Vertebrate Pests

Learning Objectives:

After reading Vertebrate Pests, the trainee should be able to:

- Identify, compare and contrast characteristics of young and adult rats and mice.
- •. Identify a venomous versus non-venomous snake.
- •. List key signs that identify the type of vertebrate pest species that is causing problems.
- •. Describe the best method, or combination of methods, for addressing a particular vertebrate pest problem.
- Know key characteristics of vertebrate pest species as they relate to control techniques. For example, know the behaviors of roof and Norway rats and understand how these behaviors affect bait selection and placement.
- •. Describe the tools (e.g., baits, traps) for administering control techniques for a specific vertebrate pest species.
- Compare the effectiveness of various control techniques for vertebrate pest control.
- Know common names of rodenticides and their classification, types of formulations and safety precautions.
- Know the legal restrictions, if any, for taking vertebrate pest species and the agency or agencies legally responsible for the pest species' management.
- Describe steps of action if bitten by a snake, skunk, bat or other vertebrate pest species.
- Know diseases and health hazards associated with a particular vertebrate pest species.

An animal with a backbone or spinal column is called a vertebrate. Humans, dogs, snakes and birds are examples of vertebrates, while insects, worms 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 increase in number, pose a health or safety risk or cause property damage. A skunk in the woods is a beneficial part of nature; a skunk denning in the crawlspace of a home is an entirely different matter.

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 those who feed them daily. These constituents react angrily to any attempt to poison or trap pigeons.

People feel a strong attachment towards vertebrates that they do not feel towards other pests. Children in particular love and cherish them. Many people today are involved emotionally in the welfare of animals, particularly domestic pets, and in conserving wildlife. Control of vertebrates, other than rats and mice, can be more of a public relations problem than a pest problem. Killing is the method of last resort and, in some circumstances, is illegal.

Public concern for the welfare of animals and the risk from vertebrate poisons to people, pets and other nontarget animals have made rules governing vertebrate pest control particularly strict. Laws and regulations at the state and local level may be much more restrictive than federal regulations. Be sure you understand all the regulations that apply where you work.

Bats

Arkansas is home to 16 bat species. State law protects all bat species, but the federally endangered Indiana bat (*Myotis sodalis*), gray bat (*Myotis grisescens*) and Ozark big-eared bat (*Corynorhinus townsendii ingens*) receive additional state and federal protection. It is illegal to kill, harm, harass or possess these endangered mammals. Removing bats requires special expertise and skills. The Arkansas Game and Fish Commission periodically offers specialized training on bat removal to pest and nuisance wildlife control operators. For more information, contact the nongame mammal program coordinator at 1-800-364-4263.

Single Bats in Buildings

If a bat enters a home or building, simply turn off the lights and open a few doors or windows leading to the outside, and allow the bat to leave on its own. Chasing or swatting bats causes undue

panic for the flying mammals and people alike. If opening windows and doors doesn't do the trick, the bat can be caught in a butterfly net. Always wear thick leather gloves when netting or capturing a bat. If the bat is resting on a wall or curtain, place a coffee can or large bowl slowly over it while sliding a piece of cardboard between the bat and the wall. The bat should be released in an elevated position such as a tree branch or wall. Unlike birds, bats have to drop and catch air under their wings before they can fly.

Bat Colonies

If a bat colony is in an occupied building, seal entrances into the home's living space. Some people decide to let a small colony remain in attics or under eaves. Additional measures may not be necessary unless bat droppings become a problem, or there is a concern about bats coming into direct contact with people or pets. To remove the bat colony, you will need to develop a plan for excluding bats without trapping them within the structure. For difficult problems, contact the Arkansas Game and Fish Commission's bat biologist for advice.

To clean an attic after relocating a bat colony, sprinkle diatomaceous earth in the roost area to eliminate any parasites that remain. Thoroughly spray bat droppings with water to reduce the amount of dust and prevent spreading spores from *Histoplasma capsulatum* that can cause histoplasmosis. Histoplasmosis is an infectious, non-contagious disease that originates from a fungus that lives in bat and bird droppings. Exposure to this fungus is widespread in Arkansas, although the vast majority of infected people have no ill effects. Some may require medical attention for respiratory problems that develop 3 to 17 days after exposure. If large amounts of bat droppings are to be removed, take precautions against inhaling airborne particles. Use a respirator mask that filters particles of two microns in diameter or smaller. For more information, contact the Arkansas Department of Health or your county Extension office for the publication titled "Histoplasmosis Control" (MP 268).

Bat Control Techniques

The best bat control technique is preventing their entry into the building. Bat-proofing should be conducted in the spring before bats enter the roost or the fall after young bats leave. Bat-proofing should never be attempted from May through August when the youngsters are in the roost. Bat-proofing at this time could lead to health risks and odor problems as the young bats will die and decay, not to mention ethics and the legality of harming and killing bats. Carefully evaluate your situation and develop a strategy, perhaps using several of the bat-proofing techniques described below:

(1) Seal entrances.

With as little as a 3/8-inch wide crack, bats can gain entry through an open window, an unscreened chimney, a gap in an outside wall, roof overhangs, loose vents, openings where electrical wire boxes or water pipes enter the house or openings between drop siding. Once bats are evicted, screen or tape their entrances, plug holes with steel wool or a copper mesh or gauze and fill cracks with expanding foam insulation or caulking. To observe where bats are entering or exiting, station several people around the building so that all sides can be seen about 30 minutes before dark or one hour before dawn. Watch for about an hour, noting where they are flying in or out. If no bats are seen, try another evening when the weather conditions are different. Observers should be as quiet as possible. A flashlight can be used, but direct the main part of the beam away from where bats are exiting, as this may cause them to stay inside the building.

(2) Install one-way doors.

Do **not** use one-way doors from May through August when flightless young bats are present. You can make your own one-way door from heavy plastic, bird netting or wire screening (Figure 7-1). If using plastic or bird netting, make a strip at least 2 feet wide and extend it at least 2 feet below where bats exit. The material should be stapled or taped several inches above the exit. Let the remaining material hang about a foot to each side and below the exit. The bats should have enough space to drop down and exit but unable to fly up and reenter the building. Another alternative is to use 1/4- to 1/2-inch wire screening or plastic mesh to cover the exit. The screening should cover the width of the hole and extend approximately 3 feet below the hole, so the bat can crawl down the screening and exit from the bottom. The screening can be secured to the building with tape or staples. Remove the one-way door after three or four days and seal the opening.

Figure 7-1. One-way doors allow bats to exit a building but prevent their reentry.

(3) Install polypropylene bird netting.

Netting for excluding birds from agricultural crops and fruit trees may be a practical exclusion device in some situations for bats. The netting can be draped over parts of a building in April or May when the bats begin arriving, then removed and stored until the next spring. Check local markets for bat netting products sold in self-contained kits.

(4) Provide alternative housing.

Advise the client to consider installing alternative housing for bats. Once bats are excluded, they have to find somewhere else to live or they will die. In one instance, bats had lived in an attic before bat-proofing began roosting under the eaves near their old exit. A bat box was installed, and the bats took residence in this alternative structure. Ideally, bats should be allowed to investigate a new bat house well in advance of bat-proofing a building in the fall. It is best if a standard bat box can be installed near the bats' entry to the building. Bats are very loyal to traditional roosting sites. By providing a bat box, those returning in the spring may be less inclined to find another entry into the building where they previously roosted.

For more information about bat box design and placement, contact:

- Your local Cooperative Extension Service office (*www.uaex.edu*) and ask for the publication titled "Bats in and Around Your Home" (FSA9088).
- Arkansas Game and Fish Commission's Web site (www.agfc.com) or call (501-223-6300) and order *Woodworking for Wildlife* for other wildlife structures.
- Bat Conservation International (www.batcon.org) is an organization dedicated to preserving bats and their habitats through partnerships with government agencies, research and education. BCI publications include *BATS* magazine, *The Bat House Builder's Handbook* and educators' packages about bats (1-800-538-BATS).
- Contact the Organization for Bat Conservation (517-339-5200, www.batconservation.org) which offers a number of educational materials and information about bats and bat house designs.

Implementing multiple techniques is the best approach to bat-proofing your home. When young bats are not present, seal all but a few bat entrances and install one-way doors in the remaining entrances. This allows bats to leave but not return.

Bats and Rabies

Rabies is the most important public health hazard associated with bats, although the incidence of transmission is very rare. Bat Conservation International reports that more humans die annually from being attacked by domestic dogs than from encounters with bats. Despite this low incidence, a sick bat is a risk for rabies and should be avoided. Sick bats are active during the daytime or are found on the ground and incapable of flying. A bat found on the ground is not necessarily rabid, but don't tempt bats by touching them, as bats are more likely to bite if touched. If bitten or scratched by a bat, wash the affected area with soap and water, and seek immediate medical attention. Try capturing the bat without damaging its head, so that it can be tested for rabies. Modern treatment for rabies is normally safe, relatively painless and very effective. A lack of treatment can result in death, so get prompt treatment after exposure.

Birds

Almost all species of songbirds are federally protected migratory species. It is illegal to destroy the birds, their eggs or nests without federal and sometimes state permits. Exceptions are pigeons, starlings and house sparrows. Although more bird

control methods are available for these species, precautions should be taken to avoid harming nontarget bird species. It is illegal to kill or harm all other songbirds without obtaining appropriate permits. For additional information, contact USDA Wildlife Services office in Little Rock (501-378-5382) or Stuttgart (870-673-1121).

It is important that bird species be identified positively prior to applying a method or technique. Clients may misidentify bird species. “Blackbirds” could refer to red-winged blackbirds, starlings, grackles or brown-headed cowbirds. Some techniques may be illegal for particular species of songbirds. Use a bird field guide, the internet or a local bird expert to identify target and non-target bird species. Pigeons, house sparrows and starlings are three primary pest bird species that will be discussed in this section.

Pigeons

Pigeons, also called rock doves, are gregarious and may congregate in flocks of a hundred or more. They were introduced to the United States as a domesticated bird, but many escaped. They have become the most common bird pest associated with people. Although primarily seed or grain eaters, in urban areas pigeons feed on garbage, spilled grains, insects and food left by outdoor diners and bird lovers who intentionally feed pigeons bread, peanuts and cookie crumbs.

Pigeons feed, roost and loaf in each other’s company 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 to be 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 sun bathing. Sunbathing is most common in the morning of cool days.

Pigeons prefer flat and smooth surfaces on which to rest and feed. Unlike most birds, they will feed from rooftops, regardless of height, because they like open feeding areas that permit a speedy get-away. They also feed on open ground and occasionally on 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.

Starlings

European starlings are black-colored birds often lumped with other “blackbird” species. Adults have light speckles on their feathers in winter. Their feathers turn glossy purplish-black and green in summer. They have a yellow bill from January to June, which is dark at other times. Starlings have relatively short tails and appear somewhat chunky and humpbacked. The wings have a triangular shape when stretched out in flight.

Starlings are pests because of their high numbers. They were brought from Europe and released in New York City in 1890 and 1891 by an individual who wanted the continent to have all of the birds mentioned in Shakespeare’s works. 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 as to become a health hazard. Starlings have been responsible for outbreaks of a number of diseases.

Leaving their evening roost at sunrise, they travel to feeding sites over well-established flight lines. When returning to the roost just before sundown, they “stage” on high perches such as trees, power lines, bridges and towers. The birds may remain on pre-roost sites until after sunset, singing and calling to each other.

House Sparrows

The house sparrow, also called the English 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 streaked back. House sparrows were introduced to the United States in the 1850s and can be found all over the continent. They are not to be confused with native sparrows that are slim, brown birds with buff or white streaks. However, rarely do native sparrows cause problems around buildings.

House sparrows can be pests in many situations. Their droppings contaminate stored grain and bulk food. Droppings and feathers make hazardous, unsanitary and smelly wastes inside and outside of buildings, on sidewalks and under roosting sites. The birds cause damage by pecking at rigid foam insulation in buildings. They are a factor in the transmission of a number of diseases, internal parasites and ectoparasites.

Bird Control Techniques

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

- What bird species are present?
- How many?
- Are they resident or migrant birds?
- Are they juveniles or adults?
- 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 nontarget birds, other wildlife, pets or children?
- What are the legal considerations?
- Could there be public relations problems?
- Is exclusion or habitat modification practical?

Some techniques are effective for a number of bird species, while others may apply to only one or two. Table 7-1 lists selected pest bird species and techniques that can be applied to the particular species. Following is a detailed description of each technique.

Exclusion

Some building designs and conditions lend themselves to bird problems. Flat ledges, overhanging eaves, openings in vents, unscreened windows, wood siding and other attributes make a building an attractive location for roosting, nesting, feeding, and loafing. Modification or repair can exclude birds. Typical solutions include replacing broken windows and screens, eliminating large crevices and blocking openings into vents and roof-top equipment with hardware cloth. Netting, custom-designed sheet

Table 7-1. Pest Bird Species and Control Options

Species	Technique							
	Exclusion	**Habitat Modification**	**Destroy Nests**	**Sticky Repellent**	**Trapping**	**Hand Capture**	**Frightening**	**Shooting**
Pigeon	X	X	X	X	X	X	Avitrol	X
Starling	X	X		X	X		Distress calls, Avitrol	X
House Sparrow	X	X		X	X		Avitrol	X
Crows	Netting	X					Distress calls, Avitrol	In season
Hawks and Owls	Porcupine wires	Eliminate perch sites						By permit only
Swallows	X	Avoid overhanging eaves; slick surfaces discourage nesting	By permit only					
Woodpecker	Netting, place hardware cloth or sheet metal over holes	Treat insect-infested wood siding with insecticide		X	By permit only		Loud noises, e.g., handclapping, toy cap pistol	By permit only

metal or plastic covers, porcupine wires and sticky repellents can keep birds from roosting on ledges, roof edges, window sills, building signs and other surfaces.

- Screen eaves, vents, windows, doors and other openings with 1/4-inch mesh hardware cloth.
- Change the angle of the roosting edge to 45 degrees or more.
- Netting can be used to block access of birds to large roosting areas in structures. Netting is especially useful in buildings where aesthetics are of minor consideration. 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. Nets will last two to five years depending on exposure to sunlight.
- Install electrical shocking device. Follow package directions for installing such devices.
- Sometimes birds' flight patterns can be impeded by constructing parallel or gridwire systems.
- Custom-designed covers for ledges, window air conditioning units and roof edges can 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.
- Attach spikes or "porcupine wires" to roosting sites. Porcupine wires, sharp metal spikes or any similar "bed of nails" can stop birds from roosting on ledges. Vendors offer a number of designs that can be bent around curved objects such as signs, or made of transparent plastic material to improve aesthetics.
    - o Check spikes every 6 months for accumulated debris or nest material. Advise clients to regularly remove falling autumn leaves and other matter that can cover the spikes and reduce their effectiveness.

