

Controlling Mice

In and Around Structures



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House mice (*Mus musculus*), deer mice (*Peromyscus maniculatus*) and white-footed mice; (*Peromyscus leucopus*) frequently infest structures where they damage property, consume foodstuffs and contaminate areas with urine and feces which threaten human health. This bulletin describes the biology of mice, the damage they cause and provides advice for how to control these vertebrate pests and protect people from associated diseases.

Description, Range & Reproduction

House Mice

House mice (Fig. 1) are small rodents that weigh slightly less than an ounce and average 6½ inches in length including a three-inch tail. Though not native to the United States (they originated in Asia), house mice are adaptive enough to human environments that they can be found wherever people are throughout Montana. House mice reproduce year-round. Females can have four to six litters of five to seven young each year.



Fig. 1. House mouse.

Deer Mice

Deer mice (Fig. 2) weigh a little less than an ounce and average 6½ inches in length including a 2¾-inch tail. Their eyes are

enlarged to assist them in their nocturnal activities. Deer mice are native to Montana and may be found throughout the state from the grasslands to the mountains. Deer mice may be identified by the sharp color line on their tail, from brown on the top to white on the bottom. The house mouse tail is brown and grayish, without a sharp line. Female deer mice have three to four litters per year with three to five young per litter. Populations tend to spike in the fall.



Fig. 2. Deer mouse.

White-footed Mice

White-footed mice (Fig. 3) are the largest of the three species. They weigh about an ounce and are about 6¾ inches long, including a three-inch tail. This native species also has the smallest geographic range, occurring in the eastern two-thirds of the state and favoring areas near streams and rivers. Like the deer mouse, white-footed mice have enlarged eyes and are bi-colored. Their tails are dark on top and light on the bottom, but they lack the sharp color change characteristic of the deer mouse. Females are believed to have two litters of three to five young per year. Populations of the white footed mouse are more constant through the year than those of the deer mouse.



Fig. 3. White-footed mouse.

Mice should not be confused with voles (Fig. 4). Voles have stocky builds, blunt noses and short tails (long-tailed voles being the exception). Their ears are less pronounced, often with only the top half visible above the fur. Voles rarely enter structures but may be found in adjacent landscapes.



Fig. 4. Meadow vole.

Behavior

All three mice species consume plant and animal matter, such as insects. Deer mice are the most carnivorous of the three species. All species will store excess food for future use when available. They are active year-round, but the native species are able to enter periods of extended sleep (not true hibernation) when weather conditions are poor.

The small size of these rodents requires them to select nest sites capable of preserving body heat. Nests typically will consist of large balls of grasses or other insulating material placed in walls, stumps or other suitable crevices. Interestingly, deer mice will readily take up residence in burrows, typically excavated by other animals. All three species forage at night, but house mice will readily change their behavior to be active when humans are not.

Damage

Rodents damage materials by gnawing, burrowing, consumption and contamination. The incisors of rodents give them incredible abilities to gnaw. In fact, the term “rodent” comes from a Latin word meaning “to gnaw.” Because their incisors grow continuously, rodents must gnaw to keep them worn down. They do this by grinding their teeth or by gnawing on other objects leaving grooves of about 1/32 of an inch on wood, wire insulation and other soft items. There is good evidence that mouse gnawing on wires is responsible for numerous structural fires.

Mice can also damage insulation by trampling. One study found that house mice need only six months of scurrying around fiberglass insulation to reduce its effectiveness by 50 percent.

Mice are not significant consumers of food or grain in terms of overall volume. Most individuals of these species eat only two or three grams of food a day. But their caching behavior along with the damage they cause while foraging greatly magnifies their negative impact. Rodents damage far more grain than they consume through

contamination by urine and feces. For example, house mice deposit 50 to 75 pellets per day along their travel routes as they explore their environment. The salmonella bacteria present on these droppings can remain viable for up to 86 days. House mouse urine has been implicated as a trigger for asthma in some people, and deer mouse excrement may contain the deadly Hantavirus.

