.

TOOLS AND METHODS FOR MANAGING PEST BIRDS

Inspection

The first step in controlling birds is to conduct a detailed and accurate bird survey. Surveys should be conducted early in the morning, at midday, and again in the evening to correspond to the activity periods of birds. The survey should not be limited to information about pest birds—knowledge of non-target bird activity is just as important to minimize risk to these birds. The survey should investigate:

- What birds are present?
- How many?
- Are they residents, migrants, adults, juveniles?
- Are they nesting, feeding, roosting, loafing?
- Where do they eat and drink?
- What is attracting them to the various sites?

- Are the birds causing a health risk?
- Are the birds causing physical damage?
- If dispersed, where would they go?
- If poisoned, where would they die?
- Is there risk to non-targets?
- What are the legal considerations?
- Could there be public relations problems?
- Is exclusion or habitat modification practical?

Habitat Modification

Habitat modification for birds means limiting a bird's food, water, or shelter. Attempting to limit the food or water of pigeons, starlings, and house sparrows is not practical. These birds will have a number of feeding and watering sites, often far from roosting and loafing sites. Where people are feeding birds in parks or lunch areas, education can help reduce this source of food; but in most cases, people will pay little attention to requests to stop.

The most successful kind of habitat modification is to exclude the birds from their roosting and loafing sites (addressed in the section on exclusion).

Pigeons may be induced to move from an infested site by the persistent destruction of nests and eggs. Nest destruction is ineffective against sparrows and starlings.

- Spray high-pressure streams of water from fire-fighting equipment or other high-pressure water lines. This is the most cost-effective method of nest destruction. This method destroys the nest, eliminates ectoparasites, cleans droppings and feathers from the nest site, and harasses the roosting birds. Use high-pressure sprays only where the high pressure or water will not damage buildings or equipment. Make sure contaminated wash is not sprayed over walks or areas where people are present. Remove all droppings and nest materials from the area.
- When spraying is not safe, a more traditional method is to use a hook fastened to a long pole to remove the nests.
- When the nests are within 20 feet of occupied sites, treat the immediate nest area with an insecticide/acaricide to eliminate ectoparasites.
- Destroy nests every two weeks during the spring and summer months until the birds move to other nest sites.

Exclusion

Some building designs and conditions lend themselves to bird infestation. Flat ledges, openings in water towers and vents, unscreened windows, and other attributes make a building an attractive location for roosting, nesting, and loafing. Modification or repair can exclude birds.

Typical solutions include replacing broken windows, adding screens, eliminating large crevices, and blocking openings into vents, cooling towers, and roof-top equipment with hardware cloth or similar material. Also changing the angle of ledges to 45 degrees or more will discourage roosting.

Exclusion methods also include the use of netting, custom-designed sheet metal or plastic covers, porcupine wire (Nixalite, for example), electrified wires, and sticky repellents to keep birds from roosting on ledges, roof edges, windowsills, building signs, and other surfaces favored by pest birds. Two advantages are that the birds are not killed and the control is comparatively long-lasting.

Netting. Netting is used to block access of birds to large roosting areas in structures. Netting is especially useful in warehouses and around mechanical equipment areas where aesthetics are of minor consideration. It has been used successfully on cooling towers. Plastic nets have replaced metal and fiber nets in bird control. Plastic nets are normally extruded black polypropylene and are made with an ultraviolet inhibitor to reduce UV degradation. Knotted nets are also available. Some newer designs in nets are less obtrusive and come in custom colors. Nets will last from 2 to 5 years or longer, depending on exposure to sunlight.

Covers or Ramps. Custom-designed covers for ledges, window air-conditioning units, and roof edges are the best technical solution to keep birds from infesting these sites. The high cost of this method usually eliminates this option on large buildings that have extensive roosting sites. But covers are valid options where limited applications will keep birds off selected sites, and where aesthetics are an important consideration. The covers usually consist of sheet metal installed at a 45 degree angle to prevent the birds from landing. Sometimes plastic inserts are custom-fit into the indentations to block off ledges. Roosting on ledges can be discouraged by changing the angle to 45 degrees or more. Sheet metal, wood, Styrofoam blocks, stone, and other materials can be fastened to ledges to accomplish the desired angle.



Figure 2.5. A wooden, metal, or plexiglass covering over a ledge at a 45 degree angle (a) or porcupine wire (b) can be used to prevent roosting and nesting.

Spikes. Porcupine wire, sharp metal spikes, or any similar "bed of nails" can stop birds from roosting on ledges. Where they can be used, they usually work fair-

ly well. If aesthetics are important, these devices are usually limited to areas where they cannot be easily seen. Some newer products, such as clear plastic spikes, may be more aesthetically pleasing.

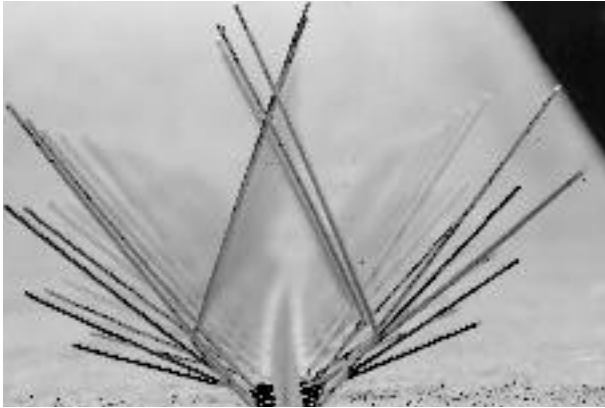


Figure 2.6. Nixalite (porcupine wire)

- If pigeons are likely to drop nest material and other debris on top of the newly installed spikes in an attempt to create a new roosting surface, install metal spikes on potential landing sites **above** the installation.
- Check metal spikes every six months for accumulated debris or nest material. Advise clients to regularly remove fallen autumn leaves and other matter that can cover the spikes and reduce their effectiveness. Ensure that no tree branches hang over protected ledges.

Sticky Repellents. Sticky repellents are tacky gels or liquids. The products are designed to be sticky enough to make a bird uncomfortable, but not so sticky that the birds are trapped. After a few attempts, the birds stop trying to land on treated surfaces. The active ingredient is polybutene or isopolybutene (the same substances used in some adhesive bandages) or petroleum naphthenic oils.

- Before applying sticky repellents, clean ledges that are covered by bird droppings, feathers, and nest material with a wire brush, paint scraper, high-pressure hose, or steam cleaning.
- Ensure that surfaces are clean and dry.
- Seal concrete, unpainted wood, or brownstone with silicone or other sealant, paint, or shellac before applying repellent. Sticky repellents will be absorbed into porous materials.
- Use a caulking gun to apply repellent. The depth of the bead necessary to repel various species of pest birds is roughly as follows: crows and seagulls, 3/8 inch; pigeons, 1/4 inch; starlings, 1/8 inch; sparrows, 1/16 inch. The pattern of application will depend on the site and personal preference. The caulking gun should be held at an angle of 30 to 45 degrees.
- Apply a straight bead on ledges and roof edges 1/2 inch from the outer edge, with another bead 3 inch-

es in from the first. It can also be applied in a zigzag or S curve.

- For another option, combine a straight line 1/2 inch from the outer edge and an S curve 3 to 5 inches back.
- Place breaks in the bead every few feet to avoid trapping rainwater against the building.
- For easy removal and replacement, apply waterproof sticky repellent tape on ledge and roof edges.
- Apply bulk gels with a paint roller, putty knife, or bulk caulking gun.
- Apply liquids with a roller, brush, or compressed-air sprayer to girders, rods, sign supports, and rooftops. They can also be used to treat the upper surfaces of branches in trees and bushes. The repellent should be 1/16 to 1/8 inch thick. Liquid application is not recommended for sites where the appearance of the sticky repellent would be undesirable.

Environmental conditions, particularly dust, make a big difference in the effective life of sticky repellents. In an area with no dust, applications should be expected to remain effective for a year or more. Some sticky repellents come with a liquid coating that is sprayed onto the repellent immediately after application. The liquid dries to a brittle film that protects the material from dust and may allow it to remain effective for as long as two to five years.

Certain precautions should be followed when sticky repellents are used:

- Remove nests.
- Check state and local regulations that may prohibit destroying or disturbing nests containing eggs or young.

Under some conditions, sticky repellents stain the surfaces to which they are applied. Some products melt and run when exposed to direct sun and high temperatures.

- Review labels and the manufacturers' technical information on the effective temperature ranges of various products.
- Compare the stability of various products by running a test on a sunny roof or window ledge.

Birds occasionally get stuck in sticky repellents. When this happens, their feathers will get gummed up and they'll be unable to fly. If a bird becomes gummed up with repellent, it can sometimes be rescued by cleaning with repellent, it can sometimes be rescued by cleaning the flight feathers with a small amount of mineral spirits followed by mineral oil. In most cases, cartridge applications (as described earlier) will repel the birds with little risk of entanglement.

Ultrasonic Devices

It should be noted that numerous tests by university, government, and private independent researchers have failed to demonstrate any efficacy against birds by any of the ultrasonic devices tested. ***These devices do not work against birds.***

Trapping

In many instances, trapping can be an effective supplemental control measure. Trapping is especially effective against pigeons. Where a group of birds is roosting or feeding in a confined and isolated area, trapping should be considered the primary control tactic.

The best time to trap pigeons is in the winter, when their food is at a minimum. There are many pigeon traps to choose from; which type and size are best is debatable. Most pigeon trapping programs use large walk-in traps. These can be 4 to 6 feet high and designed to be disassembled and moved. Another common type is a low-profile bob trap that is about 8 inches to 2 feet high. The door or entrance through which pigeons are lured is the principal feature of a trap.

- Set traps in inconspicuous places where pigeons commonly roost or feed and where traps are not likely to be vandalized (a major risk in trapping programs). Trap placement is important, and moving an inactive trap just 10 to 15 feet may significantly improve catches.

Feeding areas are the best trap sites, but they are rarely on the same property as the roosting sites. Rooftops that have water from cooling towers or air-conditioning units are often good trapping sites in summer.

The most difficult part of trapping is motivating birds to feed in a non-feeding area so that they will follow the bait into the trap. Whole corn or sorghum is generally the best bait, but wheat, milo, oat groats, millet, popcorn, sunflower seeds, peas, greens, bread, or peanuts can be very effective if the birds are feeding on similar food. Once a few birds have been trapped, putting a variety of foods in with the birds can show which bait they prefer.

- In the first few weeks of a program, scatter small quantities of bait throughout the area to start the birds feeding and determine the best trap sites. Some specialists leave traps propped open for the first few days to allow the birds to get used to them.
- When the birds are calmly entering the trap, set it. Put bait and water (a “chick fountain” is ideal) inside the trap and just a handful or so outside the trap. Leave one or two “decoy” birds in the trap to draw in other birds. Light-colored birds make better decoys than drab ones.
- Remove trapped birds regularly (except for decoys)—otherwise, other pigeons will be frightened away by the fluttering of trapped pigeons. Pigeons can fly great distances and find their way home, so trap-and-release is not normally effective. In most cases, trapped birds should be humanely destroyed. Some experts recommend gassing with calcium cyanide, but many feel it is simpler and more humane to kill the bird by breaking its neck.

Sometimes indoor roosting sites can be used as a giant trap. Pigeons often use attics, rooftop elevator houses, or empty floors of poorly maintained structures as nest and roost sites. Screening all but one or two entrances can turn such an area into a giant trap. Late in the evening (after about a two-week acclimation period) these last entrances can be closed down after the pigeons have set-

tled down for the night. The trapped birds can then be captured by hand or with butterfly nets.

Sparrow traps come in various sizes and shapes. The sparrow funnel trap is a double funnel that prevents sparrows from escaping after they have traveled through two funnels going for food bait. Fine cracked corn, millet, wheat, or bread crumbs make good bait. Trap sites should be baited for a few days before you actually begin trapping. Sparrow traps are usually more effective when placed on the ground. Nest box traps attract a sparrow with a potential nest site. Once inside, the bird trips the mechanism, which dumps the bird into a collecting bag. This trap also works against starlings, as does the center drop trap. The birds, attracted by food, drop through an opening and cannot escape. However, starlings are not usually good candidates for trapping programs.

LETHAL ALTERNATIVES

Avitrol

Avitrol is a poison bait with flock-alarming properties used to control many kinds of birds. There are different Avitrol baits for each pest bird species—whole corn for pigeons, smaller grains for sparrows and other birds. Within 15 minutes of eating a toxic dose of Avitrol, birds flutter erratically and go into convulsions. They may fly away from the baiting site, they may fly into windows, or they may “dive bomb” into the ground.

Affected birds convulse for an hour or more. Most die within a few hours, but some last for as long as 15 hours. Only a small percentage of the flock (usually from 5 to 15 percent) needs to be affected for an Avitrol program to be successful. The flock becomes frightened by the convulsions and distress of the poisoned birds, and anywhere from 65 to 85 percent of the flock will leave the area. Use of Avitrol requires consultation with a USDA representative (refer to Section 5.53 of the WCO).

Prebaiting. At most sites, birds must be trained to feed on bait. Though baits are different for each bird, the general process is the same. Here is the procedure for pigeons:

- Place untreated whole corn in numerous piles on flat rooftops, ledges, and similar sites in the treatment area.
- Place many small piles (1/4 pound each) 20 feet apart.
- Place about twenty 1/4-pound piles of bait on a flat 5,000-square-foot roof.

The goal in prebaiting is to get at least 40 percent of the birds to accept the untreated bait. Expect the effort to take from three days to three weeks. When possible, remove all untreated prebait corn before switching over to Avitrol.

Cardinals, blue jays, doves and certain other seed-eating birds also eat whole corn. Do not use Avitrol where non-target birds fed on the prebait unless the site is one

of many. When this happens, continue baiting the isolated site with untreated corn. In this way, non-targets will be kept away from your Avitrol baiting sites.

Avitrol whole corn is not used alone—it is mixed with untreated corn in ratios ranging from 1 part Avitrol and 29 parts untreated bait up to the maximum ratio of 1 to 9. The higher the proportion of Avitrol, the better the chance to move the flock quickly. However, this also increases the number and visibility of dead or convulsing birds.

With good bait acceptance, a ratio of 1:29 (treated:untreated) will generally kill about 5 percent of the flock; a 1:9 blend will generally kill 15 percent or more.

- Use the ratio that best fits the job.
- Keep in mind that you're trying to relocate the flock, not kill every pigeon.

The amount of Avitrol bait set out should be about half the total prebait used each day. For example, if 8 pounds of prebait have been set out each day for a flock of about 100 birds, 4 pounds of the Avitrol blended bait should be set out when you switch over.

One Avitrol application is adequate for most jobs. At large commercial operations (e.g., a freight yard), bait may need to be placed daily for a few days. If pigeons become bait-shy, wait about three weeks, then begin a new prebaiting program. If a site has been getting monthly Avitrol "maintenance" baiting, pigeons can become extremely bait-shy. Prebaiting for as long as three or four months may be necessary, so it is usually best to switch to another control method.

Use care to follow directions for using Avitrol specifically for each species of pest bird. Read the label carefully.

Secondary poisoning, in its classical definition, is not a risk with Avitrol because the chemical is metabolically changed in the tissue of affected birds. However, if a dead or dying bird has a supply of Avitrol-treated bait in its crop, there is potential risk to an animal feeding on this bird.

Toxic Perches

A toxic perch is a metal container with a wick surface that holds a liquid contact poison that birds absorb through their feet when they stand on the perch. The toxicant (fenthion) is hazardous to all birds and animals, **including humans**. Toxic perches are particularly useful where food is in constant supply or Avitrol bait is not accepted. They are applied in locations where birds will perch on them, usually in the evening hours. An average-sized job will require 10 to 12 perches; a large job might require 30.

Toxic perches can be used only in certain sites: inside buildings and structures (non-food areas), on building tops, structural steel, power plants, or substations, and at feedlots, loading docks, and storage yards. Pigeons develop a site-specific aversion to perches placed at feeding, loafing, or watering sites but not usually in roosting sites. Perches usually need refilling twice per year. In hot weather, perches sometimes leak toxicants.

Birds can absorb a toxic dose in less than a minute but may not die for four days. Pigeons will normally find a protected place out of the sun and wind once they begin feeling the effects of the toxicant. They usually don't fly after that time and so usually die with 20 to 30 feet of the perch, if it was set in a roosting site. There is a secondary poisoning hazard if other animals feed on dead birds. There have also been reports of hawks and owls dying after using the perches. By law, dead birds must be picked up, buried, or burned.

Ornitrol

Ornitrol is a chemosterilant, often called the "birth-control pill for pigeons." When fed to pigeons, it inhibits ovulation in the female and sperm production in the male. The effects of treatment last for six months in the female and three months in the male. When applied as directed on the label, it will not kill birds, but populations will slowly decline over the years from the natural mortality in aging pigeon populations. It is used in situations where long-term control is desired with no expectations of immediate results.

The manufacturer recommends applications for 10 days two times per year—in the early spring (March) and late summer or early fall. For each 100 pigeons, 7.5 pounds of Ornitrol corn are scattered daily for 10 days. Prebaiting with whole corn for a week will usually be necessary to achieve bait acceptance. Most birds eating Ornitrol would be temporarily sterilized, so care must be taken to avoid feeding non-target species. Research data indicate little or no activity in mammals. There is no secondary poisoning hazard.

Shooting

A possible alternative or supplemental method for eliminating birds is shooting with air-powered pellet guns. Check with local and state law enforcement before discharging any firearms.

- Shoot at night or first thing in the morning in roosting areas.
- Use a high-powered pellet gun—it is relatively accurate, quiet, and short-ranged, and it will not cause structural damage. Many models are available. Some specialists use .22 caliber smooth-bore rifles loaded with No. 12 or No. 9 birdshot or sandshot. These are noisy, however, and too powerful for urban sites.
- Use care—errant shots can be dangerous.

Risks to Non-targets

Most lethal tactics in bird control pose some risk to non-target birds, as well as other animals. Non-targets are protected by various federal, state, and local regulations, as well as by public opinion. Care must be taken to minimize the threat to non-targets or to use tactics that pose the least risk.

- First, identify the non-targets in the area.
- Second, use low-risk tactics.

- Third, modify tactics to minimize risk.
- Fourth, monitor operations to be sure that non-targets are not being adversely affected.

Public Relations

People often react more negatively to one dying bird than to accumulated pigeon droppings on sidewalks or potential risks of parasites and disease from bird roosts. Pigeons and sparrows are seen as pets rather than pests. Consider the public's perception of bird management operations. All bird management programs should put some effort into avoiding "people problems," particularly when using Avitrol or other toxic control techniques. Care should be taken to place traps or other control measures well out of sight of the public.

BIRD DROPPINGS REMOVAL AND CLEANUP

Workers removing large quantities of bird droppings should follow these precautions to minimize risk from disease organisms in the droppings:

- Wear a respirator that can filter particles down to 0.3 micron.
- Wear disposable protective gloves, hat, coveralls, and boots.
- Wet down the droppings to keep spores from becoming airborne, and keep them wet.
- Put droppings into sealed plastic garbage bags and wet the outsides of the bags.
- When finished, and while still wearing the respirator, remove the protective clothing and place the items in a plastic bag.
- Dispose of trash bags. (Disposal should be permissible through standard trash pickup).
- Wash up or shower.

CONTROL OF PEST BIRDS IN AGRICULTURAL AREAS

Several pest birds, including a variety of blackbirds, can become pests of agricultural crops. Blackbirds may cause major losses in sunflower and corn fields, and are pests around grain storage facilities. Waterfowl and wild turkeys may destroy portions of ripening grain fields or trample newly planted fields in spring. House finches and robins frequently damage soft fruits such as cherries or blueberries. These birds are protected by federal regu-

lations. Though, under special circumstances, a federal permit is not required to control certain blackbirds (see Chapter 1), state and local regulations may require special permits to trap them or to control them by lethal means. Growers require effective control of bird damage in a variety of agricultural situations. Some control methods that apply to agricultural situations are described below. These methods may be used alone or in combination with the other (i.e., trapping, shooting, baiting, etc.) methods described above.

Exclusion

- Netting is the most effective method for controlling bird damage. However, there is a high labor cost for installation and removal of netting, and this method is usually cost-effective for only the most valuable crops.

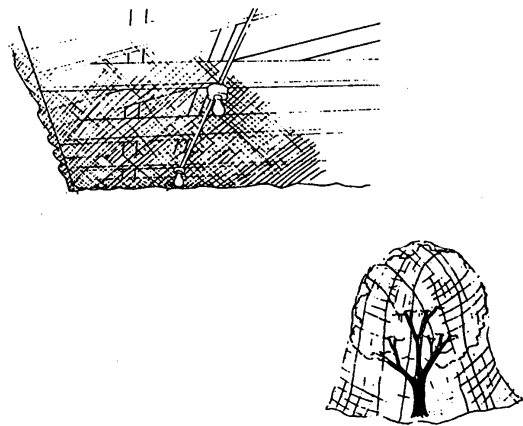


Figure 2.7. Netting can be used to exclude birds from building rafters and from fruit trees.

- Monofilament lines (cords or fine wire) have been used to reduce bird damage at landfills, fish hatcheries, public parks, and agricultural fields. The lines are stretched across the areas in a variety of spacings and configurations (grid patterns, parallel patterns, etc.) and at varying heights, depending on the species to be controlled. Species responses have been quite variable. For example, gulls, crows, and sparrows appear to be particularly sensitive to lines and have been successfully repelled. To protect crops, lines are usually practical only for small plots or home gardens.
- Commercial plastic strips can provide bird-proof barriers for doors to warehouses, grain storage areas, and other buildings. These strips can be hung from the top of the doorframe to ground level, allowing easy access for people and equipment.

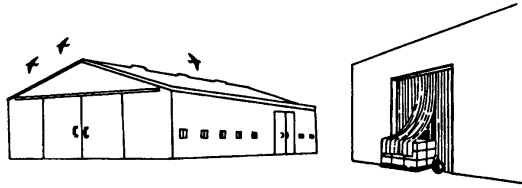


Figure 2.8. Bird-proof buildings to permanently eliminate bird problems inside.

Frightening Devices

Auditory Frightening Devices. Broadcasts of recorded distress or alarm calls have been used successfully to drive birds from fields, orchards, and roosts. Most calls are species-specific, so it is important to identify the birds causing damage. Also, appropriate distress calls may not be available commercially. Propane exploders (some with timers that automatically turn them on and off each day) are also a popular frightening device.

Visual Frightening Devices. Some devices include eye-spot balloons (helium-filled balloons tethered in fields), scarecrows (sometimes used with a propane exploder or a “scary man fall-guy” device), and reflecting tapes made of Mylar placed 3 to 7 yards apart to protect small fields (requires substantial labor).

The use of frightening devices can be effective in protecting crops from flocks of feeding birds, but their use also requires hard work and long hours for the farmer. Devices need to be employed especially in the early morning and in late afternoon when the birds are most actively feeding. In addition, birds tend to adjust or adapt to frightening devices. It is usually best to use two or more devices or methods of bird control.

Chemicals

Avitrol may be available for protecting fields from grackles, red-winged blackbirds, cowbirds, and starlings. Check state and local ordinances.

Cultural Practices

- Controlling insect populations in field crops may sometimes reduce the pest bird populations that feed on them.
- Establish new fields away from cover or perch sites (snags or power lines), or remove attractive habitat features from areas next to plantings.
- To reduce feeding by blackbirds, plant non-attractive crops such as soybeans, wheat, potatoes, or hay.

SUMMARY

Birds provide enjoyment and recreation while greatly enhancing the quality of our lives. Unfortunately, they can become pests at times, too—feeding on crops, creating health hazards, roosting on buildings, contaminating food, or creating a nuisance. The major pest birds are pigeons, starlings, and house sparrows, though many birds can become pests in the right—or wrong—situation.

Many laws and regulations protect birds. Though pigeons, starlings, and house sparrows are not directly protected by federal law, their control is often strictly regulated by state and local law. Public opinion is often strongly against any control measures that kill birds, even pest birds.

Non-lethal bird control methods include habitat modification (limiting food, water, and shelter), exclusion (with netting, porcupine wire, sticky repellents, etc.), and trapping. The most common lethal control measures are Avitrol poison baits and toxic perches. Be extremely careful when using bird poisons so that you do not harm

CHAPTER 2

Review Questions

Chapter 2: Birds

non-target birds and animals.

1-8. Match the following to the appropriate description:

- A. Pigeons
 - B. Starlings
 - C. House sparrows
 - D. All of the above
- ___ 1. Robin-sized bird, yellow beak (January-June), dark with light speckles.
 - ___ 2. Nest on buildings.
 - ___ 3. Introduced into the United States.
 - ___ 4. Usually stay in one area all year long; pairs mate for life; produce 10 young/year.
 - ___ 5. Droppings may carry diseases.
 - ___ 6. Male with black bib, white cheeks, and chestnut upper wing covers.
 - ___ 7. Congregate in large numbers on high perches; singing and calling can be irritating.
 - ___ 8. Average three broods per season with

four to seven eggs per brood.

9. Which of the following is true about pigeons?
- A. They prefer flat surfaces for resting and feeding.
 - B. They will feed on rooftops or on the ground.
 - C. Feeding, roosting, and loafing sites are usually separate.
 - D. All of the above
 - E. None of the above
10. Pigeons usually make a nest of small twigs, straw, or debris on buildings and other structures.
- A. True
 - B. False
11. Which of the following is true about starlings?
- A. They feed at night.
 - B. They may fly up to 30 miles to their feedings sites.
 - C. They usually nest on the ground in low shrubbery.
 - D. All of the above
 - E. None of the above
12. Which of the following is true about house sparrows?
- A. They are nervous around people and will not nest in high-traffic areas.
 - B. They often create fire hazards by nesting inside transformers and power stations.
 - C. They prefer to feed on small grains but will also feed on garbage.
 - D. All of the above
 - E. B and C
13. Which health risk from pest birds is the **most** serious?
- A. Disease transmitted by ectoparasites.
 - B. Inhaling disease organisms from their droppings.
 - C. Food contamination.
 - D. There are no serious health hazards associated with pest birds.
- 14-21. Match the following to the appropriate description:
- A. Histoplasmosis
 - B. Cryptococcosis
 - C. Ectoparasites
- _____14. Transmitted to humans by airborne spores from soil contaminated by droppings.
- _____15. Disease may damage eyes.
- _____16. Pigeon droppings are the main source of this disease.
- _____17. Invade buildings from nesting and roosting sites; can irritate skin.
- _____18. About 50 million people in the U.S. have been exposed to this disease.
- _____19. Disease causes lung infection.
- _____20. One form of the disease produces acne-like skin eruptions or ulcers with nodules.
- _____21. Disease causes flu-like symptoms.
22. FIFRA:
- A. Directly protects pigeons, starlings, and sparrows.
 - B. Directly protects non-target birds.
 - C. Regulates application of toxicants or repellents.
 - D. B & C
 - E. All of the above
23. With a General Damage and Nuisance Control Permit issued by the Michigan DNR, a pest control technician may do the following in relation to bird control:
- A. Use pesticides to control pigeons, starlings, and house sparrows in any location.
 - B. Use pesticides to control all bird species in any location.
 - C. Use pesticides to control pigeons, starlings, and house sparrows only to the exterior of buildings in recognized industrial areas in cities.
 - D. Use pesticides to control pigeons, starlings, and house sparrows only in out-of-building non-industrial areas.
 - E. Use pesticides to control all bird species only in out-of-building non-industrial areas.
24. With a Project Control Permit issued by the Michigan DNR, a pest control technician may do the following in relation to bird control:
- A. Use pesticides to control pigeons, starlings, and house sparrows in any location.
 - B. Use pesticides to control all bird species in any location.
 - C. Use pesticides to control pigeons, starlings, and house sparrows only to the exterior of buildings in recognized industrial areas in cities.
 - D. Use pesticides to control pigeons, starlings, and house sparrows only in out-of-building non-industrial areas.
 - E. Use pesticides to control all bird species only in out-of-building non-industrial areas.

25. According to Michigan's WCO, what steps and precautions must permittees take before the initial use of pesticides in any bird control operation?
26. All local ordinances allow pesticide use for the control of pigeons, starlings, and house sparrows.
- A. True
B. False
27. The first step in controlling pest birds is to:
- A. Attempt to modify habitat.
B. Use exclusion methods.
C. Conduct a thorough survey.
D. Prebait.
28. Nest destruction is ineffective against sparrows and starlings.
- A. True
B. False
29. Which is true about nest destruction?
- A. Destroying nest once in the spring and once in the summer is recommended.
B. Treating nest areas within 50 feet of an occupied site with an insecticide/acaricide is recommended to kill ectoparasites.
C. Nest destruction by spraying nests with high-pressure hoses is cost-effective, eliminates ectoparasites, and cleans droppings and feathers from the nest site.
D. There is no danger that spraying with high-pressure hoses will damage buildings.
E. Removing nests will not induce pigeons to leave the area.
- 30-35. Match the following to the appropriate description:
- A. Netting
B. Covers
C. Spikes
D. Sticky repellents
E. Ultrasonic devices
F. Trapping
- ____ 30. Ineffective at controlling birds.
____ 31. Commonly made of plastic; often used in warehouses, cooling towers, and places where aesthetics are not important.
____ 32. Porcupine wire; stops birds from roosting on ledges.
____ 33. Gel makes birds stop trying to land on treated surfaces.
____ 34. Custom designed for ledges; high cost; use where aesthetics are a concern.
____ 35. Method more effective for pigeons than starlings and sparrows.
36. The best time to trap pigeons is in the spring.
- A. True
B. False
37. When using traps:
- A. Leave "decoy" birds in the trap.
B. Prebait to determine feeding areas/preferences.
C. Place traps in conspicuous places.
D. A & B
E. B & C
38. Place sparrow funnel traps near roosting sites to catch the most sparrows.
- A. True
B. False
39. Which is true about Avitrol?
- A. At least 50 percent of the flock must consume Avitrol to be effective.
B. It is not necessary to prebait when using Avitrol.
C. It does not pose a risk to non-target birds.
D. Mix a ratio of treated to untreated whole corn for pigeon control.
E. A & D
40. The main effect of Avitrol on bird control is:
- A. It kills more than 50 percent of the flock.
B. It inhibits ovulation in females; sperm production in males.
C. It has flock-alarming properties.
D. After receiving a toxic dose, birds die four days later.
E. A & D

41. The main effect of Ornitrol on bird control is:
- It kills more than 50 percent of the flock.
 - It inhibits ovulation in females; sperm production in males.
 - It has flock-alarming properties.
 - After receiving a toxic dose, birds die four days later.
 - A & D
42. When non-lethal bird control is required, which of the following bird-management techniques may be used?
- Netting
 - Avitrol
 - Ornitrol
 - A & C
43. Which is NOT true when using Avitrol whole corn for pigeon control?
- Only 5 to 15 percent of the flock needs to be affected for Avitrol to be successful.
 - Prebaiting with untreated corn may be necessary for three days up to three weeks.
 - Cardinals, blue jays, and doves will not eat whole corn.
 - To prebait, place about twenty 1/4-pound piles of bait on a 5,000-square-foot roof.
 - The goal of prebaiting is to get at least 40 percent of the birds to accept the bait.
44. For Ornitrol to be effective:
- Apply for 10 days two times/year.
 - Prebait with whole corn for a week.
 - Apply for 20 days three times/year.
 - A & B
 - B & C
45. Clients should be made aware that toxic perches do not pose a hazard to humans.
- True
 - False
46. Ornitrol, unlike Avitrol, does not pose a risk to non-target birds.
- True
 - False
47. Non-target birds are protected by federal and state laws but not by local laws.
- True
 - False
48. Public opinion should be considered when deciding on a bird control program.
- True
 - False
49. After cleaning up bird droppings, remove your respirator, then remove your protective clothing and place in a plastic bag.
- True
 - False
50. For the following pest bird situations in rural areas, state what would be the most appropriate exclusion technique and describe your reasoning.
- Keep robins from destroying a high-value cherry orchard crop.
 - Keep blue jays out of grain storage areas.
 - Keep gulls out of a landfill.
51. Describe some of the auditory and visual frightening devices that may be used to control pest birds in rural areas.

CHAPTER 3

Domestic Rodents

LEARNING OBJECTIVES

After completely studying this chapter, you should:

- Know the appearance, habits, and habitats of rats and house mice.
- Be familiar with rat- and mouse-spread diseases.
- Be able to describe monitoring procedures and tools used to inspect for rats and house mice.
- Be able to describe lethal and non-lethal methods of controlling rats and house mice.
- Know the various types of traps and baits used in rat and mouse control.