Habitat Modification

Reduce the availability of food and water. Discourage people from feeding pigeons or other pest birds. Some birds rely on available standing water, and its removal could move the flock elsewhere. Modify roosting sites by severely pruning tree twigs and branches, or removing trees entirely. For woodpeckers, consider treating siding or other locations where woodpeckers are feeding with insecticide for indirect control.

Destroy Nests

Pigeons may be induced to move from an infested site by persistent destruction of nests and eggs. Effectiveness is improved if used in conjunction with other methods. Nest destruction is ineffective against sparrows and starlings. Swallow nests must be destroyed repeatedly and persistently before eggs are present, otherwise federal and state permits are required for nest removal.

- 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. It not only destroys the nest but eliminates ectoparasites, cleans droppings and feathers from the nest site and harasses roosting birds. Use high-pressure sprays where the high pressure or water will not damage buildings or equipment. Remove all droppings and nest materials from the area.
- To follow a more traditional method when spraying is not safe, use a hook fastened to a long pole to remove the nests.
- When nests are within 20 feet of occupied buildings, treat the immediate nest area with an insecticide to eliminate ectoparasites.
- Destroy nests every two weeks during the spring and summer months until the birds move to other nest sites.

Sticky Repellents

These tacky gels or liquids are designed to be sticky enough to make a bird uncomfortable but not so sticky that the birds is trapped. After a few attempts, the bird stops 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.

- When selecting a sticky repellent, read the label and manufacturer's technical information on the effective temperature ranges. Under some conditions, sticky repellents melt and run when exposed to direct sunlight and high temperatures. Others may get too cold and reportedly trap a bird. (Pigeons trapped in sticky repellent led to public scrutiny of a wildlife nuisance control company in a western state, resulting in negative publicity from questioning their ethics and humaneness of this technique.)
- 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.
- Sticky repellents can stain surfaces to which they are applied. 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.) If in doubt, first apply a small sample in a less visible area to test for staining.
- Use a caulking gun to apply repellent. The depth of the bead necessary to repel different species of pest birds is roughly as follows: crows and sea gulls, 3/8 inch; pigeons, 1/4 inch; starlings, 1/8 inch; sparrows, 1/16 inch. The caulking gun should be held at an angle of 30 to 45 degrees. Do not over-apply. Some undocumented reports indicate birds may become trapped and die as a result of sticking their bill into the repellent and blocking air passages and/or having feathers stick together. Trapping birds with sticky repellent is an illegal use of this product.
- Apply a straight bead on ledges and roof edges about 1/2 inch from the outer edge, with another bead three inches in from the first or they can be applied in a zigzag or "s" curve. Another option is to combine a straight line 1/2 inch from the outer edge and an "s" curve 3 to 5 inches back. Other patterns may work just as effectively. The pattern of application will depend on the site and personal preference.
- 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 surface 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 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 can remain effective for a year or more. Some sticky repellents have 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 improve effectiveness for as long as two to five years.

Trapping

Many types and sizes of pigeon and sparrow traps can be purchased or constructed. 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 to 24 inches high. Sparrow traps include funnel traps, automatic traps and trigger traps. Funnel traps are commonly used; however, sparrows can escape and need to be checked frequently. For automatic traps, the weight of a feeding sparrow causes an "elevator" to drop and the bird is released into a cage. Without the bird's weight, the counterbalanced elevator springs back into its original position. Trigger traps rely on the bird or an observer tripping a trigger to close the exit.

- The best time to trap pigeons and sparrows is in the winter when their food is less available.

- Set traps in inconspicuous places where pigeons and sparrows commonly roost or feed and where traps are not likely to be vandalized.

- 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 are rarely on the same property as the roosting sites.
  - Roof tops that have water from air conditioning units are often good trapping sites in the summer.

- Birds will need to be coaxed into the trap using bait similar to what they are feeding. Whole corn or sorghum (milo) seeds tend to be best, but other options include wheat, oat groats, millet, popcorn, sunflower seeds, peas, greens, bread or peanuts.
  - For a few days or weeks, scatter small quantities of bait throughout the area to start the birds feeding and determine the best trap sites.
  - Consider leaving the traps propped open for the first few days to allow birds to get accustomed to them.

- After birds are calmly entering the trap, set it. Put bait and water inside the trap and just a handful or so of bait outside the trap. For some types of traps, leave one or two "decoy" birds in the trap to draw in other birds.

- Remove trapped birds often (except for decoys); otherwise untrapped birds may become frightened by the fluttering trapped birds.

- Since birds, particularly pigeons, can fly great distances and find their way home, trapped birds should be humanely destroyed. They can be gassed with calcium cyanide or carbon monoxide, but some experts feel it is simpler and more humane to kill the bird by breaking its neck.

Hand Capture

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. By screening all but one or two entrances, these areas can be made into a giant trap. Late in the evening (after about a two week acclimation period), these last entrances can be closed after the pigeons have settled for the night. The trapped birds can then be captured by hand or with "butterfly" nets.

Frightening

Chemical Toxicant – Avitrol is a poison bait with flock-alarming properties used to control many kinds of birds and is a Restricted Use Pesticide. 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, fly into windows or "dive bomb" into the ground. Affected birds convulse for an hour or more, and die within a few hours to 15 hours. Therefore, this option is not recommended in urban or residential areas where dead birds can result in public distress and outcry from observing dead or dying birds, or cause secondary poisoning to animals that feed on dead pigeons with Avitrol-treated bait in its crop. Avitrol should be avoided when non-target species such as cardinals, blue jays and doves are feeding on corn. Read the label carefully.

- There are different Avitrol baits for each pest bird species: whole corn for pigeons, smaller grains for sparrows and other birds.
- At most sites, birds must be trained to feed on bait. Place untreated whole corn in numerous piles (1/4 lb each) on flat rooftops, ledges and similar sites in the treatment area about 20 feet apart. Continue feeding untreated corn until about 40 percent of the flock accepts the untreated bait, which could take from three days to three weeks.
- Only a small percentage of the flock (5 to 15 percent) needs to be affected for the remainder of the flock to become frightened by the convulsions and distress of the poisoned birds.
- Mix treated Avitrol whole corn with untreated corn in a ratio ranging from 1:29 (treated: untreated) for killing about 5 percent of the flock up to 1:9 for killing about 15 percent of the flock. 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. Use the ratio that best fits the job.
- Set out about half of the amount used to prebait each day. For example, if 8 pounds of prebait were set out for a flock of about 100 birds, set out about 4 pounds of the Avitrol blended bait.
- One Avitrol application is adequate for most jobs. If pigeons become bait shy, wait about three weeks, then begin a new prebaiting program. If a site has been getting a monthly Avitrol "maintenance" baiting, pigeons can become extremely shy. It may be best to switch to another control method.

Audio Frightening – The use of frightening devices can be extremely effective in reducing concentrations of flocking birds. The keys to success are timing, persistence, organization and diversity. Birds are more likely to leave a new roost site than one they have occupied for a while. Additionally, birds that are preparing for migration will be easier to disperse as their departure time draws near. Useful frightening devices include broadcasted alarm and distress calls, pyrotechnics, exploders and other devices. High-frequency (ultrasonic) sound has not proven effective in repelling birds.

- Recorded alarm and distress calls of birds can be effective for many species of birds with the exception of pigeons. The calls are amplified and broadcast, and the speakers moved periodically to enhance effectiveness. Electronically-produced sounds are usually not as effective as recorded bird calls, but their effectiveness is enhanced when used in combination with recorded calls or other methods.

- Pyrotechnic devices that create noises in the air can be effective in dispersing bird flocks. These devices include 12-gauge exploding shells, fire shell crackers, bangers, screamers and rope firecrackers.
- Automatic LP gas exploders are a source for unattended sound and can be run with a timer. Periodically vary the intervals since birds can become accustomed to explosions at regular intervals.

Combining pyrotechnics with shooting live ammunition is not recommended, as crippled birds may serve as live decoys and, therefore, attract more birds. Additional information and assistance is available from USDA Wildlife Services office in Little Rock (501-378-5382) or Stuttgart (870-673-1121).

Shooting

A possible alternative or supplemental method for eliminating birds is shooting. Large, concentrated flocks of blackbirds (i.e., red-winged blackbirds, starlings, grackles or brown-headed cowbirds) and crows which pose a health hazard or are about to cause damage to personal property, crops, trees, livestock or wildlife may be shot without obtaining a permit. For crows, a statewide hunting season is established annually and a hunting permit may be required. Check with a county Wildlife Officer first before shooting crows. English sparrows, starlings and pigeons are not protected and can be shot at any time. Shooting with air-powered pellet guns, .22 caliber rifles loaded with short-range ammunition or .410 gauge shotguns can eliminate small flocks of pest birds. However, most towns and cities have ordinances prohibiting the discharge of firearms and should be checked before shooting.

- Shoot at night or at dawn in roosting areas.
- A high-powered pellet gun is recommended over other types of firearms because it is relatively accurate, quiet, short-ranged and will not cause structural damage.
- Use care as errant shots can be dangerous.

Health Hazards Associated with Birds

Health risks are often exaggerated. Nevertheless, large populations of roosting birds may present risks of disease to 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. When parasite-infested birds leave roosts or nests to invade buildings, their parasites can bite, irritate or infest people. To be safe, when investigating or cleaning up these areas, wear a disposable mask and protective clothing, including safety glasses, plastic or rubber gloves, coveralls and a cap.

Histoplasmosis

This systemic fungal disease is transmitted to humans by airborne spores from soil contaminated by pigeon and starling droppings, as well as droppings by other birds and bats. The soil under a roost usually has to have been enriched by droppings for three or more years for the disease organism (*Histoplasma capsulatum*) to increase to significant levels.

Most infections are mild and produce either no symptoms or a minor flu-like illness. The disease can, on occasion, lead to high fever, blood abnormalities, pneumonia and even death. An estimated 50 million people have had histoplasmosis or been exposed to it, resulting in 500,000 infections, 5,000 hospitalizations, and 800 deaths. A potentially blinding eye condition, called ocular histoplasmosis syndrome, can result from infection by the disease organism. The central part of the retina becomes inflamed and is damaged as blood vessels grow inside the affected area. An estimated 100,000 people have the rapidly progressive form that can lead to blindness.

Cryptococcosis

This fungus is typically found in accumulations of pigeon droppings in attics, cupolas, ledges, water towers and other roosting and nesting sites. Even when old and dry, bird droppings can be a significant source of infection. Cryptococcosis has been found in as many as 84 percent of samples taken from old roosts. The disease, acquired by inhaling yeast-like vegetative cells, results in two forms. The cutaneous form is characterized by acne-like skin eruptions or ulcers 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, and can be fatal.

Ectoparasites

Birds can harbor external parasites that can invade buildings. A long list of mites infest pigeons, but the northern fowl mite and chicken mite are usually the main culprits. 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.

House Mice

Description

The house mouse is a small, slender rodent that is well adapted to living in people's homes, farms and commercial establishments, as well as in open fields and agriculture lands. House mice are not native to the United States, having arrived with early European settlers. They are one of 19 species of rats, mice and voles that inhabit Arkansas. House mice are prolific. Females can produce as many as 13 litters in a year, averaging between four and seven young per litter.

House mice cause an inestimable amount of damage to foodstuffs and structures, particularly wall and attic insulation, electrical wiring and other building components. House mice contaminate food with their hair, urine and droppings. Additionally, mice and their parasites transmit a number of diseases to humans, including salmonellosis (food poisoning), rickettsialpox, lymphocytic choriomeningitis, leptospirosis, ratbite fever, tapeworms and organisms that cause ringworm.

House mice can be distinguished from young rats by the comparative size of their feet and head. A young rat will have larger hind feet and head in proportion to the body than a house mouse (Figure 7-2).

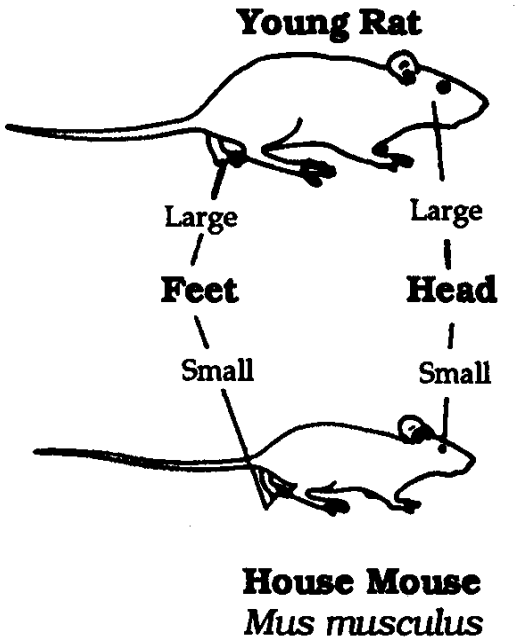

Figure 7-2. House mouse compared to a young rat

Habits and Feeding Behavior

Studies indicate that during its daily activities, a mouse normally travels an area averaging 10 to 30 feet (3 m to 9 m) in diameter. Mice seldom travel farther than this to obtain food. They obtain water from the food they eat. Mice can survive without freestanding water, though they will drink when it's available. A lack of water or food with adequate moisture content can inhibit their population growth. Because of their limited movement and feeding behavior, house mice can be difficult to control in some situations.

House mice eat many types of food but prefer those high in fat, protein or sugar. They relish bacon, chocolate, butter, peanut butter and nutmeats. House mice readily eat new foods. A single mouse eats only about 3 grams of food per day (2.4 pounds per year) but destroys considerably more food than it consumes. Mice have a habit of nibbling on many foods and discarding partially eaten items.