Capabilities of Mice

Mice have amazing physical abilities that enable them to take advantage of any opportunity to invade structures. They are good climbers, capable of scaling trees and bushes. All can swim, but white-footed mice appear to be more comfortable around water than the other species. All three species can see but deer and white-footed mice have significantly better night vision. This may be why house mice are usually much more active during moonlit nights than the other species. All species have good hearing, even able to listen in the ultrasonic range. Likewise their ability to smell and taste is quite pronounced. Mice are curious and eagerly explore. They often become so familiar with their environment that they can follow paths by memory, even in total darkness.

Recognizing Mice Infestations

Property owners typically become aware of the presence of mice by hearing sounds or finding droppings. Residents may hear scratching or tapping in walls and ceilings caused by mice travelling and maintaining nests. Sometimes the sound is louder than one would expect from creatures weighing no more than an ounce. Pets showing intense or frequent interest in a particular part of the

structure are strong indications that mice, or other vertebrate species, are present.

Droppings provide conclusive evidence for the presence of rodents. Droppings average $\frac{1}{8}$ to $\frac{1}{4}$ inch in length with one or both ends narrowing to a point (Fig. 5). On rare occasions the droppings will appear round. The droppings are usually black in color, but will vary according to the mouse's diet. Droppings of deer and white-footed mice will look similar. In contrast, droppings made by bats typically will be found in piles and will sparkle when illuminated. The sparkles are caused by light reflecting off the exoskeletons of insects, the prey of all of Montana's bats. All droppings should be treated as infectious. (See additional information below under "Disease Safety").



Fig. 5. Mouse dropping.

In areas with significant mouse contamination, you may also notice a musky odor. Finally, mice may be seen during their nocturnal travels, or less frequently, during daylight hours.

Estimating Mouse Numbers

Once a mouse problem has been identified, many people want to know how many mice they have. This desire is understandable because having a number allows owners to

hope that, once that number of mice has been caught, their problem is over. Unfortunately, the reality is more complicated. First, mice populations fluctuate, sometimes dramatically. Simply failing to capture one pregnant female can result in a rapid repopulation of the area as newborn mice take advantage of the available space and food. Second, and more likely, mice in neighboring areas will move to fill the space vacated by lethal control of the original population. Efforts that focus only on population removal and not on eliminating the conditions that allow mice to thrive and enter structures will result in an endless cycle of population reduction, repopulation, population control, etc. These comments are not to discourage lethal control of mice. They are simply to emphasize that relying only on lethal control will destine you to a lifetime of both infestation and control.

Nevertheless, while knowing precise numbers of mice is impossible, some benefit is obtained by identifying the level of the problem as being low, medium or high. This will allow the building owner to develop tolerance-thresholds of what level of infestation requires action. While this program is not ideal, it is often the only economically feasible choice when buildings are too damaged to cost-effectively repair. In addition, knowing relative levels of mouse activity can help owners plan on how much control effort needs to be applied.

The following Rodent Index (Table 1) was developed for swine housing facilities to help them estimate the level of mouse infestation in their buildings. Use the index in Table 1

for locations where grain and nesting areas are abundant, such as grain/hay storage areas.

Step 1. Place 12 baited traps (snap or multiple-capture traps) 15 feet apart in a part of the structure where rodent sign has been seen.

Step 2. Check live-capture traps every two days, but check snap traps daily. Record captures and reset as appropriate. Traps with no captures after two days should be moved to another location at least 15 feet away.

Step 3. Check traps for the next five days following the same procedure as Step 2.

Table 1. Rodent Index for Ideal Rodent Conditions.	
Number of Mice Caught in Seven Days with 12 Traps	Rodent Index
0-10	1 (Low infestation)
11-25	2 (Moderate infestation)
26 or more	3 (High infestation)

Table 2 applies to areas such as residential and office buildings where food is not as readily available to mice.

Table 2. Rodent Index for Residential and Office Buildings.	
Number of Mice Caught in Seven Days with 12 Traps	Rodent Index
0-5	1 (Low infestation)
5-10	2 (Moderate infestation)
11 or more	3 (High infestation)

Keep in mind that sightings of mice in broad daylight usually signify high numbers. Discovery of droppings in the living space of one's home means that the mice have left the walls and have moved into the main part of the structure.