Rats (*Rattus* spp.) have caused more human suffering and more economic damage than any other vertebrate pest. From causing plague epidemics (the “Black Death” of Europe) to rat-bite fever, whether feeding on stored grain or gnawing electric wires, rats are enemies of humankind. Statisticians estimate that rats destroy 20 percent of the world’s food supply every year—directly by feeding and indirectly through contamination.

Yet rats’ adaptability can be admired. They have adapted to most human environments. They live in granaries, in fields, in city sewers, on ocean-going ships, on roofs, in attics, in basements, in street trees, on top of 30-story buildings, and inside subway tunnels.

In most instances, rats are very wary. Hundreds may be nesting in a city block—in underground burrows, in sewers, on roofs, inside buildings—with few people in the area realizing it. Populations are dynamic: rats moving in, rats moving out, rats giving birth, and rats dying. Within a population, some rats will be easy to control, some difficult.

Successful long-term rat control is not simple. The key is to control rat populations, not individual rats. Rat control requires an integrated approach that includes non-lethal tools such as careful inspection, upgraded sanitation, and rat-proofing structures. Lethal control often combines the use of rodenticides with non-toxic control measures such as snap traps and glue boards.

The **house mouse** (*Mus musculus*) easily adapts to life with people. It thrives in a wide range of climatic conditions in a great variety of habitats, feeding on most human food and reproducing at a remarkable rate.

House mice are found throughout the United States and in most areas of human habitation. House mice are also found living in the wild, competing with native fauna. They are common inhabitants of grassy fields and cultivated grain crops. House mice have even been captured in open tundra in Alaska, miles away from human settlements.

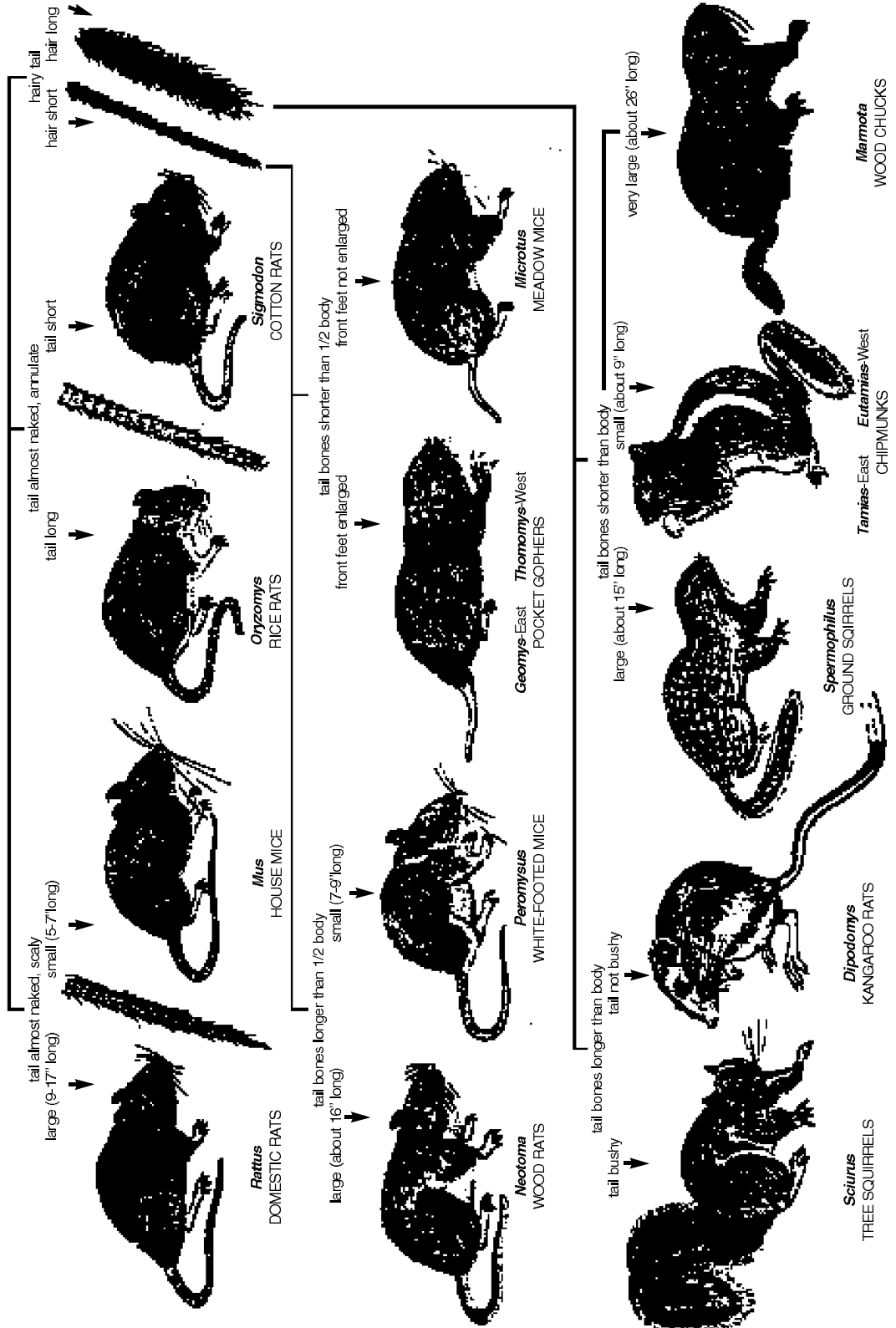
Technicians will find that the house mouse is the most troublesome and economically important rodent. House mice are a common problem in homes and in all types of businesses. Nearly everyone can remember times when they were irritated by mice. Mice are nuisances to rich and poor alike. The continual drain that house mice impose on stored food and fiber, and the damage they cause to personal possessions are the most serious economic threats. House mice also have the potential to transmit diseases and parasites to people and domestic animals.

Control of house mice requires understanding mouse biology and habits, particularly the major differences between mice and rats. During the past few decades, control of rats has improved while problems with house mice have increased. Baiting programs often are more successful in controlling rats than they are in controlling mice.

RODENTS

PICTORIAL KEY TO SOME COMMON UNITED STATES GENERA

Harold George Scott, Ph.D.



RATS AND MICE AS DISEASE CARRIERS

Rats are responsible for the spread of many diseases. Sometimes they transmit the disease directly, by contaminating food with their urine or feces. Sometimes they transmit disease indirectly—for example, when fleas first bite an infected rat, then a person. Below are some of the more important diseases associated with rats and mice. These diseases often share similar symptoms, and medical professionals must perform the proper diagnoses.

Excluding the spread of food poisoning, house mice are not as important as rats as carriers of disease and parasites. Yet their potential cannot be overlooked. House mice and their parasites are implicated in the transmission of a number of diseases.

Rat-bite Fever

Rats bite thousands of people each year. Most bites occur in inner cities. In some cases, victims, particularly infants and bed-confined elderly persons, are bitten in the face while sleeping. A small percentage of those bitten develop rat-bite fever. The bacterium that causes the disease is carried in the teeth and gums of many rats. Though the disease, in most cases, exhibits mild symptoms similar to those of flu, it can be fatal. It is of particular risk to infants. Rat-bite fever can also be transmitted by house mice.

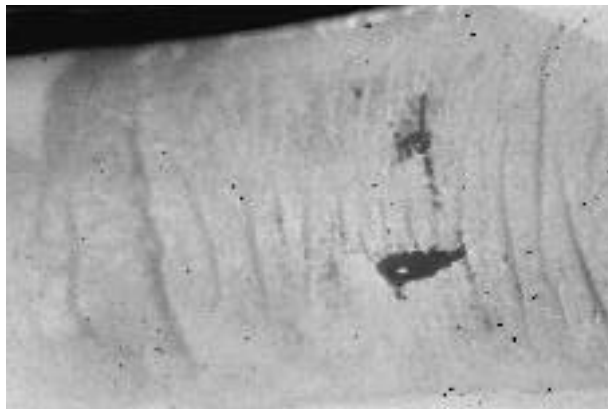


Figure 3.1. Rat bite

Salmonella Food Poisoning

Bacterial food poisoning, salmonellosis, can be spread when some foods are contaminated with infected rodent feces. Mice are probably more responsible than rats for the spread of this disease. Symptoms of food poisoning may include headache, stomach pain, diarrhea, and low-grade fever.

Leptospirosis or Weil's disease

Human cases of this disease are seldom fatal. The disease organisms are spread from rodent urine into water or food, and they enter humans through mucous membranes or minute cuts and abrasions of the skin. The dis-

ease may be so mild as to be unnoticed or may cause mild aches, pains, and fever. More serious cases, often referred to as Weil's disease, can result in high fever, jaundice, aseptic meningitis, acute kidney failure, internal bleeding, and occasionally death. The mouse can be a major carrier of leptospirosis, although human cases are more commonly caused by rats.

About Rabies

Rats in native habitats have not been found infected with rabies. Rabies transmission from rats to humans has never been documented in the United States. The U.S. Public Health Service recommends **against** anti-rabies treatments in the case of rat or mouse bites.

RAT-SPREAD DISEASES

Plague

The Great Plague of London killed half of the city's population. The Black Death of Europe in the 14th century lasted 50 years and killed 25 million people. In the first quarter of this century, an estimated 11 million people died in Asia from plague. The disease is transmitted to humans primarily by the Oriental rat flea. The flea bites an infected rat and then, feeding on a human, inoculates him/her with the bacterium that causes the disease. Although no major urban outbreak of plague has occurred since 1924, this is not a disease of the past. A reservoir of plague exists in some populations of wild rodents in several western states. Humans contacting these rodents could contract the disease. In the bubonic form of plague, symptoms include the sudden onset of fever with painful swelling of the lymph nodes. If the infection spreads to the lungs (pneumonic plague), it produces pneumonia that is highly contagious and often fatal. As suburbia expands into undeveloped areas, wild rodents can transmit the disease to urban rats. An outbreak of urban plague could occur in the United States.

Murine Typhus Fever

Murine typhus occurs in California and in southeastern and Gulf Coast states. It is a relatively mild disease in humans. As with plague, murine typhus is transmitted from rats to humans by a rat flea. In this case, however, the disease organism enters the bloodstream when feces of infected fleas are scratched into a flea-bite wound. Symptoms may include fever, severe headache, and rash.

Trichinosis

Trichinosis results from a nematode, a tiny round-worm, that invades intestines and muscle tissue. Both people and rats get the disease from eating raw or undercooked pork infected with the nematode. Rats help spread trichinosis when hogs eat food or garbage contaminated with infested rat droppings. Symptoms may include vomiting, diarrhea, and abdominal pain.

MOUSE-SPREAD DISEASES

Rickettsial pox

Rickettsia akari is the causal agent of rickettsial pox, a disease causing a rash of the chicken pox type. Rickettsial pox is transmitted from mouse to mouse, then to people by the bite of the house mouse mite.

Meningitis

Lymphocytic choriomeningitis is a virus infection of house mice that may be transmitted to people (mainly to children) through contaminated food or dust.

Dermatitis

Dermatitis caused by the bites of mites has been associated with house mouse infestations. The uncomfortable skin irritation and itching can affect children and adults. Mites may spread through all of a mouse-infested house or apartment during particular times of the year, and the dermatitis is frequently blamed on other causes (heat rash, allergies, fleas, and the like).

Ray Fungus and Ringworm

Mice can transmit ray fungus, *Actinomyces muris*. Certain tapeworms are spread in house mouse droppings, and ringworm, a skin fungus disease, can be carried to humans by mice or contracted indirectly from mice through cats. Tularemia has also been linked to house mice.

THE NORWAY RAT

The most commonly found rat pest in Michigan is the Norway rat (*Rattus norvegicus*). The Norway rat is also called brown rat, house rat, sewer rat, and wharf rat. The adult Norway rat generally weighs between 12 and 16 ounces, and the head and body are 6 to 8 inches long. The fur is coarse and varies in color, but it is often brownish or reddish gray above and whitish gray on the belly. The nose is blunt and the eyes and ears are small. The scaly tail is shorter than the head and body. The Norway rat is generally considered the most important rat in the United States. It is found in every state.



Figure 3.2. Norway rat, *Rattus norvegicus*

HABITS OF RATS

Rats must be understood to be controlled. Knowledge of their life histories, habitat and food requirements, patterns of behavior, range, and other factors is essential to their management.

Life Cycle

A mature female rat can give birth to about 20 young in a year (four to six at a time), if she lives that long. The average life span of a rat in the field is less than one year; females live longer than males. The young are born in a nest. They are hairless, and their eyes and ears are closed. Within two weeks their eyes and ears open, they become furry and ratlike, and they begin exploring the nest area. In the third week, they begin to eat solid food and imitate their mother to forage, escape, and watch for danger.

If the mother rat has become wary of rodenticides or traps, many of her young will learn to avoid them. This learning experience can make control difficult in sites where long-term rodent control programs have been unsuccessful in the past. Young are totally weaned at 4 or 5 weeks old. They then weigh about 1 1/2 ounces. At 3 months, the young are independent of their mother. They will mate and continue the cycle in the same location or will migrate to a new, unoccupied nest area.

Social Behavior

Rats are social animals and live in colonies with well defined territories that they mark with urine and glandular secretions. The colony has a complex social hierarchy with a dominant male leader and a "pecking order" of subordinate males and ranking females. The strongest and most dominant animals occupy the best nest and resting sites and feed at their leisure. Weaker, subordinate rats are pushed out to less favorable sites or forced out of the territory completely.

Rats are aggressive, and social conflicts are most common at feeding sites, prime resting areas, and territorial boundaries. Females fiercely defend their nests and young from other rats.

Senses of Rats

Rats have poor vision. They are nearly color-blind, and they react to shapes and movement rather than identifying objects by sight. The limit of their vision is 30 to 45 feet. Their eyes are adapted to dim light.

Other senses, however, compensate for poor vision. They use their sense of smell to locate food, follow pathways, tell whether another rat is friend or foe, and identify new objects in their territory. They use long whiskers and guard hairs to “touch” their way through dark burrows, pipe chases, wall voids, and other runways. Their ears detect faint sounds that signal danger. Rats can taste certain chemicals at a parts-per-million concentration. This explains why rats often reject baits or avoid traps that have been contaminated with insecticides. Finally, rats have an excellent sense of balance that allows them to walk on wires and always land on their feet in a fall.

Fear of New Objects (Neophobia)

Rats are wary of anything new that appears in their territory. A bait station, a trap, a block of wood will be avoided for a few days until the rats become familiar with the new object; even then, they approach cautiously. This fear of new objects can make baiting and trapping difficult. Rats will avoid poison bait when it is first placed. Later, they may nibble warily. If the poison bait makes them ill but doesn't kill them, they will avoid similar baits or stations in the future.

Physical Abilities

Adept athletes, rats can leap 3 feet straight up and 4 feet horizontally. They can scramble up the outside of a pipe 3 inches in diameter, and climb inside pipes 1 1/2 to 4 inches in diameter. They can walk between buildings on telephone or power lines, and scramble on board a ship on its mooring line. Rats can swim a half-mile of open water, tread water for up to three days, swim against a strong current in a sewer line, and dive through a sewer trap to come up inside a toilet. They can fall more than 50 feet and survive.

Rats gnaw constantly. Their teeth are extremely hard. They commonly chew through building materials such as cinder block, aluminum siding, sun-dried adobe brick, wall board, wooden cabinets, lead sheathing, and plastic or lead pipes. After gnawing a hole, an adult rat can compress its body and squeeze through an opening only 1/2 inch high.

Food and Water

Rats need about 1 ounce of food daily. Norway rats prefer protein-based foods such as meat, fish, insects, pet food, nuts, and grain. Household garbage is ideal food for Norway rats. However, they will feed on non-preferred food if nothing else is available.

Rats often cache or hoard food in hidden areas. This food may or may not be eaten when other food supplies run short. Hoarding is important for two reasons. First, rats may be moving toxic bait into a location where the label does not permit it to be. Second, rats may be hoard-

ing poison bait while feeding on their regular food. Thus, a baiting program becomes ineffective.

Rats need water every day. The amount varies, depending on the moisture content of their food, but is usually around 1/2 to 1 fluid ounce. Rats prefer to nest where water is easily available.

Range

Rats usually begin foraging just after dark. Most of their food gathering occurs between dusk and midnight, but short bursts of restlessness and activity can occur anytime, day or night. Rats commonly travel 100 to 150 feet from their nest looking for food and water and patrolling their territory. It is not unusual for a colony of rats that nests outdoors to forage inside a building 100 feet away.

Nests

Outdoors, Norway rats usually nest in burrows dug into the ground. The burrows are shallow (less than 18 inches) and usually short (less than 3 feet), with a central nest. Extra “bolt holes” are used for emergency escapes. They are hidden under grass or boards or lightly plugged with dirt. Burrow openings are 2 to 4 inches in diameter. Indoors, Norway rats nest inside walls, in the space between floors and ceilings, underneath equipment, between and under pallets, and in crawl spaces, storage rooms, and any cluttered area that is normally unoccupied. Norways prefer to nest in the lower floors of a building.

They also nest in sewers and storm drains, and on occasion they can be found in highly unusual nest sites. Norway rats can have several “hotel” nest sites in an area. A rat may spend a week in its home base and then move for a day or two into a secondary “hotel” nest site. Norway rats have been shown on occasion to have a home range of up to 20 acres when these secondary nest sites were included in the calculations.



Figure 3.3. Rat burrow

INSPECTION

Rats give many signs that they are infesting an area. Inspection will determine if a site is infested and will identify where rats are feeding and nesting, their patterns of movement, the size of the population, and the extent of the infestation. This helps the pest control technicians decide what control measures to use, where and how to use them, and how much effort is needed to put the program in place.

Flashlight

An inspection using a powerful flashlight just after dark is the best way to see rats. Dead rats are signs of a current or past infestation. If all that are found are old, dried carcasses and skeletons, it may mean an old infestation. Many fresh carcasses are an indication that someone may be baiting the area currently. If rats are actively observed during the day, the rat population is probably high.

Sounds

When a building is quiet, squeaks and fighting noises, clawing and scrambling in walls, or gnawing sounds may be heard.

- Use a stethoscope or electronic listening device to help pinpoint activity.

Droppings

A single rat may produce 50 droppings daily. Norway rat droppings are 3/4 inch long. The highest number of droppings will be found in locations where rats rest or feed.

- Determine if a rat population is active by sweeping up old droppings, then reinspecting a week later for new droppings.
- Look at the appearance of the droppings to determine if rats are currently active. Fresh rat droppings are black or nearly black, they may glisten and look wet, and they have the consistency of putty. After a few days or a week, droppings become dry and hard, and appear dull. After a few weeks, droppings become gray and dusty, and crumble easily. Note that old droppings moistened by rain may look like new droppings; however, if crushed, they will crumble and do not feel like soft putty.



Figure 3.4. Rat droppings

Urine

Both wet and dry urine stains will glow blue-white under an ultraviolet light (blacklight).

- Use portable ultraviolet lights developed by the food industry to identify rat urine on food items. Other substances besides rat urine also glow, so proper use of this inspection method takes practice.

Grease Marks

Oil and dirt rub off of a rat's coat as it scrambles along. The grease marks build up in frequented runways and become noticeable.

- Look along wall/floor junctions, on pipes and ceiling joists, and on sill plates where rats swing around obstacles. Grease marks are also found at regularly used openings in walls, floors, and ceilings.



Figure 3.5. Rat droppings and grease marks

Runways

Outdoors, rats constantly travel the same route. Their runways appear as beaten paths on the ground. Look next to walls, along fences, and under bushes and buildings. Indoor runways (harder to identify) may appear as well polished trails, free of dust.

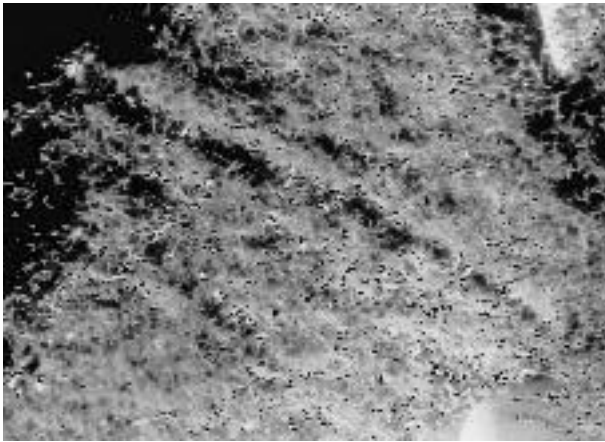


Figure 3.6. Rat runway in turf

Tracks

A rat's footprint is about 3/4 inch long and may show four or five toes. Rats may also leave a tail dragline in the middle of their tracks.

- Look in dust or soft, moist soil.
- Place a **tracking patch** in suspected rat areas to show footprints. A tracking patch is a light dusting of an inert material such as clay, talc (unscented baby powder), or powdered limestone. Don't use flour, which may attract insect pests. A good patch size is 12 by 4 inches. Apply patches in suspected runways and near grease marks. When inspecting tracking patches, shine a flashlight at an angle that causes the tracks to cast a distinct shadow. Note that a tracking patch is not the same as tracking powder. **Tracking powders** are diluted rodenticides in dust form; tracking patches use non-toxic dust. **Do not use a tracking powder to make a tracking patch.**

Gnawing Damage

A rat's incisor teeth grow at a rate of about 5 inches per year. Rats keep their teeth worn down by continuously working them against each other and by gnawing on hard surfaces.

- Look for gnawing damage as evidence of a rat infestation. Gnawed holes may be 2 inches or more in diameter.
- Inspect floor joists, ceiling joists, door corners, kitchen cabinets, and around pipes in floors and walls.



Figure 3.7. Rat teeth



Figure 3.8. Rat gnawings on trash can

Burrows

Outdoors, rat burrows may be found singly or in groups along foundation walls, under slabs and dumpster pads, in overgrown weedy areas, beneath debris, and in embankments.

- Look for a burrow opening that is free of dirt, leaves, and debris, often with smooth, hard-packed soil.
- Look for rub marks at the opening and soil pushed out in a fan-shaped pattern.
- Fill the opening with a small amount of wadded-up newspaper or a few leaves and cover it with loose soil. If the rats are still using the burrow, they will reopen and clear the hole overnight.

Pet Excitement

Cats and dogs may excitedly probe an area of floor or wall where rats are present, especially if the rats have only recently invaded.

Odor

Heavy infestations have a distinctive odor that can be identified with practice. The odor of rats can be distinguished from the odor of mice.

Estimating Rat Numbers

It is not easy to tell how many rats are infesting a site. As a rough guide, you can use rat signs to characterize the population as low, medium, or high.

- In rat-free or low-infestation conditions, no signs are seen. The area either has no rats or was invaded recently by a few.
- With medium infestation, old droppings and gnawings can be observed. One or more rats are seen at night; no rats are seen during the day.
- When there is a high infestation, fresh droppings, tracks, and gnawings are common. Three or more rats are seen at night; rats may be seen in the daytime.

CONTROL AND MANAGEMENT OF RATS

Most successful rat control programs use a combination of tools and procedures to knock down the rat population and to keep it down. Methods used combine habitat alteration and pesticide application. Some of the tools, such as baiting and trapping, are lethal to the rat. Some tools are not—rat-proofing, for example. Sometimes applicators recommend changes that their customers need to make, such as increasing the frequency of garbage pickup or making building repairs.

The following sections describe some of the major techniques and tools used in controlling rats:

Sanitation

Food. Like all animals, rats need food to survive. Baiting programs often fail because the bait can't compete with the rats' regular food. The rats simply ignore the baits or cache them. Reducing the availability of rats' normal food encourages them to feed on any rodenticide baits placed in their territory.

- Close or repair dumpsters and garbage containers that are left open or damaged.
- Clean up food spills.
- Do not allow food to be left out overnight.
- Outdoors, remove seeds spilled under bird feeders or food around doghouses.
- In warehouses and food plants, look for spills around railroad tracks and loading docks. Ensure that food in storage is rotated properly (first in, first out) and is stored on pallets, not on the ground or against walls. The pallets should be 18 to 24 inches from side walls and placed so that aisles permit inspection and cleaning around the stored food.

Eliminate Hiding Places

Outdoors:

- Remove plant ground covers such as ivy near buildings.
- Remove high grass, weeds, woodpiles, and construction debris that permit rats to live and hide adjacent to a building.



Figure 3.9. Typical rat habitat

Indoors:

- Reduce clutter in rarely used rooms—basements, storage rooms, equipment rooms.
- Organize storage areas.

Rat-proofing (Exclusion)

In the long term, the most successful form of rat control is to build them out. Also called rat-proofing, this approach makes it impossible for rats to get into a building or an area of a building. Rat-proofing prevents new rats from reinfesting a building once it has been cleared.

Building Exterior:

- Seal cracks and holes in building foundations and exterior walls.
- Block openings around water and sewer pipes, electric lines, air vents, and telephone wires.
- Screen air vents.
- Caulk and seal doors to ensure a tight fit, especially between door and floor threshold.
- Fit windows and screens tightly.
- Caulk and close openings on upper floors and the roof, inspect under siding, and repair damaged soffits.
- Repair breaks in the foundation below ground level.



Figure 3.10. Rat entry point

Building Interior:

- Seal spaces inside hollow block voids or behind wallboard. Repair broken blocks and holes around pipes.
- Repair gnaw holes or stuff them with copper wool.
- Equip floor drains with sturdy metal grates held firmly in place.

Traps

Snap Trap. The snap trap is an effective method of killing rats when used correctly. Trapping is advised for use in places where rodenticides are considered too risky or aren't working well, if the odor of dead rats in wall or ceiling voids would be unacceptable, or when there are only a few rats infesting a limited area.

Trapping has several advantages. There is less non-target risk from traps than from a toxicant. The technician knows instantly whether the trap has been successful. Traps also allow for disposal of the carcass so that there are no odor problems.

Careful attention to detail is necessary to ensure proper placement in adequate numbers or rats will simply pass them by.

The best traps are those with expanded triggers (treadles) set for a light touch.

- Leaving the traps baited but unset for a few days may increase the catch by reducing the chance that wary rats will trip the traps without capture.
- Set traps with bait, if food for rats is in short supply, or without bait, if food is plentiful. Good baits for Norway rats include peanut butter, hot dog slices, bacon, and nutmeats.
- Tie movable bait to the trigger using string or dental floss, or the rat may simply remove the bait without triggering the trap.
- Sprinkle cereal, such as oatmeal, around traps to make them more attractive.
- Set unbaited traps along runways, along walls, behind objects, in dark corners where the rat is forced through a narrow opening. Place the trigger

side of the trap next to the wall. (Rats will step on the trap during their regular travels.)

- When runways are located on rafters and pipes, set expanded trigger traps directly across them, fastening them to pipes with wire, heavy rubber bands, or hose clamps, and to rafters with nails.
- Set traps where droppings, gnawing damage, grease marks, and other evidence of activity are found.
- Use enough traps. A dozen may be needed for a house; a hundred for a small warehouse. Set five or ten traps in an active corner of a room. Set three traps in a row so a rat leaping over the first will be caught in the second or third. If unsure about sites of activity, set traps along possible runways spaced 10 to 20 feet apart.
- Camouflage traps when left with only a few rats that become very difficult to capture. Set traps in a shallow pan of meal, sawdust, or grain. (Place a small piece of cloth or plastic over the trigger to prevent the meal from jamming the mechanism.)
- In stubborn cases, expose food in shallow pans until the rats readily feed on it. Then add a buried trap.
- Move boxes and objects around to create narrow runways to the traps.
- Avoid spraying insecticide on the trap or even storing traps with application equipment. The odor of insecticide can make a rat steer clear. The odor of other rats, however, improves a trap's effectiveness.
- Inspect traps frequently to remove dead rodents and change old bait.

Glue Boards. Another way to trap rats is with glue boards. Glue boards use a sticky material that captures rodents. Although most often used against mice, they are sometimes effective against rats. Be sure to use larger glue boards designed to trap an animal the size of a rat. Be aware that some people consider glue boards inhumane because the rodents are not killed instantly.

- Place glue boards in the same locations as you would place snap traps. Place them lengthwise flush along the wall, box, or other object that edges a runway. Overhead runways along pipes, beams, rafters, and ledges are good sites, too.
- Do not place glue boards directly over food products or food preparation areas.
- Secure the glue board with a nail or wire so a rat can't drag it away.
- Install glue boards in bait stations if people might be upset to observe a struggling rat, where children or pets could come in contact with the glue, or in areas with excessive dust or moisture.
- Check glue boards frequently and dispose of rodents humanely.
- Adding a dab of bait to the center of the glue board may improve its effectiveness.
- Do not use any bait containing a vegetable oil—e.g., peanut butter—this is a solvent for the glue.

Rodenticides

A rodenticide is a pesticide designed to kill rodents. There are three major formulations of rodenticides used to control rats: food baits, water baits, and tracking powders.

Food Baits. Rat baits combine a poison effective against rats with a food bait attractive to rats. At one time, applicators mixed their own baits. Now baits are mostly purchased ready-made and packaged as extruded pellets, in a dry meal, or molded into paraffin blocks for wet sites. Baits may be obtained in 45-pound bulk tubs, in “place packs” containing less than 1 ounce of bait, or anything in between.

Some baits kill rats after a single feeding; some require multiple feedings. Some are anticoagulants (causing rats to bleed to death), some affect respiration, and others have totally different modes of action. Some are only slightly toxic to people or pets, some are moderately toxic, and some are very toxic.

Many ancient poisons that are toxic to humans have been used to poison rodents. Experimentation with poisons for killing rodents produced rodenticides made of arsenic, cyanide, strychnine, etc.—stomach poisons that were mixed with food and had such extreme toxicity that they killed any animal that ingested them in sufficient amounts. Rats that did not eat a lethal dose, however, recovered, became “bait-shy,” and communicated their preference—or revulsion—to others in the colony. Because of this, these poisons were undependable.

A new type of rodenticide was developed in the 1940s that reduced the clotting ability of the blood. This material, warfarin, became the first anticoagulant rodenticide. Others followed: warfarin, coumafuryl, chlorophacinone, diphacinone, pindone, valone. The anticoagulants were effective and did not cause bait shyness. Several factors overcame the risks of acutely toxic poisons. Though the anticoagulants could be lethal to any warm-blooded animals, many species—including poultry, farm animals, pets, and humans—would have to consume large quantities over several days for fatalities to occur. Also an antidote, vitamin K, was developed.

Evidence of resistance to anticoagulants and a desire for quicker results drove the successful search for single-dose anticoagulants—brodifacoum and bromadiolone. In recent years, non-anticoagulant rodenticides with different modes of action, such as bromethalin or cholecalciferol, have been proven effective. Zinc phosphide, a single-dose non-anticoagulant, is somewhat poisonous to all vertebrates. It is often used as a tracking powder, which the rodents lick from their fur during grooming. It is also incorporated in dry baits. ***Zinc phosphide should never be mixed with bare hands nor applied without wearing gloves.***

Remember, rodenticides must be used very carefully. They are made to kill animal species of the same class as humans.

Several general guidelines should be followed when using a poison bait. First and foremost, protect children, pets, wildlife, and domestic animals from eating the bait. All rodenticides have warnings on the label telling the

applicator to place the bait “in locations not accessible to children, pets, wildlife, and domestic animals, or place in tamper-resistant bait boxes.” Evaluate each case to determine what are safe, inaccessible areas. Ask questions such as:

- Is it possible for a child to reach under a refrigerator to grab a place pack that you hid underneath?
- Could a guard dog at a warehouse find and eat the bait blocks you placed under a loading dock?

If so, change your placement or put the bait inside a tamper-resistant bait box.

Bait Boxes. A tamper-resistant bait box is designed so that a child or pet cannot get to the bait inside but a rat can. Bait trays and flimsy plastic or cardboard stations are not tamper-resistant bait boxes. Tamper-resistant boxes vary in type and quality of construction, but they are usually metal or heavy plastic. Rat bait stations are normally larger than those used for mice. Most designs are not considered to be truly tamper-resistant unless they can be secured to the floor, wall, or ground.