Mouse Signs

There are a number of signs that indicate mice are present in a residence. Mouse **droppings** are 1/4 inch (0.6 cm) long, whereas those of cockroaches are usually 1/8 to 1/4 inch long. Under a magnifying glass, cockroach droppings show distinct longitudinal ridges and squared-off ends. In comparison, mouse droppings are smooth and have tapered or rounded ends. Mouse **tracks** (Figure 7-3) can be seen on dusty surfaces or in mud, or flour can be spread on the floor overnight to determine if rodents are present. **Urine** will fluoresce under ultraviolet light and may occur along travelways or in feeding areas. **Rub marks** may occur on beams, rafters, pipes or walls. They are the result of oil and dirt rubbing off the mouse's fur. **Gnawing** may be visible on doors, ledges, in corners, in walls, on stored materials or other surfaces. Fresh wood shavings or

chewed insulation indicate active infestations. Mouse holes are often 1 1/2 inches (3.8 cm) or less, whereas rat holes are 2 inches (5 cm) or larger. **Sounds** such as gnawing, climbing in walls, running above ceilings and squeaks are common when mice are present. A characteristic musty **odor** is a positive indication that house mice are present. **Visual sightings** can occur during daylight or after dark using a flashlight. **Nests** may be found when cleaning garages, closets, attics, basements and outbuildings. They are constructed of shredded fibrous materials, such as paper or burlap, and appear as a ball of loosely woven material usually 4 to 6 inches (10.2 to 15.2 cm) in diameter.

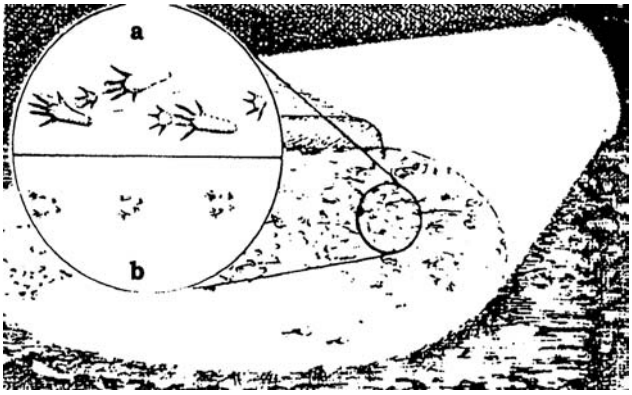

Figure 7-3. Mouse (b) and rat (a) tracks

Mouse Control

The three essential steps for effectively controlling house mice are (1) applying sanitation practices and habitat modification, (2) rodent-proof construction and (3) population reduction. Figure 7-4 (page 81) is a flow chart for determining appropriate techniques for mouse control, based on your particular situation. The techniques recommended in the flow chart are described below.

1. Sanitation and Habitat Modification

Sanitation practices are an effective tool when used in conjunction with rodent-proofing techniques and population reduction methods. Mice can live off a few crumbs or scraps and, therefore, cannot be controlled by good sanitation practices alone. However, good sanitation aids in mice control by (1) permitting easier detection of mouse signs, (2) increasing the effectiveness of traps and baits by reducing alternative food sources and (3) reducing the growth of the mouse population. Good sanitation will seldom eliminate mice; however, poor sanitation will attract mice and permit them to thrive in greater abundance.

Modifying mouse habitat around the home may also help in controlling their numbers and access into the home. Regular removal of debris and control of weeds around homes will reduce shelter available to rodents. Maintaining a clean, 3-foot wide (1 m), weed-free area around building foundations, concrete slabs and footings often discourages rodents from burrowing, as well as eliminating a food source. In some instances, placing a strip of heavy gravel around building foundations will reduce rodent burrows.

2. Rodent-proof Construction

Often ignored, rodent-proof construction is the best defense for preventing problems with house mice. To exclude mice, seal all holes and openings larger than 1/4 inch (0.6 cm) across. Use heavy materials that will withstand rodent gnawing, such as concrete, galvanized sheet metal and heavy-gauge hardware cloth.

To prevent rodent entry, their capabilities need to be understood. Their physical abilities are impressive. Mice can:

- Enter openings larger than 1/4 inch (0.6 cm).
- Run along or climb electrical wires, pipes, fences, poles, ropes, cables, vines, shrubs and trees to gain entry into a building.
- Climb almost any rough vertical surface, including weathered sheet metal and many plastic products.
- Crawl horizontally along or through pipes, augers, conveyors, conduit and underground utility and communications lines.
- Gnaw through a variety of materials including lead, aluminum sheeting, window screens, wood, rubber, vinyl, fiberglass, plastic and low-quality concrete or concrete block.
- Jump as high as 18 inches (46 cm) from a floor onto an elevated surface.
- Travel considerable distances crawling upside-down along screen wire.
- Survive and reproduce at temperatures of 24 degrees F (-4 degrees C) if adequate food and nesting material are available.

When inspecting for potential entryways, look for mouse signs. Pay attention to areas behind, under, or in appliances, sinks, cabinets, drawers, stored goods, wall voids, false ceilings and other undisturbed areas. To conduct a thorough survey, keep a detailed record while inspecting the house of

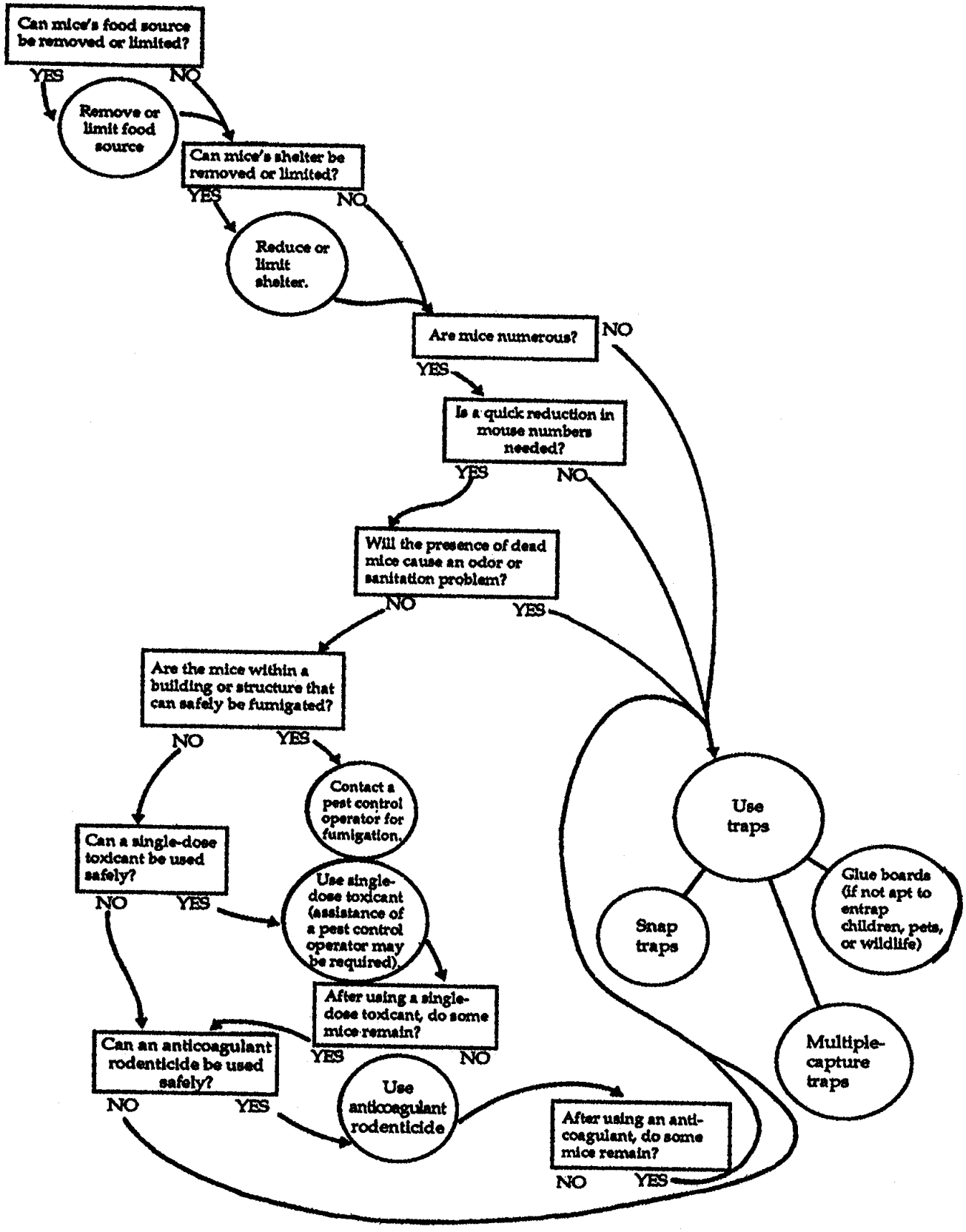

Figure 7-4. A flow chart of steps in house mouse control. Additional factors, such as cost of particular control methods, must be taken into account when planning a control program. Reprinted from "House Mice" in *Prevention and Control of Wildlife Damage* (1994) with permission.

items needing alteration. Bring a pencil or ballpoint pen for keeping records. Also bring a flashlight, mirror (to see under or behind objects), screwdrivers and other tools (to remove interior and exterior vent grills, appliance base plates, attic doors, crawlspaces and utility cabinets), tape measure (for preparing repair materials) and perhaps a camera if leaving the site (for photographing problem areas and designing a solution away from the site).

Mice can enter under doors, through holes beside water pipes and electrical conduit and through the cold air return ducts on forced air furnaces, especially those located in outside cabinets or garages and underneath mobile homes. Mice often find easy access to garage areas through open doors or under poor-fitting garage doors. Once inside the garage, they may gain entry into the main structure along electrical lines, pipes, poorly sealed firewall sheathing, around furnace ducts, hot water heaters or laundry drains.

Pay particular attention to utility entry points, including underground electrical and communication trunk lines, and exhaust vents for cloths dryers. Check all roof joints for tightness and presence of flashing, particularly if mice have access to the roof via wire, pipes, plants or rough-textured walls. Check roof and sewer vents for adequate screening and sealing. Chimneys should be checked for properly installed flashing or missing mortar.

If rodents are able to reach the attic, they may travel from room to room through openings for pipes, ducts and wiring. Inside entry can be achieved through the fireplace, which may have poorly fitted sheeting or metal collars, an open damper or cool air and warm air returns around the fire box. If the outside cannot be sealed, glass doors that seal the burn area are recommended to prevent entry throughout the year.

Gaps in foundations and slabs, or where the wall framing meets the foundation or slab floor, may provide large enough openings for entry. Older buildings commonly have cracked foundations, cracked plaster or mortar, warped siding or broken and torn vent screens. Wood or masonite siding is especially vulnerable to warping and cracking near corners and around the base of the building. Old, unused holes where utilities formerly entered the structure are also common points of entry.

Recommendations for Repair

Holes and openings: For a temporary plug, seal with steel wool, copper gauze or screen wire packed tightly into opening. For a permanent repair, mix a quick-drying patching plaster into a wad of patch material (avoid steel wool, as it will rust) and push the material into the hole. Smooth over the outside so that it will be difficult for a mouse to find a rough edge to gnaw. (The inward curve of a mouse's teeth make it difficult to gnaw into a flat, hard surface. When given a rough surface or an edge to bite into, however, they can quickly gnaw into most materials.)

Holes 3 inches (8 cm) or more in diameter should be covered or backed with 1/4 inch (0.6 cm) woven/welded hardware cloth prior to patching. An alternative is a sheet metal patch with a self-adhesive backing. Close openings around augers, pipes and electric cables using Portland cement mortar, masonry, metal collars or other appropriate product. For large openings, recommended materials are concrete (minimum thickness of 2 inches [5.1 cm] reinforced, or 3 3/4 inches [9.5 cm] if not reinforced), galvanized sheet metal (24 gauge or heavier for wall or pipe barriers, 22 gauge or heavier for kick plates or door edging, 14 gauge for perforated or expanded sheet metal grills), brick (3 3/4 inch [9.5 cm] thick with joints filled with mortar), hardware cloth (woven, 24 gauge, 1/4 x 1/4 inch [0.6 cm x 0.6 cm] mesh), and aluminum (22 gauge for frames and flashing, 18 gauge for kick plates and guards) (Figure 7-5).

Vents and windows: Use only metal window screening materials to prevent mice entry. For large openings or where the screen may be subject to abuse, add crossbars to support the screen.

Vents for heating and air conditioning should be screened if at all possible. To prevent a reduction of airflow, 1/2 x 1/2 inch (1.3 cm x 1.3 cm) hardware cloth is recommended, although a smaller gauge would be more effective for rodent control. Sometimes, power vents can be covered with hinged metal plates (louvered) that open with air flow and close when the fans are off. However, louvers must fit tightly to be effective at preventing mice entry.

Exterior doors: Doors should fit tightly and the threshold not exceed 1/4 inch (0.6 cm). Metal thresholds can be fastened to floors.

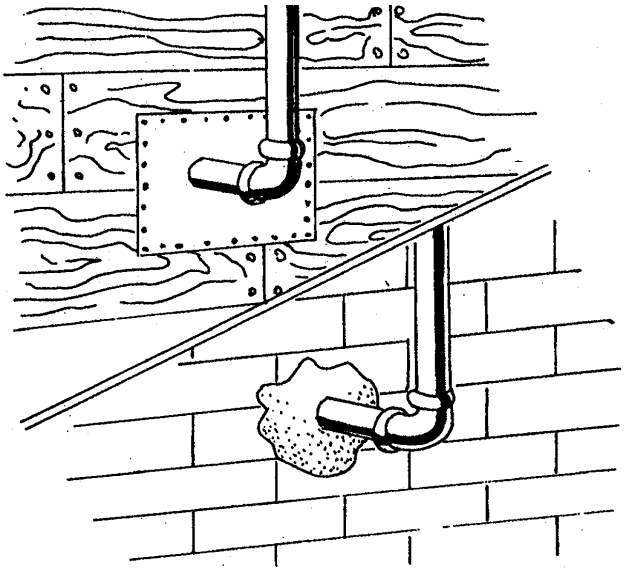

Figure 7-5. Seal holes with rodent-proof materials where pipes, wires or similar objects enter buildings.

Foundations and floors: Gaps or flaws along building exteriors where the wall framing or siding meets the foundation provide easy entry for mice. Such openings can be prevented by well-formed and finished concrete work and installation of tight wall framing and siding, or installing metal screed-type flashing between the siding and the foundation. Metal siding may provide entry points where panel ends are left open. Use of concrete, plaster or metal sheeting is effective if properly installed so that all the ribs or corrugations are closed. Rubber or vinyl weather stops are quickly gnawed through. Repair cracks in foundations and floors with concrete or masonry grout. Note that rodents can claw and gnaw at concrete and Portland cement until it is fully cured, so the use of hardware cloth laid in the top 1/4 inch (0.6 cm) of the repair area may be necessary or provide a rodent-proof overlay until the concrete is fully cured. **Caution:** Metal products placed within one inch (2.5 cm) of a concrete surface will oxidize and corrode and may discolor the concrete.