Methods to Control Mice

Effective long-term control of mice requires habitat modification, sanitation, exclusion, population reduction and regular monitoring. The first three are preventive measures. When mice are established in an area, some form of population reduction by trapping and/or toxicants is generally necessary.

Habitat Modification and Sanitation.

Habitat modification and sanitation reduces both the conditions attractive to mice and the ability of resident mice to survive. Mice cannot maintain large populations when the availability of living space and food are restricted. Reduce the attractiveness of structures by creating a three-foot wide weed-free barrier around the structure. Crushed stone (one-inch diameter) to a depth of three inches or more is best but even bare soil will do. Research shows that mice do not like to cross areas lacking cover (Fig. 6).



Fig. 6. Crushed stone provides a superb weed-free barrier.

Trim branches and bushes around structures so that mice cannot use them to access rooflines. Whenever possible, eliminate debris piles, hay bales, stacked wood or other items that can give shelter to mice. At the very least, you should move or replace items as frequently as possible so that they do not become permanent homes for mice.

Modification of potential mouse habitat inside structures is more difficult because the building itself is attractive to mice. Clutter should be eliminated, and stacked or stored inventory, like wood and tools, should be moved regularly or stacked neatly. Whenever possible, store items at least 8 inches off the ground and at least 1 foot away from vertical walls to reduce the attractiveness to mice and to allow for easier inspections. Keep foodstuffs inside rodent-proof containers to prevent rodents from having access.

Bird feeders and stored pet food are very common food sources for mice. Store bird seed and pet food in tight-fitting bins. Modify bird feeders to reduce spillage of seed. A publication detailing how to modify your bird feeders can be downloaded from http://www.academia.edu/18446513/Selective_Bird_Feeding_Deterring_Nuisance_Wildlife_from_Bird_Feeders. Avoid feeding pets outdoors. If indoor feeding is not practical, then provide pets only with enough food to be consumed in one meal. Total elimination of mice through sanitation alone, however, is almost impossible, as mice can survive in small areas with limited amounts of food and shelter. On the other hand, any neglect of sanitation will cause even the most aggressive control efforts to fail, due to the rapid reproductive rate of mice.

Rodent-resistant construction. Mouse-proof construction is another key element in an effective mouse control program. Mice are attracted to buildings when they detect openings and escaping heat. Secure all openings larger than 3/16 of an inch. Typically, gaps less than ½ inch wide may be secured with a silicone-based sealant. Wider openings will require a backing to help hold the sealant in place. Two products that are flexible enough to squeeze into odd shaped areas and will not rust like steel wool include Xcluder™ and Stuf-Fit. Complete the job with the appropriate type of sealant to prevent air movement. Expandable foam products are great ways to stop air flow but cannot stop mice or even some insects. When using expandable foam, be sure to secure the outside with aluminum flashing, wood or other durable material.

Larger openings can be secured with wood, aluminum flashing, concrete or ¼-inch wire mesh. Doors, windows and screens should fit tightly. Cover the edges of doors and windows with metal to prevent gnawing. Latex, plastic, rubber, wood less than ½ inch thick or other soft materials are unsuitable for plugging openings used by mice.

Exclusion Safety

Think carefully before securing openings larger than ½ inch in diameter or larger. Could they lead to a void occupied by bees, bats or larger animals? If you are unsure, take the time to check. The last thing you want to do is to trap bees or animals like bats, birds, or squirrels inside the structure. Inspect the opening repeatedly for several days. Do you see any insects? Are there any droppings? Do you see any brown smudge marks left on the

edges of the hole that could signify that an animal was squeezing through? Consider crumpling up some newspaper and using it as a cork for the hole. Monitor the paper for at least five days of continuously good weather. Animals often will be able to push or chew through the paper. At the end of the time period, if the paper is undisturbed you can be reasonably confident that the hole is inactive and may be secured.