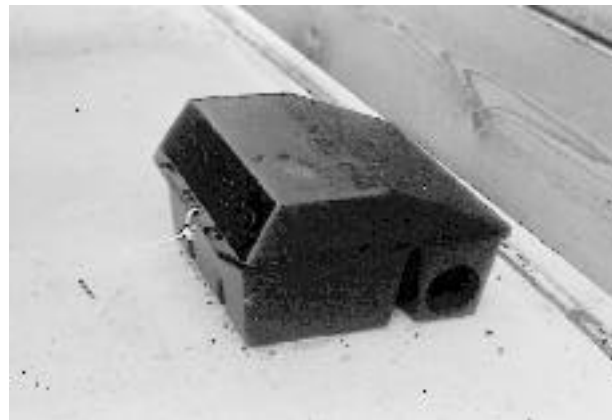


Figure 3.11. Tamper-resistant plastic bait box

- Ensure that bait boxes are clearly labeled with a precautionary statement.
- Check stations or boxes periodically to make sure that rats are taking the bait and that the bait is fresh. Rats will rarely feed on spoiled bait.
- Bait boxes should be placed wherever the rats are most active, as indicated by droppings and other signs (near burrows, along walls, at other travel sites, etc.).
- Put bait packs in burrows, wall voids, and similar protected sites. If a site is damp, use paraffin bait blocks or other water-resistant formulations. Put out enough bait and check it often. Incomplete baiting can lead to bait shyness and make control difficult.
- Be sure to limit the rats' normal food supply, or your baits may be rejected.
- Remember that rats fear new objects at first, so your baits may not be taken for a few days or a week.

- Once bait is taken, leave the box in place for some time. The rats now consider it to be part of their normal surroundings.
- Good bait placements can be effective even when placed 15 to 50 feet apart. Bait placed outdoors around a commercial building can kill rats that are moving in from nearby areas.

Water Baits. Rats drink water daily if they can. When rat water supplies are short, water baits—specially formulated rodenticides that are mixed with water—can be extremely effective. Several types of liquid dispensers are available. The best are custom designed for toxic water baits, but plastic chick-founts can also be used in protected sites. *Use water baits only where no other animals or children can get to them.*

Tracking Powders. Rats groom themselves by licking their fur. Tracking powder makes use of this behavior. This formulation is a rodenticide carried on a talc or powdery clay that is applied into areas where rats live and travel. The powder sticks to the rats' feet and fur and is swallowed when the rats groom themselves. The major advantage to tracking powders is that it can kill rats even when food and water are plentiful, or if rats have become bait- or trap-shy.

- Apply tracking powders more heavily than an insecticide dust but never deeper than 1/8 inch. Best application sites are inside wall voids, around rub marks, along pipe and conduit runs, and in dry burrows (when permitted by label). Apply with a hand bulb, bellows duster, or with a (properly labeled) flour sifter or salt shaker.
- Do not use tracking powders in suspended ceilings, around air ventilators, or near food or food preparation areas—the powder can become airborne and drift into non-target areas. The rodenticide in tracking powders is generally 5 to 40 times more concentrated than that in baits. Tracking powders can be made with acute poisons or slower acting poisons.

THE HOUSE MOUSE

The house mouse is a delicate, agile little rodent. Adult weights vary from region to region and may be linked to the suitability of habitat, but they usually range from 1/2 to 1 ounce. Adult house mice vary in color from light brown to dark gray but most often are a dusky gray or medium brown over most of their bodies, except the belly, which may be a slightly lighter shade of their general color but never white.



Figure 3.12. House mouse, *Mus musculus*

The mouse has moderately large ears for its body size. The tail is nearly hairless and about as long as the body and head combined (2 1/2 to 4 inches). The feet are small in proportion to its body. The eyes are also relatively small (see Rodent Chart, page 185).

Our native deer or white-footed mice (*Peromyscus* spp.), which often invade buildings adjacent to fields and woodlands, are about the same size as or slightly larger than house mice. Deer mice have a distinct, bicolored tail; the upper portion is brown or gray and the underside is distinctly white, with a well-defined line where the two colors meet.

Meadow mice or voles (*Microtus* spp.) sometimes invade homes. They are less agile, have larger, chunky bodies, and weigh at least twice as much as house mice. They also have much shorter tails and small ears and eyes.

LOSSES DUE TO MICE

When mice infest stored food, the greatest loss is not what mice eat but what is thrown out because of real or suspected contamination. In six months, one pair of mice can eat about 4 pounds of food and deposit about 18,000 droppings. The amount of food contaminated by the mice is estimated to be about 10 times greater than the amount eaten.

So common are mice that the government permits a certain number of rodent hairs, and sometimes droppings, to remain in food commodities destined for human consumption. Yet food inspectors often have to condemn food products and fine manufacturers because of house mouse contamination in excess of that permitted.

Losses are not connected only with food. Family bibles or heirlooms stored in a trunk in the attic or garage that are damaged by mice are irreplaceable, as are original paintings and manuscripts stored in museums. Mouse-riddled documents in the bottom file drawer of an office cannot generally be valued in dollars and cents, but these losses can be costly.

Electrical wiring gnawed by rodents has started many fires. Many fire-related incidents listed as “cause unknown” are probably rodent-related. House mice frequently take up residence in electrical appliances and end up chewing into the power supply. This is particularly costly when computer systems are disrupted.

HABITS OF HOUSE MICE

Life Cycle

Under optimum conditions, house mice breed year round. Outdoors, house mice may tend toward seasonal breeding, peaking in the spring and fall. Environmental conditions, such as the availability and quality of food, can influence frequency of pregnancies, litter sizes, and survival. Under ideal conditions, females may produce as many as 10 litters (about 50 young) in a year. At very high densities, however, reproduction may nearly cease despite the presence of excess food and cover.

Newborn mice are quite undeveloped, weigh between 0.02 and 0.03 ounce and are nearly hairless. Eyes and ears are closed, but by the end of two weeks, the body is covered with hair and the eyes and ears are open. At about 3 weeks, the young begin short trips away from the nest and begin taking solid food.

Social Behavior

Though mice are active primarily at night, some day activity occurs. Movements of house mice are largely determined by temperature, food, and hiding places. Home ranges of mice tend to be smallest where living conditions are good.

Mice tend to travel over their entire territory daily, investigating each change or new object that may be placed there. They are very aggressive. Unlike rats, they show no fear of new objects. They dart from place to place, covering the same route over and over again. This behavior can be used to advantage in control programs. Disturbing the environment at the beginning of a control program by moving boxes, shelves, pallets, and other objects can improve the effectiveness of traps, glue boards, and bait. Mice will investigate the changed territory thoroughly.

Senses of Mice

Like rats, mice have relatively poor vision and are colorblind. They rely heavily on smell, taste, touch, and hearing. Mice use their keen sense of smell to locate food items and to recognize other individuals, especially those of the opposite sex. Taste perception in mice is good also. Mice use their acute hearing to detect and escape danger.

An important sensory factor with mice is touch. Like rats, mice use long, sensitive whiskers near the nose and the guard hairs on the body as tactile sensors to enable them to travel in the dark, pressing against walls and boxes, and scurrying through burrows.

Mice also have an excellent sense of balance. A mouse's ability to quickly carry out actions or movements is governed by a constant practice of sequences of muscular movements—sometimes referred to as the kinesthetic sense. The kinesthetic sense is a subconscious recording of a series of movements necessary to go from point A to point B. This activity occurs from stimulation of sensory nerve endings in muscles, tendons, and joints and allows mice to quickly escape danger.

Curiosity

Mice do not fear new objects as rats do. As mentioned earlier, they quickly detect new objects in their territory and investigate them. They will immediately enter bait stations and sample a new food (although they may only nibble on a small amount). They will also investigate traps and glue boards. Control programs against mice often have success early—just the opposite of rat programs.

Physical Abilities

It is difficult to mouse-proof a building or control mice without understanding their physical capabilities:

- For their size, they are excellent jumpers, with some of the more agile individuals jumping 12 inches (30.5 cm) high from the floor onto an elevated flat surface.
- They can jump against a wall or flat vertical surface and use it as a springboard to gain additional height.
- They can run up almost any vertical surface—from wood and brick walls to metal girders, pipes, weathered sheet metal, wire mesh, and cables—without much difficulty if the surface is rough.
- They can run horizontally along insulated electrical wires, small ropes, and the like, with ease.
- They can squeeze through openings slightly more than 1/4 inch (6 mm) in diameter.
- They can easily travel for some distance hanging upside-down from 1/4-inch (6 mm) hardware mesh.
- They are capable swimmers, though they generally do not take to water as well as rats do and tend not to dive below the surface.
- They can walk or run along ledges too narrow for rats.
- They can jump from a height of 8 feet (2.5 meters) to the floor.
- They can survive at a constant -24 degrees F (-30 degrees C) temperature for 10 generations.
- They have been reported 1,800 feet below the ground in a coal mine.
- They are quick to explore any physical change in their environment.

Food and Water

House mice prefer cereals more than other items, though they will feed on a wide variety of foods. Mice sometimes search for foods high in fat and protein, such as lard, butter, nuts, bacon, and meat. Sweets, including chocolate, are taken at times. Mice get much of their water from moisture in their food, but they will drink if water is readily available.

Mice are nibblers, feeding 20 or more times during evening rounds. Mice have two main feeding periods, at dusk and just before dawn. In any territory, there will be one or two feeding sites, dark and protected, where mice will eat more than at other places. Mice tend to hold grain kernels, such as oats or wheat, nibbling on them like people eating corn on the cob. They often drop portions of the kernels as they get smaller.

Range

Mice are territorial and seldom travel more than 30 feet from their nest. Their range is much smaller than the rat's range of 100 to 150 feet. When food is nearby, mice may restrict their activity to a few feet. Males average slightly larger ranges than females.

Nests

House mice may nest in any dark, sheltered location. Nests are constructed of fibrous, shredded materials such as paper, cloth, burlap, insulation, or cotton and generally look like a loosely woven ball. They are approximately 4 inches in diameter.

Outdoors, house mice sometimes dig and nest in small burrows.

The small range of mice, the way they feed, and their food preferences are the characteristics that set house mice apart from rats. Keep these in mind when controlling mice. Many failures in mouse control can be blamed on applicators using rat control techniques.

INSPECTION

Sounds

Sounds are common at night where large numbers of mice are present.

- Listen for squeaks, scrambling, and sounds of gnawing.

Droppings

A house mouse produces about 70 droppings per day. Fresh droppings are not usually as soft as rat droppings and in a few days become quite hard. Mouse droppings are frequently the first evidence that mice are infesting. Large cockroaches, bats, and other species of mice such as deer mice (*Peromyscus* spp.) and meadow mice (*Microtus* spp.) may produce droppings similar to those of house mice.

- Look along runways, by food, near shelters, and in other places mice may frequent.

Urine

House mice occasionally make small mounds known as "urinating pillars." These consist of a combination of grease, urine, and dirt and may become quite conspicuous.

- Look for many small drops of urine.
- Use a blacklight. Urine stains will fluoresce under ultraviolet light.

Grease Marks

Like rats, mice produce greasy smears where dirt and oil from their fur mark pipes and beams. House mouse spots are not as easy to detect.

- Expect markings to cover a smaller area than those made by rats.

Runways

Most house mouse runways are indistinct trails free of dust but not readily detectable.

Tracks

- Look for footprints or tail marks on dusty surfaces or on mud.
- Use a non-toxic tracking dust to help determine the presence of house mice within buildings.

Gnawing Damage

Recently created gnawings on wood are light colored; they turn darker with age.

- Look for enlarged cracks beneath doors.
- Look for small tooth marks. Such evidence frequently helps to distinguish between mice and rats.
- Look for wood chips with a consistency like those of coarse sawdust around baseboards, doors, basement windows and frames, and kitchen cabinets.

Visual Sightings

Mice are often active in daylight. This may not indicate a high population, as it does with rats.

- Use a powerful flashlight or spotlight at night in warehouses and food plants to confirm house mouse presence.

Nest Sites

- Look in garages, attics, basements, closets, and other storage places.
- Be alert to finely shredded paper or other fibrous materials. These are common nest-building materials.

Pet Excitement

- Follow up when cats and dogs paw excitedly at a kitchen cabinet door, the floor at the base of a refrigerator, or at the base of a wall, especially if mice have invaded the premises only recently.

Mouse Odors

- Smell for the characteristic musky odor produced by mice. It can easily be differentiated from that of rats.

Estimating Numbers of Mice

Estimates are more difficult to get than for rats. The number of mice observed or food consumed is not highly reliable as a census technique with house mice. Unlike rats (which may travel widely within a building, leaving tracks on many patches of dust), house mice do not range widely.

- Read natural signs such as droppings, urine stains, tracks, and damage.
- Make non-toxic tracking patches of talc at 20- to 30-foot intervals (5 to 10 meters) throughout a building. The more tracks seen in each patch, and the more patches showing tracks, the larger the population.
- The percentage of patches showing tracks will reflect the extent of the local infestation.

Tracking patches are also an excellent means to evaluate a control operation. Compare the number of tracks or patches with mouse tracks before and after a control program.

CONTROL AND MANAGEMENT OF HOUSE MICE

Control of house mice is a three-part process:

- Sanitation.
- Mouse-proofing.
- Population reduction with traps or toxicants.

The first two are useful preventive measures. When a mouse population already exists, some kind of lethal control is necessary. Otherwise, the reproductive capability of the mice and their remarkable ability to find food in almost any habitat will keep their populations up or increase them.

House mouse control is different from rat control. Applicators who do not take these differences into account will have control failures.

- Sealing mice out of a building is difficult because mice are smaller.
- Range is small. Identify each infested site to target control procedures.
- Mice often can produce offspring faster than control methods can work.

Nevertheless, many of the techniques to control and manage rats also apply to mice. In the sections below, the

differences in procedures for rats and mice are emphasized.

Sanitation

Good sanitation makes it easier to detect signs of mouse infestation. It also increases the effectiveness of baits and traps by reducing competing food. However, the best sanitation will not eliminate house mice. They require very little space and small amounts of food to flourish.

- Store bulk foods in mouse-proof containers or rooms. In warehouses, restaurants, and food plants, stack packaged foods in orderly rows on pallets so that they can be inspected easily. A family of mice can happily live in a pallet of food without ever having to leave the immediate area.
- Keep stored materials away from walls and off the floor. A 12- to 18-inch yellow or white painted band next to the wall in commercial storage areas permits easier detection of mouse droppings. This band and the areas around pallets should be swept often so that new droppings can be detected quickly.

Mouse-proofing

It isn't easy to completely mouse-proof a building because mice are reported to be able to squeeze through an opening as little as 1/4 inch in diameter.

- Seal large holes to limit the movement of mice into and through a building.
- Plug holes in foundation walls with steel wool or copper mesh.
- Caulk and fit doors and windows tightly.
- Seal holes around pipes, utility lines, vents, etc., to make it difficult for mice to move in and out of wall and ceiling voids. This confines mice to a smaller area and may make snap traps and glue boards more effective.

Traps

Snap Traps. If used correctly, snap traps are very effective in controlling mice. They must be set in the right places, in high numbers, and in the right position, or mice will miss them entirely. Here are some factors to keep in mind when trapping mice:

- Remember that the territory of mice rarely extends farther than 30 feet from the nest; more often about 10 feet. If mice are sighted throughout a building, it means that there are numerous discrete locations where you will have to set traps. Place snap traps not only wherever you see obvious signs of mice, but look for good trap locations in a three-dimensional sphere about 10 feet in diameter around those signs.
- Mice can be living above their main food supply in suspended ceilings, attics, inside vertical pipe runs, and on top of walk-in coolers. Or they can be below, in floor voids or crawlspaces, or under coolers and/or processing equipment.

- The best sites are those with large numbers of droppings—that means the mice are spending a lot of time there. Other good sites are along walls, behind objects, and in dark corners, particularly where runways narrow, funneling the mice into a limited area.

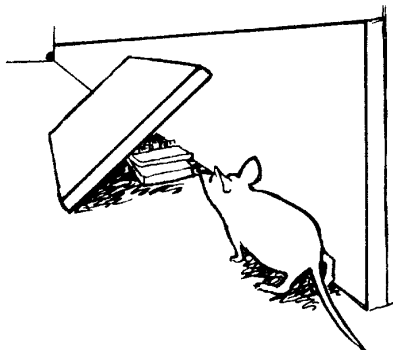


Figure 3.13. Place snap traps along walls and cover them with a board. This will force rodents to walk over the trap.

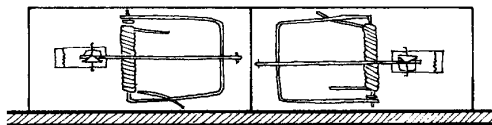


Figure 3.14. For greater effectiveness, place traps in pairs along walls to prevent rodents from jumping over a trap to avoid being caught.

- Good mouse baits increase a trap's effectiveness. Peanut butter, bacon, cereal, and nuts are traditional, but one of the best baits is a cotton ball, which the female mice like to use for nest material. It must be tied securely to the trigger. Food baits must be fresh to be effective.
- Probably the biggest mistake made in mouse trapping is not using enough traps. Use enough to make the trapping campaign short and effective.

Multiple-catch Traps. Multiple-catch mousetraps catch up to 15 mice without requiring resetting. Some brands are called “wind-up” traps; the wind-up mechanism kicks mice into the trap. Others use a treadle door. Live mice must be humanely killed.

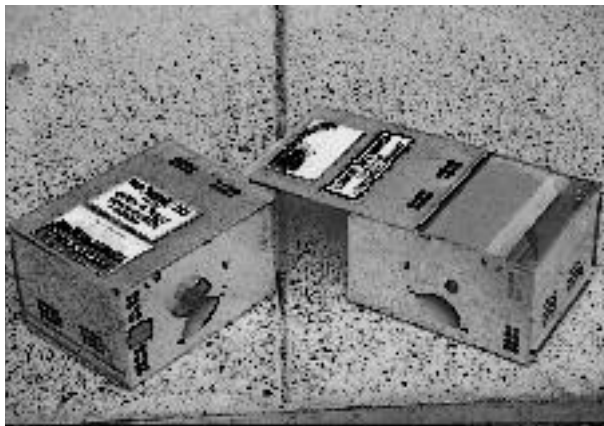
Mice like to investigate new things. They enter the small entrance hole without hesitation. Odor plays a role, too. Traps that smell “mousy” catch more mice. Place a small dab of peanut butter inside the tunnel entrance to improve the catch.

- Check traps frequently. Mice are captured alive but may die in a day or two. Some traps have a clear plastic end plate or lid so you can see if any have been captured.
- Place the traps directly against a wall or object with the opening parallel to the runway, or point the tun-

nel hole towards the wall, leaving 1 or 2 inches of space between the trap and the wall.

- If mice are active, place many traps 6 to 10 feet apart. For maintenance trapping, place the traps in high-risk areas and also at potential mouse entry points such as loading docks, near utility lines, and at doorways.

Figure 3.15. These multiple-catch traps will catch up to 15



mice and do not have to be reset each time one is caught.

Glue Boards. Glue boards are very effective against mice. As with traps, placement is the key. Locations that are good trap sites are good sites for glue boards.

- Do not put glue boards directly above food products or in food preparation areas.
- Set glue boards lengthwise and flush against a wall, box, or other object that edges a runway.
- Move objects around; create new, narrow runways 6 inches wide to increase the effectiveness of glue boards.
- Put a cotton ball in the center of the board.
- Place the glue boards 5 to 10 feet apart in infested areas; closer if the population is large.
- If no mice are captured in three days, move the boards to new locations.
- If a trapped mouse is alive, kill it before disposal. Replace the boards if they fill up with insects.

Rodenticides

Food Baits. Observe the same safety guidelines for mouse baits as discussed in the section on rat baits. Protect children, pets, wildlife, and domestic animals by putting the bait in inaccessible locations or inside tamper-proof bait boxes.

- Apply many small bait placements rather than a few large placements.
- Use baits labeled for mouse control.
- Place the baits in favorite feeding and resting sites, as revealed by large numbers of droppings.

- Place the baits between hiding places and food, up against a wall or other object to intercept the mice.
- Bait in three dimensions (see earlier discussion on trapping).
- Make bait placements 10 feet apart or closer in infested areas.
- If bait is refused, try switching to a different type and replacing the baits often.
- Use small bait stations—they are more attractive to mice than the larger rat-type stations.
- Practice strict sanitation so that other food is not outcompeting the baits.
- Place secure, tamper—proof bait boxes in safe locations near doors in late summer to intercept mice entering from the wild.

Liquid Baits. Mice get most of their water from their food. They also drink from a water container. Liquid baits that are labeled for mouse control can be effective in sites that do not have a ready supply of water. The same water bait dispensers used for rats can be used for mice. As with food baits and traps, many water stations will be necessary to put the bait into the territory of all mice infesting a building.

Tracking Powders. Tracking powders are especially effective against mice. Mice groom themselves more than rats, and they investigate enclosed areas that can be dusted with tracking powder.

- Apply inside infested dry wall voids.
- Dust tracking powder into voids in heavily infested apartment or office buildings.
- Place tracking powder in a bait station, a PVC tube, a cardboard tube, or any small, dark shelter that a mouse could enter. Mice will explore such a shelter. Apply the tracking powder in a layer less than 1/16 inch deep.
- Do not allow tracking powder to drift into non-target areas.

SUMMARY

Rats have adapted to most human environments. Along the way, they have caused more human suffering and economic damage than any other vertebrate pest. But they are marvelous athletes and successful survivors as well. Successful long-term rat control is not simple. The key is to control rat populations, not individual rats. To be controlled they must be understood. Two of the most important biological factors to help control rats are their fear of new objects and their large foraging range of 100 to 150 feet or more from their nest.

Successful rat control programs usually use a combination of tools and procedures to knock down a rat population and keep it down. In the long term, the most successful form of rat control is to build them out, also called rat-proofing. Other control tactics include trapping and poisons. People using rodenticide baits and tracking powders must take care to avoid risks to other people, children, pets, and non-target animals.

The house mouse is the most successful rodent in adapting to live with people. It is found almost anywhere people are, feeding on human food, sheltering in human structures, and reproducing at a remarkable rate. It is the most troublesome and economically important vertebrate pest, contaminating untold millions of dollars worth of food, damaging possessions, and causing electrical fires with its constant gnawing.

Many control failures against house mice are due to the applicator's lack of understanding of mouse biology and habits, particularly the major differences between mice and rats. Mice have a remarkable reproductive ability. A mated pair can produce 50 offspring in one year. They also have a foraging range much smaller than a rat's, usually only 10 to 30 feet. Baits, traps, glue boards, and the like must be placed close to the nest to be effective. Thus, good inspections are critical.

On the plus side, mice are curious and investigate new objects in their territory, so control measures can work fast when done correctly. Control of house mice is best when it is a three-part process: sanitation, mouse-proofing, and population reduction with traps and toxicants.

CHAPTER
3

Review Questions

Chapter 3: Domestic Rodents

- Rats are a major carrier of rabies.
 - True
 - False
- There is no chance of a modern-day outbreak of plague in the United States.
 - True
 - False
- Match the following to the appropriate description:
 - Plague
 - Rat-bite fever
 - Salmonella food poisoning
 - Leptospirosis
 - Trichinosis
 - Murine typhus fever

_____ 3. Caused by a nematode spread by hogs eating food contaminated with rat droppings and humans subsequently eating undercooked pork.

_____ 4. Bacterial disease transmitted by the Oriental rat flea.

_____ 5. Disease caused by organisms spread by rat urine in water or food.

_____ 6. Bacterial disease causes mild flulike symptoms but can be fatal, especially to infants.

_____ 7. Disease organism enters bloodstream by scratching rat flea feces into flea bite wound.

_____ 8. Disease caused by bacterium from rodent droppings in stored food or on dishes.
- Mice are more likely to cause _____ than rats.
 - Leptospirosis
 - Trichinosis
 - Rat-bite fever
 - Salmonella food poisoning
 - Plague
- Mice, unlike rats, may also be responsible for the spread of:
 - Leptospirosis.
 - Meningitis.
 - Trichinosis.
 - Rickettsial pox.
 - B & D
- Match the following to the appropriate description:
 - Dermatitis
 - Meningitis
 - Rickettsial pox
 - Ringworm

_____ 11. A rash caused by the bites of house mouse mites.

_____ 12. A skin irritation caused by the bites of house mouse mites.

_____ 13. A virus infection of house mice; transmitted to people through contaminated food or dust.

_____ 14. A fungus that humans contract directly or indirectly (through cats) from mice.
- A mature female rat gives birth to about:
 - 10 young/year.
 - 20 young/year.
 - 30 young/year.
 - 40 young/year.
- A rat can compress its body and squeeze through an opening as small as:
 - 1/4 inch high.
 - 1/2 inch high.
 - 1 inch high.
 - 2 inches high.
- A reason for "bait shyness" in rats is:
 - Young learn to be wary of baits from their mothers.
 - Rats can taste chemicals at a parts-per-million concentration.
 - Rats are wary of anything new in their territory.
 - Other food sources are available.
 - All of the above

18. Rats commonly travel a distance of ____ from their nest looking for food and water and patrolling their territory.
- 10 to 25 feet
 - 100 to 150 feet
 - 1 to 2 miles
 - None of the above
19. Which is NOT true of rat nests?
- Burrows have openings 2 to 4 inches in diameter.
 - Burrows have “bolt holes” for emergency escapes.
 - Indoors, Norway rats may nest inside walls, between floors and ceilings, under pallets and in crawl spaces.
 - Indoors, Norway rats prefer to nest in attics.
 - Norway rats will nest in sewers and storm drains.
20. When “hotel” nest sites are included in calculations, a rat’s foraging range may be up to 20 acres.
- True
 - False
21. Why is the hoarding behavior of rats a pest management concern?
22. Which of the following is NOT true about adult rat droppings?
- They average 5/16 inch long.
 - Fresh droppings are black or nearly black.
 - The highest number of droppings will be found where rats rest or feed.
 - A single rat can produce 50 droppings in a day.
23. In the long term, the most successful form of rat control is rat-proofing (“building them out”).
- True
 - False
24. Match the inspection tool with the rat sign it is used to detect.
- | | |
|------------|-----------------------------|
| A. Urine | _____ Ultraviolet light |
| B. Burrows | _____ Light dusting of talc |
| C. Tracks | _____ Wadded-up newspaper |
| D. Sounds | _____ Stethoscope |
25. With a medium-level rat infestation, you would NOT expect to see:
- Rats during the daytime.
 - One or two rats at night.
 - Gnawings.
 - Droppings.
26. List some non-lethal methods used to control rats and give an example of each.
27. Rodenticides should be placed:
- In locations not accessible to children, pets, wildlife, and domestic animals.
 - In tamper-resistant bait boxes.
 - Only outdoors.
 - All of the above
 - A or B
28. Some rat food baits may kill rats after a single feeding; others will kill after multiple feedings.
- True
 - False
29. Clients should be made aware that rodent baits are only slightly toxic to humans.
- True
 - False
30. When using a trigger trap to catch a Norway rat, you should:
- Spray insecticide near the trap to keep insects away from bait.
 - Set traps a distance away from droppings and gnawings.
 - Bait with peanut butter.
 - Place the trigger side away from the wall.
 - C & D
31. Which type of baits are best placed inside rat burrows?
- Bait packs
 - Bait boxes
 - Water baits
 - Tracking powders
 - A & D

32. Once rats have fed from a bait box, remove it immediately.
- True
 - False
33. When water is limiting, water baits can be used in open areas.
- True
 - False
34. Tracking powder kills rats because:
- Rats swallow tracking powder when they groom their fur.
 - Tracking powder is a powdery rodenticide bait.
 - Tracking powder is absorbed dermally through the rats' skin.
 - B and C
 - None of the above
35. The advantage of using tracking powders is that they can be used anywhere.
- True
 - False
36. The key to rat control is to control rat **populations**, not individual rats.
- True
 - False
37. List some features of bait boxes that help make them "tamper-resistant."
38. In 6 months, one pair of house mice can eat about 4 pounds of food and deposit about _____ droppings.
- 400
 - 1,800
 - 4,000
 - 18,000
39. When mice infest food, the greatest loss is not what mice eat but what is thrown out because of contamination.
- True
 - False
40. Government regulations currently exclude any contamination of food commodities by rodent hairs.
- True
 - False
41. Which is NOT true of mice's physical abilities?
- Can jump 12 inches from the floor onto an elevated flat surface.
 - Are better swimmers than rats, diving below the surface.
 - Can travel upside-down hanging off a 1/4-inch hardware mesh.
 - Can jump from a height of 8 feet to the floor.
 - Can run up almost any vertical surface.
42. Voles (meadow mice) have shorter tails and smaller ears than house mice.
- True
 - False
43. Mice, unlike rats, are shy of changes in their territory.
- True
 - False
44. Which of the following is NOT true about mice?
- Outdoors, mice tend to breed all year long.
 - Mice are mostly active at night.
 - Females can produce up to 50 young per year.
 - Mice seldom travel 30 feet from their nest.
 - Mice are nibblers.
45. Mouse control is difficult because:
- They can squeeze through openings slightly larger than 1/4 inch.
 - There can be many nests in an infested building.
 - They have a very high reproductive potential.
 - All of the above.
46. Which is NOT true of the food and water habits of mice?
- Feed at dusk and just before dawn.
 - May feed 20 or more times during an evening.
 - Prefer cereals over meats.
 - Must drink water every day.

47. The signs of mice infestations can be differentiated from rat infestations by the:
- Size of gnawings.
 - Odor.
 - Urination pillars.
 - A & C
 - All of the above
48. The **best** way to estimate the number of mice infesting is by:
- The amount of food consumed.
 - Non-toxic tracking patches.
 - The number of mice observed.
 - A & B
 - All of the above
49. Mouse-proofing is all that is needed to control an existing mouse population.
- True
 - False
50. Glue boards trap mice better than rats.
- True
 - False
51. Which is NOT true about multiple-catch traps?
- Can catch up to 15 mice without requiring resetting.
 - Mice often enter entrance holes without hesitation.
 - Mice are killed instantly.
 - Mousy-smelling traps often catch more mice.
 - B & D
52. Tying a cotton ball to a trigger trap will attract mice.
- True
 - False
53. The key difference between baiting mice and baiting rats is:
- You need to apply many small bait placements.
 - You must use water baits.
 - You need to wait weeks for mice to stop avoiding the "new" bait.
 - Baits are not effective against mice.
54. Tracking powders should be applied in a layer less than 1/16 inch deep for control of mice.
- True
 - False
55. Tracking powders are more effective against rats than mice.
- True
 - False
56. Mousetraps should be placed:
- About 6 inches away from a wall.
 - Every 30 feet.
 - Along walls, behind objects, and in dark corners.
 - In the center.
57. Which would be an effective placement of glue boards for trapping mice?
- Every 5 to 10 feet in infested areas
 - Lengthwise flush against the wall; along narrow runways
 - Every 5 feet in food preparation areas
 - In areas free of mouse droppings
 - A & B
58. Why should you use food baits in three dimensions when controlling mice?
59. List some sanitation methods for controlling mouse populations.
60. List some ways to mouse-proof a building.

CHAPTER 4

WILD RODENTS

LEARNING OBJECTIVES

After completely studying this chapter, you should:

- Be able to identify common wild rodent pests.
- Know the habitats, habits, and life cycles of wild rodent pests.
- Be able to describe situations in which wild rodents are considered pests.
- Know the public health concerns and precautions to take when attempting to control wild rodents.
- Know the lethal and non-lethal methods of wild rodent control and management.

Though rats and house mice are the rodents most commonly associated with urban environments, other “wild” rodents may also become pests when their activity damages valuable landscape plants, gardens, or lawns, or when they invade buildings. **Tree squirrels** commonly store food and find shelter in attics and garages. The burrowing activity of **ground squirrels, chipmunks, woodchucks,** and sometimes **muskrats** can cause significant damage in lawns, golf courses, homes, and gardens. **Voles** are known to cause significant damage to agricultural crops and often cause girdling damage to valuable landscape plants.

A variety of lethal and non-lethal techniques—including exclusion, habitat modification, and trapping—are available that may effectively control these pests.

WILD RODENTS AS DISEASE CARRIERS

Wild rodents, like domestic rodents, are associated with the spread of disease. Category 7D pest control operators are at a particular risk because their work often brings them in contact with rodents, their droppings, urine, and nests, all of which are potential disease sources. One particular respiratory disease, hantavirus pulmonary syndrome (HPS), is an infrequent but often fatal disease that can be easily prevented. The wild rodents known to carry the disease are usually found in rural areas. However, when conditions are right, such as easily available food, water, and shelter, these rodents can be found in cities and in homes. The proper prevention techniques need to be applied to limit their contact with people.