Drains and pipes: Mice use drainage pipes or sewage systems as routes to enter buildings. Equip floor drains with metal grates held firmly in place, with grate openings not exceeding 1/4 inch (0.6 cm). Maintain 1/2 inch (1.3 cm) hardware cloth over sewer roof vents.

Climbing walls, vertical pipes or electrical wires: Physical barriers and guards can be constructed to prevent mice from climbing up walls or at corners of walls. A sheet metal band attached to a wall at least 26 inches (91 cm) above the floor or ground will prevent mice from climbing (Figure 7-6). This rodent guard should be at least 14 inches (36 cm) but preferably 18 inches (46 cm) wide. A flat guard can be placed on top of a vertical pipe or electrical wire that is attached to a wall. Cone-shaped circular guards can be constructed for placement around free-standing pipes or wires. Use 24-gauge metal and extend the cone out at least 18 inches (46 cm) around the pipe or line. Anchor the cone in place by one or more arms on the side opposite to that accessible to rodents.

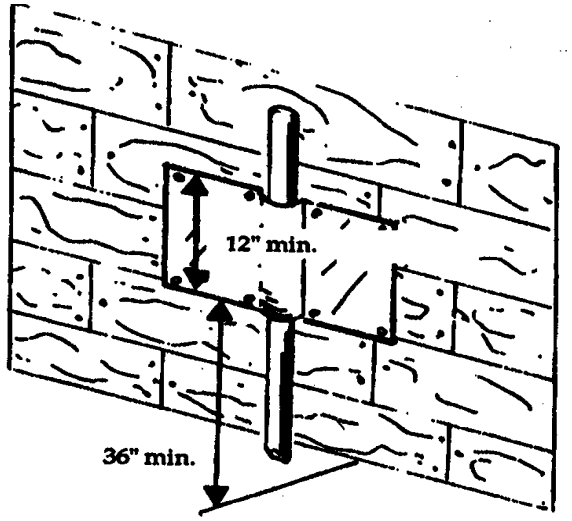

Figure 7-6. Guards of various designs can prevent rodents from climbing along walls, wires or pipes.

3. Population Reduction

Once sanitation practices are in place and rodent-proofing has begun, it is time to concentrate on reducing the number of mice in the home. In homes with moderate or severe infestation, techniques to reduce or eliminate mice won't solve the problem if mice populations outside the home can gain easy entry. The mice outside can repopulate those that are removed from inside the home, thus becoming a never-ending cycle unless rodent-proof measures and sanitation practices are attempted before or simultaneous to population reduction.

House mice populations can be reduced using a variety of traps and baits. Generally, baiting is recommended in cases of severe infestation and a quick reduction of mouse numbers is needed. Trapping is recommended when only a few mice are causing problems and a quick reduction is not necessary. Considerations for other circumstances are described more fully in the flow chart (Figure 7-4).

Trapping – Trapping can be effective for controlling a few mice around homes, garages or small structures. For large mice infestations, trapping requires more labor and is recommended only in situations where poisons cannot be used. Trapping also offers the advantage of being able to dispose of mice carcasses, rather than dealing with problems associated with odors from irretrievable carcasses that decompose after poisoning.

A simple, inexpensive, wood-based snap trap is available in most home and hardware stores and, if set properly, is very effective in killing mice. Set traps close to walls, behind objects, in dark places and in locations where mice activity is observed. Place the trap trigger along the mouse's runway, which is usually along the base of a wall, so that the mouse will pass directly over the trigger. Place the trigger side of the trap closest to the wall, and set another trap beside it to improve your success (Figure 7-7). Another trick is to expand the trigger region by attaching a square of cardboard, metal or screen wire to the bait pan. When placing multiple traps, position them no more than 6 feet apart where mice are active. Bait traps with peanut butter or tie securely a small piece of nutmeat, chocolate candy, bacon or marshmallow to the trigger.

Multiple-capture (automatic) mouse traps are available commercially and from some home and hardware stores. These work on the principle of a one-way door where mice enter but cannot exit and may catch many mice at one location. These can be effective, but must be emptied periodically so that mice do not die of starvation or exposure in the traps. Other types of box traps (e.g., Sherman traps) will capture one mouse at a setting and are typically used for research purposes.

An alternative to traps is glue boards, which catch and hold mice attempting to cross them. Place glue boards wherever mice travel. Do not use glue board where children, pets or other wildlife can contact them. Glue boards are considered by some to be inhumane, as mice attempting to free themselves may struggle for up to several hours. Glue boards lose their effectiveness in dusty areas unless they are covered, for example, with a shoebox having an entry hole at each end. Temperature extremes can also affect the tackiness of some glues.

Baits – The use of toxic baits, i.e., rodenticides, is recommended when there are large infestations of house mice and there is less concern about odors resulting from decomposing carcasses. Whenever a rodenticide is used, safety must be the first consideration. Place toxic baits where inaccessible

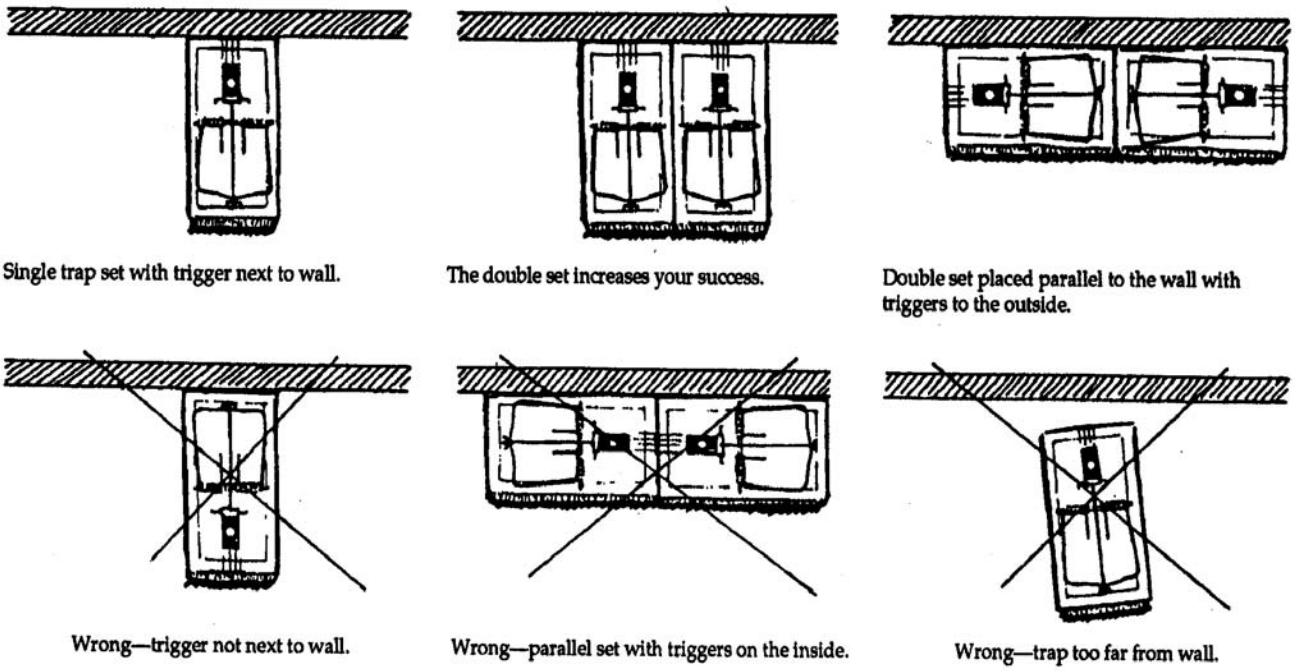

Figure 7-7. Right and wrong ways to set a snap trap. Examples are setting a single trap set with the trigger next to the wall, a perpendicular double set, and a parallel double set with the triggers to the outside.

to children and pets. Mice are color-blind; therefore, dyes that are tasteless to rodents can be used in baits to identify them for reasons of safety.

One classification of rodenticides are anticoagulants (Table 7-2), which are slow-acting, chronic toxicants that require multiple feedings to be effective. Examples of first-generation anticoagulants are warfarin, chlorophacinone and pindone. Second-generation anticoagulants (brodifacoum, bromadiolone and difethialone) can be effective after a single dose, though it may take up to five days before death ensues.

Rodents poisoned with anticoagulants die from bleeding internally. A few cases of pet poisoning have been reported when pets feed on dead rodents. Dogs are more sensitive to antigoagulants than are cats, and pets accustomed to feeding on dry foods can easily ingest a toxic dose of rodenticide if these baits are accessible to them. Older, first-generation anticoagulants (e.g., warfarin, diphacinone, chlorophacinone) are considered less hazardous to pets because they typically require multiple feedings to achieve a lethal dose, and accidental poisoning can be treated with an antidote, Vitamin K_1. However, the majority of anticoagulants being marketed today (including many d-CON products) contain brodifacoum or other second-generation materials than can be fatal in a single feeding.

Label directions on anticoagulants commonly instruct maintenance of a continuous supply of bait for 15 days or longer until feeding ceases. Anticoagulants are purposefully slow-acting to prevent mice from becoming bait-shy. If the bait produces an ill effect in a mouse but not death within a few hours, the bait will often become associated with the illness. Bait shyness can persist for weeks or months and may be transferred to nontoxic foods of similar types.

Bromethalin, cholecalciferol and zinc phosphide are single-dose, non-anticoagulant rodenticides that can be effective for anticoagulant-resistant populations of house mice (Table 7-3). Although only a single dose is required, both bromethalin and cholecalciferol may take up to four days before death ensues. Because of this slow action, the mice's subsequent illness is not associated with the bait even if a sublethal dose is consumed. Bait shyness does not usually occur. These baits, in effect, serve as their own prebait.

Zinc phosphide is relatively quick acting, with results evident one-half to 20 hours after ingestion. Because a mouse could potentially ingest a small amount of zinc phosphide and survive, prebaiting is recommended. Prebaiting, training mice to feed repeatedly on non-toxic bait prior to applying the toxic bait, will encourage mice to feed subsequently on the toxic bait, largely preventing sublethal doses and bait shyness. As with any product mentioned, be sure to follow label recommendations to achieve best success. All single-dose, non-anticoagulant baits should be removed and destroyed at the end of a poisoning program.

Table 7-2. Anticoagulants Used for House Mouse Control

Common name and typical trade names	Chemical name	Usual types of formulations		
		Food bait	Liquid	Tracking powder
Brodifacoum* (Talon®)	3-[3(4'-bromo[1,1' biphenyl]-4-yl-)-1,2,3,4-tetrahydro-1-naphthalenyl]-4-hydroxy-2H-1-benzopyran-2-one	X		
Bromadiolone* (Maki®, Contrac®)	3-[3-(4'-bromo [1,1'biphenyl]-4-yl)-3-hydroxy-1-phenyl-propyl]-4-hydroxy-2H-1-benzopyran-2-one	X		
Chlorophacinone (RoZol®)	2-[(α-chlorophenyl)phenylacetyl]-1,3-indandione	X		X
Difethialone* (Generation®)	[(bromo-4'-[biphenyl-1-1']-yl-4) 3-tetrahydro-1,2,3,4-nathyl-1] 3-hydroxy-4, 2H-1-benzo-thiopyran-2-one	X	X	
Diphacinone (Ramik®, Ditrac®)	2-diphenylacetyl-1,3-indandione	X		X
Warfarin	3- (α-acetonylbenzyl)-4-hydroxycoumarin	X	X	

Single-dose, non-anticoagulant rodenticides work in a variety of ways. Bromethalin depresses the central nervous system and results in paralysis. Cholecalciferol, also called Vitamin D_3, is a calcium releaser that causes too much calcium to be released into the blood, resulting in kidney, liver or heart failure. The advantage of Vitamin D_3 is a minimal risk of secondary poisoning to pets or wildlife that eat poisoned rodents. Zinc phosphide causes gas to enter the circulatory system, resulting in heart paralysis, gastrointestional damage and liver damage. Many formulations of zinc phosphide are Restricted Use and require an applicator's license to be administered.

Ready-to-use baits come in a variety of formulations. Oatmeal, ground or rolled wheat, rolled barley, ground or rolled milo and corn have been successfully used as chief ingredients in toxic baits for house mice. Grain-based baits in loose meal or pelleted form are available in bulk or packaged in small plastic, cellophane or paper "place packs." These packs keep bait fresh and are easy to place in burrows, walls or other locations. Mice will gnaw through the bag to feed on a preferred bait. The disadvantage of bait bags is that they may be moved to places where it is undetected and hazardous to other animals besides mice.

Other bait formulations are available but are more suitable for agricultural or industrial purposes. Bait in wax or extruded blocks can be used in moist areas where grain baits may readily spoil. When no water is present, concentrated baits are available that can be mixed with water and sugar to create a liquid bait for thirsty mice. Neither of these baits, however, is any more effective than grain baits.

Sometimes mice may ingest baits with no results or reject baits altogether. In situations with moderate to severe infestation, check for differences in bait acceptance among several types of bait prior to investing time and money in a specific bait product. Mice may be rejecting a bait product simply because the bait does not taste as good as other available foods. In this instance, reduce the availability of other foods and test different formulations of bait. Other reasons for failure of baits are:

- Too short a period of bait exposure.
- Insufficient bait and insufficient replenishment of bait.
- Too few bait stations and/or too far apart. For mice, stations should be within 6 feet (2 m) of each other in areas where mice are active.
- Mice moving in from untreated areas, e.g., your neighbors.
- Abundance of other food choices.
- Tainted bait – bait has become moldy, rancid, insect-infested or contaminated.

When anticoagulant resistance to the first-generation anticoagulants is suspected or known, try second-generation anticoagulants or another single-dose product. If bait was initially consumed and a few remaining mice are not taking the bait, the best strategy is to switch to a different bait formulation, place baits in different locations and use other control methods such as traps.

To improve safety of bait application, bait stations (bait boxes) are recommended. Stations may provide mice a protected place to feed, allowing them to feel more secure. Bait stations are available commercially or can be made from scrap wood

Table 7-3. Single-dose, Non-anticoagulant Rodenticides Used for House Mouse Control

Common name and typical trade names	Chemical name	Usual types of formulations		
		Food bait	Liquid	Tracking powder
Bromethalin (Assault®, Vengeance®)	N-methyl-2,4-dinitro-N-(2,4,5-tribromophenyl)-6-(trifluoromethyl) benzenamine	X	X	
Chloecalciferol (Vitamin D_3, Quintox®, Rampage®)	9,10-Seocholesta-5,7,10 (19)-trein-3 betaol	X		
Zinc phosphide (Ridall®)	Zinc phosphide	X		X

or other materials. Manufactured bait stations are made of plastic, cardboard or metal and come in a variety of shapes and sizes. Rodent bait stations can be constructed from a length of pipe or placed under a secure board or box. Clearly label all bait stations with "POISON" or "RODENT BAIT – DO NOT TOUCH" or with a similar warning.