Cultural Practices

Cultural practices are the physical and mechanical actions involved with growing or managing crops and landscapes. Sometimes how or when a crop is planted or harvested can significantly reduce the amount of losses caused by animals.

The success of cultural practices is highly dependent on the target pest. Planting seeds at the maximum depth that will still permit germination, for example, reduces the likelihood that they will be dug up and consumed by mice. Scattering seed over the soil surface to divert attention away from planted seed the seed has been shown to be effective for thirteen-lined ground squirrels. It is unclear whether diversionary seeding reduces seed theft by mice.

Repellents

A variety of chemicals are claimed to be noxious to mice. While research has confirmed the efficacy of some ingredients in laboratory conditions, proof of their effectiveness in real-world settings is usually lacking. Readers choosing to use repellents should follow label directions carefully and maintain low expectations regarding potential results.

Population Reduction

Mouse populations can be reduced and sometimes eliminated through the use of traps and toxicants.

Traps. Trapping is the preferred method for controlling mice in homes, schools, hospitals and other sensitive areas for several key reasons: 1) it is pesticide free; 2) it permits users to view their success; 3) it is versatile, as traps can be placed in a variety of areas and ways; and 4) it allows for disposal of trapped mice, thereby eliminating the potential for odors and flies from the carcasses of dead mice. In situations where children or pets may interfere with traps, place them out of reach or in homemade boxes with one-inch holes cut in them. Traps may also be placed in professionally manufactured bait stations.

Snap traps come in a variety of models and designs. All are effective in catching mice. Traps with expanded triggers, however, have a higher capture rate. (Fig. 7).



Fig. 7. Traditional trigger (left) and expanded trigger (right) mouse traps.

Set triggers lightly so the traps will spring easily. Mice almost always follow walls, so placing the traps with the trigger side abutting the walls (Fig. 8). Traps positioned in this way can be baited or not. If you decide to bait, use peanut butter, caramel, chocolate, whole canary grass (*Phalaris canariensis*) seed, or nesting material, such as cotton balls and soft cloth.



Fig.8. Traps set abutting wall.

Double setting (placing two traps close to each other) is recommended in situations with high mouse activity. Be sure that at least one inch separates traps placed in a double set to prevent the firing of one trap from prematurely triggering the other.

If you must place traps sideways against walls, then be sure the triggers of the traps face outward, as in Figure 9.



Fig. 9. Traps set side-ways against a wall.

Pre-baiting unset traps is strongly recommended advised to condition the mice to the bait and traps. Place baited and unset traps in areas where mice are active. Check traps each morning as mice are most active during the evening. Rebait as needed. Add additional traps in areas where activity is high. After a few baiting cycles, set all the traps. Experience has shown that this method increases the speed of trapping programs.

Successful trapping requires setting a sufficient number of traps where mice are active. Inside structures, concentrate your efforts in areas where you have seen mouse droppings or other activity. Pay special attention to areas within 50 feet of food sources and warm spots, such as refrigerators, appliances with pilot lights and water heaters. Place traps behind objects, in dark corners and in areas where droppings have been found. Concentrate traps in areas where mouse activity is evident. Traps should be no more than 10 feet apart in areas where mice are active.

As a rough guide, two dozen properly placed snap traps should be sufficient to control a new mouse infestation in a 1,500 ft² structure. If food baits disappear without the trap firing, then the culprit could be insects or mice. Set traps with a light or “hair trigger” or move traps to a new location. It may also be helpful to wrap the trigger with a small strip of cloth and apply a food lure to it. The cloth will absorb the bait, forcing mice to tug and trigger the trap. Although more expensive, clam-shell style traps provide users the convenience of one-hand setting and removal of trapped mice.

Multiple-capture traps for mice, such as the Victor Tin Cat[®], Ketch-All[®] and Tomcat[®] (Fig. 10) can catch several mice at a time without being reset, thereby reducing labor requirements.



Fig. 10. Tomcat[®] Multiple Live Catch Mouse Trap.

These devices are valuable for long-term monitoring and control of mice. When used on the exterior of buildings, the traps can capture mice before they enter the structure. Some multi-catch traps are designed to hold glue boards inside to ease cleaning and removal of carcasses. Multiple-catch traps are available in hardware and feed stores.