HANTAVIRUS PULMONARY SYNDROME (HPS)

An outbreak of HPS occurred in the southwestern United States in 1993. Since that time, cases of HPS have been reported in over half of the lower 48 states. Two wild rodents found in Michigan have been identified as carriers of the type of hantavirus that cause HPS in the United States. They are the deer mouse (*Peromyscus maniculatus*) and the white-footed mouse (*Peromyscus leucopus*). Other known carriers, the cotton rat (*Sigmodon hispidus*) and the rice rat (*Oryzomys palustris*) are more common in the southern United States. ***It is not known whether other rodent species are hosts to other types of hantaviruses. Therefore, avoiding close contact with rodents in general is advised. Pest control operators should treat all rodents as if they may be infected.***

The Deer Mouse

The deer mouse, in particular, has been identified as a carrier of the HPS-causing hantavirus. The deer mouse body is about 2 to 3 inches long with a tail that adds another 2 to 3 inches. It is often described as a “cute” mouse with big ears and big eyes. They range in color from gray to reddish brown, depending on age. The underbelly is always white and the tail has sharply defined white sides. Deer mice are found almost everywhere in North America. They are frequently found in Michigan woodlands.



Figure 4.1. Deer mouse, *Peromyscus maniculatus*
(L.L. Master, Mammal Images Library of the American Society of Mammalogists)

The White-footed Mouse

The white-footed mouse has also been identified as a carrier of the HPS-causing hantavirus. It is often hard to distinguish from the deer mouse. The body is about 4 inches long and the tail is normally shorter than the body (about 2 to 4 inches long). These mice range from pale brown to reddish brown with a white underbelly and white feet. White-footed mice prefer wooded and brushy areas, although sometimes they are found in more open ground.

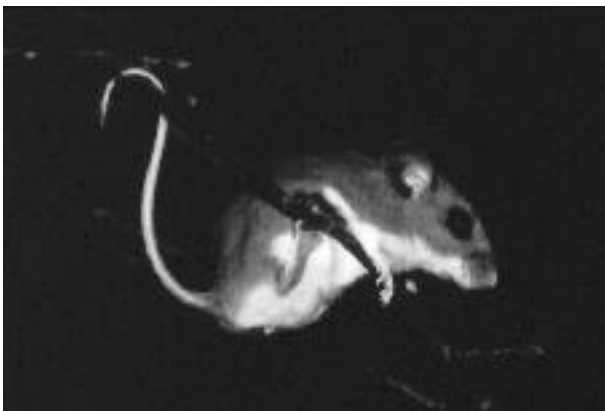


Figure 4.2. White-footed mouse, *Peromyscus leucopus*
(L.L. Master, Mammal Images Library of the American Society of Mammalogists)

How is Hantavirus Transmitted?

Transmission of the HPS-causing hantavirus can happen anywhere that infected rodents have infested. These rodents shed the virus in their urine, droppings, and saliva. The virus is mainly transmitted to people when they breathe in air contaminated with the virus. This happens when fresh rodent urine, droppings, or nesting materials are stirred up and tiny droplets containing the virus get into the air in a process known as aerosolization. Other possible but less common means of transmission are being bitten by a hantavirus-carrying rodent; touching contaminated rodent urine, droppings, or saliva and then touching your nose or mouth; or eating food contaminated with virus-infected rodent urine, droppings, or saliva.

Symptoms

Early symptoms of hantavirus include fatigue, fever, and muscle aches. These symptoms have occurred in all cases. **At the first onset of symptoms, consult a doctor immediately.** Be sure to tell the doctor you have been working around rodents. The earlier the treatment in an intensive care unit, the greater the chance of recovery. Other possible early symptoms, appearing in about half of HPS patients, include headaches, dizziness, chills, and/or abdominal problems such as nausea, vomiting, diarrhea, and abdominal pain. These early symptoms may occur within one to five weeks after exposure.

Late symptoms of HPS occur 4 to 10 days later. Symptoms include coughing, shortness of breath, a tight feeling around the chest, and a suffocating feeling as lungs fill with fluid.

Prevention

Any activity that puts a person in contact with rodent droppings, urine, or nest materials puts him/her at risk for HPS. These activities include opening up cabins or sheds, or cleaning outbuildings that have been closed during the winter, such as barns, garages, or storage facilities for farm and construction equipment. These activities encourage disease transmission by bringing people into direct contact with rodents or their droppings or by “stirring up the dust” so they then inhale the virus. Hikers and campers are also at risk for exposure when they use infested trail shelters or camp in other rodent habitats.

Overall, the chance of being exposed to hantavirus is greatest for people who work, play, or live in closed spaces where rodents are actively living. Pest control operators who work in crawlspaces under houses or other enclosed areas inhabited by rodents are at a particular risk. Research shows that many people who have become ill with HPS got the disease after having been in frequent contact with rodents and/or their droppings for some time. Also, many people who became ill reported that they had not seen rodents or their droppings at all. Therefore people living or working in areas where the carrier rodents such as the deer mouse are known to live should take sensible precautions before doing any of the activities described above—even when they don’t see the

rodents or their droppings. Some tips for preventing HPS:

- Put on latex rubber gloves before working or cleaning up in suspected rodent areas.
- Don't stir up dust by sweeping up or vacuuming droppings, urine, or nest materials. Instead, thoroughly wet contaminated areas with detergent or liquid to deactivate the virus. Most general-purpose disinfectants and household detergents are effective. However, a hypochlorite solution prepared by mixing 1 1/2 cups of household bleach in 1 gallon of water may be used in place of a commercial disinfectant. When using the chlorine solution, avoid spilling the mixture on clothing or other items that may be damaged.
- Once everything is wet, take up contaminated materials with a damp towel, then mop or sponge the area with disinfectant.
- Spray dead rodents with disinfectant, then double-bag along with all cleaning materials and bury or burn—or throw out in an appropriate waste disposal system. If burning or burying isn't feasible, contact your local or state health department about other disposal methods.
- Finally, disinfect gloves before taking them off with a disinfectant or soap and water. After taking off the clean gloves, thoroughly wash hands with soap and warm water.
- When going into cabins or outbuildings (or work areas) that have been closed for awhile, open them up and air out before cleaning.

Carefully wetting down dead rodents and areas where rodents have been will reduce the chance the virus will get into the air. Use of disinfectants such as ordinary household bleach and other fat solvents will actually kill the virus by destroying its outer lipid (fatty) envelope.

Some further precautions recommended by the Centers for Disease Control (CDC) for pest control workers and other persons frequently exposed to rodents are:

- A baseline serum sample, preferably drawn at the time of employment, should be available for all persons whose occupations involve frequent rodent contact. The serum sample should be stored at -20 degrees C.
- Workers in potentially high-risk settings should be informed about the symptoms of the disease and be given detailed guidance on prevention measures.
- Workers who develop a febrile or respiratory illness within 45 days of the last potential exposure should immediately seek medical attention and inform the attending physician of the potential occupational risk of hantavirus infection. The physician should contact local health authorities promptly if hantavirus-associated illness is suspected. A blood sample should be obtained and forwarded with the baseline serum through the state health department to the CDC for hantavirus antibody testing.
- Workers should wear a half-face air-purifying (or negative pressure) respirator or PAPR equipped

with the N-100 filters when removing rodents from traps or handling rodents in the affected area. (Please note: the HEPA classification recently has been discontinued. Under the new classification system, the N-100 filter type is recommended. Use of the N-100 filter should provide the same protection as the previous HEPA filter.) Refer to the federal Occupational Safety and Health Administration (OSHA) directive "OSHA Directives: CPL 2-0.120-Inspection Procedures for Respiratory Protection Standard."

- Respirators (including positive-pressure types) are not considered protective if facial hair interferes with the face seal because proper fit cannot be assured. Respirator use practices should be in accord with a comprehensive user program and should be supervised by a knowledgeable person.
- Workers should wear rubber or plastic gloves when handling rodents or handling traps containing rodents. Gloves should be washed and disinfected before removing them, as described above.
- Traps contaminated by rodent urine or feces or in which a rodent was captured should be disinfected with a commercial disinfectant or bleach solution. Dispose of dead rodents as described above.

For updates on the spread of hantavirus and recommendations for prevention and risk reduction, contact the CDC (www.cdc.gov).

VOLES

Voles (*Microtus* spp.) are also called meadow mice or field mice. They are compact rodents with stocky bodies, short legs, and short tails. Their eyes are small and their ears partially hidden. They are usually brown or gray.

Voles eat a wide variety of plants, most frequently grasses. In late summer and fall, they store seeds, tubers, and bulbs. They eat bark at times, primarily in fall and winter, and will eat crops, especially when their populations are high.

Voles are active day and night year round. They do not hibernate. Home range is usually 1/4 acre or less. They construct many tunnels and surface runways with numerous burrow entrances. A single burrow system may contain several adults and young.

Voles may breed throughout the year but most commonly in spring and summer. In the field they have one to five litters per year with average litter sizes of three to six. Life spans are short, ranging from 2 to 16 months. Large population fluctuations are characteristic of voles. Population levels generally peak every two to five years; however, these cycles are not predictable.

Voles may cause extensive damage to orchards, ornamentals, and tree plantings by girdling seedlings and mature trees. Girdling damage usually occurs in fall and winter. Field crops may be damaged or destroyed by voles. Voles eat crops and also damage them when they build extensive runways and tunnel systems.

Girdling and gnaw marks do not necessarily indicate the presence of voles because other animals, such as rab-

bits, may cause similar damage. Vole girdling can be differentiated from girdling by other animals by the non-uniform gnaw marks. They occur at various angles and in irregular patches. Rabbit gnaw marks are larger and they usually neatly clip the branches off, leaving slanting cuts. Examine girdling damage and accompanying signs (feces, tracks, and burrow systems) to identify the animal causing the damage. Voles are classified as non-game mammals and can be controlled without a permit when causing damage. However, check with local and state wildlife agencies for details regarding acceptable control methods.



Figure 4.3. Meadow vole, *Microtus pennsylvanicus*
(L.L. Master, Mammal Images Library of the American Society of Mammalogists)

Control and Management of Voles

Exclusion

Large-scale fencing of areas is not a cost-effective method of controlling voles. Use hardware cloth cylinders to exclude voles from seedlings and young trees.

- Use hardware cloth mesh that is $\frac{1}{4}$ inch or less in size. Bury the wire 6 inches to keep voles from burrowing under the cylinder.
- Drift fences with pit traps may be used to monitor populations and can indicate when voles are migrating to crops, orchards, etc.

Habitat Modification

Cultural and habitat modification practices can reduce the likelihood and severity of vole damage.

- Eliminate weeds, ground cover, and litter in and around crops, lawns, and cultivated areas.
- Lawn and turf should be mowed regularly.
- Mulch should be cleared 3 feet or more from the bases of trees.
- Soil tillage is effective in reducing vole damage because it removes cover, destroys existing runway-burrow systems, and kills some voles outright. Because of tillage, annual crops tend to have lower vole population levels than perennial crops.

Repellents

Repellents using thiram (also a fungicide) or capsaicin (the “hot” in hot peppers) as an active ingredient are registered for meadow voles. These products may afford short-term protection, but their effectiveness is uncertain. Check with the Michigan Department of Agriculture for availability.

Rodenticide

Zinc phosphide is the most commonly used toxicant for vole control. It is a single-dose toxicant available in pelleted and grain bait formulations and as a concentrate. Zinc phosphide baits generally are broadcast at rates of 6 to 10 pounds per acre, or are placed by hand in runways and burrow openings. Zinc phosphide baits are potentially hazardous to ground-feeding birds, especially waterfowl. Placing bait into burrow openings may reduce this hazard.

Anticoagulant baits are also effective in controlling voles. Anticoagulants are slow-acting toxicants requiring from 5 to 15 days to take effect. Multiple feedings are needed for most anticoagulants to be effective. Check with the Michigan Department of Agriculture to see which anticoagulant baits are registered.

In addition to broadcast and hand placement, anticoagulant baits also can be placed in various types of bait containers. Water-repellent paper tubes with an anticoagulant bait glued to the inside surface make effective disposable bait containers. Bait containers protect bait from moisture and reduce the likelihood of non-target animals and small children consuming bait.

Trapping

Trapping is not effective for controlling large vole populations. Mouse snap traps can be used to control a small population by placing the traps perpendicular to the runway with the trigger end in the runway. A peanut butter-oatmeal mixture or apple slices make good bait. Many vole species are easiest to trap in fall and late winter.

Voles rarely invade houses. In the event they do, they can be controlled by setting snap traps or live traps as you would for house mice.

TREE SQUIRRELS

Tree squirrels are found in forest areas throughout most of the United States. Many species have adapted well to suburban and city life. Occasionally, these squirrels enter buildings and cause damage or disturbance. The most common species that become pests are the gray squirrel, red squirrel, flying squirrel, and fox squirrel.

Tree squirrels usually build their nests in trees. They also may store food and find shelter in attics and garages. Probably the primary way squirrels become pests is by scrambling and scratching inside attics and in wall voids. They may travel on power lines and short out transformers. They like to gnaw on wires.

The legal status of squirrels varies greatly with geographic area and species. Many are classified as game animals. Some are protected. Be sure to check with local game conservation officers if you plan any kind of lethal control or trapping program.



Figure 4.4. Gray squirrel, *Sciurus* spp.



Figure 4.5. Fox squirrel, *Sciurus niger*

Control and Management of Tree Squirrels

Exclusion

Squirrel-proofing. Step one in eliminating a squirrel problem in a building is to find out where the squirrels are entering. Remember that squirrels will be coming and going each day. Common points of entry include damaged attic louvers, ventilators, soffits, joints of siding, knotholes, openings where utility wires or pipes enter, chimneys, and flashing. Squirrels may gnaw directly through siding and shingles, too.

- Use heavy gauge 1/2-inch hardware cloth or sheet metal to seal most openings.
- Make other suitable repairs as for rat-proofing.
- Squirrels can be stopped from travelling on wires by installing 2-foot sections of 2- to 3-inch diameter plastic pipe. Split the pipe lengthwise, spread the opening apart, and place it over the wire. The pipe

will rotate on the wire and the squirrel will tumble off. **Do not attempt to install on high-voltage wires. Contact your local electricity/utility company for assistance.**

Squirrels often use overhanging branches as highways to rooftops. Tree branches should be trimmed back 10 feet from the building. If the branches can't be trimmed, a 2-foot-wide band of metal fastened around a tree 6 to 8 feet off the ground keeps squirrels from climbing up the tree and jumping to the building.

Repellents

Naphthalene has been used (in the same way as for bats) to keep squirrels out of attics, particularly in summer homes and camps that are unoccupied in winter. There is at least one sticky repellent product for squirrels. It is similar to the sticky repellents used in bird control. Apply it to ledges, gutters, windowsills, and the like to keep squirrels off.

Trapping

Live trapping with box or wire traps can be used to remove one or a few squirrels from a building. Traps should be left open and unset for a few days, surrounded by bait, so that the squirrels get used to them. Good baits include peanuts, nutmeats, peanut butter, whole corn, sunflower seeds, and rolled oats. Good trap locations include on the roof, at the bases of nearby trees, or in the attic itself.

Squirrels are nasty biters—handle them carefully. Experts differ on whether squirrels should be released or killed. If they are released, do so at least 5 miles away so that they do not return.

Where lethal control is permitted, rat snap traps are effective against the smaller squirrel species and can be used in attics. The bait should be tied to the trigger and the trap nailed or wired to a beam.

GROUND SQUIRRELS AND CHIPMUNKS

A number of species of squirrels and chipmunks occasionally become pests in and around buildings. The major concern is that they burrow around foundations, in lawns, on golf courses, and in gardens. Ground squirrels, in particular, can have extensive burrows with large mounds, especially along roads and ditch banks. On occasion, burrows beneath buildings have caused structural damage.

One species of ground squirrel common to Michigan is the 13-lined ground squirrel (*Spermophilus tridecemlineatus*). It is a slender, rat-sized rodent about 10 inches long (including a tail of 3 inches). As its name implies, 13 stripes run the length of this ground squirrel's body. Five of the light-colored lines break up into a series of spots as they progress down the back and over the rump. Ground squirrels can transmit diseases (such as tularemia and plague) to people, particularly when populations are dense.



Figure 4.6. Thirteen-lined ground squirrel, *Spermophilus tridecemlineatus* (G.L. Twiest [top] and M.D. Carleton [below], Mammal Images Library of the American Society of Mammalogists)

The chipmunk is a small, brownish, ground-dwelling squirrel. The eastern chipmunk (*Tamias striatus*) is typically 5 to 6 inches long and has two tan and five blackish longitudinal stripes on its back, and two tan and two brownish stripes on each side of its face. The tail is 3 to 4 inches long and hairy but not bushy.

Both ground squirrels and chipmunks are active during the day and are easily seen when foraging. But they spend much of their time in their burrows. In winter, ground squirrels hibernate and chipmunks go underground and stay inactive. In some areas, ground squirrels will go into summer hibernation when temperatures are high.

Ground squirrels are primarily vegetarians, feeding on grasses. When vegetation dries up, they switch to seeds, grains, and nuts. Chipmunks eat both plant and animal material, from seeds, nuts, insects, and worms to songbirds and frogs.

Control and Management of Ground Squirrels and Chipmunks

Ground Squirrels

Control is usually required only in severe infestations. Several important steps must be taken if a control or management program is to succeed:

- Correctly identify the species causing the problem.
- Alter the habitat, if possible, to make the area less attractive to the squirrels.
- Use the most appropriate control method.
- Establish an inspection or monitoring program to detect reinfestation.

Ground squirrels are generally found in open areas. However, they usually need some kind of cover to survive. Removing brush piles and debris will make the area less attractive to the squirrels and will facilitate detection of burrows and improve access during the control program. Ground squirrels can be controlled with traps, rodenticides, and fumigants. Exclusion is expensive and generally practical only in situations where cost is not a primary concern. Certain cultural methods, such as deep soil cultivation, which destroys burrows and changes the habitat, will discourage activity in fields and gardens.



Figure 4.7. Ground squirrel, *Spermophilus* spp.

Habitat Modification

Certain cultural methods will discourage ground squirrel activity in fields and gardens:

- Deep soil cultivation destroys burrows.
- Deter ground squirrels and other small mammals from feeding on crop seeds and seedlings by providing them with an alternative food source such as cracked corn.
- Plant crops as early as possible, before the squirrels emerge from hibernation, to reduce losses to seeds and seedlings.

Trapping

Trapping is a practical means of controlling ground squirrels in limited areas where numbers are small. Live traps are effective but present the problem of disposal of a live squirrel. Because squirrels can carry disease, check state and local laws regarding their release at some new location.

For the smaller species, rat snap traps can be effective.

- Place traps near burrow entrances or runs and bait with nuts, oats, barley, or melon rind.

- Place traps under a box if any non-targets might be killed in the trap.

Rodenticides

Rodenticides are the most cost-effective way of controlling large populations of ground squirrels. A number of products are registered for this use. Grain baits are most effective when squirrels are feeding on grains and seeds.

- Place rodenticides in burrows or in protected bait stations according to the label directions.

Fumigation

Ground squirrels can also be killed by gassing their burrows. Aluminum phosphide tablets or smoke cartridges are most commonly used. Fumigation is most effective when soil moisture is high; moisture helps seal the tiny cracks in the burrow walls. Fumigation is not effective during periods of hibernation because the squirrels plug their burrows. Spring is normally considered to be the best time for burrow fumigation. Treat and plug all burrows, wait 24 to 48 hours, and re-treat any burrows that have reopened. Repeat this process until all burrows stay closed.

Fumigation is not a good choice adjacent to buildings because of the risk that the fumigant gas could find its way into the structure. Also do not use fumigants in places where people, livestock, or other non-target animals will come in contact with the gases. Aluminum phosphide is a restricted-use pesticide and can be applied only by a certified applicator. Be sure to read and follow all label instructions.



Figure 4.8. Chipmunk, *Tamias* spp.

Chipmunks

Only rarely do chipmunks become a serious pest problem. When chipmunks are present in large numbers, they can cause structural damage by burrowing under patios, stairs, retention walls, or foundations. They may also consume flower bulbs, seeds, or seedlings as well as bird seed, grass seed, and pet food that is not stored in rodent-proof storage containers. In most cases, lethal control is unnecessary. Altering the habitat may cause the chipmunks to move.

Exclusion

- Chipmunk-proof the building to prevent entrance. Use 1/4-inch mesh, caulking, or other appropriate materials to close openings where they could gain entry.
- Remove objects such as logs, stones, and debris close to a structure that may provide an attractive denning environment.
- Hardware cloth may also be used to exclude chipmunks from flower beds. Seeds and bulbs can be covered by 1/4-inch hardware cloth and the cloth covered with soil. The cloth should extend at least 1 foot past each edge of the planting.

Trapping

Live trapping and relocating chipmunks (where permitted) is considered a humane method of control. Effective baits include peanut butter, nuts, sunflowers, seeds, oats, bacon, and apple slices. Relocation should be done into forested areas at least 5 miles from the trap site.

Rat snap traps can also be used effectively. Traps should be placed at den entrances and baited with an apple slice or perhaps with some peanut butter. Seeds and nuts should not be used because they will attract ground-feeding birds.

Because chipmunk burrows are long, difficult to find, and often near buildings, burrow fumigation is not usually a recommended control tactic.

WOODCHUCKS

The woodchuck (*Marmota monax*) is a member of the squirrel family. It is also known as the groundhog. It is usually brownish gray with a compact, chunky body supported by short, strong legs. Its forefeet have long, curved claws that are well adapted for digging burrows. Its tail is short, well furred, and dark brown. The total length of the head and body is 16 to 20 inches and the tail is 4 to 7 inches long. Males are usually slightly larger than females. Like other rodents, woodchucks have white, chisel-like incisor teeth. Though they are slow runners, woodchucks are alert and scurry quickly to their dens when they sense danger.

In general, woodchucks prefer open farmland and the surrounding wooded or brushy areas adjacent to open land. Burrows commonly are located in fields and pastures; along fencerows, stone walls, and roadsides; and near building foundations or the bases of trees. Woodchuck burrows are distinguished by a large mound of soil at the main entrance. The main opening is approximately 10 to 12 inches in diameter. Each burrow system has two or more entrances. Some secondary entrances are dug from below the ground and do not have mounds of earth beside them. They are usually well hidden and sometimes difficult to locate. The burrow system serves as home to the woodchuck for mating, weaning young, hibernating in winter, and protection when threatened.

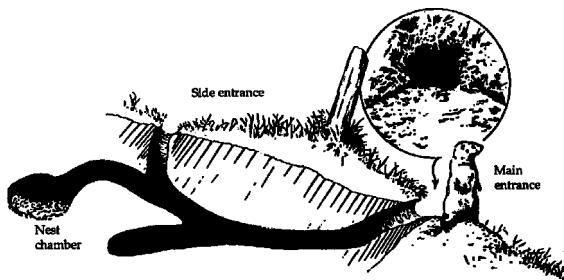


Figure 4.9. Burrow system of the woodchuck

Woodchucks prefer to feed in the early morning and evening hours. They eat vegetables, grasses, and legumes. Preferred foods include soybeans, beans, peas, carrot tops, alfalfa, clover, and grasses.

On occasion the woodchuck's feeding and burrowing habits conflict with human interests. Damage often occurs on farms, in home gardens, orchards, and nurseries, and around buildings. Damage to crops and structures can be costly and expensive. Gnawing on underground power cables has caused electrical outages. Fruit trees and ornamental shrubs are damaged by woodchucks as they gnaw or claw woody vegetation. Their burrowing, feeding, and gnawing habits may cause aesthetic damage to lawns, gardens, golf courses, etc. The most common methods of controlling woodchucks include exclusion, fumigants, and trapping.



Figure 4.10. Woodchuck, *Marmota monax*
(G.L. Twiest, Mammal Images Library of the American Society of Mammalogists)

Control and Management of Woodchucks

Exclusion

Fences can help reduce woodchuck damage. Woodchucks, however, are good climbers and can easily scale wire fences if precautions are not taken.

- Fences should be at least 3 feet high and made of heavy woven wire.

- To prevent burrowing under the fence, bury the lower edge 10 to 12 inches in the ground or bend the lower edge at an L-shaped angle leading outwards and bury it in the ground 1 to 2 inches.
- An electric wire may be placed 4 to 5 inches off the ground and the same distance outside the fence to prevent climbing and burrowing.
- Bend the top 15 inches of a wire fence outward at 45 degree angle to prevent climbing over the fence.

Fencing is the most useful in protecting home gardens and has the added advantage of keeping rabbits, dogs, cats, and other animals out of the garden area. In some instances an electric wire alone, placed 4 to 5 inches above the ground, has deterred woodchucks from entering gardens. Vegetation in the vicinity of any electric fence should be removed regularly to prevent the system from shorting out.

Fumigants

A common means of woodchuck control is the use of commercial gas cartridges. They are placed in burrow systems and all entrances are sealed. Directions for gas cartridge use are on the label—they should be carefully read and closely followed. Gas cartridges are ignited by lighting a fuse, so do not use gas cartridges in burrows located under wooden sheds, buildings, or near other combustible materials because of the potential fire hazard. Avoid prolonged breathing of fumes. Gas cartridges are general-use pesticides and are available from local farm supply stores.

Aluminum phosphide is a restricted-use pesticide that can be applied only by a certified applicator. Place two to four tablets deep into the main burrow. Plug the burrow openings with crumpled newspapers and then pack the opening with loose soil. All burrows must be sealed tightly, but avoid covering the tablets with soil. The treatment site should be inspected 24 to 48 hours later and opened burrows should be retreated.

Aluminum phosphide in the presence of moisture in the burrow produces hydrogen phosphide (phosphine) gas. Therefore, soil moisture and a tightly sealed burrow system are important. The tablets are approved for outdoor use on non-cropland and orchards for burrowing rodents. Storage of unused tablets is critical—they must be kept in their original container in a cool, dry, locked, and ventilated room. They must be protected from moisture, open flames, and heat.

Trapping

Trapping with live traps may be used to reduce woodchuck damage, especially in or near buildings. Bait traps with apple slices or vegetables such as carrots and lettuce, and change baits daily. Locate traps at main entrances or on major travel lanes. Placing guide logs on each side of the path between the burrow opening and the trap will help funnel the animal into the trap. Check all traps twice daily, morning and evening, so that captured animals may be quickly removed. A captured animal may be relocated to an area with suitable habitat

where no additional damage can be caused. Disposing of the animal through lethal means—i.e., shooting, lethal injection by a veterinarian, etc.—might also be considered.

Shooting

If shooting can be accomplished safely and legally, it is an effective means of keeping woodchuck populations low. Generally a .22-caliber centerfire rifle is used. Shooting is not recommended in populated areas. Check local regulations before discharging any firearm.

MUSKRATS

The muskrat (*Ondatra zibethicus*) is a large rodent that spends its life in aquatic habitats and is well adapted for swimming. The fur varies from dark tan to reddish brown, dark brown, and black. The belly fur is generally light gray to silver to tan. Its large hind feet are partially webbed, and its laterally flattened tail is almost as long as its body. The muskrat is stocky-looking with small eyes and very short, rounded ears. Its front feet, which are much smaller than its hind feet, are adapted primarily for digging and feeding. The overall length of adult muskrats is usually from 18 to 24 inches. Large males, however, will sometimes be more than 30 inches long, 10 to 12 inches of which is tail.



Figure 4.11. Muskrat, *Ondatra zibethicus*
(R.B. Forbes, Mammal Images Library of the American Society of Mammalogists)

Tail mark sometimes shows

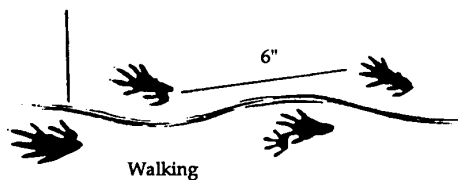


Figure 4.12. Muskrat tracks

Muskrats can live almost anywhere where water and food are available year round—streams, ponds, lakes, marshes, canals, roadside ditches, swamps, beaver ponds, and other wetland areas. In shallow water areas with plentiful vegetation, they use plant materials to construct houses, generally conical or mound-shaped (Figures 13 and 14). Elsewhere, they prefer bank dens, and in many habitats, they construct both bank dens and houses of vegetation. Both the houses of vegetation and the bank burrows or dens have several underwater entrances via “runs” or trails. Muskrats often have feeding houses, platforms, and chambers that are somewhat smaller than houses used for dens. Muskrats prefer to feed on aquatic plants but will sometimes leave the pond to feed on field crops. They are also known to eat frogs, mussels, turtles, crayfish, and fish in ponds where vegetation is scarce.

Burrowing activity is the source of the greatest damage caused by muskrats. They damage pond dams, floating Styrofoam marinas, docks and boathouses, and lake shorelines. In waterfowl marshes, large populations of feeding muskrats may eliminate much of the vegetation. One way to observe early burrowing in farm ponds or reservoirs is to walk along the edge of the dam or shorelines when the water is clear and look for “runs” or trails from just below the normal water surface to as deep as 3 feet. If no burrow entrances are observed, look for droppings along the bank or on logs or structures that a muskrat can easily climb on. Sometimes muskrat dens are exposed when water levels drop—burrows can be filled in at these times.

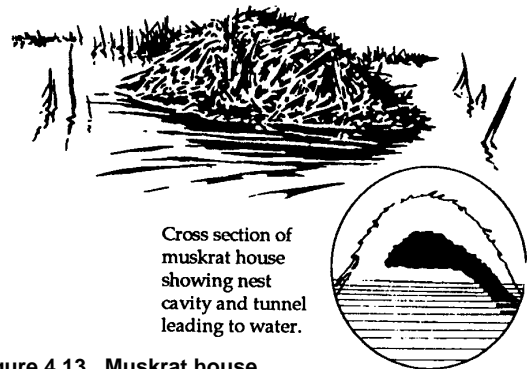


Figure 4.13. Muskrat house

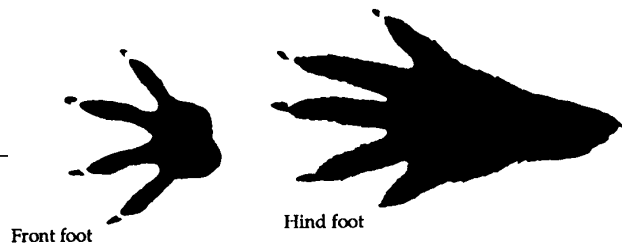




Figure 4.14. Muskrat emerging from house
(R.B. Forbes, Mammal Images Library of the American Society of Mammalogists)

Control and Management of Muskrats

Exclusion

Muskrats in some situations can be prevented from digging into farm pond dams by stone riprapping of the dam. Serious damage can be prevented by constructing dams to the following specifications:

- The inside face of the dam should be built at a 3 to 1 slope with a top width of not less than 8 feet, preferably 10 to 12 feet.
- The normal water level in the pond should be at least 3 feet below the top of the dam and the spillway should be wide enough that heavy rainfalls will not increase the level of the water for any length of time (see Figure 4.15).

These specifications are often referred to as overbuilding, but they will generally prevent serious damage from burrowing muskrats.

Fencing can be used in situations where muskrats may be leaving a pond or lake to cut valuable garden plants or crops.

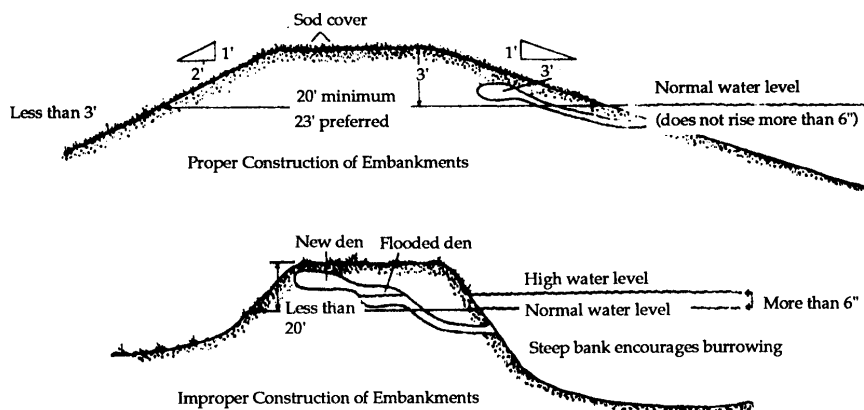


Figure 4.15. Proper dam construction can reduce muskrat damage to the structure.

Habitat Modification

The best ways to modify habitat are to eliminate aquatic or other suitable foods eaten by muskrats, and where possible, to construct farm pond dams. If farm pond dams or levees are being damaged, one of the ways that damage can be reduced is to draw the pond down at least 2 feet below normal levels during the winter, then fill dens, burrows, and runs, and riprapp the dam with stone. Once the water is drawn down, trap or otherwise remove all muskrats.

Rodenticides

Zinc phosphide as a 63 percent concentrate is federally registered for muskrat control. It is a restricted-use pesticide for making baits. Zinc phosphide baits for muskrats generally are made by applying a vegetable oil sticker to cubes of apples, sweet potatoes, or carrots; sprinkling on the toxicant, and mixing thoroughly. The bait is then placed on floating platforms, in burrow entrances, or on feeding houses. Use caution when mixing and applying baits treated with zinc phosphide. Follow label instructions carefully.