Bait stations should be designed with hole entrances 1 to 1 1/2 inches in diameter and large enough to let several mice feed at once. A cigar box about 10 x 6 x 2 inch high with a hole in each end is ideal for mice. Another type of bait station is a flat, 18-inch (or longer) board nailed at an angle between the wall and floor to protect bait from pets and children, yet allow rodents to feed in a sheltered location (Figure 7-8). Alternatively, bait can be placed in a pipe 2 to 3 inches in diameter and at least 18 inches in length. More elaborate bait stations are completely enclosed with hinged lids for convenient inspection and can contain both liquid and solid baits.

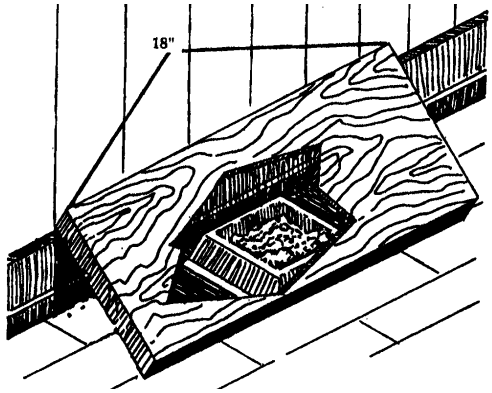

Figure 7-8. A properly designed and placed bait station can help control house mice. In this example, a flat board is nailed to a garage wall to allow rodents to feed in a sheltered location while preventing pets, children and other non-target species from reaching the bait.

Proper placement of bait stations is just as important as using the appropriate bait. Mice will not visit bait stations if they are located in areas with no mouse activity. When possible, place bait stations between the rodents' source of shelter and their food supply. Put bait stations near burrows, against walls or along travel routes. Look for signs of activity such as droppings, gnawings, tracks and rubmarks. Inspect the bait station daily and replenish eaten bait. If bait becomes moldy, musty, soiled or insect-infested, empty the bait station, clean it and refill with fresh bait, as mice will reject soiled or stale bait foods.

Safety Precautions

Certain general safety precautions should be observed in addition to those appearing on labels of specific products.

- Consider all rodenticides dangerous enough to cause death, and place baits where only rodents can get them. No known rodenticides are without some hazard to nontarget animals. Be sure the baits are not accessible to children or pets and other animals.
- People handling baits should neither smoke, eat, drink nor put their hands near their mouths. After preparing or handling baits, wash well, using soap, a brush and plenty of water.
- Whenever possible, buy prepared or ready-to-use baits rather than trying to mix your own. Commercial formulators are governed by regulations that require that operations are safe for their employees. Wear gloves, protective eyewear and a dust mask/mist respirator when handling baits in nonpackaged forms. Clean all bait-mixing utensils thoroughly, and use them only for bait preparation.
- When acute (single-dose) toxicants are used, it may be advisable that each bait placement be recorded. Remove or destroy all uneaten baits at the end of the poisoning period. Only trained individuals should use the more toxic acute-poison baits, even on their own premises. Except for special situations, never leave acute-poison baits exposed for long periods as you would with anticoagulants.
- Tracking powders are a Restricted Use Pesticide and should be used only in limited circumstances. As with any baiting material, certified applicators must wear gloves, protective eyewear and dust/mist respirators when applying tracking powders. Do not place poisonous tracking powders where the rodents might carry them on their feet or bodies to food or food-preparation surfaces. Do not place tracking powders in the vicinity where children, pets and nontarget species frequent.
- During and after a poisoning program, pick up all dead mice. Handle the mouse carcass using rubber gloves or a pair of long tongs.

To dispose of large numbers of dead mice, burn (unless prohibited by law) or bury deep enough not to be dug up by pets or other carnivores. If there are only a few dead mice, place in a plastic bag, close it tightly and dispose with the garbage.

- Label all bait containers or stations, unused baits and rodenticide concentrates with an appropriate warning. Store unused bait away from children, preferably in a locked place. Keep all rodenticides in locked and labeled cabinets. Restrict access to authorized, responsible individuals.

What Isn't Recommended

There are a number of commercial products that are ineffective at controlling house mice populations or are not recommended around homes because of their hazardous nature.

- Frightening devices producing ultrasonic sounds are commercially available, but their effectiveness is unsubstantiated by scientific research. Therefore, these are not recommended as a solution to rodent problems. Loud or unusual noises may temporarily frighten house mice, but mice soon become accustomed to new sounds heard repeatedly.

- Repellents, such as mothballs or household ammonia, may temporarily move mice from one location to another but do nothing to remove the mice. A product called Ro-pel is registered for use in repelling mice from gnawing on trees, poles, fences, garbage and other objects, but will do nothing to remove mice.

- Fumigants typically are not an option in homes. Some fumigants are registered for use in rodent burrows. House mice burrows are often small, difficult to find and cannot be fumigated efficiently or economically.

Tracking powders can be effective at mouse control but are not recommended around homes. When mice walk over a patch of toxic powder, they pick up some on their feet and fur and later ingest it while grooming. Tracking powders are useful in situations where food is plentiful and good bait acceptance is difficult to achieve. The concentration of active ingredient in tracking powders is considerably higher than food baits using the same toxicant. Therefore powders are more hazardous. Many, if not all, are Restricted Use Pesticides.

Concluding Remarks

An effective mouse control program can be achieved through a combination of sanitation practices and habitat modification, rodent-proofing and population reduction. In areas with moderate to severe infestation, a cooperative effort among adjoining properties will be necessary to achieve long-term, effective rodent control measures. Otherwise, mice from surrounding habitats can be expected to "fill the void" and return to the unoccupied rodent habitat in the home. Many commercial products are available for rodent-proofing homes and trapping and baiting mice. Rodenticides (toxic baits) can pose a risk to the handler, children, pets and nontarget wildlife species. Safety considerations should be a priority when implementing these techniques. Because of product turnover, information presented in this chapter may become outdated. Always follow the pesticide label when applying baiting practices.

Moles

Moles are not rodents like mice and rats but are classified as insectivores (insect eaters). Moles search for food and burrow in lawns, meadows, stream banks and open woodlots. They feed on earthworms and insect larvae. 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.

As they burrow, they sometimes damage plants, but the major problem is the mounds and ridges that disfigure lawns. As they tunnel just below the surface, moles raise the sod up with their digging feet, looking for food or new tunneling sites.

Mole Control Techniques

The most effective method for controlling moles is lethal traps, though this method is also time-consuming. Since moles normally do not consume grain, toxic baits are seldom effective.

To establish which tunnels are active, step down on tunnels in several places in the yard. Mark the tamped area with a peg or wire flag. If the tunnel

has been pushed back up in a day or so, set the trap in that section of the tunnel. Seek a long, straight runway for setting the trap.

Three trap types are harpoon, scissor-jawed and choker loop. The scissor-jawed and choker traps require digging and exposing the tunnel. The jaws or loops are set to encircle the tunnel and are triggered when the mole moves through the trap. The harpoon trap is set directly over the runway, so that the supporting stakes straddle the runway and its spikes go into the runway. The trap is triggered when the mole's tunneling activity causes the soil to strike the pan and trigger the spikes. Set the trigger pan where it just touches the earth where the soil is packed down. Setting the trigger too high or too low will result in misfires. If any of these traps fail to catch a mole after two or three days, move the trap to a new location.

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 trap every day.

Norway and Roof Rats

Description

Norway and roof rats are well adapted to living in people's homes, farms, warehouses, stores and sewers. Both were introduced unintentionally, arriving on ships of early North American settlers.

The Norway rat is also called the brown rat, house rat, barn rat, sewer rat, gray rat or wharf rat (Figure 7-9). The Norway rat is a stocky, burrowing rodent that weighs about 1 pound (454 g) on average. Fur coloration varies from brownish or reddish gray above and whitish gray on the belly, although blackish Norway rats can occur. Their hairless tail is shorter than the head or body. Though they can climb, Norway rats tend to reside closer to the ground or on lower floors of buildings. They may burrow to make nests under buildings, beneath concrete slabs, along stream banks, around ponds, in garbage dumps and other locations where suitable food, water and shelter are present (Figure 7-10).

The roof rat is also called the black rat or ship rat. Fur coloration varies from black with a gray belly, agouti (brownish streaked with gray) back and gray belly, or agouti back and white belly.

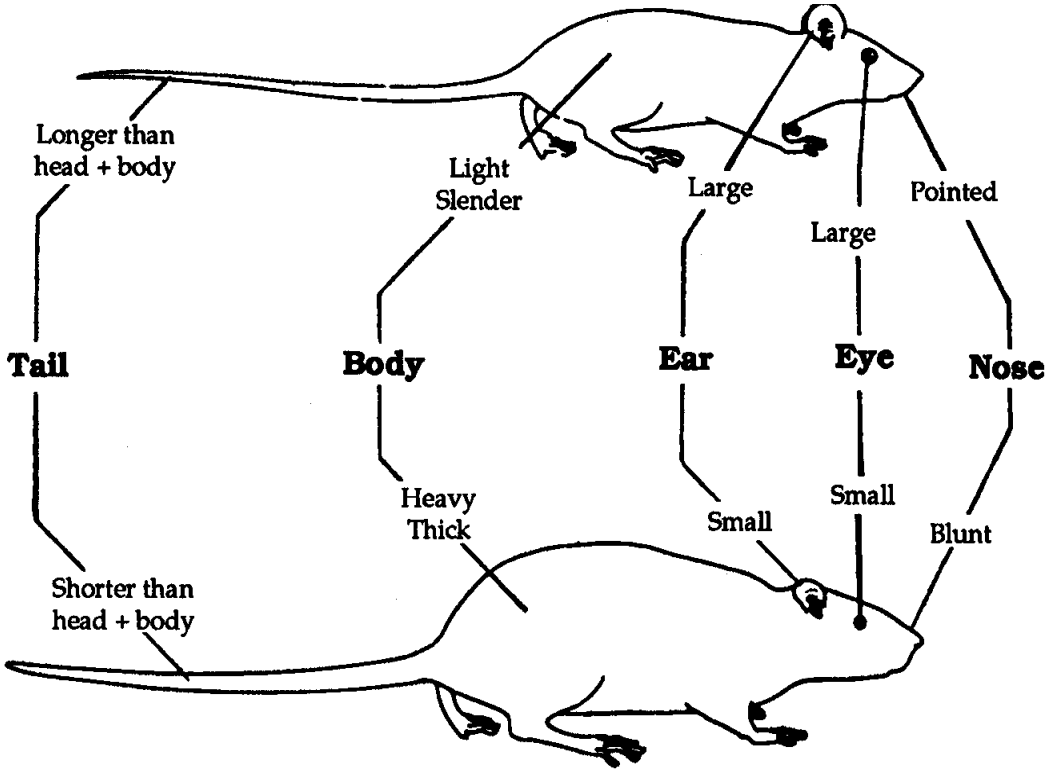

Figure 7-9. Distinguishing characteristics of Norway versus roof rats, and a young rat versus a house mouse

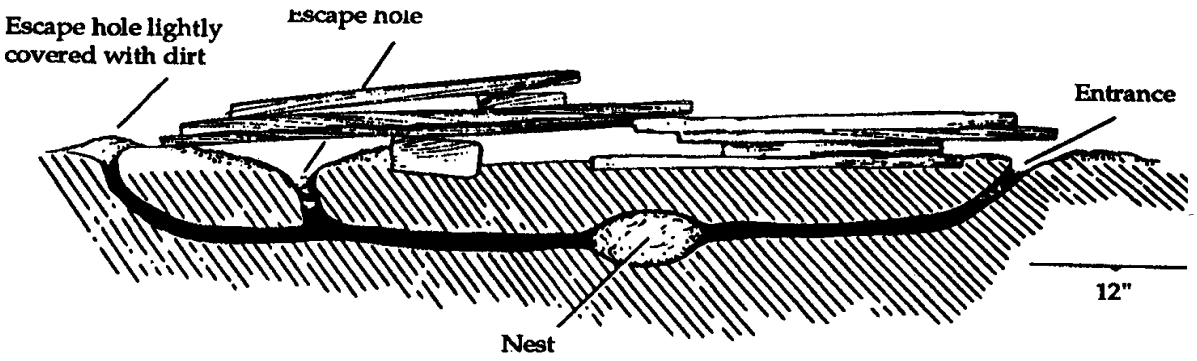

Figure 7-10. Burrowing system of a Norway rat. Burrows are typically 2 to 2 1/2 inches in diameter.

Compared to Norway rats, roof rats are more sleek and graceful, and generally not as large. Their belly fur is uniformly white, buff or gray compared to Norway rats, whose belly fur is white with gray underfur. Roof rats have a pointed muzzle, larger ears and a tail that is longer than their body. Roof rats are more aerial than Norway rats in their habitat selection and often live in trees or vine-covered fences. Unlike Norway rats, roof rats prefer to nest off the ground and rarely dig burrows for living quarters. Roof rats frequently enter buildings from the roof or overhead utility lines. They tend to inhabit upper floors, while Norway rats occupy the first or basement floors. Occasionally, they may live in sewer systems.

Rats consume and contaminate foodstuffs and animal feed, as well as damage the containers and packaging materials where stored. Rats cause structural damage to buildings by burrowing and gnawing. They undermine building foundations and slabs, gnaw on electrical wires or water pipes and chew openings through doors, window sills, walls, ceilings and floors. Considerable damage to insulated structures can result from rats burrowing and nesting in walls and attics. Rats may transmit several diseases to people, including murine typhus, leptospirosis, trichinosis, salmonellosis and ratbite fever. Roof rats are more commonly associated with the plague than Norway rats.

Rat populations can expand rapidly, making them difficult to control. Females can produce 6 to 12 young in 21 days, and sexual maturity is reached at three months. The average female rat has four to six litters annually.

Habits and Feeding Behavior

Rats prefer fresh, wholesome items over stale or contaminated foods. They use their keen sense of smell to locate food items and can taste contaminants as low as 0.5 parts per million. Rats eat cereal grains, meats, fish, nuts and some types of fruits. Roof rats do very well consuming dog or cat food. One rat can eat about a half a pound (227 g) per week, and probably contaminate 10 times that amount with its urine and droppings. Many rat species hoard considerable amounts of solid food in attics, wood piles or behind boxes in a garage, which they find and eat later. They require 1/2 to 1 ounce (15 to 30 ml) of water daily when feeding on dry foods, but need less water when moist foods are consumed.