If you are catching juvenile mice, you are probably getting close to the nest area and should add more traps. In severe or continuous trapping programs, periodically add clean traps to your trapping effort. Fresh traps eliminate the possibility that a mouse may avoid a trap contaminated with the pheromones of another mouse. Continue to trap seven days after the last capture or as long as mouse sign is present.

Glueboards. They catch and hold mice that are attempting to cross them, in much the same way that flypaper catches flies. Many consider them to be a convenient alternative to snap traps. But they often only capture

juveniles because the wiser adult mice avoid the danger before being fully entrapped.

If you choose to use glueboards, set them along walls where mice travel. Some glueboards are scented with artificial peanut butter oil, while others are unscented. Both are effective. Never place peanut butter directly on the glue, as the peanut oil will dissolve the glue, rendering it ineffective. Rather, place the peanut butter inside a plastic soda bottle cap and set it in the middle of the glueboard. Be aware that glueboards lose their effectiveness as dust collects on the surface. Extreme temperatures also can reduce affect the tackiness of glue boards. In freezing conditions, consider purchasing glueboards designed for cold conditions. Do not use glueboards where children, livestock, pets, or desirable wildlife can contact them. If a child or non-target animal gets caught, use vegetable oil to dissolve the glue. Use care to avoid being bitten by trapped animals.

Box traps (aka “live mouse traps”) for mice are not recommended as mice should not be moved to new locations and released. Relocated animals usually do not survive, and may carry diseases and parasites to new populations.

Rodenticides

Toxic bait rodenticides come in a variety of active ingredients and formulations. A few rodenticides are classified as Restricted Use Pesticides (RUP) and require a license to purchase and use. Most, however, are unclassified and available for general use. While some products are classified as RUPs because of their toxicity, it is often the use pattern allowed by the label that makes the

difference. You may be able to buy the same active ingredient in a formulation perfectly suitable for home use in a bait station, for example, even though other versions of the product may be RUP if they are labeled for use on farms or other higher-risk locations. In general, it is expertise that solves a rodent problem, not a specific chemical compound. If you are not successful on your own, you may wish to consider hiring a pest control operator or obtain your own training and Pesticide Applicators License by contacting the Montana Department of Agriculture at <http://agr.mt.gov/agr/Programs/Pesticides/> or calling (406) 444-4900.

Anticoagulant rodenticides. Anticoagulant rodenticides (Tables 3 and 4) generally are considered much safer than non-anticoagulant rodenticides because of their lower toxicity and known antidote (Vitamin K).

Anticoagulants cause death by preventing the blood’s ability to clot. The active ingredients are used at very low levels, so bait shyness does not occur when using properly formulated baits. First generation anticoagulants may be purchased without a pesticide license. First-generation anticoagulants require mice to feed for several days to obtain a lethal dose.

Therefore, fresh bait must be made available to mice continuously for at least two weeks, or as long as feeding continues. In contrast, second-generation anticoagulants require mice to feed only once to receive a lethal dose. Unfortunately, due to the delayed effect of the toxicant, mice can continue to consume toxic bait for several days, thereby increasing the amount of poison in their bodies. Since second-generation anticoagulants present a significantly higher risk of secondary

poisoning, it is best to try to achieve control using first-generation anticoagulants first. Second-generation anticoagulants are most useful in settings where rodent access to food cannot be sufficiently reduced (see Understanding Pesticides). Second-generation anticoagulants may require a pesticide license in order to purchase.

Understanding Pesticides

Pesticides are chemicals registered by the EPA to control plant, insect, and vertebrate pests. Rodenticides are pesticides designed to kill rodents. Read labels carefully to ensure that the pesticide is appropriate for control of the species and location for bait placement. Many rodenticides, for example, are not labelled for the control of deer or white-footed mice or use outside of a bait station. Other restrictions may apply.

Target species are the organisms which we want the pesticide to affect. Non-target species are the organisms that we do not want the pesticide to affect. For example, if we use a pesticide to control mice, we don't want it to kill songbirds or pets. Restrictions on pesticide labels are designed to balance the need for control of the pest species with protection for non-targets.