Some anticoagulant baits, similar to those registered for domestic rodent control, may be available for controlling muskrats. These baits are often made of paraffin mixed with grain and pesticide. They are placed in the burrows or feeding houses, or the pesticide may be in a grain mixture placed inside floating bait boxes.

Trapping

Muskrats are probably the easiest aquatic furbearer to trap. A special type of body-gripping trap is available for muskrats that will kill them quickly and humanely in 6 inches of water or more. A stake is used to set the trap in place. Leghold traps are also available for catching muskrats. These traps can be set in the run, the house or den entrance, or even under a feeding house. Muskrats are usually caught in one or two nights.

CHAPTER
4

Review Questions

Chapter 4: Wild Rodents

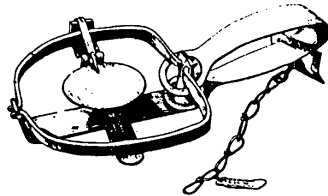


Figure 4.16. Body-gripping trap (top) and leghold trap (below)

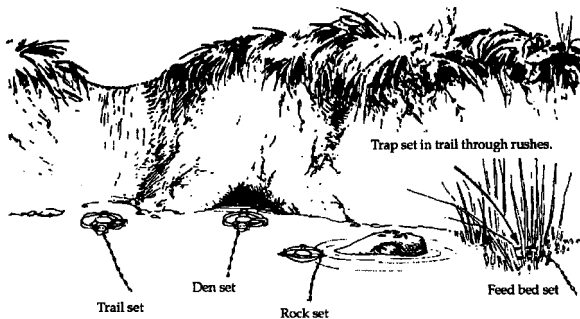


Figure 4.17. Four leghold trap sets for muskrats. Note: all traps are set under water. Chains are wired to anchors in deep water.

Shooting

Where it can be done safely and legally, shooting may be used to eliminate one or two individuals in small farm ponds.

SUMMARY

Wild rodents become pests when they damage crops and landscape plants and invade buildings. Exclusion is often the preferred method for controlling the damage caused by these pests. Use of rodenticides may be more practical to control some of the smaller rodent pests such as voles, but care must be taken to protect non-target animals and children from consuming bait. Live trapping is a more practical method for controlling larger rodent pests such as tree squirrels and woodchucks.

- Which is true of hantavirus pulmonary syndrome (HPS)?
 - It is difficult to prevent.
 - It is easily cured.
 - It is an infrequent but often fatal disease.
 - It primarily affects people who are very young or very old.
 - So far, it has appeared only in the southwestern United States.
- Which rodent species would most likely be carriers of the hantavirus in Michigan?
 - Deer mouse and white-footed mouse
 - Deer mouse and rice rat
 - Cotton rat and rice rat
 - Rice rat and white-footed mouse
 - Cotton rat and deer mouse
- Which are considered the *common early* symptoms of HPS infection?
 - Fatigue, fever, and chills
 - Coughing and shortness of breath
 - Rash and sore throat
 - All of the above
- Which is the correct series of steps to take when cleaning out a shed that had been closed for the winter?
 - Sweep out all debris, then disinfect the area with a bleach solution, and air out the building.
 - Put on latex gloves, wet down the area with a bleach solution, sweep out all debris, and air out the building.
 - Air out the building first, put on latex gloves, sweep out the area and disinfect with bleach.
 - Air out the building first, put on latex gloves, wet down the area with a bleach solution, then clean area by mopping or sponging with disinfectant.
 - Put on latex gloves, sweep out all debris, mop and sponge with disinfectant, then air out the building.

5. Always disinfect gloves after taking them off.
- True
 - False
6. If rodents or their droppings are not seen in crawlspaces or outbuildings, there is no danger of hantavirus infection.
- True
 - False
7. Which are precautions to take to prevent hantavirus infection?
- Wear a respirator when working in crawlspaces or other potentially rodent-infested areas.
 - Disinfect used rodent traps with a commercial disinfectant or bleach solution.
 - Dispose of dead rodents by spraying with a disinfectant and double bagging.
 - A & B.
 - All of the above.
- 8-13. Match the following to the appropriate description:
- Vole
 - Tree squirrel
 - Ground squirrel
 - Chipmunk
 - Woodchuck
 - Muskrat
- _____ 8. Also referred to as a groundhog; head and body measure 16 to 20 inches long.
- _____ 9. Also referred to as a field mouse; tail is shorter than that of a house mouse.
- _____ 10. Nests are usually built in trees; often a problem in attics and garages.
- _____ 11. Spends most of its life in aquatic habitats; overall length is usually 18 to 24 inches long.
- _____ 12. Thirteen-lined is one type; a rat-sized rodent.
- _____ 13. A type of ground-dwelling squirrel, 5 to 6 inches long; the eastern type has two tan and five blackish longitudinal stripes on its back.
14. Which is NOT true about voles?
- A vole's home range is usually about 1 acre.
 - In the field, voles have one to five litters per year with an average litter size of three to six.
 - Voles do not hibernate.
 - Voles are active day and night all year long.
 - Voles can cause extensive crop loss.
15. Vole populations are relatively stable from year to year.
- True
 - False
16. Vole damage can be distinguished by neatly clipped-off branches, uniform gnaw marks, and slanting cuts.
- True
 - False
17. Which is NOT true concerning control of voles?
- Hardware mesh 1/4 inch in size may be used to exclude voles from seedlings and young trees.
 - Large-scale fencing is an effective means of controlling voles.
 - Hardware mesh should be buried 6 inches deep to keep moles from burrowing under.
 - Fencing with pit traps may be used to monitor vole populations and indicate when voles are migrating.
 - Repellents such as thiram and capsaicin may be used to help manage voles.
18. List some habitat modifications that would help manage vole problems.
19. How may zinc phosphide and anticoagulant baits be applied to control voles? What is the advantage of using bait containers?
20. Which of the following control methods is never used against tree squirrels?
- Trimming tree branches that hang over a house
 - Squirrel-death bait blocks
 - Squirrel-proofing with 1/2-inch hardware cloth
 - Naphthalene repellent
 - Live trapping

21. What can be done to squirrel-proof a building? How can squirrels be prevented from entering buildings by climbing on wires or on tree branches?
- A. True
B. False
22. Ground squirrels can transmit plague to people.
- A. True
B. False
23. When necessary, and if not prohibited by law, ground squirrels can be controlled with traps, rodenticides, and fumigants.
- A. True
B. False
24. Release trapped squirrels or chipmunks at least _____ miles away.
- A. 2
B. 3
C. 5
D. 10
25. A small ground squirrel population has made burrows near a building. The best control method is:
- A. Fumigate in the spring when soil moisture is high.
B. Fumigate during hibernation periods.
C. Trap them.
D. Use rodenticides.
E. A & D
26. Which is the best method for controlling chipmunks?
- A. Fumigate in the spring when soil moisture is high.
B. Fumigate during hibernation periods.
C. Trap them.
D. Habitat alteration.
E. C & D
27. Under what circumstances might you consider fumigation for control of ground squirrels?
- A. When populations are high and in the spring when soil moisture is high.
B. When populations are low and in winter during hibernation.
C. When populations are high and in the winter during hibernation.
D. When populations are low and in the spring when conditions are dry.
E. When burrows are located near buildings.
28. What is the primary damage caused by woodchucks?
- A. Invade attics and garages.
B. Girdling young trees and landscape plants.
C. Their burrowing damages pond dams, docks, shorelines, etc.
D. Their burrowing, feeding, and gnawing habits damage lawns, gardens, golf courses, etc.
E. A&B
29. Which characterizes a woodchuck burrow?
- A. A large mound of earth at the main entrance, with an opening 10 to 12 inches in diameter.
B. A single burrow system containing several adults and young and numerous entrances.
C. Some secondary entrances may be hard to locate because they were dug from below ground.
D. Burrows are built along banks with several underwater entrances.
E. A & C
30. What are the specifications for building a fence to exclude woodchucks?
31. Gas cartridges are general-use pesticides that may be placed in woodchuck burrows under wooden sheds and other buildings.
- A. True
B. False
32. Describe the procedure for using aluminum phosphide tablets to fumigate woodchuck burrows. What precautions should be taken when using the tablets?

33. Which is NOT a correct procedure for trapping woodchucks?
- A. Bait traps with apple slices or vegetables.
 - B. Locate traps at main burrow entrances or major travel lanes.
 - C. Place guide logs to help funnel the animal into the trap.
 - D. Check the traps every 48 hours.
 - E. Release the trapped woodchuck in a suitable habitat were no additional damage can be caused.
34. What is the primary damage caused by muskrats?
- A. Invade attics and garages.
 - B. Girdling young trees and landscape plants.
 - C. Their burrowing damages pond dams, docks, shorelines, etc.
 - D. Their burrowing, feeding, and gnawing habits damage lawns, gardens, golf courses, etc.
 - E. A & B
35. Which is characteristic of muskrats?
- A. Conical houses constructed of plant material in shallow water areas.
 - B. Have feeding houses, platforms, and chambers that are smaller than houses used for dens.
 - C. Prefer to feed on aquatic plants but will sometimes leave the pond to feed on field crops.
 - D. Burrows are built along banks with several underwater entrances.
 - E. All of the above.
36. What are the specifications of a dam built to prevent muskrat damage?
37. After drawing a farm pond down at least 2 feet below the normal levels in the winter, what should be done to prevent muskrat damage?
38. Describe how baits may be used to control muskrats.
39. Describe how traps may be used to control muskrats.

CHAPTER 5

OTHER VERTEBRATE PESTS

LEARNING OBJECTIVES

After completely studying this chapter, you should:

- Be able to identify common vertebrate pests.
- Be able to discuss the habitats, habits, and life cycles of vertebrates that may be pests.
- Be able to describe public health concerns associated with vertebrate pests.
- Be able to describe situations in which vertebrates are considered pests.
- Know what precautions to take when working with vertebrate pests.

Vertebrates become pests when they damage crops, gardens, landscape plants, or lawns (e.g., **deer, rabbits, and moles**). They may also become pests when they wander into residential areas from nearby wild areas or parks and adapt to living near people—next to or sometimes inside buildings (e.g., **bats, snakes, skunks, raccoons, and opossums**). Vertebrates may also pose a public health hazard because they help spread certain diseases (e.g., rabies and Lyme disease).

Whatever the pests, sometimes they must be controlled. Because some are often game animals or are otherwise protected, many control actions will be non-lethal.

BATS

Bats are unique in the animal kingdom—they are the only true flying mammals. A thin membrane of skin stretches from the long, modified front legs to the back legs and then to the tail. The greatly elongated bones in the bat's "fingers" support the wings.

Bats in the United States are almost always beneficial. Many bats feed on insects and can consume up to half their body weight in insects in one feeding. Occasionally, however, they become a nuisance inside buildings or pose a public health problem.

The bats that most often become a problem around people are those that live in colonies or groups, such as little brown bats and big brown bats. These species sometimes hibernate or roost inside buildings.

Roosting and hibernating sites may occur in building attics, wall and ceiling voids, belfries, chimney voids, unused furnaces, and the like. The bats' droppings and urine can cause a foul odor and stains in walls and ceilings. Their squeaking and scrambling noises can be intolerable to residents of the building.



Figure 5.1. Little brown bat, *Myotis lucifugus*

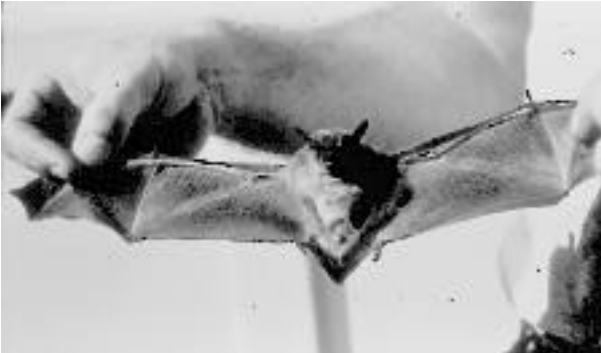


Figure 5.2. Big brown bat, *Eptesicus fuscus*

Bats and Disease

Bats are associated with a few diseases that affect people. Rabies and histoplasmosis are the most serious. Rabies is a dangerous, fatal disease. However, the bat's role in transmission has been greatly exaggerated. Though bats are confirmed carriers of the disease, only a few human fatalities have been attributed to bat bites. Nevertheless, care must be exercised when handling bats and bat bites should be considered potential rabies exposure.

- Bats may try to bite when handled and should be picked up with heavy gloves or forceps.
- If a bat has bitten someone, it should be captured without crushing its head. Refrigerate it (don't freeze it). Take it to the local health department for testing.

The incidence of histoplasmosis (discussed in detail in the chapter on birds) being transmitted from bat droppings to humans is not thought to be high.

- When working in a bat roosting site with lots of accumulated droppings, wear a respirator and protective clothing, and follow the safety procedures outlined in the chapter on birds.

Habits of Bats

During warm weather, bats feed on flying insects in late afternoon, evening, and early morning. They are not normally active in bright daylight. If you see a bat at this time, it has either been disturbed from its daytime resting place or may be sick. When not in flight, bats rest in dark hiding and roosting sites (e.g., caves, buildings, and hollow trees). Bats can enter these places of refuge through holes as small as 3/8 inch in diameter.

Bats capture flying insects by echolocation—they emit high-frequency sounds inaudible to humans and similar to sonar. They also make audible squeaking sounds to communicate with other bats.

In much of the country, bats migrate or hibernate when the weather turns cold. Sometimes they hibernate in hanging clusters inside buildings. Depending on the species and the geographic location, they breed from late spring to midsummer. Young bats grow rapidly and can fly three to seven weeks after birth.

Inspection

Look for two things:

- Entry and exit points of the bats.
- The location of the roost.

Entry and exit points. A building in poor repair will have seemingly unlimited entry points.

- Look for loose flashing, vents, shingles, or siding that bats can squeeze through or under.
- Look for damage and openings under eaves and soffits, at cornices, louvers, and doors; by chimneys and windows; and anywhere pipes or wiring enter.
- Notice droppings under openings, smudges around holes, and odors.
- Bats can be observed at twilight from spring through autumn as they leave the building to feed. The best time to observe the bats and pinpoint major exit and entry points is usually from just before to an hour after sunset.
- Station one or more observers on each side of the building, looking up toward the roof.
- Listen for squeaking at the exits just prior to flight.
- If the night is chilly or rainy, the bats may not come out.

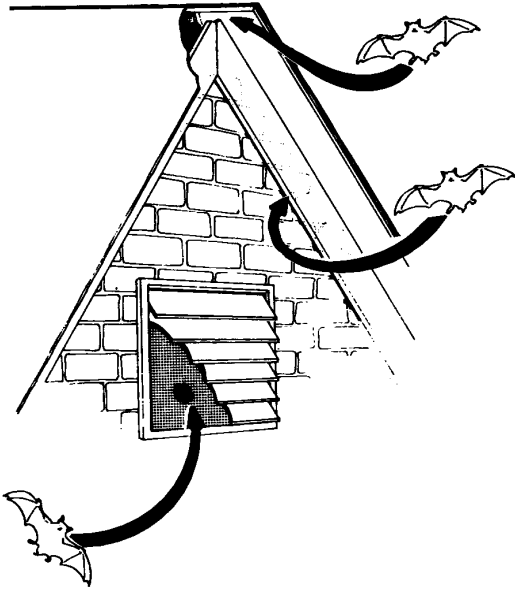


Figure 5.3. Common entry points for bats in a building

Location of roost

- Look in attics and unused rooms during daylight.
- Check inside louver vents.
- Bang on the walls and listen for squeaks and scratches as roosting bats are disturbed.
- Check behind shutters.
- Look for bat droppings. They will be found below roosting bats. Their droppings look like mouse droppings. However, bat droppings contain wings, legs, and other body parts of insects not found in mouse droppings. Bat droppings often accumulate to a depth of several inches or more.
- Smell for bats in large roosts. Roosting sites have a very pungent and penetrating odor, musky and sweet, that comes from rotting droppings and bat urine.

Control and Management of Bats

Chemical control is no longer an option for eliminating bats. No pesticides are currently registered for bat control by the EPA. The best way to get rid of bats roosting in a building is through bat-proofing.

Exclusion

Bat-proofing. Making a building bat-proof means sealing or screening all of the openings that bats use to enter. It can be a difficult job because, in many cases, all upper openings 3/8 inch and larger must be sealed. But this is the only permanent method of ridding a building of bats.

Complicating the process is the fact that you have to be certain there are no bats inside before sealing the build-

ing. Otherwise, you will have created a bigger problem by trapping the bats inside.

June and July are peak months for bat complaints in much of the country. Unfortunately, this is the worst time of the year for control. At this time, bats are rearing young in their colonies. The young can not fly and stay in the roost. Bat-proofing during this period will trap the young bats inside. They will die and rot and cause odor problems. They may also crawl and flutter into living areas.

The best time of year to bat-proof a building is either in late fall after bats have left for hibernation or in late winter and early spring before the bats arrive. If bat-proofing must be done in summer, it should be done after mid-August.

- Seal all but one or two principal openings.
- Wait three to four days for the bats to adjust to using the remaining openings.
- Then seal those openings some evening just after the bats have left for their nightly feeding.
- “Bat valves” can also be used. These are placed over the remaining openings and allow the bats to leave but not to return.

Standard bat-proofing materials include ¼-inch hardware cloth, screening, sheet metal, caulking, expanding polyurethane foam, steel wool, and duct tape—the same things used for rodent proofing. Old, deteriorated buildings often have more openings than can be sealed economically. Large sections of plastic bird netting can be draped over the roof areas of old buildings to keep out bats at a reasonable cost.

Repellents

If bat-proofing is not possible or bats need to be forced out of a building before it is bat-proofed, the bats can sometimes be repelled from their roost. At this time, only one chemical is registered as a bat repellent. Naphthalene crystals or flakes can be spread on attic floors or placed in voids. The crystals are most effective in confined air spaces. Three to 5 pounds will treat an average attic.

Though naphthalene may repel the bats, it vaporizes and disappears in a few weeks and the bats often return. Many humans dislike the smell of naphthalene as much as bats do; some people are very sensitive to the smell of naphthalene and should avoid all contact.

- Bright lights have had some success in repelling bats.
- On commercial buildings, floodlights can be pointed at the bats’ entry points to keep them from entering. (Of course, the bright lights may attract insects, too, which are the bats’ food.)
- Attics can be illuminated with four or more bulbs. Ensure that all corners of the attic are illuminated.
- Drafts of cool air from fans and air-conditioners have, on occasion, kept bats from roosting in a poorly sealed attic.
- Ultrasonic devices do not repel bats.

A single bat. When a single bat finds its way into a home, office, or store, it will usually find its way out again. When it does not, capture the bat with an insect net, a coffee can, or even with a gloved hand. The bat can be released or destroyed. A glue board attached to a broom handle can be used to reach a bat high in a corner or at the apex of an attic.

MOLES

Moles (*Scalopus* spp.) are not rodents but relatives of the insectivores (insect eaters) such as shrews and hedgehogs. In their search for food, moles burrow in lawns, meadows, stream banks, and open woodlots, creating elaborate underground tunnels. They feed mainly on earthworms and insect larvae (grubs). Only rarely seen above ground, moles are 4 to 9 inches long, including the tail, with long dark gray or brown fur. Eyes are tiny, like a pinhead, and the tail and feet are usually pink. They have no visible ears. There are seven species in the United States.

As they burrow, they sometimes damage plants, but the major problem with moles is the mounds and ridges that disfigure lawns. As they tunnel just below the surface, moles raise the sod up with their front digging feet, looking for food or new tunneling sites. They can push up surface tunnels at the rate of a foot per minute if the soil is loose. They prefer loose, moist soil shaded by vegetation.

Control and Management of Moles

Though time consuming, using traps is the most effective method of control. Killing moles with fumigants or poison baits is not effective.

To find out which parts of the surface tunnels are active and which are abandoned, tramp down mole tunnels in several places over the yard and mark flattened sections with a peg or wire flag. If the tunnel has been pushed back up the next day or so, a trap should be set in that place.



Figure 5.4. Eastern mole, *Scalopus aquaticus*
(Illinois Natural History Survey)

Three types of traps are in general use: harpoon traps, scissor traps, and chokers. A harpoon trap consists of two prongs that straddle the tunnel and a set of spring-driven spikes. The spikes are raised above the tunnel and caught in the trigger release. When the mole triggers the trap, the prongs are released and driven through the sod, impaling and killing the mole.

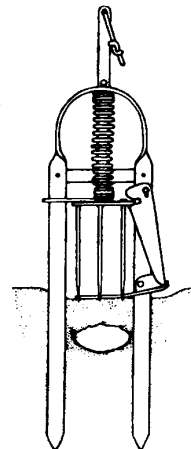


Figure 5.5. A harpoon trap properly set in a surface runway (ridge). A narrow portion of the runway (1 to 1½ inch) is collapsed halfway down, the trap is inserted so that the support prongs straddle the runway, and the trigger rests lightly on top of it. Plastic pails can be placed over traps to prevent animals or children from tampering with them.

A choker trap consists of a cast metal frame with two spring-retractable loops. Two slits are cut in the tunnel and the loops placed inside. Scissor traps are similar to choker traps except prongs rather than loops are used. When moles trigger these traps, they are immediately crushed.

- When using traps, place a plastic pail with a warning sign over each trap.
- An average set will require three to five traps per acre.
- Check the traps every couple of days.
- After no results for three to four days, move the traps to new locations.

SKUNKS, RACCOONS, AND OPOSSUMS

These three vertebrates are considered together because they are similar pests with similar management and control recommendations. Management of these animals almost always involves exclusion and/or live trapping.

Skunks

The skunk commonly found in Michigan is the striped skunk (*Mephitis mephitis*). The striped skunk is about the size of a large house cat and typically has two broad, white stripes running from the back of the head to the large, bushy tail.

Skunks are nocturnal. They do not hibernate but may sleep through cold weather periods. They usually live in underground burrows, hollow logs, or rock piles. They may decide to live under houses, decks, sheds, cabins, or storage buildings.

Of course, the main problem with skunks is their odor. They become pests when they change their dietary selections from rodents, insects, and wild fruit to garden crops, garbage, and lawn insects, and locate their habitat

closer to humans. Another major problem in some areas of the country is the transmission of rabies.



Figure 5.6. Striped skunk, *Mephitis mephitis*

Raccoons

Raccoons are common throughout North America. They are easy to recognize with their black face mask and black-, brown-, and white-ringed bushy tail. They have long, thick fur, a pointed muzzle, and pointed ears. Their feet are well adapted to climbing. They are large animals, weighing between 10 and 25 pounds.

Their senses of hearing, sight, and touch are well developed; those of taste and smell are not. They are commonly found near streams, lakes, and swamps, and they often do quite well in suburban areas and even in city parks. Raccoons den inside hollow trees or logs, rock crevices, deserted buildings, culverts, storm sewers, chimneys, attics, sheds, and crawlspaces. More than one den may be used.

Raccoons are mostly active at night, though they may be seen at dawn or dusk and sometimes even in the middle of the day. Winter months are spent in the den, but they do not hibernate. They may become active during warm spells.

Raccoons feed on animals and plants. In the spring and summer, they feed on crayfish, mussels, frogs, and fish. In the fall, they switch to fruits, seeds, nuts, and grains. They also eat mice, squirrels, and birds, and are quite happy knocking over a garbage can. Raccoons, too, can transmit rabies.



Figure 5.7. Raccoon, *Procyon lotor*

Opossums

Opossums, which are related to kangaroos, are the only North American marsupial. The opossum is a whitish or grayish animal the size of a house cat with a naked, ratlike tail. Its face is long and pointed with rounded, hairless ears. It grows up to 40 inches long and will weigh up to 14 pounds. The average is 6 to 7 pounds for males and 4 pounds for females. Its tracks look as if they were made by little human or monkey hands.

Opossums prefer to live near streams or swamps. They den in the burrows of other large animals, and in tree cavities, in brush piles, and under sheds and buildings. Occasionally, they move into attics and garages.

They eat nearly everything, from insects to carrion, fruits to grains, garbage to pet food. Opossums are active at night. Their mating season is January to July, and they may raise two to three litters per year. Most young die in their first year. Those that survive may live up to 7 years.

Opossums move slowly. Their top speed is about 7 miles per hour. When threatened, opossums climb trees or go down into burrows. If cornered, they may growl, hiss, bite, screech, and exude a smelly green fluid from their rear end. If these defenses aren't successful, they may play dead. They have the reputation of being stupid, but scientists consider them to be smarter than domestic dogs.

The main complaint against opossums is that they get into garbage, bird feeders, or pet food left outside.



Figure 5.8. Opossum, *Didelphis marsupialis*

Control and Management of Skunks, Raccoons, and Opossums

Exclusion

These animals can be prevented from entering buildings by repairing breaks in foundations and screening crawlspace vents with hardware cloth.

- If the animal is currently living under the building, seal all openings but one, then sprinkle a tracking patch of talc at the opening.
- Examine the area after dark. If tracks show that the animal has left, close this last opening immediately.

- Seal attic openings.
- Cap chimneys with a wire cage or other animal-proof cover.

When excluding animals in spring or early summer, be aware that young may also be present. Be sure that all animals have been removed before sealing the building. Otherwise, a serious odor problem from a dead animal could result.

These animals can also be prevented from climbing over wire mesh fences by installing a tightly stretched electric fence wire near the top of the fence 3 inches out from the mesh.

Trapping

Live Traps. The best way to remove animals from around buildings is to trap them. Know your state and local regulations before releasing a trapped animal. Some areas prohibit releasing a trapped animal, especially skunks and raccoons, because they may carry rabies. State fish and game laws may also regulate the capture and release of some of these animals.

- If the animal must be killed, follow all appropriate regulations.
- If the animal is to be released, do it far away from human dwellings. Try to use what you have learned about the biology of the animal to find a suitable habitat. The release site for these large animals should be at least 10 miles away.
- Remember to check state and local regulations.
- Set traps as close to the den as possible or place them where damage is occurring—e.g., at corners of gardens or breaks in stone walls, or along obvious animal trails.
- Set multiple traps in a number of locations.
- These animals are active at night, so check traps at least every morning; preferably twice a day.
- Check traps often to spot and release non-target animals.
- There is obviously a special problem when trapping skunks. Skunks don't like to "shoot" if they can't see their target, so cover all but the trap entrance with burlap or canvas before placing the trap, or use a commercially sold skunk trap. Approach the trap slowly and transport it gently.

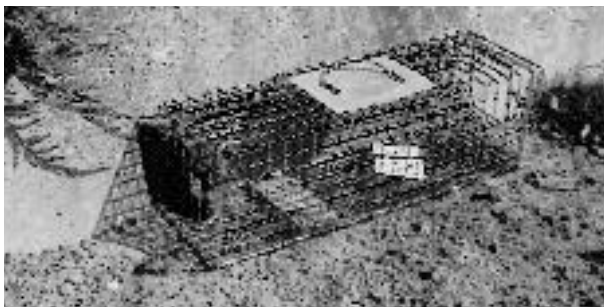


Figure 5.9. One type of live trap

To release a trapped skunk, stand more than 20 feet away and release the trap door using a string or fishing line.

Effective baits for each animal are:

Skunk: Chicken parts and entrails, fresh fish, cat food, sardines, eggs.

Raccoon: Chicken parts and entrails, corn, fresh fish, sardines, cat food.

Opossum: Apple slices, chicken parts and entrails, fresh fish, sardines, cat food.

Leghold traps and body-gripping traps might be considered in more rural areas. Leghold traps may be set in dirt holes about 8 inches deep along fences or trail ways. The leghold trap can also be buried as a cubby set—a small enclosure made of rocks, logs, or a box. The trap is set at the entrance to the cubby so that the animal will place its foot on the trap. Place bait in the dirt hole or cubby to attract the animal. Skunks will discharge scent when caught in a leghold trap so it is especially important to ensure the trap is not near any structures. Animals caught in leghold traps may be disposed of humanely by a veterinarian or a wildlife official.

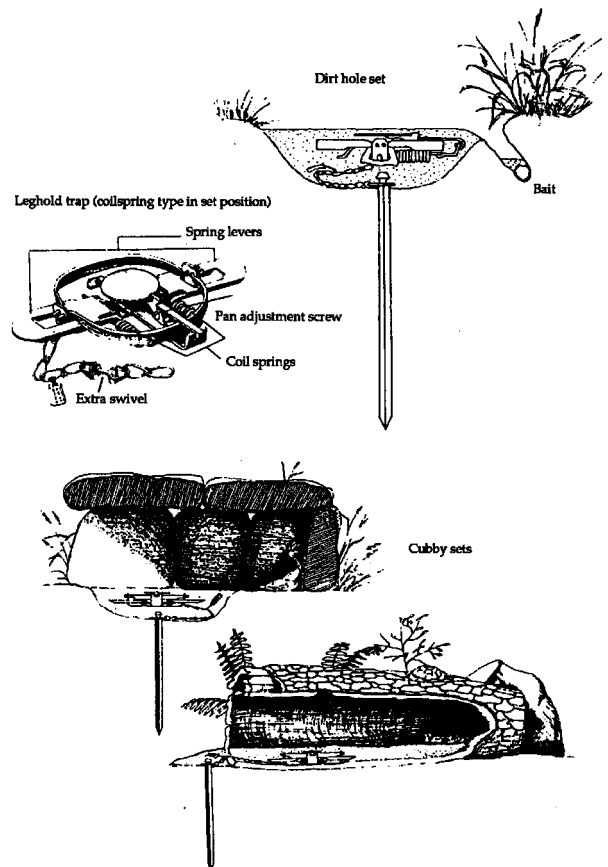


Figure 5.10. Leghold trap and dirt and cubby sets

A body-gripping trap will kill the animal instantly. Place bait behind the trap in such a way that the animal must pass through the trap to get it. To reduce chances of catching pets, set the trap above ground on a running pole or place it in a specially designed dog-proof box. Leghold and body-gripping traps are not recommended if non-target animals are at risk.

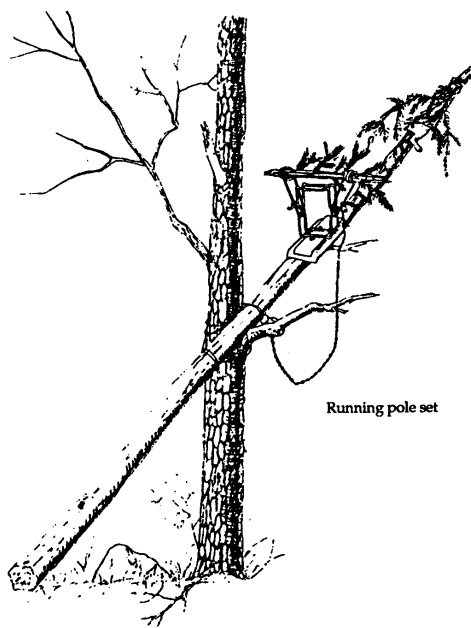
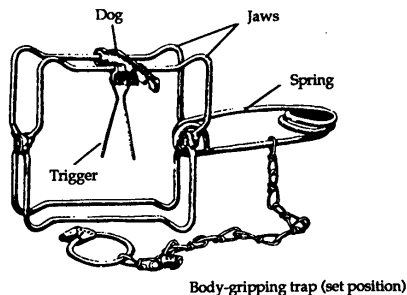


Figure 5.11. Body-gripping trap and running pole set

Shooting

Shooting is one possible means of controlling these animals. Use a shotgun with No. 6 shot or a .22-caliber rifle. Expect a scent discharge when shooting skunks. Check local regulations before discharging any firearm. Shooting is not recommended in more populated areas.

Prevention through Habitat Modification

The best preventive measure for skunks, raccoons, and opossums is to establish a good level of sanitation in a neighborhood. Remind clients that released vertebrates must fight their way into new territory to establish themselves and that overcrowded habitat results in increased risk of disease and marginal resting sites. Prevention is the most humane way of managing vertebrate pests.

RABBITS

Rabbits mean different things to different people. For hunters, the rabbit is an abundant sporting and game animal. However, vegetable and flower gardeners, farmers, and homeowners who are suffering damage may have very little to say in favor of them. They can do considerable damage to flowers, vegetables, trees, and shrubs any time of the year and in places ranging from suburban yards to rural fields and tree plantations. Control is often necessary to reduce damage, but complete extermination is not necessary, desirable, or possible.

Cottontail rabbits in North America do not dig burrows as the European rabbit does. Cottontails use natural cavities or burrows excavated by woodchucks or other animals. Most rabbits live only 12 to 15 months; probably one rabbit in 100 lives to see its third fall. Yet they make the most of the time available to them. In northern regions, there are usually two to three litters per year with five to six young per litter.