Rats are primarily nocturnal, though some may be active during daylight when rat populations are high. Studies indicate that a Norway rat normally travels an area averaging 100 to 150 feet (30 to 45 m) in diameter, seldom traveling more than 300 feet (100 m) from a burrow to obtain water. Roof rats will travel 100 to 300 feet (30 to 90 m) for food, and can be seen at night running along overhead utility lines or fences. While rats constantly explore and learn about their environment – memorizing the locations of pathways, obstacles, food, water, shelter and other elements in their territory – they quickly detect and avoid new objects, such as a trap or bait, placed in their environment.

Rat Signs

There are a number of signs that indicate rats are present in a residence. Rat **droppings** may be as large as 3/4 inch (2 cm) long and 1/4 inch (0.6 cm) in diameter. Rat **tracks** (see Figure 7-3) can be seen on dusty surfaces or in mud or in flour spread on the floor overnight to determine if rodents are present. **Urine** will fluoresce under ultraviolet light and may occur along travelways or in feeding areas. **Runs or burrows** may be found next to walls, along fences, next to buildings or under bushes and

debris. **Smudge or rub marks** may occur on beams, rafters, pipes or walls, as a result of oil and dirt rubbing off the rat's fur. **Gnawing** may be visible on doors, ledges, in corners, in walls, on stored materials or other surfaces. Fresh wood shavings or chewed insulation indicate active infestations. Mouse holes are often 1 1/2 inches (3.8 cm) or less, whereas rat holes are 2 inches (5 cm) or larger. **Sounds** such as gnawing, climbing in walls, running above ceilings and squeaks are common when rats are active.

Rat Control

The three essential steps for effectively controlling rats are (1) applying sanitation practices and habitat modification, (2) rodent-proof construction and (3) population reduction.

(1) Sanitation and Habitat Modification

Sanitation plays an important role in controlling rats. Studies indicate that poor sanitation is one of the basic reasons that moderate to high rat populations flourish in urban and suburban areas. Sanitation involves good housekeeping, including proper storage and handling of food, feed and edible garbage. Pet foods are often a food source for rats in and around homes. Store in metal, rodent-proof materials, and feed pets only what they will consume at a single feeding. Garbage and rubbish from homes, restaurants and other such sources should be properly stored and disposed. A proper refuse storage container is heavy-duty, metal, rust-resistant and equipped with a tight-fitting lid. Containers should be set on racks or stands to prevent rusting, minimize the chance of being overturned and reduce rat shelter under containers.

Regular removal of debris and control of weeds around homes will reduce shelter available to rodents. Eliminate vines growing on buildings and overhanging tree limbs that roof rats may use as travel routes. In some instances, placing a strip of heavy gravel around building foundations will reduce rodent burrows. Gravel should be at least 1 inch (2.5 cm) in diameter and placed in a band at least 2 feet (0.6 m) wide and 1/2 foot (15 cm) deep. Keep the perimeter clean of debris, including stacked firewood and other materials.

(2) Rodent-proof Construction

Often ignored, rodent-proof construction is the best defense for preventing problems with rats. To exclude rats, seal all holes and openings larger than 1/2 inch (1.3 cm) across. Use heavy materials that will withstand rodent gnawing – concrete, galvanized sheet metal and heavy-gauge hardware cloth.

To prevent rodent entry, their capabilities need to be understood. Their physical abilities are impressive. Rats can:

- Enter openings larger than 1/2 inch (1.3 cm).
- Run along or climb electrical wires, pipes, fences, poles, ropes, cables, vines, shrubs and trees to gain entry into a building.
- Climb almost any rough vertical surface, including weathered sheet metal and many plastic products.
- Crawl horizontally along or through pipes, augers, conveyors, conduit and underground utility and communications lines.
- Gnaw through a variety of materials including lead, aluminum sheeting, window screens, wood, rubber, vinyl, fiberglass, plastic and low-quality concrete or concrete block.
- Jump as high as 36 inches (91 cm) vertically and as far as 48 inches horizontally.
- Drop 50 feet (15 m) without being seriously injured.
- Burrow straight down into the ground for at least 36 inches (91 cm).
- Travel considerable distances crawling upside-down along screen wire.
- Reach as high or wide as 13 inches (33 cm).
- Swim as far as 1/2 mile (800 m) in open water, dive through water traps in plumbing and travel in sewer lines against substantial current.

When inspecting for potential entryways, look for rat signs. Pay attention to areas behind, under or in appliances, sinks, cabinets, drawers, stored goods, wall voids, false ceilings and other undisturbed areas. To conduct a thorough survey, keep a detailed record of items needing alteration while inspecting the house. Bring a pencil or ballpoint pen for keeping records. Also bring a flashlight, mirror (to see under or behind objects), screwdrivers and other tools (to remove interior and exterior vent grills, appliance base plates, attic doors, crawlspaces and utility cabinets), tape measure (for preparing repair materials) and perhaps a camera if leaving the site (for photographing problem areas and designing a solution away from the site).

Pay particular attention to utility entry points including aerial (roof rats) and underground (Norway rats) electrical and communication trunk lines and exhaust vents for clothes dryers. Powerlines are a favorite travel route for rodents, especially for roof rats. Rat guards can be attached to overhead utility wires; however, these need to be checked periodically because rats may fray the insulation and cause short circuits. Check all roof joints for tightness and presence of flashing, particularly if rats have access to the roof via wire, pipes, plants or rough-textured walls. Also, check roof and sewer vents for adequate screening and sealing. Chimneys should be checked for properly installed flashing or missing mortar.

In areas with high rat populations, both species can enter buildings through toilets and uncovered drains. A "rat guard" one-way flap can be installed in toilets to prevent entry. Rats often find easy access to garage areas through open doors or under poor-fitting garage doors. Once inside the garage, they may gain entry into the main structure along electrical lines, pipes, poorly sealed firewall sheathing, around furnace ducts, hot water heaters or laundry drains.

If rodents are able to reach the attic, they may travel from room to room through openings for pipes, ducts and wiring. Also, inside entry can be achieved through the fireplace, which may have poorly fitted sheeting or metal collars, an open damper or cool air and warm air returns around the firebox. If the outside cannot be sealed, glass doors that seal the burn area are recommended to prevent entry throughout the year.

Gaps in foundations and slabs, or where the wall framing meets the foundation or slab floor, may provide large enough openings for entry. Older buildings commonly have cracked foundations, cracked plaster or mortar, warped siding or broken and torn vent screens. Wood or masonite siding is especially vulnerable to warping and cracking near corners and around the base of the building. Old, unused holes where utilities formerly entered the structure are also common points of entry.

Dense shrubbery, vine-covered trees and fences and vine ground cover make ideal habitat for roof rats. Severe pruning and/or removal of certain ornamentals is often required to obtain lasting rat control. Remove preharvest fruits or nuts that drop in backyards. Collect and remove all unwanted fruit when harvest is over.

Recommendations for Repair

Holes and openings: For a temporary plug, seal with steel wool, copper gauze or screen wire packed tightly into opening. For a permanent repair, mix a quick-drying patching plaster into a wad of patch material (avoid steel wool, as it will rust) and push the material into the hole. Smooth over the outside so that it will be difficult for a rat to find a rough edge to gnaw. (The inward curve of a rodent's teeth make it difficult to gnaw into a flat, hard surface. When given a rough surface or an edge to bite into, however, they can quickly gnaw into most materials.)

Holes 3 inches (8 cm) or more in diameter should be covered or backed with 1/4 inch (0.6 cm) woven/welded hardware cloth prior to patching. An alternative is a sheet metal patch with a self-adhesive backing. Close openings around augers, pipes and electric cables using Portland cement mortar, masonry, metal collars or other appropriate product. For large openings, recommended materials are concrete (minimum thickness of 2 inches [5.1 cm] reinforced, or 3 3/4 inches [9.5 cm] if not reinforced), galvanized sheet metal (24 gauge or heavier for wall or pipe barriers, 22 gauge or heavier for kick plates or door edging, 14 gauge for perforated or expanded sheet metal grills), brick (3 3/4 inch [9.5 cm] thick with joints filled with mortar), hardware cloth (woven, 24 gauge, 1/4- x 1/4-inch [0.6 cm x 0.6 cm] mesh) and aluminum (22 gauge for frames and flashing, 18 gauge for kick plates and guards).

Vents and windows: Use only metal window screening materials to prevent entry. For large openings or where the screen may be subject to abuse, add crossbars to support the screen.

Vents for heating and air conditioning should be screened if at all possible. To prevent a reduction of airflow, 1/2 x 1/2 inch (1.3 cm x 1.3 cm) hardware cloth is recommended. Sometimes, power vents can be covered with hinged metal plates (louvered) that open with air flow and close when the fans are off. However, louvers must fit tightly to be effective at preventing entry.

Exterior doors: Doors should fit tightly and the threshold not exceed 1/4 inch (0.6 cm). Metal thresholds can be fastened to floors.

Foundations and floors: Gaps or flaws along building exteriors where the wall framing or siding meets the foundation provide easy entry for rats.

Such openings can be prevented by well-formed and finished concrete work and installation of tight wall framing and siding or installing metal screed-type flashing between the siding and the foundation. Metal siding may provide entry points where panel ends are left open. Use of concrete, plaster or metal sheeting is effective if properly installed so that all the ribs or corrugations are closed. Rubber or vinyl weather stops are quickly gnawed through. Repair cracks in foundations and floors with concrete or masonry grout. Note that rodents can claw and gnaw at concrete and Portland cement until it is fully cured, so the use of hardware cloth laid in the top 1/4 inch (0.6 cm) of the repair area may be necessary or provide a rodent-proof overlay until the concrete is fully cured. **Caution:** Metal products placed within 1 inch (2.5 cm) of a concrete surface will oxidize and corrode and may discolor the concrete.

Drains and pipes: Rats use drainage pipes or sewage systems as routes to enter buildings. Equip floor drains with metal grates held firmly in place, with grate openings not exceeding 1/4 inch (0.6 cm). Maintain 1/2 inch (1.3 cm) hardware cloth over sewer roof vents.

Climbing walls, vertical pipes or electrical wires: Physical barriers and guards can be constructed to prevent rats from climbing up walls or at corners of walls. A sheet metal band attached to a wall at least 26 inches (91 cm) above the floor or ground will prevent rats from climbing (see Figure 7-6). This rodent guard should be at least 14 inches (36 cm) but preferably 18 inches (46 cm) wide. A flat guard can be placed on top of a vertical pipe or electrical wire that is attached to a wall. Cone-shaped circular guards can be constructed for placement around free-standing pipes or wires. Use 24-gauge metal and extend the cone out at least 18 inches (46 cm) around the pipe or line. Anchor the cone in place by one or more arms on the side opposite to that accessible to rodents.

(3) Population Reduction

The adaptability of rats to human-created environments and their high fertility rate make for quick recuperation of their populations. Population reduction efforts must reduce numbers to a very low level. Otherwise, rats will not only reproduce rapidly, but can quickly exceed their former density for a short period of time. Unless the rat's living environment is destroyed by habitat modification, improved sanitation and rat proofing, control methods must be unrelenting to be effective.

Trapping is recommended when only a few rats are causing problems. For moderate to severe infestations, a variety of rodenticides are available commercially. The capability of rats to memorize objects in their environment presents a special challenge when introducing traps or baits. Roof rats have a stronger tendency than Norway rats to avoid new objects in their environment. For either rat species, it may take several days before they will approach a trap or bait station. Roof rats may even modify their travel routes and feeding locations; therefore, habitat modifications should be made only after the rat population is under control.

Trapping

Trapping can be effective for controlling a few rats around houses, garages or small structures, but requires more skill and labor than other methods. Trapping is recommended when poison baits cannot be used. It also offers the advantage of being able to dispose of rat carcasses, rather than dealing with problems associated with odors from irretrievable carcasses that decompose after poisoning.

A simple, inexpensive, wood-based snap trap is available in most home and hardware stores and, if set properly, is very effective in killing rats. For Norway rats, set traps close to walls, behind objects, in dark places and in locations where rat activity is observed. For roof rats, traps will need to be placed at the very points that rats traverse in attics or along rafters or ledges. Place the trap trigger along the runway so that the rat will pass directly over the trigger. If along a wall, place the trigger side of the trap closest to the wall, and set another trap beside it to improve your success (see Figure 7-7). Another trick is to expand the trigger region by attaching a square of cardboard, metal or screen wire to the bait pan. When placing multiple traps, position them no more than 6 feet apart where rats are active. Bait traps with a small sample of peanut butter, raisin, prune, gumdrop, marshmallow, hot dog, bacon or nutmeat tied securely to the trigger.

Wire-mesh, live traps are available commercially for trapping rats. Rats that are captured should be humanely destroyed and not released elsewhere because of their role in disease transmission, damage potential and detrimental effect on native wildlife.

An alternative to traps is glue boards, which catch and hold rats attempting to cross them. Place glue boards wherever rats travel. Generally, glue

boards are less effective for rats than mice. They are also more difficult to place where roof rats are active compared to Norway rats. Do not use glue board where children, pets or other wildlife can contact them. Glue boards are considered by some to be inhumane, as rats attempting to free themselves may struggle for several hours. Glue boards lose their effectiveness in dusty areas unless they are covered, for example, with a shoebox having an entry hole at each end. Temperature extremes can also affect the tackiness of some glues.

Baits

The use of toxic baits, i.e., rodenticides, is recommended when there are large infestations of rats and there is less concern about odors resulting from decomposing carcasses. Whenever a rodenticide is used, safety must be the first consideration. Toxic baits should be placed where they are inaccessible to children and pets. Rats are color-blind; therefore, dyes that are tasteless to rodents can be used in baits to identify them for reasons of safety.

One classification of rodenticides are anticoagulants (Table 7-4), which are slow-acting, chronic toxicants that require multiple feedings to be effective. Examples of first-generation anticoagulants are warfarin and chlorophacinone. Second-generation anticoagulants (brodifacoum, bromadiolone and difethialone) can be effective after a single dose, though it may take up to five days before death ensues. Roof rats generally require a few more feedings of first-generation anticoagulants than Norway rats to produce death. However, little difference is evident when using second generation anticoagulants.