Pesticides also have primary and secondary hazards. Primary hazards are the effects a creature experiences directly from the pesticide. For example, a mouse that eats some toxicant and dies has suffered the primary hazard of the pesticide. Secondary hazards occur when the animal affected by the pesticide is consumed by another animal which suffers negative effects of the same pesticide. Secondary hazards often occur with

second-generation anticoagulants as the toxicant persists in the livers of poisoned rodents longer than first generation anticoagulants. Predators and scavengers that consume enough poisoned mice will often suffer illness and sometimes death through secondary poisoning.

Proper pesticide use requires the careful balancing of need and risk. Always follow the label, and always keep the risk as low as practical by using the least toxic control method possible.

Table 3. First-generation anticoagulant rodenticides (multi-feed).

Common Name	Species
Chlorophacinone	House mice
Diphacinone	House mice
Warfarin	House mice, deer mice and white-footed mice

Table 4. Second-generation anticoagulant rodenticides (single feed).

Common Name	Species
Brodifacoum	House mice
Bromadiolone	Mouse mice, deer mice and white-footed mice
Difenacoum	House mice
Difethialone	House mice, deer mice and white-footed mice

Rodenticide Myths. Ideas suggesting that poisoned mice go outside to seek water, or roam to the middle of the room are little more than hopeful speculations. Whether dead mice will cause an odor depends on the number of mice killed, the location of their demise, relative humidity and airflow, the size of the mice and the sensitivity of the resident's nose. If odor is a significant concern, then reduce the available number of mice through trapping before using toxicants.

Non-anticoagulant rodenticides. Non-anticoagulant rodenticides (Table 5) are more acutely toxic than anticoagulant rodenticides and thus can provide quick knockdown of mouse populations. They may be preferred where it is difficult to get mice to accept bait for several days in succession due to competing food items. No antidotes are available for non-anticoagulant baits, however, making their primary hazard level fairly high. Primary hazards can be reduced by using the bait in bait stations. Despite their primary hazard, non-anticoagulant rodenticides have lower secondary hazards than second-generation anticoagulants. Non-anticoagulants are available for purchase without a pesticide license.

Common Name	Species
Bromethalin	House mice
Cholecalciferol	House mice
Zinc phosphide	House mice, deer mice and white-footed mice

Zinc phosphide bait has several characteristics that require special attention. First, make sure bait does not get wet, either in storage or while in use as water quickly reduces the bait's toxicity. Second, zinc phosphide has a bitter taste which sometimes causes rodents to avoid eating it; a behavior called "bait shyness." To reduce bait shyness consider "prebaiting" with non-treated bait for several days before applying zinc phosphide treated bait. Since "bait shyness" can occur with zinc phosphide, it is best to use it no more than once per year at any location.

Proper Use of Rodenticides

Use fresh bait. Remove any bait that has become moldy or contaminated with foreign odors. Remove all uneaten bait at the end of a baiting program. Read the label for details regarding the proper disposal of toxic baits.

EPA regulations require that all rodenticides be applied in a manner to reduce access by non-target animals. Bait stations (bait boxes) are designed to protect bait from non-target access (Fig. 11).



Fig. 11. Two different styles of bait stations for mice designed for indoor use.

Choose the bait station tier (Table 6) needed to protect the bait from non-target animals in your area. Bait stations provide mice with a dark space where they feel safe and will eat more toxicant. Bait stations should have at least two openings, about 1 inch in diameter, and should be large enough to accommodate several mice at a time. Place bait boxes next to walls (with the openings close to the wall) or in other places where mice are active. If not already marked, clearly label all bait boxes "Caution - Mouse Bait". Establish bait stations in and around the perimeters of buildings where it is impossible to exclude rodents. Place fresh bait in these stations to control invading mice before breeding populations become established as instructed by the label.