Rabbits eat flowers and vegetables in spring and summer. In fall and winter, they damage and kill valuable woody plants. Rabbits will devour a wide variety of flowers. The one most commonly damaged is the tulip; they especially like the first shoots that appear in spring. In vegetable gardens, cottontails eat not only carrots down to ground level but also peas, beans, and beets. Only a few crops—corn, squash, cucumbers, tomatoes, potatoes, and some peppers—seem to be immune from rabbit problems.

Equally annoying, and much more serious, is the damage rabbits do to woody plants by gnawing on bark or clipping off branches, stems, and buds. In winter, when the ground is covered with snow for long periods, rabbits often severely damage expensive home landscape plants, orchards, forest plantations, and park trees and shrubs. Some young plants are clipped off at snow height, and large trees and shrubs may be completely girdled.

Rabbit damage can be identified by the characteristic appearance of gnawing on older woody growth and the clean-cut, angled clipping of young stems. Distinctive round droppings in the immediate area are also a sign of their presence.



Figure 5.12. Eastern cottontail rabbit, *Sylvilagus floridanus*
(G.L. Twiest, Mammal Images Library of the American Society of Mammalogists)

Control and Management of Rabbits

Exclusion

One of the best ways to protect a backyard garden or berry patch is to put up a fence. It does not have to be tall or especially sturdy. A fence of 2-foot chicken wire (1 inch or less mesh) with the bottom tight to the ground or buried a few inches is sufficient.

Cylinders of ¼-inch mesh hardware cloth will protect valuable young trees or other landscape plants. The cylinders should extend higher than a rabbit's reach while standing on the expected snow depth, and stand 1 to 2 inches out from the tree trunk. Commercial tree guards or tree wrap are other alternatives.

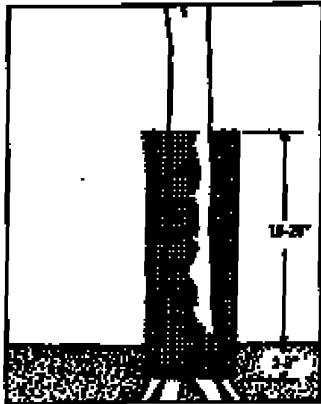


Figure 5.13. A cylinder of hardware cloth or other wire mesh can protect trees from rabbit damage.

A dome or cage of chicken wire secured over a small flowerbed will allow vulnerable plants such as tulips to get a good start before they are left unprotected.

Habitat Modification

Habitat modification may be especially effective in suburban areas where fewer suitable habitats are available.

- In suburban areas, remove brush piles, weed patches, dumps, stone piles, and other debris where rabbits live and hide.
- Controlling vegetation along ditch banks or fencerows will eliminate rabbits in agricultural settings, but this will likely have detrimental effects on other species, such as pheasants.

Always weigh the consequences before carrying out any form of habitat management.

Repellents

Several chemical repellents discourage rabbit browsing. Always follow the label directions. Remember that some repellents are poisonous and require safe storage and use. For best results, use repellents and other damage control methods at the first sign of damage.

Most repellents can be applied, like paint, with a brush or sprayer. Many commercially available repellents contain the fungicide thiram and can be purchased in a ready-to-use form.

Most repellents are not designed to be used on plants or plant parts destined for human consumption. Most rabbit repellents are *contact* or *taste repellents*. Taste repellents protect only the parts of the plant they contact—new growth that emerges after application is not protected. Heavy rains may necessitate reapplication of some repellents.

Mothballs (naphthalene) are an example of an *area* or *odor repellent* that repels by creating a noxious odor around the plants to be protected. Taste repellents are usually more effective than odor repellents. The degree of efficacy, however, is highly variable, depending on the behavior, the number of rabbits, and availability of alternative foods. When rabbits are abundant and hungry, use other control techniques along with chemical repellents.

Trapping

Trapping is the best way to remove rabbits in cities, parks, and suburban areas, though rabbits may be difficult to catch. Several styles of commercial live traps are available. Handmade box traps are also frequently used. Place traps where rabbits feed or rest. Keep traps near cover—rabbits are not likely to cross large open areas to reach them. Check traps daily to replenish bait or remove the catch. In winter, dry baits such as corn cobs and dried apples can be used. Dried leafy alfalfa and clover are also good cold-weather baits. Fresh apples and green vegetables can be used in warmer months. A commercial wire trap can be made more effective (especially in winter) by covering it with canvas or some other dark material. Be sure the cover does not interfere with the trap's mechanism. Move traps if they fail to make a catch within a week.

Release rabbits in rural areas several miles from where they were trapped if local regulations allow relocation. Do not release them where they may create a problem for someone else.

Shooting

Shooting may be done in rural areas during the legal hunting season if it can be done safely and if local regulations allow it.

WHITE-TAILED DEER

The white-tailed deer (*Odocoileus virginianus*) is an important game animal that is found throughout much of North America. The deer population in Michigan is an important economic and aesthetic resource. Each year the positive economic value of deer is realized through license fees, hunter and vacationer expenditures for food, transportation, and equipment, etc. Despite their economic and aesthetic values, deer also have a variety of negative economic impacts—they damage crops and personal property, cause automobile accidents, and harbor diseases common to humans and livestock.

Unlike moles, rats, and other species implicated in damage, deer cannot be casually eliminated when in conflict with humans. Control methods are built around effective deer herd management. Deer are protected year round in Michigan except during the legal hunting season. In cases where deer are causing persistent or severe damage, special permits may be issued to shoot deer at other times.

Deer damage a wide variety of row crops, forage crops, vegetables, fruit trees, nursery stock, and ornamentals as well as stacked hay. Ornamental trees or nursery stock may be permanently disfigured by deer browsing. Besides damage to vegetation, deer collisions with vehicles pose a serious risk, and deer have been implicated in the distribution and transmission of Lyme disease.

Damage identification is not difficult. White-tailed deer lack upper incisors and leave a jagged or torn surface on twigs and stems that they browse. Rabbits and rodents, however, leave a clean-cut surface. In addition, deer tracks are very distinctive. The height of damage from the ground up (up to 6 feet) often rules out any mammal other than deer. Deer are often observed in the act of causing damage.



Figure 5.14. White-tailed deer, *Odocoileus virginianus*
(G.L. Twiest, Mammal Images Library of the American Society of Mammalogists)

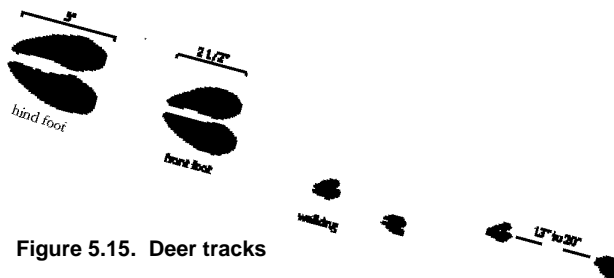


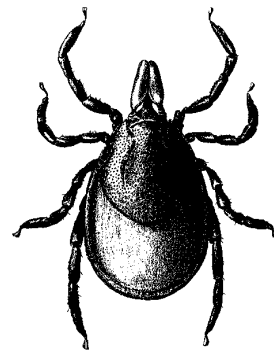
Figure 5.15. Deer tracks

Lyme Disease

Reducing the deer population through hunting is one way to manage the spread of Lyme disease. Lyme disease is caused by a spiral-shaped bacterium transmitted by the deer tick (*Ixodes scapularis*). The body of the adult female deer tick is brick red with black legs and has a black shield (scutum) in the front. The adult deer tick is usually about the size of a sesame seed.

Ticks feed on the blood of their hosts. Deer ticks feed on deer and other mammals including humans. Unlike humans and dogs, deer are unaffected by Lyme disease. The deer tick bite is painless and may go unnoticed. Once attached and feeding, the tick cannot detach itself until feeding stops. The first indication of a potential infection may be the discovery of an attached tick. ***Disease transmission does not occur for an estimated 10 to 12 hours after feeding begins. If the tick is located and removed within that time, no infection will occur.***

Usually, within 7 days (from 3 to 32 days) after disease transmission, a rash appears (in 60 to 75 percent of all cases). The rash looks like a red, expanding ring with a clear center. This center often is the site of the bite. The rash may burn or itch. Technically, this rash is called erythema cronicum migrans (ECM); it is not uncommon to find ECM at multiple sites. It disappears within three weeks but can recur.



Other skin symptoms may be hives, redness of cheeks under eyes, and swelling of eyelids with reddening of the whites of the eyes. Flu-like symptoms may accompany the skin symptoms—e.g., high fever, headache, stiff neck, fatigue, sore throat, and swollen glands.

Regular inspection, location, and early removal of ticks prevents disease transmission. To remove feeding ticks, dab them with alcohol. If feeding has just started, and mouthparts are not cemented in, ticks sometimes pull their mouthparts out.

If they do not release in a few minutes, ***take tweezers, grasp the tick at the skin level and pull steadily*** until the tick is removed. Grasping the tick at the back end, or

heating it, can force disease organisms into the wound. Place the tick in alcohol or otherwise keep it for identification. ***If the mouthparts are left in the skin, they will not transmit the disease, but the wound should be treated with an antiseptic to prevent secondary infection.*** If the tick is identified as a deer tick, see a physician. Note the date of removal to calculate the time of symptoms onset.

Prevention of Lyme Disease

For those working in tick-infested areas, the following precautions will help prevent transmission of the disease:

- Wear long pants tucked into socks while working or hiking in tick habitat (wear light-colored clothing so that ticks can be more easily detected).
- Use insect repellents on clothes and skin. Do not use formulations with over 20 to 30 percent active ingredient directly on skin.
- Use permethrin formulations that are labeled for use as a repellent on clothes. They withstand washing and remain effective.
- Schedule regular body inspections for ticks at noon and at bedtime.
- Nymphal deer ticks are smaller than adults but can be seen with close inspection. ***Ninety percent of the human Lyme disease cases are the result of nymphal tick feeding.***

Control and Management of Deer

Exclusion

Fencing may be the only effective way to minimize deer damage, especially in areas where the deer population is large and/or the crops are particularly valuable. Several fencing designs are available to meet specific needs. **Temporary electric fences** are a simple, effective way to protect garden and field crops during snow-free periods. **Permanent high-tensile electric fences** provide year-round protection from deer and are best suited to high-value specialty or orchard crops. **Permanent woven-wire fences** provide the ultimate deer barrier. They require little maintenance but are very expensive to build.

Fencing in general is expensive. Gather as much information as you can in determining what type of fence to build. Some factors to consider are the history of past deer numbers and the extent of damage, **deer pressure**—i.e., the number of deer and their level of dependence on agricultural crops—the value of the crop, and the field size. With this information a cost-benefit analysis should be prepared to determine the cost-effectiveness of fencing and the type of fence to install. Weigh the value of the crop to be protected against the acreage involved, costs of fence construction and maintenance, and the life expectancy of the fence.

Temporary Electric Fencing. Temporary electric fences provide inexpensive protection for many crops during periods without snow. They are easy to construct,

they do not require rigid corners, and materials are readily available. Install fences at the first sign of damage to prevent deer from establishing feeding patterns on the crops. Weekly inspection and maintenance are required. Various types of temporary electric fences are described below.

One type of design—the **peanut butter fence**—lures the deer to the fence with the smell of peanut butter. The deer make nose-to-fence contact and receive an electric shock. Being shocked teaches the deer to avoid fenced areas. The peanut butter fence is effective for small gardens, nurseries, and orchards (up to 3 to 4 acres) subject to moderate deer pressure. The steps to building the peanut butter fence are described below (see Figure 5.15).

- Install wooden corner posts and string 17-gauge smooth wire around the corners, applying light tension.
- Set fiberglass grounding rods along the wire at 45-foot intervals. Attach the wire to insulators on the rods 2½ feet above ground level, and apply 50 pounds of tension.
- Use a 1:1 mixture of peanut butter and vegetable oil applied to 1- to 2-inch strips of cloth adhesive tape. Place the tapes at 3-foot intervals.
- Fold a 3- by 4-inch piece of aluminum foil over each tape.
- Connect the wire to the positive (+) post of a well grounded fence charger.

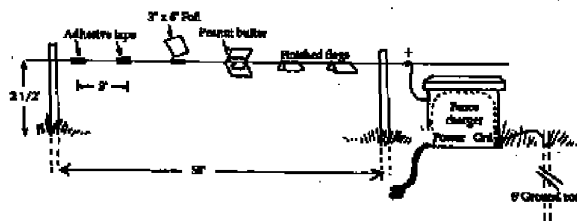


Figure 5.16. The peanut butter fence

Another type of temporary fence—the **polytape fence**—uses polytape or polywire strung in two strands between the posts and attached to the positive (+) post of a well-grounded fence charger. These fences can be used to protect up to 40 acres of vegetable and field crops under moderate deer pressure. Usually white or yellow tape is used for visibility. Peanut butter can be applied in places along the polytape to train deer to avoid the fence.

Temporary fences need to be inspected weekly for damage by deer and for vegetation interfering with grounding. Peanut butter must be reapplied monthly.

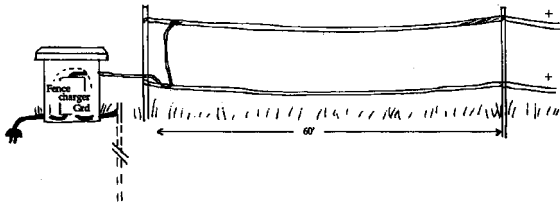


Figure 5.17. The polytape fence

Permanent High-tensile Electric Fencing. High-tensile fencing can provide year-round protection from deer damage. Many designs are available to meet specific needs. All require strict adherence to construction guidelines concerning rigid corner assemblies and fence configurations. Frequent inspection and maintenance are required. High-tensile fences can be expected to last 20 to 30 years. Types of high-tensile fences are described below.

The **offset or double fence** is mostly for gardens, truck farms, or nurseries up to about 40 acres that experience moderate deer pressure. Deer are repelled by the shock and the three-dimensional nature of the fence. Maintenance includes weekly fence and voltage checks.

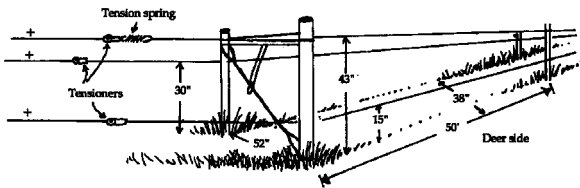


Figure 5.18. The offset or double fence

Vertical deer fences are effective at protecting large truck gardens, orchards, and other fields from moderate to high deer pressures. Because of the prescribed wire spacing, deer either attempt to go through the fence and are effectively shocked or are physically impeded by the barrier. Vertical fences use less ground space than three-dimensional fences but are probably less effective at inhibiting deer from jumping over fences.

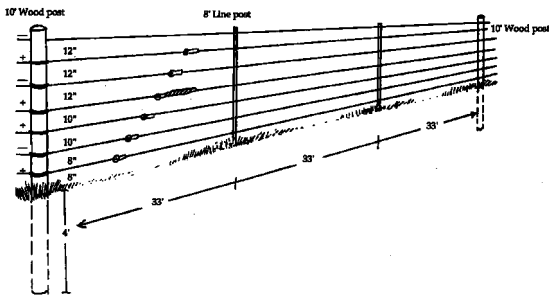


Figure 5.19. The seven-wire vertical deer fence

A wide variety of fence materials, wire spacings, and specific designs can be used. One variation, the **slanted seven-wire deer fence**, uses wooden braces set at angles so that the fence is slanting outward. In addition to the electric shock, the three-dimensional nature of this fence discourages deer from jumping over.

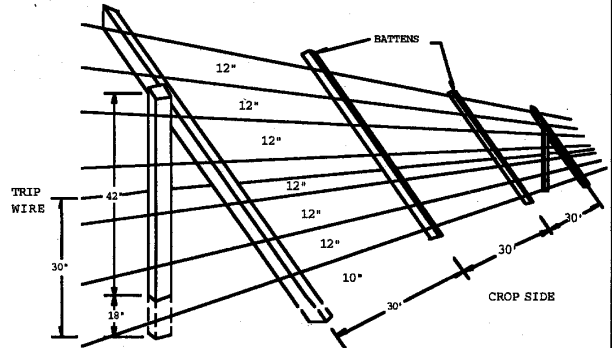


Figure 5.20. The slanted seven-wire deer fence

High-tensile electric fences are more easily repaired than conventional fences and may cost up to half as much as a woven-wire design. Disadvantages include the need for frequent monitoring and vegetation control to maintain shocking power.

Permanent Woven-wire Fencing. Woven-wire fences are used year round for protection of high-value crops subject to high deer pressures. These fences are expensive and difficult to construct but easy to maintain. Before high-tensile electric fencing, woven-wire fences were used most often to protect orchards or nurseries where the high crop value, the perennial nature of damage, acreage, and 20-year life span of the fences justified the cost. Materials used to build woven-wire fences include round fiberglass or treated wood posts, rolls of high-tensile woven wire, and gates. These fences may be constructed with or without volt chargers. For high-tensile woven-wire fences, use high-voltage, low-impedance chargers only (3,000 to 5,000 volts and current pulse duration of at most 1/1,000 second).

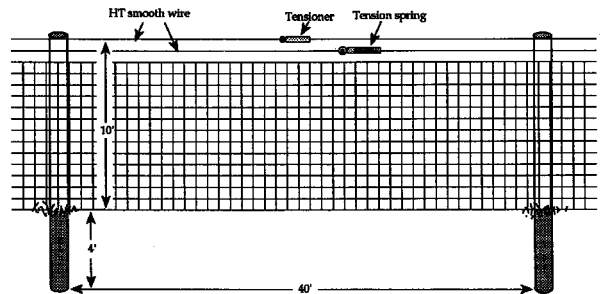


Figure 5.21. The deer-proof woven-wire fence

Fence Maintenance. There are many possible variations in the design of temporary, permanent, and woven-wire fencing. There are also commercial dealers who supply these fences. The most frequent reasons why fences fail to prevent deer damage include the selection of an unsuitable fence design, the failure to install fencing according to specifications, and inadequate maintenance. Below are some fence maintenance recommendations.

- Control vegetation near fences by mowing or applying herbicides to avoid excessive fence grounding by weeds.
- On slopes or highly erodible soils, maintain a good sod cover beneath fences to avoid fenceline erosion.
- Always keep the fence charger on. Check the fence voltage weekly with a voltmeter. Maintain at least 3,000 volts at the farthest distance from the fence charger on high-tensile, woven-wire fences. Disconnect the lower wires if they are covered by snow.
- In the fall and early summer, adjust the fence tension for high-tensile fences.
- Always remember to attach warning signs to electric fences.

Tree Protectors. Plastic tree wraps or woven-wire cylinders can be used to protect young trees from deer and rabbits. Four-foot woven-wire cylinders can keep deer from rubbing tree trunks with their antlers.

Repellents

Repellents are best suited for use in orchards and gardens, and on ornamental plants. High cost, limitations on use, and variable effectiveness make most repellents impractical on row crops, pastures, or other large areas. Success with repellents is measured in the reduction, not total elimination, of damage.

Repellents are described by mode of action as “contact” or “area.” Contact repellents, which are applied directly to the plants, repel by taste. They are most effective when applied to trees and shrubs during the late fall and winter when the plants are not actively growing. New growth that appears in the spring will not be protected by the repellent. Contact repellents, in general, should not be used on plant parts destined for human consumption.

Area repellents are applied near the plants to be protected and repel by odor alone. They are usually less effective than contact repellents but can be used in perimeter applications and some situations where contact repellents cannot.

During the winter or dormant season, apply contact repellents on a dry day when temperatures are above freezing. Treat young trees completely. It will be more economical to treat only the terminal growth of older trees. Be sure to treat to a height of 6 feet above the expected maximum snow depth. During the growing season, apply contact repellents at about half the concentration recommended for winter use.

The effectiveness of repellents will depend on several factors. Rainfall will dissipate some repellents, so reapplication may be necessary after a rain. Some repellents do not weather well even in the absence of rainfall. The deer’s hunger and the availability of other food will have a great effect on success. In times of food stress, deer are more likely to ignore both taste and odor repellents.

Several repellents are available and sold under a variety of trade names. Taste repellents often contain **capsaicin** (the “hot” in hot peppers) or **thiram** (a fungicide). Odor repellents may contain **egg solids** and may be combined with taste repellents such as capsaicin. When using a commercial preparation, follow the manufacturer’s instructions. One of the few repellents registered for use on edible crops contains **ammonium soaps** of high fatty acids as the active ingredients. Most repellents—such as thiram, for example—are primarily used on dormant trees and shrubs. Others, such as many capsaicin formulations, may **not** be applied to fruit-bearing plants after fruit set or to vegetable plants after the edible parts develop. Repellents may be applied by spraying, brushing, or dipping, depending on the label instructions.

Human hair in bags is an odor repellent that costs very little but has not consistently repelled deer. Place two handfuls of hair in fine-mesh bags (onion bags, nylon stockings). Where severe damage occurs, hang hair bags on the outer branches of each tree with no more than 3 feet between bags. For larger areas, hang several bags, 3 feet apart, from a fence or cord around the area. Attach the bags early in spring and replace them monthly throughout the growing season. Hair can be obtained from local barber shops or salons.

Ordinary **bars of soap** can be applied in the same manner as hair bags to reduce deer damage. Drill a hole in each bar and suspend it with a twist tie or soft cord. Each bar appears to protect a radius of about 1 yard. Any inexpensive brand of bar soap will work.

Live Capture

In special cases, such as city parks, refuges, or suburban neighborhoods, it may be necessary or desirable to capture deer alive and move them to other areas. Deer can be captured safely with rocket nets, drop-door box traps, or tranquilizer guns, but these techniques are expensive and time-consuming, and they require the expertise of a professional wildlife biologist.

Live capture and relocation is seldom a practical alternative unless delicate public relations problems mandate live removal as the only choice. In addition to high costs, the survival of relocated deer is usually low.

Shooting

Effective use of the legal deer season is probably the best way to control deer populations. Shooting permits may be issued for the removal of problem deer where they are causing damage during non-hunting season periods.

SNAKES

Most snakes are non-poisonous, harmless, and beneficial. But few people want them in their homes. In general, poisonous snakes have a large triangular head, a pit between the eye and nostril, and vertical and elliptical pupils. They may also have rattles on their tail, noticeable fangs, and a single row of scales between the vent (anal opening) and the tip of the tail. When unsure, assume that the snake may be poisonous and protect yourself accordingly. The only poisonous snake found in Michigan is the eastern massasauga rattlesnake (*Sistrurus catenatus*). Encountering other poisonous snakes in Michigan is highly unlikely.

Snakes are predators. Depending on the species, their diet may include insects, rodents, frogs, birds, worms, and toads. Snakes hibernate in dens during the winter, sometimes under houses. At certain times of the year, they may enter buildings for warmth, shade, or moisture, or in search of prey. When managing a snake problem, keep in mind that the snake may be a protected species in Michigan.



Figure 5.22. Garter snake, *Thamnophis sirtalis*

Control and Management of Snakes

If snakes are a regular problem, the best solution is to eliminate snake hiding places.

- Clean up brush piles, woodpiles, rock piles, and other debris.
- Keep shrubbery away from foundations.
- Cut high grass.

Often, snake problems follow rodent problems. Eliminate the rodents—the snakes' food—and the snakes will move elsewhere.

- Eliminate rodent food and harborage.
- Mow grass short to expose rodent runs.

Snakes often enter structures through broken block foundations, cracked mortar, and damaged vents. These should be repaired, sealed, or blocked with ½-inch hardware cloth.

In a rattlesnake-infested area, a snake-proof fence can be installed around a backyard or play area.

- Bury galvanized 36-inch-wide, ¼-inch-mesh hardware cloth 6 inches in the ground and slant outward at a 30 degree angle.
- Keep all vegetation away from the fence.

Snake removal. If a snake gets into a house or other building, several methods are available to remove it:

- Place damp burlap sacks on the floor and cover them with dry sacks. Check them every few hours to see if the snake has crawled underneath. The snake and bags can be lifted with a shovel and taken outside. The snake can be killed or released.
- Rat glue boards will capture all but the largest snakes. The glue boards should be tied down or attached to a plywood base. Place the glue boards along wall and floor junctions. Captured snakes may be killed or released. To release, pour vegetable oil over the snake and glue to loosen it.
- Expanded trigger rat traps set in pairs along wall and floor junctions can kill smaller snakes.

SUMMARY

Almost any vertebrate animal may become a pest by wandering where it is not wanted. Sometimes it will leave by itself; at other times, it will need to be controlled. There are many non-lethal alternatives to managing vertebrate pests. During the non-hunting season, exclusion is the preferred method to control deer. Live trapping is the most common solution for vertebrates such as raccoons, skunks, and opossums. Be aware of state or local laws regarding the release of trapped animals in other areas. There may be concerns about the spread of disease (rabies, in particular). In these cases, the trapped animal must be killed or turned over to wildlife officials.

CHAPTER
5

Review Questions

Chapter 5: Other Vertebrate Pests

- Which of the following is true about bats?
 - They are usually beneficial to the environment.
 - Most feed on animal blood.
 - Many feed on insects.
 - A and C
- Two diseases associated with bats are:
 - Rabies and histoplasmosis.
 - Histoplasmosis and cryptococcosis.
 - Rabies and cryptococcosis.
 - Leptospirosis and histoplasmosis.
 - Rabies and leptospirosis.
- When bat-proofing, seal all upper openings that bats use that are:
 - 1/8 inch or larger.
 - 3/8 inch or larger.
 - 5/8 inch or larger.
 - 1 inch or larger.
 - 1 1/2 inches or larger.
- List some areas you would inspect on a building to find bat exit and entry points.
- The best time to control bats is in:
 - Midsummer and late winter.
 - Late fall and late winter.
 - Early fall and midsummer.
 - Early fall and early winter.
- Young bats begin to fly and leave the roost in June and July.
 - True
 - False
- Which may be used to repel bats?
 - Ultrasonic devices
 - Bright lights
 - Naphthalene flakes
 - Sticky repellents
 - B & C
- Always wear a respirator while working in a bat roost.
 - True
 - False
- List some materials needed for bat-proofing.
- Which of the following is true about moles?
 - Trapping is the most effective control measure.
 - Poison bait is the most effective control measure.
 - Moles feed on grass roots.
 - A and C
- What is the procedure for trapping moles?
- Control of skunks, raccoons, and opossums almost always involves exclusion or live trapping.
 - True
 - False
- Which is true about skunks?
 - Mostly active during the day
 - Hibernate in winter
 - May live under houses
 - May transmit rabies
 - C & D
- Which is NOT true about opossums?
 - May hiss, growl and bite if cornered
 - Less intelligent than skunks and raccoons
 - Sometimes play dead
 - Mostly active at night
 - A & B

15. Describe the procedure for excluding a skunk or raccoon living under a building.
16. Which of the following statements is true concerning trapping skunks, raccoons, or opossums?
- Trapped animals should always be released at least 10 miles away.
 - Traps should be checked every 48 hours.
 - Set only one trap at a time.
 - All of the above
17. To release a trapped skunk, open the door, then run away quickly.
- True
 - False
18. Which is NOT true about cottontail rabbits in North America?
- They usually live only 12 to 15 months.
 - They dig their own burrows.
 - They produce two to three litters per year in northern regions.
 - They live in natural cavities and other animal burrows.
 - A&C
19. Which is NOT characteristic of damage caused by rabbits?
- Young tulip shoots eaten as they emerge in spring.
 - Young landscape plants clipped off at snow height in winter.
 - Carrots, peas, and beets eaten down to ground level.
 - Gnawing on bark and clipping off branches of woody plants.
 - Peppers, squash, and tomatoes eaten in home gardens.
20. What are the specifications for building a fence to exclude rabbits from a backyard garden? How may young trees and other plants be protected from rabbits?
21. Odor repellents such as naphthalene are usually more effective at discouraging rabbit browsing than taste repellents.
- True
 - False
22. Live trapping is the best way to remove rabbits in cities, parks, and suburban areas.
- True
 - False
23. Which is NOT a problem associated with deer?
- Spread of Lyme disease
 - Collisions with motor vehicles
 - Spread of rabies
 - Damage to ornamental plants
 - Damage to row crops
24. The critical time period for removing a tick before transmission of Lyme disease is:
- 10 to 12 hours.
 - 24 hours.
 - Three days.
 - One week.
25. What is the procedure for removing a feeding tick?
26. What precautions can be taken to prevent tick bites?
27. What are the factors to consider when deciding on the type of fence to build when excluding deer?

28. Which is true concerning temporary electric fencing to control deer damage?
- They are recommended for providing year-round protection for high-value crops.
 - They should be inspected weekly.
 - Two types are the peanut butter fence and the polytape fence.
 - B & C
 - All of the above.
29. Which is true concerning permanent high-tensile electric fencing?
- They are recommended for providing year-round protection for high-value crops.
 - They should be inspected weekly.
 - Two types are the peanut butter fence and the polytape fence.
 - They are more expensive than permanent woven-wire fencing.
 - A & B
- 30-35. Match the following to the appropriate description:
- The peanut butter fence
 - The polytape fence
 - The offset or double fence
 - The seven-wire vertical fence
 - The slanted woven-wire fence
 - The permanent woven-wire fence
- Choose the best type of fence to exclude deer, considering factors such as cost-effectiveness, desires of the client, deer pressure, and size of the area to be protected, for the following situations:**
- ___ 30. A small garden (3 acres) subject to moderate deer pressure; deer need to be excluded in spring and summer only.
- ___ 31. A 30-acre nursery subject to moderate deer pressure; three-dimensional to prevent deer from jumping.
- ___ 32. A 40-acre orchard subject to high deer pressure; year-round protection and easy maintenance are desired.
- ___ 33. Twenty acres of vegetable crops subject to moderate deer pressure; year-round protection and prevention of jumping not required.
- ___ 34. A 40-acre orchard subject to moderate to high deer pressure; year-round protection required, deer jumping not a concern.
- ___ 35. A 30-acre nursery subject to moderate to high deer pressure; year-round protection and prevention of jumping are desired.
36. What are the recommendations for maintaining temporary, permanent, and woven-wire fencing?
37. Four-foot woven-wire cylinders can keep deer from rubbing tree trunks with their antlers.
- True
 - False
38. Which is true about deer repellents?
- Best suited for use on row crops, pastures and other large areas.
 - Area repellents repel deer by taste alone.
 - Best suited for use in orchards, gardens, and on ornamental plants.
 - Success with repellents is measured in total elimination of damage.
 - C & D
39. Describe how contact repellents should be applied in the winter.
40. The effectiveness of deer repellents will depend on factors such as the deer's hunger and food availability, the amount of rainfall, and the weathering ability of the repellent used.
- True
 - False

41. Which is NOT true concerning repellents?
- A. During the growing season, contact repellents should be applied at about half the concentration recommended for winter use.
 - B. In general, contact repellents should not be used on plant parts destined for human consumption.
 - C. If contact repellents are applied in winter, new growth in the spring will also be protected.
 - D. Repellents may be applied by spraying, brushing, or dipping, depending on the label directions. Capsaicin formulations may not be applied to fruit-bearing plants after fruit set or to vegetable plants after the edible parts develop.
 - E. Odor repellents containing egg solids may be combined with taste repellents such as capsaicin.
42. Name two taste repellents and describe how they are used.
43. Name two relatively inexpensive types of odor repellents and describe how they are used.
44. Which of the following are acceptable snake control methods?
- A. Clean up brush piles.
 - B. Use poison snake baits.
 - C. Eliminate rodent food and harborage.
 - D. A & C
45. Inside a home, a snake can be captured by using:
- A. Damp burlap bags.
 - B. Rat glue boards.
 - C. Rat trigger traps.
 - D. A & B
 - E. All of the above

APPENDIX A

ANSWERS TO STUDY QUESTIONS

VERTEBRATE PEST MANAGEMENT

Chapter 1 Legalities of Vertebrate Pest Management

- (1) A pest is any unwanted organism. Vertebrates become pests when they invade structures; when they become outdoor pests of lawns, gardens, crops, etc.; and when they pose a human health risk.
- (2) B (3) D (4) C (5) A (6) C (7) D
- (8) Definition, general description, why pesticide is used, general toxicity information (i.e., compound type, where applied, exposure information, amount/rate applied, label compliance), precautionary measures, and instructions to customer on site preparation, precautions, etc.
- (9) True
- (10) Unless otherwise specified by the product label, applicators must wear long pants, protective footwear, long-sleeved clothing (short-sleeved allowed if wash water or waterless soap is immediately available), and gloves impervious to the pesticide.
- (11) False
- (12) Site evaluation, description, inspection, and monitoring; the concept of threshold levels; the relationship between pest biology and pest management methods; pest population reduction and pest prevention; development and implementation of an IPM program that reduces the possible impact of pesticides; evaluation of an IPM program to determine effectiveness; record-keeping requirements of an IPM program.
- (13) a. None of the above. A permit is not required when means other than hunting, trapping, or pesticide use are used to deter or prevent animal damage.
- b. A special permit and/or referral by a wildlife conservation officer. A general permit allows trapping of beavers only in Zone 3 of Michigan (southern lower Michigan).
- c. None of the above. A permit is not required when means other than hunting, trapping, or pesticide use are used to deter or prevent animal damage.
- d. A general permit or a special permit. A general permit covers the live trapping of pigeons. If pesticides were being used, a Project Control Permit would be required. A special permit would apply, if treated as a single-case situation (i.e., non-holders of general permits may wish to obtain a special permit to control one particular problem).
- e. A general permit or a special permit. A general permit covers the trapping of beavers in Zone 3 of Michigan (southern lower Michigan). A special permit may be used if the trapping were to be done outside of the dates April 1 - September 30, or beavers may be trapped during the designated hunting season with the appropriate license. Non-holders of general permits may also wish to obtain a special permit to control the problem as a single-case situation. Also, when local laws regulate the animal-control situation, a special permit may be required.
- f. A special permit and/or referral by a wildlife conservation officer. Deer are not one of the wild animal species covered by the general permit and cannot be shot during the non-hunting season without a special permit.
- g. A general permit or a special permit. Squirrels are one of the animal species covered by the general permit and may be trapped in residential areas all year long. In areas open to hunting, squirrels may be controlled during the designated hunting/trapping season, or a special permit may be used outside of the dates April 1 - September 30. Non-holders of general permits may wish to obtain a special permit to control a squirrel problem as a single-case situation.
- h. A special permit and/or referral by a wildlife conservation officer. The general permit allows for control of the listed animal species only between April 1 and September 30 when the damage is occurring in non-urban areas open to hunting.
- i. A general permit or a special permit. Weasels are one of the animal species covered by the general permit and may be controlled in areas open to hunting between April 1 and September 30. A special permit may be used when trapping is done outside of these dates, or weasels may be trapped during the designated hunting season with the appropriate license. Non-holders of general permits may also wish to obtain a special permit to control the problem as a single-case situation.
- j. None of the above. A permit is not required when means other than hunting, trapping, or pesticide use are used to deter or prevent animal damage.
- k. A general permit or a special permit. Coyotes are one of the animal species covered by the general permit and may be controlled in areas open to hunting between April 1 and September 30. A special permit

may be used if the trapping were to be done outside of these dates, or coyotes may be trapped during the designated hunting season with the appropriate license. Non-holders of general permits may also wish to obtain a special permit to control the problem as a single-case situation.

l. A special permit and/or referral by a wildlife conservation officer. Bears are not covered by the general permit.

m. None of the above. Chipmunks are a non-game animal and are not protected by any federal or state laws.