Rodents poisoned with anticoagulants die from bleeding internally. A few cases of pet poisoning have been reported when pets feed on dead rodents. Dogs are more sensitive to anticoagulants than are cats, and pets accustomed to feeding on dry foods can easily ingest a toxic dose of rodenticide if these baits are accessible to them. Older, first-generation anticoagulants (e.g., warfarin, diphacinone, chlorophacinone) are considered less hazardous to pets because they typically require multiple feedings to achieve a lethal dose, and accidental poisoning can be treated with an antidote, Vitamin K_1. However, the majority of anticoagulants being marketed today (including many d-CON products) contain brodifacoum or other second-generation materials than can be fatal in a single feeding.

Label directions on anticoagulants commonly instruct maintenance of a continuous supply of bait for 15 days or longer until feeding ceases. Anticoagulants are purposefully slow-acting to prevent rats from becoming bait-shy. If the bait produces an ill effect in a rat but not death within a few hours, the bait will often become associated with the

Table 7-4. Anticoagulants Used for Rat Control

Common Name and Typical Trade Names	Chemical Name	Usual Types of Formulations		
		Food bait	Liquid	Tracking powder
Brodifacoum* (Talon®)	3-[3(4'-bromo[1,1' biphenyl]-4-yl-)-1,2,3,4-tetrahydro-1-naphthalenyl]-4-hydroxy-2H-1-benzopyran-2-one	X		
Bromadiolone* (Maki®, Contrac®)	3-[3-(4'-bromo [1,1'biphenyl]-4-yl)-3-hydroxy-1-phenylpropyl]-4-hydroxy-2H-1-benzopyran-2-one	X		
Chlorophacinone (RoZol®)	2-[(α-chlorophenyl)phenylacetyl]-1,3-indandione	X		X
Difethialone* (Generation®)	[(bromo-4'-[biphenyl-1-1']-yl-4) 3-tetrahydro-1,2,3,4-nathyl-1] 3-hydroxy-4, 2H-1-benzo-thiopyran-2-one	X	X	
Diphacinone (Ramik®, Ditrac®)	2-diphenylacetyl-1,3-indandione	X		X
Warfarin	3-(α-acetonylbenzyl)-4-hydroxycoumarin	X	X	

*This product is capable of being lethal in a single feeding.

Table 7-5. Single-dose, Non-anticoagulant Rodenticides Used for Rat Control				
		Usual Types of Formulations		
Common Name and Typical Trade Names	Chemical Name	Food bait	Liquid	Tracking powder
Bromethalin (Assault®, Vengeance®)	N-methyl-2,4-dinitro-N-(2,4,5-tribromophenyl)-6-(trifluoromethyl) benzenamine	X	X	
Chloecalciferol (Vitamin D_3, Quintox®, Rampage®)	9,10-Seocholesta-5,7,10 (19)-trein-3 betaol	X		
Zinc phosphide (Ridall®)	Zinc phosphide	X		X

illness. Bait shyness can persist for weeks or months and may be transferred to nontoxic foods of similar types.

Bromethalin, cholecalciferol and zinc phosphide are single-dose, non-anticoagulant rodenticides that can be effective for anticoagulant-resistant populations of rats (Table 7-5). Although only a single dose is required, both bromethalin and cholecalciferol may take up to four days before death ensues. Because of this slow action, the rat's subsequent illness is not associated with the bait even if a sublethal dose is consumed; thus, bait shyness does not usually occur. These baits, in effect, serve as their own prebait.

Zinc phosphide is relatively quick acting, with results evident one-half to 20 hours after ingestion. Because a rat could potentially ingest a small amount of zinc phosphide and survive, prebaiting is recommended. Prebaiting, that is, training rats to feed repeatedly on non-toxic bait prior to applying the toxic bait, will encourage rats to feed subsequently on the toxic bait, thus largely preventing sublethal doses and thus bait shyness. As with any product mentioned, be sure to follow label recommendations to achieve best success. All single dose, non-anticoagulant baits should be removed and destroyed after the end of a poisoning program.

Single-dose, non-anticoagulant rodenticides work in a variety of ways. Bromethalin depresses the central nervous system and results in paralysis. Cholecalciferol, also called Vitamin D_3, is a calcium releaser that causes too much calcium to be released into the blood, resulting in kidney, liver or heart failure. The advantage of Vitamin D_3 is a minimal risk of secondary poisoning to pets or wildlife that eat poisoned rodents. Zinc phosphide causes gas to enter the circulatory system, resulting in heart paralysis, gastrointestional damage and liver damage. Many formulations of zinc phosphide are Restricted Use and therefore require an applicator's license to be administered.

Ready-to-use baits come in a variety of formulations. Usually corn, oats, wheat, or barley are the grains that rats prefer. Grain-based baits in loose meal or pelleted form are available in bulk or packaged in small plastic, cellophane or paper "place packs." These packs keep bait fresh and are easy to place in burrows, walls or other locations. Rats will gnaw through the bag to feed on a preferred bait. The disadvantage of bait bags is that they may be moved to places where it is undetected and hazardous to other animals besides rats.

Other bait formulations are available. Bait in wax or extruded blocks can be used in moist areas, such as sewers, where grain baits may readily spoil. Rats accept paraffin block baits less readily than loose or pelleted grain baits, but acceptance of bait blocks is still high. Bait blocks tend to be more effective for roof rats where they can be easily placed in small areas and difficult-to-reach locations. Where label instructions permit, small blocks can be fastened on rafters, ledges or tree limbs where they are accessible to roof rats.

When no water is present, concentrated baits are available that can be mixed with water and sugar to create a liquid bait for thirsty rats. Since rats require water daily, they can be drawn to water stations when other water sources are absent. Rodents are more likely to detect anticoagulants in water baits; therefore, up to 5 percent sugar is sometimes added to liquid baits. Since water is attractive to most animals, use water baits in ways that prevent nontarget animals from drinking them.

Contrary to popular belief, rats prefer fresh, high-quality foods and will reject spoiled or inferior foods. In situations with moderate to severe infestation, check for differences in bait acceptance among several types of bait prior to investing time and money in a specific bait product. Rats may be rejecting a bait product simply because the bait does

not taste as good as other available foods. In this instance, test different nontoxic baits by placing about 4 ounces (115g) of each about one foot (30 cm) apart in several locations where rats are present. Check baits the next few days, keeping in mind that rats are suspicious of new objects and novel foods. They may not accept a new bait until the third or fourth day.

Besides bait acceptance, other reasons for failure of baits are:

- Too short a period of bait exposure.
- Insufficient bait and insufficient replenishment of bait.
- Too few bait stations and/or too far apart. In some situations, stations may have to be within 20 to 30 feet (7 to 10 m) of one another.
- Rats moving in from untreated areas, e.g., the neighbors.
- Improperly placed bait stations. Other foods are more convenient to rats.
- Abundance of other food choices.
- Tainted bait – bait has become moldy, rancid, insect-infested or contaminated.

Sometimes rats ingest baits with no results. Although unlikely, genetic resistance to anticoagulant baits can occur. This may be the case if about the same amount of bait is taken daily for a number of weeks, indicating that the rat population is not declining. In this case, switch to a non-anticoagulant rodenticide. If bait was initially consumed and a few remaining rats are not taking the bait, the best strategy is to switch to a different bait formulation, place baits in different locations and use other control methods such as traps.

Bait stations (bait boxes) are recommended to improve safety of rodenticides from being consumed by non-target animal species and children, protect bait from moisture and dust, provide a protective, attractive place for rodents to feed, allow placement in locations where it might be otherwise difficult and help prevent accidental spilling of bait. Bait stations are available commercially or can be made from scrap wood or other materials. Manufactured bait stations are made of plastic, cardboard or metal and come in a variety of shapes and sizes. Rodent bait stations can be constructed from a length of pipe or placed under a secure board or box. Clearly label all bait stations with “POISON” or “RODENT BAIT – DO NOT TOUCH” or with a similar warning.

Bait stations should be designed with two hole entrances 2 1/2 inches in diameter on opposite sides of the station, so that rodents can see an alternate escape route. A simple bait station is a flat, 18-inch (46 cm) or longer board nailed at an angle between the wall and floor to protect bait from pets and children, yet allow rodents to feed in a sheltered location. Alternatively, bait can be placed in a pipe of 3 1/2 to 6 inches (9 to 15 cm) in diameter and at least 18 inches in length. More elaborate bait stations are completely enclosed with hinged lids for convenient inspection and can contain both liquid and solid baits (Figure 7-11).

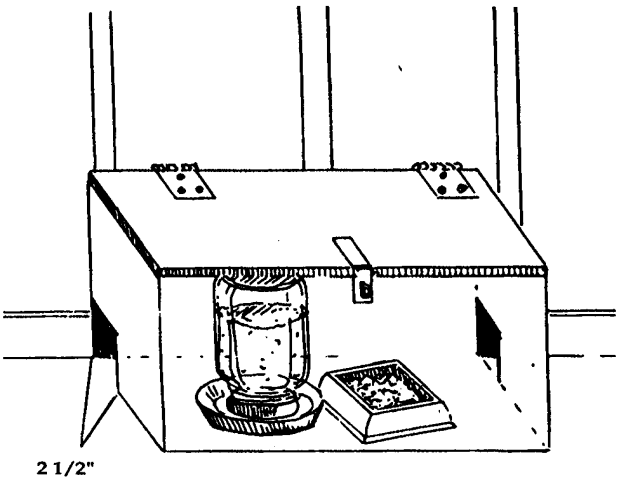

Figure 7-11. A homemade rodent bait station can contain liquid as well as solid baits. This bait station allows rats to feed in a sheltered location while preventing pets, children and other non-target species from reaching the bait.

Proper placement of bait stations is just as important as using the appropriate bait. Rats will not visit bait stations if they are in an inconvenient location where rats are not active. Bait stations are more effective for Norway rats than roof rats, because of the difficulty of placing bait stations along rafters or ledges where roof rats are active. Paraffin-type bait blocks provide an alternative when controlling roof rats. When possible, place bait stations or bait blocks between the rodents’ source of shelter and their food supply. Place bait stations or blocks near burrows, against walls or along travel routes. Since rats are suspicious of new or unfamiliar objects, it may take several days for them to enter and feed in bait stations or eat bait blocks. When first putting out bait boxes, inspect daily and add fresh bait as needed. After a short time, rodent numbers and feeding will decline, and the boxes can be checked less frequently, e.g., every two weeks or once a month. If bait becomes moldy,

musty, soiled or insect-infested, empty the bait station, clean it and refill with fresh bait, as rats will reject soiled or stale bait foods. Dispose of soiled or uneaten bait in accordance with the label.

Safety Precautions

Certain general safety precautions should be observed in addition to those appearing on labels of specific products.

- Consider all rodenticides dangerous enough to cause death, and place baits where only rodents can get them. No known rodenticides are without some hazard to nontarget animals. Be sure the baits are not accessible to children or pets and other animals.

- People handling baits should not smoke, eat, drink nor put their hands near their mouths. After preparing or handling baits, wash well using soap, a brush and plenty of water.

- Whenever possible, buy prepared or ready-to-use baits rather than trying to mix your own. Commercial formulators are governed by regulations that require that operations are safe for their employees. Wear gloves, protective eyewear and a dust mask/mist respirator when handling baits in nonpackaged forms. Clean all bait-mixing utensils thoroughly, and use them only for bait preparation.

- When toxicants are used, it may be advisable that each bait placement be recorded. Remove or destroy all uneaten baits at the end of the poisoning period according to label directions.

- Tracking powders are a Restricted Use Pesticide and should be used only in limited circumstances. As with any baiting material, certified applicators must wear gloves, protective eyewear and dust/mist respirators when applying tracking powders. Do not place poisonous tracking powders where the rodents might carry them on their feet or bodies to food or food-preparation surfaces. Do not place tracking powders in the vicinity where children, pets and nontarget species frequent.

- During and after a poisoning program, pick up all dead rats. Handle the carcass using rubber gloves or a pair of long tongs. To dispose of large numbers of dead rats, burn (unless prohibited by law) or bury deep enough not to be dug up by pets or other carnivores. If there are only a few dead rats, place them in a plastic bag, close it tightly and dispose with the garbage.

- Label all bait containers or stations, unused baits and rodenticide concentrates with an appropriate warning. Store unused bait away from children, preferably in a locked place. Keep all rodenticides in locked and labeled cabinets. Restrict access to authorized, responsible individuals.

What Isn't Recommended

There are a number of commercial products that are ineffective at controlling rat populations or are not recommended around homes because of their hazardous nature.

- Frightening devices producing ultrasonic sounds are commercially available, but their effectiveness is unsubstantiated by scientific research. Therefore, these are not recommended as a solution to rodent problems. Loud or unusual noises may temporarily frighten rats, but they soon become accustom to new sounds heard repeatedly.

- Repellents such as mothballs or household ammonia may temporarily move rats from one location to another, but do nothing to remove the rats. A product called Ro-pel is registered for use in repelling rodents from gnawing on trees, poles, fences, garbage and other objects, but will do nothing to remove them.

- Fumigants typically are not an option in homes. Some fumigants are registered for use in rodent burrows at outdoor locations. Compounds including aluminum phosphide, chloropicrin and gas cartridges are registered for this purpose. Fumigants should only be used by pest control operators who are familiar with the necessary precautions for fumigation, because these fumigants are highly toxic to humans and other animals. Do not use fumigants in any situation that might expose the occupants of a building to

the fumes. To fumigate Norway rat burrows, close the burrow opening with soil or sod immediately after introduction of the fumigant. Norway rat burrows often have multiple entrances, and all openings must be sealed for fumigants to be effective. Fumigants are less effective in soils that are very porous or dry. Since roof rats rarely dig burrows, burrow fumigants are of limited use.

- Tracking powders can be effective at rat control but are not recommended around homes. When rats walk over a patch of toxic powder, they pick up some on their feet and fur, and later ingest it while grooming. Tracking powders are used in situations where food is plentiful and good bait acceptance is difficult to achieve. The concentration of active ingredient in tracking powders is considerably higher than food baits using the same toxicant; therefore, powders are more hazardous. Tracking powders are used much less often for roof rats because roof rats frequent overhead areas, where it is difficult to find a suitable place to apply tracking powder without contaminating food, materials or people below. Many, if not all, are Restricted Use Pesticides.

Concluding Remarks

An effective rodent control program can be achieved through a combination of sanitation practices and habitat modification, rodent-proofing and population reduction. In areas with moderate to severe infestation, a cooperative effort among adjoining properties will be necessary to achieve long-term, effective rodent control measures. Otherwise, rats from surrounding habitats can be expected to "fill the void" and return to the unoccupied rodent habitat in the home. Many commercial products are available for rodent-proofing homes, and trapping and baiting rats. Rodenticides (toxic baits) can pose a risk to the handler, children, pets and nontarget wildlife species. Safety considerations should be a priority when implementing these techniques. Because of product turnover, information presented in this chapter may become outdated. Always follow the pesticide label when applying baiting practices.