(14) a. A general permit, a federal permit, or a special permit/referral. Crows are covered by the general permit. A federal permit is not required when certain blackbirds are “found committing or about to commit depredations upon ... agricultural crops...” However, a federal Depredation Permit may be obtained instead of a general permit. A special permit may be necessary if the shooting is to be done outside of the dates April 1 - September 30, or crows may be shot during the designated hunting season with the appropriate license. Always check local regulations first regarding the discharge of firearms.

b. A Project Control Permit. A Project Control Permit is required when pesticides are being used outside of buildings in non-industrial areas for control of pigeons, starlings, and English sparrows.

c. A general permit. Pesticide use on starlings is covered by the general permit as long as the control is being done in a recognized industrial area.

d. A federal permit. Owls are protected under the federal Migratory Bird Treaty Act.

e. A federal permit. Seagulls are protected under the federal Migratory Bird Treaty Act.

(15) C (16) E

(17) False. It is generally illegal for permittees to sell animals or their parts, but there are certain exceptions, such as when a licensed hunter took the animal parts during the legal hunting season.

(18) C

(19) Belowground common grave:

No more than 250 carcasses/grave.

Each individual carcass should be covered with at least 12 inches of soil within 24 hours after burial.

The common grave should not remain open for more than 30 days and should have at least 4 feet of soil as a final cover.

The number of common graves should not exceed 5 graves per acre.

The carcasses must not come into contact with surface or groundwater and must not be disposed of in a 100-year floodplain or wetland.

The common grave must be located at least 200 feet from any groundwater well.

(20) False. Ecologically, aboveground, belowground, or

through a licensed dead animal dealer is preferred over incineration and landfill disposal.

(21) C

(22) The complainant’s name, address, date of service, service technician, species of nuisance animal, number of each species taken, and the disposition of all animals taken.

Chapter 2 Birds

(1) B (2) D (3) D (4) A (5) D (6) C (7) B
(8) C (9) D (10) True (11) B

(12) E (13) B (14) A (15) A (16) B (17) C (18) A
(19) B (20) B (21) A (22) C (23) C

(24) D

(25) The permittee must contact the Michigan representative of the USDA to obtain guidance and technical advice regarding the methods of controlling nuisance birds without threatening protected species. Prebaiting must be done before bait-type pesticides can be used outside of buildings in non-industrial areas. Treated pesticidal bait cannot be left unattended—a person must be on the site ensuring that non-target species are not being killed. The permittee must also promptly and properly dispose of bird carcasses to ensure that secondary poisoning does not occur (i.e., other animals feeding on dead, poisoned birds).

(26) False. Some local ordinances may prohibit pesticide use for any type of bird control.

(27) C (28) True (29) C (30) E (31) A (32) C
(33) D (34) B (35) F

(36) False. Trapping of pigeons is best in the winter, when their food is at a minimum.

(37) D

(38) False. Sparrow funnel traps are usually more effective when placed on the ground.

(39) D (40) C (41) B (42) D (43) C (44) D

(45) False. Fenthion, the toxicant in toxic perches, is hazardous to all birds and animals, including humans.

(46) False. Non-target birds feeding on Ornitrol-treated bait will also be sterilized.

(47) False. Many local laws protect non-target bird species.

(48) True

(49) False. Remove the protective clothing and place the items in a plastic bag before removing the respirator.

(50) a. Use netting to exclude robins from cherry trees. Netting is effective, and the cost is justifiable when netting is used to protect high-value crops.

b. Use commercial plastic strips to exclude jays from grain storage areas. They provide bird-proof barriers and allow easy access for people.

c. Use monofilament lines to exclude gulls from landfills. Gulls can be successfully repelled with monofilament lines.

(51) Auditory devices: broadcasts of recorded distress or alarm calls (species specific) and propane exploders with timing devices set out in fields. Visual devices: eye-spot balloons tethered in fields, scarecrows, and Mylar reflecting tapes.

Chapter 3 Domestic Rodents

- (1) False. Rabies transmission from rats to humans has never been documented in the United States.
- (2) False. A reservoir of plague exists in some populations of wild rodents in several western states.
- (3) E (4) A (5) D (6) B (7) F (8) C (9) D
(10) E (11) C (12) A (13) B (14) D (15) B (16) B
(17) E (18) B (19) D (20) True
- (21) Rats may be moving toxic bait into a location where the label does not permit it to be. Also rats may be hoarding poison bait while feeding on their regular food. Thus, a bait program becomes ineffective.
- (22) A (23) True (24) A, C, B, D (25) A
- (26) Sanitation (clean food spills, close or repair dumpsters, etc.); eliminate hiding places (remove plant ground covers such as ivy near buildings, reduce clutter in rarely used rooms, etc.); rat-proofing (seal cracks and holes in foundations, block openings around water and sewer pipes, screen air vents, caulk and seal doors, etc.).
- (27) E (28) True
- (29) False. Rodenticides vary from slightly to very toxic to humans. Clients should be cautious about handling even slightly toxic rodenticides.
- (30) C (31) E
- (32) False. The bait box should be left in place for some time so that the rats consider it part of their normal surroundings.
- (33) False. Water baits should be placed where no other animals or children can get to them.
- (34) A
- (35) False. Tracking powders should not be used in suspended ceilings, around air ventilators, or near food or food preparation areas or other places where the powder can become airborne and drift into non-target areas. The main advantage of tracking powders is that they can kill rats even when food and water are plentiful, or if rats have become bait- or trap-shy.
- (36) True
- (37) Bait box should be made of metal or heavy plastic; can be secured to floor, wall, or ground; should be clearly labeled with precautionary statements; should be placed in locations inaccessible to pets, children, etc.
- (38) D (39) True
- (40) False. Mice are so common that the government permits a certain number of rodent hairs, and sometimes droppings, to remain in food commodities destined for human consumption.
- (41) B (42) True

(43) False. Mice do not fear new objects as rats do.

(44) A (45) D (46) D (47) E (48) B

(49) False. Control of house mice is a three-part process involving sanitation, mouse-proofing, and population reduction with traps or toxicants. It is difficult to completely mouse-proof a building because mice can squeeze through openings as little as 1/4 inch in diameter.

(50) True (51) C (52) True (53) A (54) True

(55) False. Tracking powders are especially effective against mice because mice groom themselves more than rats and are more likely to investigate enclosed areas that can be dusted with tracking powder.

(56) C (57) E

(58) Mice can be living above their main food supply in suspended ceilings, in attics, inside vertical pipe runs, and on top of walk-in coolers. Or they can be below, in floor voids, crawlspaces, or under coolers and/or processing equipment.

(59) Store bulk food in mouse-proof containers or rooms; stack packaged food in orderly rows on pallets for easy inspection; keep stored materials away from walls and off the floor; paint a 12- to 18-inch yellow band next to the wall to detect mouse droppings, sweep often.

(60) Seal large holes in buildings; plug holes in foundation walls with steel wool or copper mesh; caulk and fit doors and windows tightly; seal holes around pipes, utility lines, vents, etc.

Chapter 4 Wild Rodents

(1) C (2) A (3) A (4) D

(5) False. Disinfect gloves *before* taking them off.

(6) False. Many people who became ill with HPS reported that they did not see rodents or their droppings. Always take precautions to prevent HPS when working in potentially rodent-infested areas.

(7) E (8) E (9) A (10) B (11) F (12) C
(13) D (14) A

(15) False. Large population fluctuations are characteristic of voles, with populations peaking every two to five years. The cycles are not predictable, however.

(16) False. Rabbits neatly and uniformly clip off branches with slanting cuts. Vole gnaw marks are smaller and non-uniform and occur at various angles and in irregular patches.

(17) B

(18) Eliminate weeds, ground cover, and litter in and around crops, lawns, and cultivated areas. Mow lawn regularly. Clear mulch 3 feet or more from the bases of trees. Tilling soil removes cover, destroys existing runway-burrow systems, and kills some voles directly.

(19) Zinc phosphide is available in pelleted and grain bait formulations and as a concentrate. Zinc phosphide baits can be broadcast at rates of 6 to 10 pounds per

acre, or placed by hand in runways and burrow openings (reduces hazard to ground-feeding birds). Zinc phosphide kills with a single dose. Anticoagulant baits require multiple feedings and 5 to 15 days to take effect. They may be applied broadcast or by hand, or in various types of bait containers. One type of container is a water-repellent tube with the anticoagulant bait glued to the inside surface. The advantage of using bait containers is that they reduce the likelihood of non-target animals and children consuming bait.

(20) B

(21) Squirrels can be excluded from buildings by using heavy gauge 1/2-inch hardware cloth or sheet metal to seal most openings. Placing 2-foot sections of 2- to 3-inch-diameter plastic pipe can stop squirrels from travelling on wires. The pipes rotate on the wire and the squirrels tumble off (be careful near high voltage wires). All tree branches should be trimmed back 10 feet from buildings. If the branches can't be trimmed, a 2-foot-wide band of metal fastened around a tree 6 to 8 feet off the ground keeps squirrels from climbing up the tree.

(22) True (23) True (24) C (25) C (26) E

(27) A (28) D (29) E

(30) Fences should be at least 3 feet high and made of heavy woven wire. The lower edge should be buried 10 to 12 inches in the ground or bent into an L-shaped angle leading outwards and buried in the ground 1 to 2 inches. An electric wire may be placed 4 to 5 inches off the ground and the same distance outside the fence to prevent climbing and burrowing. The top 15 inches of the wire fence should bend outward at a 45 degree angle to prevent climbing over. In some instances, an electric wire placed 4 to 5 inches above the ground with no fencing is enough to deter woodchucks.

(31) False. Gas cartridges should not be placed under wooden sheds or other combustible materials.

(32) Two to four tablets are placed deep in the main burrow. The burrow openings should be plugged with crumpled newspapers and then packed with loose soil. The burrows must be sealed tightly without covering the tablets with soil. The treatment site should be inspected 24 to 48 hours later and opened burrows should be retreated. The aluminum phosphide tablets work by producing phosphine gas in the presence of moisture. Therefore, it is critical to ensure a tightly sealed burrow system. Unused tablets should be stored in their original container in a cool, dry, locked, and well ventilated room. They must be protected from moisture, open flames, and heat.

(33) D (34) C (35) E

(36) The inside face of the dam should be built at a 3 to 1 slope with a top width of not less than 8 feet, preferably 10 to 12 feet. The normal water level in the pond should be at least 3 feet below the top of the dam, and the spillway should be wide enough that

heavy rainfalls will not increase the level of the water for any length of time.

(37) Fill dens, burrows, and runs, and riprap the dam with stone. Once the water is drawn down, trap or otherwise remove all muskrats.

(38) Zinc phosphide baits are made by applying a vegetable oil sticker to cubes of apples, sweet potatoes, or carrots, and then sprinkling on the toxicant and mixing thoroughly. The bait is often placed on floating platforms, in burrow entrances, or on feeding houses. Use caution when mixing and applying baits, and follow label directions carefully. Anticoagulant baits may be available and are often made of paraffin mixed with grain and pesticide. They are placed in burrows or feeding houses or the pesticide may be in a grain mixture placed inside floating bait boxes.

(39) A special body-gripping trap is available for muskrats that will kill them instantly in 6 inches of water or deeper. A stake is used to set the trap in place. Leghold traps are also available and may be set in the run, the house, or the den entrance, or even under a feeding house.

Chapter 5 Other Vertebrate Pests

(1) D (2) A (3) B

(4) Look for loose flashing, vents, shingles, or siding that bats can squeeze through or under. Look for damage and openings under eaves and soffits, at cornices, louvers, and doors, by chimneys and windows, and places where pipes and wiring enter. Remember that twilight is the best time to observe bats leaving a building to feed.

(5) B

(6) False. The young can not fly and stay in the roost in June and July.

(7) E (8) True

(9) Quarter-inch hardware cloth, screening, sheet metal, caulking, expanding polyurethane foam, steel wool, and duct tape.

(10) A

(11) Tramp down mole tunnels in several places over the yard. Mark tramped-down sections with a peg or wire flag. If the tunnel has been pushed back up in the next day or so, a trap should be set in that place. Place a plastic pail with a warning sign over each trap. Three to five traps per acre are required. Check the traps every couple of days. If there are no results after 3 to 4 days, move the traps to new locations.

(12) True (13) E (14) B

(15) Seal all openings under the building except one. Sprinkle a tracking patch of talc at the opening. Examine the area after dark. If tracks show that the animal has left, close this last opening immediately.

(16) A

(17) False. To release a trapped skunk, stand more than 20

- feet away and release the trap door using a string or fishing line.
- (18) B (19) E
- (20) Use a fence of 2-foot chicken wire (1-inch or smaller mesh) with the bottom tight to the ground or buried a few inches. Cylinders of 1/4-inch hardware cloth are used to protect valuable young trees or landscape plants. The cylinders should extend higher than a rabbit's reach while it's standing on the expected snow depth, and stand 1 to 2 inches out from the tree trunk. Commercial tree guards or tree wrap are also available. A dome or cage of chicken wire secure over a small flowerbed will protect vulnerable plants such as tulips.
- (21) False. Taste repellents are usually more effective than odor repellents.
- (22) True (23) C (24) A
- (25) First dab the tick with alcohol. Ticks sometimes pull their mouthparts out if feeding has just started. If the tick does not release, take tweezers and grasp the tick at the skin level (near the tick's head), not the back end of the tick. Grasping the tick at the back end, or heating it, can force disease organisms into the wound. Place the tick in alcohol or otherwise keep it for identification. If the tick is identified as a deer tick, see a physician. Be sure to note the date of tick removal.
- (26) Wear long pants tucked into socks while working or hiking in tick habitat (wear light-colored clothing so that ticks can be more easily detected). Use insect repellents on clothes and skin. Do not use formulations with over 20 to 30 percent active ingredient on skin. Use permethrin formulations that are labeled for use as a repellent on clothes. They withstand washing and remain effective. Schedule regular body inspections for ticks at noon and at bedtime. Nymphal deer ticks are smaller than adults but can be seen with close inspection.
- (27) The history of past deer numbers and extent of damage, deer pressure (i.e., the number of deer and their level of dependence on agricultural crops), the value of the crop, and the field size.
- (28) D (29) E (30) A (31) C (32) F (33) B (34) D (35) E
- (36) Control vegetation near fences by mowing or applying herbicides to avoid excessive fence grounding by weeds. On slopes or highly erodible soils, maintain a good sod cover beneath fences to avoid fenceline erosion. Always keep the fence charger on. Check the fence voltage weekly with a voltmeter. Maintain at least 3,000 volts at the farthest point from the fence charger on high-tensile, woven-wire fences. Disconnect the lower wires if they are covered by snow. In the fall and early summer, adjust the fence tension for high-tensile fences. Always remember to attach warning signs to electric fences.
- (37) True (38) C
- (39) Apply contact repellents on a dry day in winter or the dormant season when temperatures are above freezing. Treat young trees completely. It is more economical to treat only the terminal growth of older trees. Be sure to treat to a height of 6 feet above expected maximum snow depth.
- (40) True (41) C
- (42) Capsaicin (the "hot" in hot peppers) formulations may not be applied to fruit-bearing plants after fruit set or to vegetable plants after the edible parts develop. Thiram (a fungicide) is used primarily on dormant trees and shrubs (not edible crops). When using a commercial preparation, follow the manufacturer's instructions. Repellents may be applied by spraying, brushing, or dipping, depending on the label instructions.
- (43) Human hair in bags is an odor repellent. Place two handfuls of hair in fine-mesh bags (onion bags, nylon stockings). Where severe damage occurs, hang hair bags on the outer branches of trees with no more than 3 feet between bags. For larger areas, hang several bags, 3 feet apart, from a fence or cord around the area. Attach the bags early in spring and replace them monthly throughout the growing season. Hair can be obtained from local barber shops or salons. Also, inexpensive bars of soap can be applied in the same manner as hair bags to reduce deer damage. Drill a hole in each bar and suspend it with a twist tie or soft cord to act as an odor repellent.
- (44) D (45) E

APPENDIX B

GLOSSARY

Glossary of Terms for Vertebrate Pest Management

ABSORPTION—The movement of a chemical into plants, animals (including humans), and/or microorganisms.

ACTIVE INGREDIENT—The chemical or chemicals in a pesticide responsible for killing, poisoning, or repelling the pest. Listed separately in the ingredient statement.

ACUTE TOXICITY—The capacity of a pesticide to cause injury within 24 hours following exposure. LD₅₀ and LC₅₀ are common indicators of the degree of acute toxicity. (See also *chronic toxicity*.)

ADJUVANT—A substance added to a pesticide to improve its effectiveness or safety. Same as additive. Examples: penetrants, spreader-stickers, and wetting agents.

ADSORPTION—The process by which chemicals are held or bound to a surface by physical or chemical attraction. Clay and high organic soils tend to adsorb pesticides.

AEROSOL—A material stored in a container under pressure. Fine droplets are produced when the material dissolved in a liquid carrier is released into the air from the pressurized container.

ANTI-SIPHONING DEVICE—A device attached to the filling hose that prevents backflow or back-siphoning from a spray tank into a water source.

ANTICOAGULANT—A chemical that prevents normal blood clotting; the active ingredient in some rodenticides.

ANTIDOTE—A treatment used to counteract the effects of pesticide poisoning or some other poison in the body.

ATTRACTANT—A substance or device that will lure pests to a trap or poison bait.

AVICIDE—A pesticide used to kill or repel birds. Birds are in the class Aves.

AREA REPELLENT—A compound that discourages pests from entering the area to be protected by its disagreeable odor. (See *repellent* and *contact repellent*.)

BACTERIA—Microscopic organisms, some of which are capable of producing diseases in plants and animals. Others are beneficial.

BAIT—A food or other substance used to attract a pest to a pesticide or to a trap.

BARRIER APPLICATION—Application of a pesticide in a strip alongside or around a structure, a portion of a structure, or any object.

BIOLOGICAL CONTROL—Control of pests using predators, parasites, and/or disease-causing organisms. May be naturally occurring or introduced.

BIOMAGNIFICATION—The process whereby one organism accumulates chemical residues in higher concentrations from organisms it consumes.

BRAND NAME—The name or designation of a specific pesticide product or device made by a manufacturer or formulator; a marketing name.

CALIBRATE, CALIBRATION OF EQUIPMENT, OR APPLICATION METHOD—The measurement of dispersal or output and adjustments made to control the rate of dispersal of pesticides.

CARBAMATES (N-methyl carbamates)—A group of pesticides containing nitrogen, formulated as insecticides, fungicides, and herbicides. The N-methyl carbamates are insecticides and inhibit *cholinesterase* in animals.

CARCINOGENIC—The ability of a substance or agent to induce malignant tumors (cancer).

CARRIER—An inert liquid, solid, or gas added to an active ingredient to make a pesticide dispense effectively. A carrier is also the material, usually water or oil, used to dilute the formulated product for application.

CERTIFIED APPLICATORS—Individuals who are certified to use or supervise the use of any restricted-use pesticide covered by their certification.

CHEMICAL NAME—The scientific name of the active ingredient(s) found in the formulated product. This complex name is derived from the chemical structure of the active ingredient.

CHEMICAL CONTROL—Pesticide application to kill pests.

CHEMOSTERILANT—A chemical compound capable of preventing animal reproduction.

CHEMTREC—The Chemical Transportation Emergency Center has a toll-free number (800-424-9300) that provides 24-hour information for chemical emergencies such as a spill, leak, fire, or accident.

CHLORINATED HYDROCARBON—A pesticide containing chlorine, carbon, and hydrogen. Many are per-

sistent in the environment. Examples: chlordane, DDT, methoxychlor. Few are used in structural pest management operations today.

CHOLINESTERASE, ACETYLCHOLINESTERASE—An enzyme in animals that helps regulate nerve impulses. This enzyme is depressed by N-methyl carbamate and organophosphate pesticides.

CHRONIC TOXICITY—The ability of a material to cause injury or illness (beyond 24 hours following exposure) from repeated, prolonged exposure to small amounts. (See also *acute toxicity*.)

COMMERCIAL APPLICATOR—A certified applicator who uses or supervises the use of any pesticide classified for restricted use for any purpose or on any property other than that producing an agricultural commodity.

COMMON NAME—A name given to a pesticide's active ingredient by a recognized committee on pesticide nomenclature. Many pesticides are known by a number of trade or brand names, but each active ingredient has only one recognized common name.

COMMUNITY—The various populations of animal species (or plants) that exist together in an ecosystem. (See also *population* and *ecosystem*.)

CONCENTRATION—Refers to the amount of active ingredient in a given volume or weight of formulated product.

CONTACT REPELLENT—A compound that keeps pests away through taste—i.e., the pest must make contact with the substance for it to be effective. (See *repellent* and *area repellent*.)

CONTAMINATION—The presence of an unwanted substance (sometimes pesticides) in or on plants, animals, soil, water, air, or structures.

CRAWLSPACE—A shallow space below the living quarters of at least a partially basementless house, normally enclosed by the foundation wall.

CULTURAL CONTROL—A pest control method that includes changing human habits—e.g., sanitation, work practices, cleaning and garbage pickup schedules, etc.

DECONTAMINATE—To remove or break down a pesticidal chemical from a surface or substance.

DEFECT ACTION LEVELS—The maximum levels for defects such as the presence of insect fragments, mold, or rodent hairs in food products allowed by the Food and Drug Administration (FDA).

DEGRADATION—The process by which a chemical compound or pesticide is reduced to simpler compounds by the action of microorganisms, water, air, sunlight, or other agents. Degradation products are usually, but not always, less toxic than the original compound.

DEPOSIT—The amount of pesticide on treated surfaces after application.

DERMAL TOXICITY—The ability of a pesticide to cause acute illness or injury to a human or animal when absorbed through the skin. (See *exposure route*.)

DETOXIFY—To render a pesticide's active ingredient or other poisonous chemical harmless.

DIAGNOSIS—The positive identification of a problem and its cause.

DILUENT—Any liquid, gas, or solid material used to dilute or weaken a concentrated pesticide.

DISINFECTANT—A chemical or other agent that kills or inactivates disease-producing microorganisms. Chemicals used to clean or surface-sterilize inanimate objects.

DOSE, DOSAGE—Quantity, amount, or rate of pesticide applied to a given area or target.

DRIFT—The airborne movement of a pesticide spray or dust beyond the intended target area.

DUST—A finely ground, dry pesticide formulation containing a small amount of active ingredient and a large amount of inert carrier or diluent such as clay or talc.

ECOSYSTEM—The pest management unit. It includes a community (of *populations*) with the necessary physical (*harborage*, moisture, temperature) and biotic (food, hosts) supporting factors that allow an infestation of pests to persist.

EMULSIFIABLE CONCENTRATE—A pesticide formulation produced by mixing or suspending the active ingredient (the concentrate) and an emulsifying agent in a suitable carrier. When added to water, a milky emulsion is formed.

EMULSIFYING AGENT (EMULSIFIER)—A chemical that aids in the suspension of one liquid in another that normally would not mix together.

EMULSION—A mixture of two liquids that are not soluble in each other. One is suspended as very small droplets in the other with the aid of an emulsifying agent.

ENCAPSULATED FORMULATION—A pesticide formulation with the active ingredient enclosed in capsules of polyvinyl or other materials; principally used for slow release.

ENDANGERED SPECIES—A plant or animal species whose population is reduced to the extent that it is near extinction and that a federal agency has designated as being in danger of becoming extinct.

ENTRY INTERVAL—See *re-entry interval*.

ENVIRONMENT—All of our physical, chemical, and biological surroundings, such as climate, soil, water, and air, and all species of plants, animals, and microorganisms.

ENVIRONMENTAL PROTECTION AGENCY OR EPA—The federal agency responsible for ensuring the protection of humans and the environment from potentially adverse effects of pesticides.

EPA ESTABLISHMENT NUMBER—A number assigned to each pesticide production plant by the EPA. The number indicates the plant at which the pesticide

product was produced and must appear on all labels of that product.

EPA REGISTRATION NUMBER—An identification number assigned to a pesticide product when the product is registered by the EPA for use. The number must appear on all labels for a particular product.

ERADICATION—The complete elimination of a (pest) population from a designated area.

EXPOSURE ROUTE OR COMMON

EXPOSURE ROUTE—The manner (dermal, oral, or inhalation/respiratory) by which a pesticide may enter an organism.

FIFRA—The Federal Insecticide, Fungicide, and Rodenticide Act; a federal law and its amendments that control pesticide registration and use.

FLASHING—Strips of aluminum, lead, tin, or copper that are worked into the slates or shingles around dormers, chimneys, and other rising parts of buildings to prevent leaking.

FLOWABLE—A pesticide formulation in which a very finely ground solid particle is suspended (not dissolved) in a liquid carrier.

FORMULATION—The pesticide product as purchased, containing a mixture of one or more active ingredients, carriers (inert ingredients), and other additives making it easy to store, dilute, and apply.

FUMIGANT—A pesticide formulation that volatilizes, forming a toxic vapor or gas that kills in the gaseous state. Usually, it penetrates voids to kill pests.

GENERAL-USE (UNCLASSIFIED) PESTICIDE—A pesticide that can be purchased and used by the general public. (See also *restricted-use pesticide*.)

GRANULE—A dry pesticide formulation. The active ingredient is either mixed with or coated onto an inert carrier to form a small, ready-to-use, low-concentrate particle that normally does not present a drift hazard. Pellets differ from granules only in their precise uniformity, larger size, and shape.

GROUNDWATER—Water sources located beneath the soil surface from which spring water, well water, etc., are obtained. (See also *surface water*.)

HARBORAGE—Any place or site that shelters and provides other elements (i.e., food, water) required for survival of a particular organism.

HAZARD—See risk.

HERBICIDE—A pesticide used to kill plants or inhibit plant growth.

HOST—Any animal or plant on or in which another lives for nourishment, development, or protection.

INERT INGREDIENT—In a pesticide formulation, an inactive material without pesticidal activity.

INGREDIENT STATEMENT—The portion of the label on a pesticide container that gives the name and

amount of each active ingredient and the total amount of inert ingredients in the formulation.

INHALATION—Taking a substance in through the lungs; breathing in. (See *exposure route*.)

INSPECTION—To examine for pests, pest damage, other pest evidence, etc. (See *monitoring*.)

INTEGRATED PEST MANAGEMENT (IPM)—A planned pest control program in which various methods are integrated and used to keep pests from causing economic, health-related, or aesthetic injury. IPM includes reducing pests to a tolerable level. Pesticide application is not the primary control method but is an element of IPM, as are cultural and structural alterations. IPM programs emphasize communication, monitoring, inspection, and evaluation (keeping and using records).

JOIST—One of a series of parallel beams, usually 2 inches in thickness, used to support floor and ceiling loads, and supported in turn by larger beams, girders, bearing walls, or foundation.

LABEL—All printed material attached to or on a pesticide container.

LABELING—The pesticide product label and other accompanying materials that contain directions that pesticide users are legally required to follow.

LC₅₀—**Lethal concentration.** The concentration of a pesticide, usually in air or water, that kills 50 percent of a test population of animals. LC₅₀ is usually expressed in parts per million (ppm). The lower the LC₅₀ value, the more acutely toxic the chemical.

LD₅₀—**Lethal dose.** The dose or amount of a pesticide that can kill 50 percent of the test animals when eaten or absorbed through the skin. LD₅₀ is expressed in milligrams of chemical per kilogram of body weight of the test animal (mg/kg). The lower the LD₅₀, the more acutely toxic the pesticide.

LEACHING—The movement of a substance with water downward through soil.

MATERIAL SAFETY DATA SHEETS (MSDS)—These data sheets contain specific information on toxicity, first aid, personal protective equipment, storage and handling precautions, spill and leak cleanup and disposal practices, transportation, physical data, and reactivity data. MSDS are available from manufacturers.

MODE OF ACTION—The way in which a pesticide exerts a toxic effect on the target plant or animal.

MONITORING—On-going surveillance. Monitoring includes inspection and record keeping. Monitoring records allows technicians to evaluate pest population suppression, identify infested or non-infested sites, and manage the progress of the management or control program.

NON-RESIDUAL PESTICIDE—Pesticides applied to obtain effects only during the time of treatment.

NON-TARGET ORGANISM—Any plant or animal other than the intended target(s) of a pesticide application.

ORAL TOXICITY—The ability of a pesticide to cause injury or acute illness when taken by mouth. One of the common exposure routes.

ORGANOPHOSPHATES—A large group of pesticides that contain the element phosphorus and inhibit cholinesterase in animals.

PARASITE—A plant, animal, or microorganism living in, on, or with another living organism for the purpose of obtaining all or part of its food.

PATHOGEN—A disease-causing organism.

PERSONAL PROTECTIVE EQUIPMENT (PPE)—Devices and clothing intended to protect a person from exposure to pesticides. Includes such items as long-sleeved shirts, long trousers, coveralls, suitable hats, gloves, shoes, respirators, and other safety items as needed.

PEST MANAGEMENT—The reduction of pest populations to tolerable numbers by changing practices, making habitat or structural alterations, and carefully using pesticides to kill pests only when indicated.

PEST—An undesirable organism (plant, animal, bacterium, etc.); any organism that competes with people for food, feed, or fiber, causes structural damage, is a public health concern, reduces aesthetic qualities, or impedes industrial or recreational activities.

PESTICIDE—A chemical or other agent used to kill, repel, or otherwise control pests or to protect from a pest.

pH—A measure of the acidity/alkalinity of a liquid—acid below pH7; basic or alkaline above pH7 (up to 14).

PHEROMONE—A substance emitted by an animal to influence the behavior of other animals of the same species. Examples are sex pheromones (to attract mates) and aggregation pheromones (to keep members of the same species together in a group). Some pheromones are synthetically produced for use in insect traps

PHOTODEGRADATION—Breakdown of chemicals by the action of light.

PHYSICAL CONTROL—Altering habitat or changing the infested physical structure—e.g., caulking holes, cracks, tightening around doors, windows, moisture reduction, ventilation, etc.

PHYTOTOXICITY—Injury to plants caused by a chemical or other agent.

POISON CONTROL CENTER—A local agency, generally a hospital, that has current information on the proper first aid techniques and antidotes for poisoning emergencies. Centers are listed in telephone directories.

POPULATION—Individuals of the same species. The populations in an area make up a community. (See *ecosystem*.)

PRECIPITATE—A solid substance that forms in a liquid and settles to the bottom of a container; a material that no longer remains in suspension.

PREDATOR—An animal that attacks, kills, and feeds on other animals. Examples of predaceous animals are hawks, owls, snakes, many insects, etc.

PROPELLANT—The inert ingredient in pressurized products that forces the active ingredient from the container.

RAFTER—One of a series of structural members of a roof designed to support roof loads. The rafters of a flat roof are sometimes called roof joists.

RATE OF APPLICATION—The amount of pesticide applied to a plant, animal, unit area, or surface; usually measured as per acre, per 1,000 square feet, per linear foot, or per cubic foot.

READY-TO-USE PESTICIDE—A pesticide that is applied directly from its original container consistent with label directions, such as an aerosol insecticide or rodent bait box, which does not require mixing or loading prior to application.

RE-ENTRY INTERVAL—The length of time following an application of a pesticide when entry into the treated area is restricted.

REGISTERED PESTICIDES—Pesticide products that have been registered by the Environmental Protection Agency for the uses listed on the label.

REPELLENT—A compound that keeps insects, rodents, birds, or other pests away from humans, plants, domestic animals, buildings, or other treated areas. (See *area* and *contact repellent*.)

RESIDUAL PESTICIDE—A pesticide that continues to remain effective on a treated surface or area for an extended period following application.

RESIDUE—The pesticide active ingredient or its breakdown product(s) that remain in or on the target after treatment.

RESTRICTED-USE PESTICIDE—A pesticide that can be purchased and used only by certified applicators or persons under their direct supervision. A pesticide classified for restricted use under FIFRA, Section 3(d)(1)(C).

RISK—A probability that a given pesticide will have an adverse effect on humans or the environment in a given situation.

RODENTICIDE—A pesticide used to control rodents.

RUNOFF—The movement of water and associated materials on the soil surface. Runoff usually proceeds to bodies of surface water.

SOFFIT—The underside of an overhanging part or member (especially on the roof) of a building.

SIGNAL WORDS—Required word(s) that appear on every pesticide label to denote the relative toxicity of the product. Signal words are DANGER-POISON, DANGER, WARNING, and CAUTION.

SILL PLATE—A horizontal member anchored on top of a masonry wall.

SITE—Areas of pest infestation. Each site should be treated specifically or individually.

SOLUTION—A mixture of one or more substances in another substance (usually a liquid) in which all the ingredients are completely dissolved. Example: sugar in water.

SOLVENT—A liquid that will dissolve another substance (solid, liquid, or gas) to form a solution.

SPACESPRAY—A pesticide that is applied as a fine spray or mist to a confined area.

SPOT TREATMENT—Application of a pesticide to limited areas where pests are likely to be found. A method used to avoid contact of pesticides with food, utensils, or people.

STOMACH POISON—A pesticide that must be eaten by an animal to be effective; it will not kill on contact.

SURFACE WATER—Water on the earth's surface: rivers, lakes, ponds, streams, etc. (See also *ground-water*.)

SUSPENSION—Pesticide mixtures consisting of fine particles dispersed or floating in a liquid, usually water or oil. Example: wettable powders in water.

TARGET—The plants, animals, structures, areas, or pests at which the pesticide or other control method is directed.

THRESHOLD—A level of pest density. The number of pests observed, trapped, counted, etc., that could be tolerated without an economic loss or aesthetic injury. Pest thresholds in structural pest management may be site-specific—for example, different numbers of cockroaches may be tolerated at different sites (e.g., hospitals and garbage rooms). A threshold may be set at zero (e.g., termites in a wooden structure, flies in an operatory).

TOLERABLE LEVELS OF PESTS—The presence of pests at certain levels is tolerable in many situations. Totally eliminating pests in certain areas is sometimes not achievable without major structural alterations, excessive control measures, unacceptable disruption, unacceptable cost, etc. Pest levels that depend on pest observations vary. The tolerable level in some situations will be zero (e.g., termites). Structural pest management programs usually have lower tolerable levels of pests than agricultural programs.

TOXIC—Poisonous to living organisms.

TOXICANT—A poisonous substance such as the active ingredient in a pesticide formulation.

TOXICITY—The ability of a pesticide to cause harmful, acute, delayed, or allergic effects. The degree or extent to which a chemical or substance is poisonous.

TOXIN—A naturally occurring poison produced by plants, animals, or microorganisms. Examples: the poison produced by the black widow spider, the venom produced by poisonous snakes, and the botulism toxin produced by a bacterium.

TRACKING PATCHES—A non-toxic dust (clay, talc, or powdered limestone) placed in suspected rodent runways and used to detect rodent tracks and estimate the numbers of rodents present.

TRACKING POWDER—Diluted rodenticide in dust form. It is applied to areas where rodents live and travel and sticks to their feet and fur. The tracking powder kills rodents when they swallow it while grooming themselves.

USE—The performance of pesticide-related activities requiring certification include application, mixing, loading, transport, storage, or handling after the manufacturer's seal is broken; care and maintenance of application and handling equipment; and disposal of pesticides and their containers in accordance with label requirements. Uses not needing certification are long-distance transport, long-term storage, and ultimate disposal.

VAPOR PRESSURE—The property that causes a chemical to evaporate. The higher the vapor pressure, the more volatile the chemical and the easier it will evaporate.

VECTOR—A carrier, an animal (e.g., insect, nematode, mite) that can carry and transmit a pathogen from one host to another.

VERTEBRATE—Animal characterized by a segmented backbone or spinal column.

VIRUS—Ultramicroscopic parasites composed of proteins. Viruses can multiply only in living tissues and cause many animal and plant diseases.

VOLATILITY—The degree to which a substance changes from a liquid or solid state to a gas at ordinary temperatures when exposed to air.

WATER TABLE—The upper level of the water-saturated zone in the ground.

WETTABLE POWDER—A dry pesticide formulation in powder form that forms a suspension when added to water.

For the further definition of terms, consult:

Pesticide Applicator Core Training Manual, E-2195, Michigan State University Extension.

The Federal Insecticide, Fungicide, and Rodenticide Act as amended. Public Law 92-516, October 21, 1972, as amended by Public Law 94-140, November 28, 1975, and Public Law 95-396, September 30, 1978.

Federal Register, November 7, 1990, Part II Environmental Protection Agency 40, CFR Part 171, Certification of Pesticide Applicator; Proposed Rule.

Region V Office of the EPA, Chicago, Ill.

Michigan Department of Agriculture State Plan for Commercial and Private Applicators.

Local, state, and national pest control associations.

APPENDIX C: DNR Permit Forms



MICHIGAN DEPARTMENT OF NATURAL RESOURCES
WILDLIFE DIVISION

WILDLIFE DAMAGE AND NUISANCE CONTROL APPLICATION AND PERMIT

By authority of Part 401 of Act 451, P. A. of 1994, as amended, an approved permit is required for all Wildlife Damage and Nuisance Control Commercial Operators. Failure to comply with the provisions of this Act is a violation of State law and may result in the revocation of this permit, fine, and/or imprisonment. See permit regulations in Information Circular Number 9152.

This is not a valid permit until approved and signed by the MDNR Director's authorized representative.

All information must be typed or printed (except written signatures). Apply firm pressure when writing. Verify legibility on all copies.

Name of Business: _____	Nuisance Control Business Telephone Number: (____) _____
Name of Applicant: _____	Applicant's Home Telephone Number: (____) _____
Business Address: _____	Applicant's Work Telephone Number: (____) _____
City, State & Zip Code: _____	County of Business Location: _____

PERMIT TYPE & REQUIREMENTS: (Check one box)

- New.** Applicant (except public agencies) must attach a "Certificate of Person Conducting Business Under Assumed Name" from the County Clerk where the business is located. **General Permit** applicants must also attach a category 7A or 7D Pesticide Applicator's License from the Michigan Department of Agriculture.
- Amended, Permit No. _____.** Changes to business / applicant name, address, or telephone numbers are identified above.
- Renewal, Permit No. _____.** Applicant must complete and attach signed Renewal Report (PR2004-1). **General Permit** applicants must also attach a current category 7A or 7D Pesticide Applicator's License.

PERMIT CLASSIFICATION: Restricted and General permits are subject to all provisions of this permit, Sections 5.50 to 5.55 of the Wildlife Conservation Order and Information Circular Number 9152. Permittee is authorized to control damage and nuisance caused by wild animals as stipulated in Section 5.52. (Check one box)

- RESTRICTED WILDLIFE DAMAGE AND NUISANCE CONTROL PERMIT (Restricted to Non-Pesticide Methods Only)**
- GENERAL WILDLIFE DAMAGE AND NUISANCE CONTROL PERMIT (Pesticides Allowed):** In addition to the provisions above, also subject to the "Rules and Regulations Governing the Operation of Pest Control Operators" and labeled directions for application of pesticides. Control of the wild animals listed in Subsection 5.52(3) may include pesticides if used in accordance with all regulations governing the use of pesticides. Permittee must have a current Commercial Pesticide Applicator's License in the category 7A or 7D issued by the Michigan Department of Agriculture before this permit is valid.

LIABILITY. Permittee hereby releases, waives, discharges and covenants not to sue, the State of Michigan, its departments, officers, employees and agents, from any and all liability to Permittee, its officers, employees and agents, for all losses, injury, death or damage, and any claims or demands therefore, on account of injury to person or property, or resulting in death of Permittee, its officers, employees or agents, whether caused by the State of Michigan, its departments, officers, employees or agents, in reference to the activities of this permit.

INDEMNIFICATION. Permittee hereby covenants and agrees to indemnify and save harmless, the State of Michigan, its departments, officers, employees and agents, from any and all claims and demands, for all loss, injury, death or damage, that any person or entity may have or make, in any manner, arising out of any occurrence related to (1) this permit; (2) the activities authorized by this permit; and (3) the use or occupancy of the premises which are the subject of this permit, as well as any other state-owned lands. This indemnification and save harmless agreement shall extend to all loss, injury, death or damage, proximately caused or arising out of the negligence of the State of Michigan, its departments, officers, employees and agents.

I have read and understand the regulations on this form and Information Circular Number 9152 and agree to abide by those regulations. To the best of my knowledge, the information supplied by me is true and correct. I understand that this permit does not provide any authorization to circumvent any federal, state, local zoning, or any other local laws and ordinances. I understand it is my responsibility to know and comply with all federal, state, and local laws. I certify that I am not ineligible by state law, court order, or administrative ruling to secure or possess a hunting, trapping or fur dealer's license.

Applicant's Signature

Date

Staple required documents per Permit Type above (Certificate, License, Renewal Report) to completed application set **and Mail To:** → → →

WILDLIFE DIVISION
MICHIGAN DEPARTMENT OF NATURAL RESOURCES
PO BOX 30444
LANSING MI 48909-7944

FOR DNR USE ONLY			
This Permit Is: <input type="checkbox"/> Approved <input type="checkbox"/> Denied		Permit Number	
Issue Date	Expiration Date	District Number	
_____ Signature of Director's Authorized Representative			

DISTRIBUTION FOR APPROVED PERMITS: White - Permittee Canary - Wildlife Division
Pink - District Law Goldenrod - Dept. of Agriculture (General Permits Only)

PR 2004 (Rev. 11/04/1998)

APPENDIX C: DNR Permit Forms



MICHIGAN DEPARTMENT OF NATURAL RESOURCES - WILDLIFE DIVISION

WILDLIFE DAMAGE AND NUISANCE CONTROL ACTIVITY/RENEWAL REPORT

By authority of Part 401 of Act 481, PA of 1994, as amended. Failure to comply with the provisions of this Act is a violation of State law and may result in permit revocation, fine, and/or imprisonment.

Your current permit will expire on March 31, 1998. This report of your control activities for calendar years 1996, 1997 and 1998 is required and due by February 1, 1998. Species other than those specifically listed under Section 5.62 (3) of the Wildlife Conservation Order are not authorized for control under this permit and shall not be listed on this report. Attach additional sheets if necessary. Staple this report to the enclosed application (FR 2004) whether or not you are renewing your permit. If you do not wish to renew your permit, indicate that on the application. Your permit cannot be renewed without submitting this report in accordance with the instructions on this form. Retain a copy of this report for your records. Type or print all information, except your signature.

Name of Business:		Permit Number:	
State of Permittee:		Business Telephone Number: ()	
Business Address:		Permittee's Home Telephone Number: ()	
City, State & Zip Code:		Permittee's Work Telephone Number: ()	

SPECIES	NUMBER OF COMPLAINTS	HANDLING METHOD (number of Animals)					DISPOSAL METHOD (number of Animals)		
		Shot	Steel Trap	Live Trap	Poison	Other	Released	Killed	Legally Sold
1									
8									
9									
8									

SPECIES	NUMBER OF COMPLAINTS	HANDLING METHOD (number of Animals)					DISPOSAL METHOD (number of Animals)		
		Shot	Steel Trap	Live Trap	Poison	Other	Released	Killed	Legally Sold
1									
9									
9									
7									

SPECIES	NUMBER OF COMPLAINTS	HANDLING METHOD (number of Animals)					DISPOSAL METHOD (number of Animals)		
		Shot	Steel Trap	Live Trap	Poison	Other	Released	Killed	Legally Sold
1									
8									
9									
8									

Staple completed report to application and Mail To:
WILDLIFE DIVISION
MICHIGAN DEPARTMENT OF NATURAL RESOURCES
PO BOX 30444
LANSING MI 48299-7844

To the best of my knowledge, the information provided is true and correct.

Permittee's Signature _____ Date _____

FR 2004-1 (1/18/98)

APPENDIX C: DNR Permit Forms



MICHIGAN DEPARTMENT OF NATURAL RESOURCES, WILDLIFE DIVISION

PROJECT CONTROL APPLICATION AND PERMIT

Under the authority of Part 401 of Public Act 451 of 1994 and Sections 5.50 to 5.55 of the Wildlife Conservation Order.

This application is required for the placement of any pesticides outside of buildings in any non-industrial area, i.e., any area where non-target species are likely to be present. This application is not required for control work in industrial area, i.e., areas where non-target species are not likely to be present.

PROJECT AREA (Check one): Non-Industrial Area Industrial Area (Project Control Application and Permit NOT required.)

Apply firm pressure • Verify legibility on all four copies • Type or print all information, except signature.

APPLICANT INFORMATION BUSINESS NAME	DATE OF APPLICATION
APPLICANT NAME	TELEPHONE NUMBER
ADDRESS	DNR PERMIT NUMBER
CITY, STATE, ZIP	PESTICIDE APPLICATOR LICENSE NUMBER

LOCATION OF PROJECT BUSINESS NAME (if any)		COUNTY
ADDRESS	PROPOSED PESTICIDE	
CITY, STATE, ZIP	<input type="checkbox"/> AVITROL TREATED WHOLE CORN	
NEAREST MAJOR INTERSECTION	<input type="checkbox"/> FENTHIONE 1100	
	<input type="checkbox"/> OTHER (Specify)	

NATURE AND EXTENT OF DAMAGE

PROJECT DATES	SPECIES OF BIRDS CREATING DAMAGE
PRE-BAITING DATES _____ through _____	<input type="checkbox"/> PIGEONS
PESTICIDE BAITING DATES _____ through _____	<input type="checkbox"/> STARLINGS
	<input type="checkbox"/> ENGLISH SPARROWS

If approved, Permittee is authorized to control damage and nuisance caused by the species indicated above by use of the pesticide indicated above at the location indicated above. Permittee is subject to the "Rules and Regulations Governing the Operation of Pest Control Operators" and must follow labeled directions for application of pesticide. Permittee must have a current Commercial Pesticide Applicators License in the category 7A or 7D issued by the Michigan Department of Agriculture before this permit is valid. Failure to have such license will render this permit null and void. Baiting must be in such a manner so as not to endanger protected, nontarget birds and animals. Baiting must cease if threats to nontarget birds and animals exist. Daily surveillance and removal of dead birds is required. Violation of the conditions of this permit shall cause this permit to be revoked. This permit expires on the date indicated below unless sooner revoked.

LIABILITY: Permittee hereby releases, waives, discharges and covenants not to sue the State of Michigan, its departments, officers, employees and agents, from any and all liability to Permittee, its officers, employees and agents, for all losses, injury, death or damage, and any claims or demands therefore, on account of injury to person or property, or resulting in death of Permittee, its officers, employees or agents, whether caused by the State of Michigan, its departments, officers, employees or agents, in reference to the activities of this permit.

INDEMNIFICATION: Permittee hereby covenants and agrees to indemnify and save harmless, the State of Michigan, its departments, officers, employees and agents, from any and all claims and demands, for all loss, injury, death or damage, that any person or entity may have or make, in any manner, arising out of any occurrence related to (1) this permit; (2) the activities authorized by this permit; and (3) the use or occupancy of the premises which are the subject of this permit, as well as any other state-owned land. This indemnification and save harmless agreement shall extend to all loss, injury, death or damage, proximately caused or arising out of the negligence of the State of Michigan, its departments, officers, employees and agents.

Signature of Applicant	Date
------------------------	------

RETURN COMPLETED FORM TO:

WILDLIFE DIVISION
MICHIGAN DEPARTMENT OF NATURAL RESOURCES
PO BOX 30444
LANSING MI 48909-7944

FOR DNR USE ONLY

AUTHORIZATION IS: <input type="checkbox"/> APPROVED <input type="checkbox"/> DISAPPROVED			
ISSUE DATE	EXPIRATION DATE	PERMIT NO.	DISTRICT NO.
SIGNATURE OF AUTHORIZED REPRESENTATIVE			DATE

DISTRIBUTION: White: Permittee, Canary: Wildlife Division, Pink: District Law, Goldenrod: Dept. of Agriculture

PR-2002
(Rev. 10/20/97)

APPENDIX D

DAMAGE PREVENTION AND CONTROL METHODS

Vertebrate Pest	Exclusion	Habitat Modification or Cultural Methods	Repellents/Frightening Devices	Toxicants/Lethal Alternatives	Trapping
Pigeon	Screen eaves, vents, windows, doors, and other openings with ¼-inch-mesh hardware cloth. Attach sharp metal projections such as porcupine wires to roosting sites. Change angle of roosting ledge to 45 degrees or more.	Eliminate food supply. Destroy nests. Discourage people from feeding pigeons in public areas. Clean up spilled grain around elevators, feed mills, and railcar cleanout areas. Eliminate standing water.	Tactile: various non-toxic sticky repellents; odor: naphthalene flakes.	Oral: toxic baits (Avitrol); contact: toxic perches.	Various types of live traps.
House sparrow	Block entrances larger than ¼ inch. Design new buildings or alter old ones to eliminate roosting and nesting places. Install plastic bird netting or overhead lines to protect high-value crops. Sharp metal projections such as porcupine wires to prevent roosting.	Remove roosting sites. Plant bird-resistant varieties.	Sticky repellents.	Toxic perches.	Funnel traps.
European starling	Close all openings larger than 1 inch. Place covering at 45 degree angle on ledges. Porcupine wires on ledges or rafters. Netting to prevent roosting on building beams or to protect fruit crops.	Reduce availability of food and water; remove spilled grain and standing water; use bird-proof feeders and storage facilities.	Tactile: sticky repellents. Frightening devices including distress or alarm calls, various sound-producing devices, bright lights.	Toxic baits. Toxic perches.	Various types of live traps.
Norway rat	Seal all openings larger than ½ inch wide.	Good sanitation practices reduce sources of food, water, and shelter. Store foodstuffs in rodent-proof structures or containers. Store and dispose of refuse and garbage properly. Control weeds and remove debris from around structures.	Naphthalene may be of some value. One EPA-registered product is available to discourage gnawing on trees, poles, fences, etc.	Many anticoagulant rodenticides registered; also some acute or chronic poisons.	Snap traps. Live traps. Glue boards.
House mouse	Seal all openings larger than ¼ inch wide.	See Norway rat.	See Norway rat.	See Norway rat.	See Norway rat.

Vertebrate Pest	Exclusion	Habitat Modification or Cultural Methods	Repellents/Frightening Devices	Toxicants/Lethal Alternatives	Trapping
Vole	Hardware cloth (½-inch mesh or less) cylinders to exclude voles from seedlings and young trees.	Eliminate ground cover to reduce populations. Soil cultivation destroys burrows and reduces cover.	Uncertain effectiveness.	Zinc phosphide, anticoagulants.	Mouse snap traps; live traps.
Tree squirrel	Use heavy gauge ½-inch hardware cloth or sheet metal to seal most openings to buildings. Install 2-foot sections of 2- to 3-inch-diameter plastic pipe on wires to prevent travelling. Install sheet metal bands on isolated trees to prevent damage to developing nuts. Generally not practical.	Remove selected trees or their branches to prevent access to structures.	Naphthalene; at least one sticky repellent registered.	No toxicant registered.	Various types of live traps; rat snap traps.
Ground squirrel		Destroy burrows and habitat by deep soil tillage. Provide alternative foods. Plant crops as early as possible before squirrels emerge from hibernation.	No repellent registered.	Zinc phosphide; fumigants; gas cartridges and aluminum phosphide.	Live traps; rat snap traps.
Chipmunk	Rodent-proof construction; use ½-inch hardware cloth to exclude chipmunks from gardens and flower beds.	Store food items, such as bird seed and dog food, in rodent-proof containers. Ground covers, shrubs, and woodpiles should not be located adjacent to structure foundations.	Taste repellents applied to flower bulbs, seeds, and vegetation may control feeding damage; naphthalene applied in confined places.	No toxicant registered.	Live traps; rat-sized snap traps; glue boards.
Wood-chuck	Buried welded or woven-wire fences. Single-strand electric fences.	Exclusion, fumigants, and trapping are the most common methods of control.	No repellent registered.	Fumigants: gas cartridges and aluminum phosphide; shooting effective where legal and safe.	Various types of live traps.
Muskrat	Riprap the inside of a pond dam face with rocks, or slightly overbuild the dam to certain specifications.	Eliminate aquatic vegetation as a food source. Draw down farm ponds during the winter months.	No repellent registered.	Zinc phosphide; anticoagulants (state registrations only); shooting effective to eliminate some individuals.	Body-gripping traps, leg-hold traps.

Vertebrate Pest	Exclusion	Habitat Modification or Cultural Methods	Repellents/Frightening Devices	Toxicants/Lethal Alternatives	Trapping
Bats	Bat-proofing—initiate control before young are born or after they are able to fly.	Build alternative roost (bat house) away from human high-use areas.	Naphthalene: limited efficacy; illumination; drafts of cool air.	No toxicant registered.	Use insect net to remove a single bat.
Mole	Generally not practical.	Packing the soil destroys burrows and sometimes moles if done in early morning or late evening. Use of insecticides discourages moles by reducing their food source.	No repellent registered.	A few products registered in some states.	Harpoon traps and choker traps.
Skunk	Buildings: close cellar and outside basement and crawlspace doors; seal and cover all openings including window wells and pits. Usually the best method for coping with almost all types of raccoon damage (see skunk).	Remove garbage, debris, and lumber piles.	No repellent registered—mothballs recommended by some.	No toxicant registered. Shooting practical only when far from residential areas.	Various types of live traps.
Raccoon	Practical where opossums are entering structures (see skunk).	Remove obvious sources of food or shelter around the premises.	No repellent registered.	No toxicant registered. Shooting effective when legal and safe.	Various types of live traps.
Opossum	Low fences effective around gardens or shrubs. Hardware cloth cylinders will protect fruit trees and ornamental plants.	Remove cover and plug burrows to reduce frequency of visits.	No repellent registered.	No toxicant registered. Shooting effective when legal and safe.	Various types of live traps.
Rabbits	Fences: 8-foot woven wire, electric, etc. Tree protectors: woven wire or plastic cylinders.	Remove brush piles, debris, dumps, and other cover.	Many taste repellents available.	No toxicant registered. Shooting effective; check state and local regulations.	Various types of live traps.
Deer	Construct a snake-proof fence; seal entrances to buildings and structures.	Plant trees and shrubs that are resistant or less susceptible to deer damage. Harvest crops as early as possible to reduce vulnerability. Lure crops may divert deer away from areas susceptible to damage.	Repellents: a wide variety of commercial formulations are available.	No toxicant registered. Shooting during the legal hunting season; special permit required at other times.	Live capture and removal by professional biologists in special cases.
Snakes		Eliminate snake shelter; control rodents that attract snakes.	No repellent registered.	No toxicant registered.	Glue boards; burlap bags.

APPENDIX E

SELECTED BIBLIOGRAPHY

Selected References in Pest Management and Control

General Pest Control References

- Bennett, G.W., J.M. Owens, and R.M. Corrigan. 1997. Truman's Scientific Guide to Pest Control Operations (5th ed.). Cleveland, Ohio: Purdue University/Advanstar Communications.
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- Hygnstrom, S.E., R.M. Timm, and G.E. Larson (eds.). 1994. Prevention and Control of Wildlife Damage. Lincoln, Nebraska: University of Nebraska Cooperative Extension Service, USDA-APHIS, Great Plains Agricultural Council Wildlife Committee.
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- Selected Subject References** (subjects are in bold print).
- Bennett, G.W., and J.M. Owens (eds). 1986. Advances in Urban **Pest Management**. New York: Van Nostrand Reinhold Company.
- Bottrell, D.G. 1979. Integrated **Pest Management**. Washington, D.C.: Council on Environmental Quality.
- Greenholl, A.M. 1982. House **Bat** Management Resource Publication 143. Washington, D.C.: U.S. Department of the Interior, Fish and Wildlife Service.
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- Marsh, R.E., and W.E. Howard. 1981. The **Rat**: Its Biology and Control Leaflet 2896. Berkeley, Calif.: University of California Extension Service.
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- National Pest Control Association. 1982. Encyclopedia of **Structural Pest Control** (7 volumes). Dunn Loring, Va.: NCPA.
- National Pest Control Association. **Pest Control Publications**. Publications Resource Center, 8100 Oak St., Dunn Loring, VA 22027.
- National Pest Control Association **Sanitation** Committee. 1972. Sanitation and Pest Control Floor-level **Inspection** Manual. Vienna, Va.: NPCA.
- Pratt, H.D., B.F. Bjornson, and K.S. Littig. Manual 11, Control of Domestic **Rats and Mice**. Communicable Disease Control, Homestudy Course 86-8396. Atlanta, Ga.: Vectorborne Disease Control Health and Human Services.
- Pratt, H.D., and R.Z. Brown. Manual 10, Biological Factors in Domestic **Rodent Control**. Communicable Disease Control, Homestudy Course 86-8396. Atlanta, Ga.: Vectorborne Disease Control Health and Human Services. .
- Reigart, J.R., and J.R. Roberts. 1999. Recognition and Management of **Pesticide Poisoning** (5th ed.). Washington, D.C.: U.S. Environmental Protection Agency.
- Schoenherr, W. 1972. A Guide to Good Manufacturing Practices for the **Food Industry**. Danville, Ill.: Lauhoff Grain Co.

Strickland, R.K., R.R. Gerrish, J.L. Hourrigan, and G.O. Schubert. 1976. *Ticks of Veterinary Importance*. Agric. Handbook No. 485. Washington, D.C.: USDA.

Trade Magazines

Pest Control. P.O. Box 6215, Duluth, MN 55806-9915.

Pest Control Technology. P.O. Box 5817, Cleveland, OH 44101-9599

Pest Management. National Pest Control Association, 8100 Oak St., Dunn Loring, VA 22027.

Trade Newsletter for Pest Control Technicians

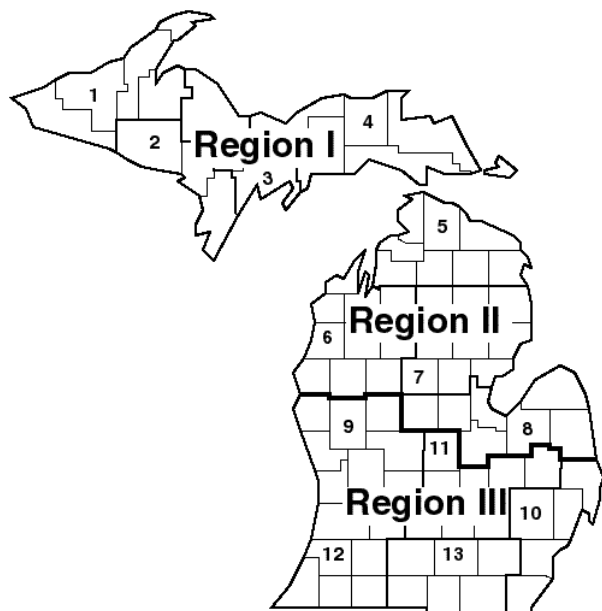
Techletter Pinto and Associates, Inc., 29839 Oak Road, Mechanicsville, MD 20659-2201; phone (301) 884-3020.

APPENDIX F

RESOURCES

Questions?

For more information, contact: Permit Coordinator, DNR, Wildlife Division, Box 30444, Lansing, MI 48909-7944, 517-373-1263, or a district wildlife or law enforcement supervisor at one of the following locations:



Region I

District 1: North US-41
Box 440
Baraga, MI 49908
906-353-6651

District 2: 1420 Hwy. US-2 West
Crystal Falls, MI 49920
906-875-6622

District 3: 6833 Hwy. 2, 41 and M-35
Gladstone, MI, 49837
906-786-2351

District 4: Box 77 - RR#1
South M-123 nr M-28
Newberry, MI 49868
906-293-5131

Region II

District 5: Box 667
1732 West M-32
Gaylord, MI 49735
517-732-3541

District 6: 8015 Mackinaw Trail
Cadillac, MI 49601
616-775-9727

District 7: Box 939
191 S. Mt. Tom Road
Mio, MI 48647
517-826-3211

District 8: 503 North Euclid
Suite 1
Bay City, MI 48706
517-684-9141

Region III

District 9: State Office Building
Sixth Floor
350 Ottawa Street, N.W.
Grand Rapids, MI 49503

District 10: 38980 Seven Mile Road
Livonia, MI 48152
313-953-0241

District 11: 10650 S. Bennett
Morrice, MI 49080
616-685-6851

District 13: 301 E. Louis Glick Hwy.
Jackson, MI 49201
517-780-7900

Web site for Material Safety Data Sheets:
<http://www.ilpi.com/msds/index.shtml>



PESTICIDE EMERGENCY INFORMATION

For any type of an emergency involving a pesticide, immediately contact the following emergency information centers for assistance.

Current as of December 1998



Human Pesticide Poisoning

MICHIGAN POISON CONTROL SYSTEM

From anywhere in Michigan, call

1 - 8 0 0 - P O I S O N 1
1 - 8 0 0 - 7 6 4 - 7 6 6 1

Special Pesticide Emergencies

Animal Poisoning

Your veterinarian:

Phone No.

or

Animal Health Diagnostic Laboratory (Toxicology) Michigan State University:

(517) 355-0281

Phone No.

and

Fire Marshal Division, Michigan State Police: M-F: 8-12, 1-5

(517) 322-1924

* **Telephone Number Operated 24 Hours**

Pesticide Fire

Local fire department:

Traffic Accident

Local police department or sheriff's department:

Phone No.

and

Operations Division, Michigan State Police:

***(517) 336-6605**

Environmental Pollution

Pollution Emergency Alerting System (PEAS), Michigan Department of Environmental Quality:

District/DEQ Office Phone No.

and

For environmental emergencies:

***1-800-292-4706**

also

***1-800-405-0101**

Michigan Department of Agriculture Spill Response

Pesticide Disposal Information

Michigan Department of Environmental Quality, Waste Management Division.

Monday - Friday: 8 a.m.-5 p.m.

(517) 373-2730

National Pesticide Telecommunications Network

Provides advice on recognizing and managing pesticide poisoning, toxicology, general pesticide information and emergency response assistance. Funded by EPA, based at Oregon State University

7 days a week; excluding holidays 6:30 a.m. - 4:30 p.m. Pacific Time Zone

1-800-858-7378
FAX: 1-541-737-0761



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New 10:99-2,000-KMF-Mb , Price \$10.70, for sale only. (Pesticide Applicator Certification)