Skunks

Skunks are classified as furbearers and, as such, are protected by state regulations. A hunting license is required from the Arkansas Game and Fish Commission (www.agfc.com) for either live trapping or administering lethal methods of control. With a hunting license, skunks may be live-trapped or killed during furbearing season. If skunk problems need to be handled outside furbearing season, a depredation permit is required. Contact a county Arkansas Game and Fish wildlife officer or wildlife biologist for this permit. Note that a depredation permit does not include permission to shoot skunks when local law prohibits discharge of firearms.

Skunks have short, stocky legs and disproportionately large feet equipped with well-developed claws for digging. Skunks are carnivores and eat insects such as grasshoppers, beetles and crickets, as well as mice, moles, young rabbits, grubs, bees, wasps and their hives. Skunks also eat fruits, some grasses, leaves, buds, roots, nuts and grains. In residential areas, they contribute to controlling rodents as well as insect pests found around the home; however, their underground dens can weaken foundations and contribute to odor problems.

Skunk Control Techniques

Skunks occasionally become pests by living near or beneath residences. Although a chief objection to their presence is the penetrating odor they produce, skunks can carry rabies. Skunks that are overly aggressive or show abnormal behavior should be treated cautiously. Contact local animal control or sheriff's office for assistance with disposing of a rabid skunk. Avoid shooting or striking the head to protect against damaging the brain for testing rabies. If removing a potentially rabid skunk, gloves and/or shovels should be used. Place skunk in a sealed plastic bag and bury the carcass where pets will not dig it up.

Removal and relocation in combination with exclusion methods oftentimes is the best option for addressing skunk problems. Shooting is also an option, where legal and with proper hunting license or depredation permit. There are no toxicants or repellents registered for skunks.

Typically, skunk problems involve removing and excluding skunks from a den site. Avoid skunk removal from May through early August when

den-bound, immobile young may be present. A combination of live trapping, relocation and exclusion are recommended as follows.

- **Live trapping**. Bait live traps with a few tablespoons of pet food having a fish base. When using a wire cage trap, place a tarp or plywood shell around the cage. Check the trap frequently particularly in the summer, as skunks could die from excessive heat and lead to accusations of inhumane treatment. After a skunk is trapped, cover the opening so the skunk cannot see. With a minimum of jarring or shaking, the trapped skunk can be transported and released with little concern for a musk discharge. Leg-hold traps can be used to catch skunks, but because of odor problems, this method should not be used near housing.

- **Relocation**. When relocating skunks, transport them at least 10 miles and release in habitat far from human dwellings.

- **Exclusion**. Typically, more than one skunk occupies a denning site. Seal off all foundation openings except one. Cover openings with wire mesh, sheet metal or concrete. Skunks may dig to gain entry, so obstructions such as fencing should be buried 1 1/2 to 2 feet. In front of the remaining opening, spread a layer of flour on the ground. Typically, skunks are active at night. Check at night for tracks indicating the skunks have left the den, then seal the opening. To ensure no skunks are sealed inside, use one or both of the following approaches.
  - o For several successive nights, unseal one opening at dark and place flour on the ground. After a couple hours, check for tracks exiting the den and reseal the opening. If no tracks are detected after several nights, seal the opening permanently.
  - o Place a trap inside the sealed up area. Bait with pet food and water. Remove and relocate any trapped skunks. Repeat until no skunks are trapped on successive days.

Odor Abatement

When a skunk raises its tail, it is a warning. When a skunk's hind legs begin hopping, leave the vicinity as quickly as possible. Ordinarily, there is no discharge. But if a skunk believes it is in danger, one discharge will not empty the reservoir. Many people find the odor repugnant or even nauseating. Because of its persistence, the scent is difficult to remove. Diluted solutions of vinegar or tomato juice can have limited effectiveness when applied to pets, people or clothing. Clothing can be soaked in weak solutions of household chlorine bleach or ammonia, but oftentimes the clothing is also ruined using this treatment. For spraying under foundations or structures, a number of skunk deodorizers are on the market. These offer some relief by masking, rather than removing, the odor. Merchants can be found on the internet, such as at http://crittercontrol.com/catalog/enter.html.

Snakes

There are 46 snake species in Arkansas, of which only 6 are venomous (poisonous). Most species are harmless to people. Snakes cannot be killed indiscriminately, as they are protected under the wildlife code of the Arkansas Game and Fish Commission. Snakes feed on rats, mice and insects, so they should not be killed unless they pose a direct threat to humans or pets. Only venomous snakes pose this threat, and it must be apparent and defensible. Wildlife officers have issued tickets and imposed fines for killing rattlesnakes. Venomous snakes rarely enter homes but can be found in yards.

Identifying Venomous Snakes

The most-often reported features for distinguishing venomous and non-venomous snakes are pupils, pits, and tail scales (Figure 7-12). Sometimes, the head shape is mentioned as well. Non-venomous snakes have a round pupil, no pit near the nostril and divided scales on the underside of the tail. Venomous snakes have an elliptical eye, a pit or opening close to the nostril and undivided scales on the underside of the tail. Of these features, only the presence or absence of a pit is consistent for identifying pit vipers. The shape of the pupil may vary depending on light conditions, tail scales may be difficult to detect and non-venomous species have head shapes that imitate their venomous counterparts. Only one venomous snake in Arkansas is not a pit viper, the coral snake. It can be distinguished by its coloration – a black snout with wide black and red bands on the body separated by narrow yellow bands. The similar-looking milk snake has a red snout with narrow black-yellow-black bands separated with wide red bands.

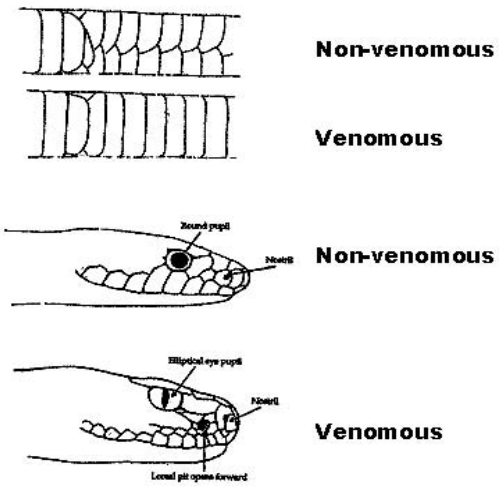

Figure 7-12. Characteristics of venomous and non-venomous snakes

Snake Control Techniques

Outside of rattlesnakes or copperheads, most other native snakes are quite harmless but cause concern when they enter buildings to escape the hot part of the day, seek food or hibernate during the winter. No toxicants are registered for snakes. Control measures are limited but can be effective.

- **Remove habitat.** Remove brush and lumber piles, and mow grass frequently. Not only will this remove hiding places for snakes, it also removes habitat for rodents. Often, snake problems follow rodent problems. Eliminate the rodents, the snake's food, and the snakes will move elsewhere.

- **Exclusion**. Seal all openings 1/4 inch (0.6 cm) and larger. Check the corners of doors and windows, and seal spaces around water pipes and electrical conduits. Seal holes in foundations with concrete. Patch holes in wooden buildings with fine mesh (1/8 inch, 0.3 cm) hardware cloth or sheet metal.

- **Snake-proof fence**. A properly constructed fence will keep out venomous snakes, though some non-venomous snakes are good climbers. Constructing a snake-proof fence is expensive but may be worthwhile in particular situations. The fence should be made of heavy galvanized hardware cloth 36 inches (91 cm) wide with 1/4 inch (0.6 cm) mesh. The lower edge should be buried 6 inches (15 cm) in the ground. The top of the fence should be slanted outward from bottom to top at a 30-degree angle. Place supporting stakes inside the fence. Gates should close tightly and swing inward, because of the outward slope of the fence. Any opening under the fence should be firmly filled. Concrete is preferable. Keep vegetation mown short around the fence, as a snake could use plants to climb over the fence.

- **Repellents.** Although repellents have been tried, evidence suggests they have little effectiveness. Currently, Dr. T's Snake-A-Way© is registered for rattlesnakes and checkered garter snakes. Active ingredients are sulfur and naphthalene (i.e., moth balls). A 6- to 8-inch band of product is applied to keep snakes from an area. If the band is broken, snakes can pass through.

- **Trapping.** A funnel or pit trap with drift fences can be used to capture and relocate snakes found in a yard. The fence is set up in a "V" shape with a funnel or pit trap placed at the intersection of the two fences. Drift fences can be constructed from 1/4 or 1/2 inch (0.6 or 1.3 cm) mesh hardware cloth that is 2 feet (0.6 m) wide and 25 feet (7.5 m) long.

- **Glue board.** A purchased or homemade glue board can trap snakes inside or under a building. Snakes become stuck when they travel across the board, then relocated and released by pouring vegetable oil on the glue. Put the captured snake in a cloth bag for transport. To construct a glue board for snakes, securely tack several rodent glue traps to plywood, or purchase the special glue in bulk and affix to plywood. The plywood board should be approximately 24 x 16 inches (61 x 41 cm) with a glue patch of at least 7 x 12 inches (15 to 30 cm). Drill a hole through the board so the snake and board can be moved with a long stick or hooked pole. Place the board along a wall where snakes are likely to travel. Do NOT place the board near any object, such as pipes or beams, a snake can use for leverage to free itself. Do NOT place the glue board in locations where it may catch pets, children or other wildlife. The glue is messy and can be difficult to remove.

- **Burlap bags.** Place piles of damp burlap bags or towels in areas where snakes have been seen. Cover each pile with a dry bag to slow evaporation. Snakes are attracted to cool, dark, damp areas such as these piles. After a day or so, take a large scoop or shovel and remove them during the day, when snakes are more likely to be inside or underneath the pile.

Responding to Snakebites

In the event of a snakebite, it is imperative to determine whether the snake is venomous. If possible, the snake should be positively identified or, if killed, carefully secured in a sealed container and transported with the victim for treatment at a hospital. Proper identification is necessary to insure the appropriate anti-venom is administered. Unlike the past, no extraordinary actions are recommended for snakebites other than keeping calm, avoiding quick movements, keeping the body part motionless and below heart level and quickly getting medical attention.

Tree Squirrels

There are three species of tree squirrels in Arkansas: gray squirrels, fox squirrels and flying squirrels. Squirrels are members of the rodent family, like mice and rats. Gray and fox squirrels are protected as game animals by state law with open and closed hunting seasons. Flying squirrels are protected as non-game animals and may not be hunted at any time. Flying squirrels typically do not create structural damage problems to buildings. Gray and fox squirrels often get into attics, walls and chimneys and may also eat flowers, shrubs and birdseed. They can store food and scratch inside attics and wall voids. They may travel on power-lines and short out transformers. Squirrels like to gnaw on wires.

Squirrel Control Techniques

Control methods for reducing squirrel damage can be more effective if used in combination. These methods are squirrel-proofing the structure, repellents, trapping and in some cases, shooting.

Squirrel Proofing

To eliminate squirrel problems in a building, find out where squirrels are entering. Gray and fox squirrels are active during the day, so you may be able to observe their activity. Common entry points for fox and gray squirrels are 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.

Be cautious about squirrel-proofing from mid-February until April and from June through September when young are born, particularly if there is evidence that squirrels are nesting in the structure. Squirrels typically have two litters a year, and their young are weaned at 6 weeks. The young may die inside the building, creating an odor problem as well as questionable ethics.

To repair openings, seal with heavy gauge, 1/2-inch hardware cloth or sheet metal. For details, follow instructions for rat-proofing that are in this chapter. Once all the openings are sealed, place a live trap in the attic where squirrels were active. This is a preventive measure in case squirrels were inadvertently trapped inside the structure. Such a squirrel will become desperate and can create extensive damage trying to escape. Continue to reset the trap until no squirrels are trapped for several days up to a week. Use instructions described below for setting live traps.

Squirrels can be stopped from traveling 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. Be careful near high voltage wires.

Repellents

Naphthalene (moth balls) has been used to keep squirrels out of attics, particularly in summer homes and camps that are unoccupied in winter. There are bitter-tasting repellents on the market to keep squirrels from chewing on wood and plant materials and sticky repellents for repelling squirrels.

Trapping

Squirrels causing property damage may be live-trapped and released or killed under a depredation permit issued by the local wildlife enforcement officer. Live trapping can be used to remove one or a few squirrels from a building. Box or wire traps should be left open and unset for a few days, surrounded by bait, so that the squirrels get use to the trap. Good baits include peanuts, peanut butter, nut meats, whole corn, sunflower seeds or rolled oats. Good trap locations are the roof, the base of nearby trees or the attic itself.

Squirrels are nasty biters, so handle them carefully. Experts differ as to whether squirrels should be released or killed. If released, transport the squirrel at least five miles away so they do not return.

If a depredation permit is issued, rat snap traps can be used to kill squirrels in attics. The bait should be tied to the trigger and the trap nailed or wired to a beam.

Shooting

Squirrels causing property damage may be shot under a depredation permit issued by the local wildlife enforcement officer, if discharging a firearm is legal at the site. Gray and fox squirrels may be shot without a permit during declared open squirrel season, if local ordinances allow discharging firearms.

Acknowledgements (Vertebrate Pests)

Major portions of text and illustrations for this chapter on vertebrate pests were taken from publications written by:

General Pest Pesticide Application Manual: Industrial, Institutional, Structural, and Health Related (1999), Oklahoma Cooperative Extension Service.

Robert M. Timm, Rex O. Baker, and Gerald R. Bodman in *Prevention and Control of Wildlife Damage* (1994 edition), Nebraska Cooperative Extension Service.

Rebecca McPeake, Blake Sasse, and David A. Saugey in *Bats in and Around Your Home* (2002), University of Arkansas Cooperative Extension Service. (FSA9088)

Using Pesticides: Commercial Applicator Manual, Pest Control Category (2002), Texas Cooperative Extension Service.

Arkansas Nuisance Wildlife Control Guidelines (1999). Arkansas Game and Fish Commission, Little Rock.

Additional information was used from:

“The House Mouse: Its Biology and Control,” (1981 edition) by Rex E. Marsh and Walter E. Howard, Div. of Agric. Sciences, Univ. of California.

“The Rat: Its Biology and Control,” (1980 edition) by Rex E. Marsh and Walter E. Howard, Div. of Agric. Sciences, Univ. of California.