Table 6. Rodenticide Bait Stations and Levels of Tamper- and Weather-Resistance				
Bait Station Capabilities	Tier 1	Tier 2	Tier 3	Tier 4
Resistant to Children	Yes	Yes	Yes	No
Resistant to Dogs	Yes	Yes	No	No
Resistant to Outdoor Weather	Yes	No	No	No
Resistant to Indoor Conditions	Yes	Yes	Yes	Yes

Proper placement of bait stations is essential for successful control. Place stations where mouse activity is evident (e.g. droppings) or as close as possible to those locations (preferably within 10 feet). For mice living in wall spaces, place stations where mice can exit the walls such as along pipes, above drop ceilings, in attics and on foundation sill plates. Consider placing stations inside wall voids if other access points are not available. Use of bait in food preparation areas is not advised. All rodenticides used in these areas should be placed in tamper-resistant stations and should be placed in secure areas, out of the reach of unauthorized persons.

Check bait stations every few days at the beginning of your control program to ensure that an adequate supply of bait remains available. Ensuring an adequate supply of bait is critical to success with all rodenticides, particularly anticoagulants.

Sometimes mice avoid or become resistant to a particular toxicant. Bait spoilage, poor placement, or the availability of other food sources are the usual causes of bait avoidance behavior. Correcting those issues will usually resolve the problem. If it doesn't, then consider switching to a toxicant with a different formulation. If control is still not being achieved, switch to a different active ingredient (see Tables 3-5).

Use of Toxicants. Toxicants are an important tool in the management of rodent pests. But despite their value, all rodenticides present some degree of hazard to humans, livestock, pets and other non-target animals. To reduce the negative consequences of toxicants, be sure to:

1. Read the toxicant label thoroughly before purchasing and using the product. Make sure that the product permits use for the species and sites you wish to manage.
2. Carefully follow all product label recommendations. The label is the law.
3. Use first-generation anticoagulants whenever conditions permit.
4. Use block rodenticide formulations to reduce the risk of mice translocating loose bait to unsecured areas.
5. Place baits where only the target rodents can access them.
 - a. Use bait stations suitable for the environmental conditions (Table 6). For example, outdoor bait stations are stronger and more durable in order to resist access by wildlife and damage by the elements.
 - b. Make sure all bait containers and bait stations are clearly labelled with appropriate warnings.
 - c. Store unused pesticides in their original labelled container in a cool, dry and locked cabinet or room out of the reach of children or animals.
 - d. Consider using rodenticides mixed with the bittering agent denatonium benzoate (Bitrex[®]) to reduce the chances a pet or child will consume the bait.
6. Pick up all accessible dead mice after a poisoning program.

Electronic devices. Ultrasonic sounds (those above the range humans can hear) are frequently marketed as an effective way to frighten mice from a structure. Ultrasound, however, has numerous limitations. First,

multiple units need to be used to cover three-dimensional space. Second, the sound does not penetrate walls, turn corners or extend for any great distance. Researchers have found little evidence that electronic, sound, magnetic, or vibrating devices can evict established mice from buildings or otherwise provide adequate control. Electronic devices are not recommended for the management of mice.

Biological Controls

Owls, coyotes and other native predators kill mice and their presence should be encouraged. However, they will not provide sufficient control to prevent or eliminate mice in and around structures. The same can be said of house cats. The fact is mice often live quite well in close association with cats and other pets, even consuming pet food. Effective control of mice requires diligent management of habitat, food, water and access.

Disease Safety

Though rodents are associated with many harmful diseases, this bulletin will focus on two significant ones, namely Hantavirus and plague.

Hantavirus

Hantavirus is a flu-like disease that kills over a third of the people it infects. Its primary host is the deer mouse but other rodents can carry the virus as well. Deer mice shed the virus through their feces, urine and saliva. It is spread between mice through bites and other territorial and dominance interactions.

Most human Hantavirus infections occur through inhalation or contact with

contaminated materials. Disturbing feces and areas contaminated by urine can cause infection from viruses in airborne dust or on the skin. Infections are strongly associated with activities like cleaning or repairing vacation cabins, out buildings, or other enclosed or sheltered spaces where contaminated particles can concentrate. Since the droppings of deer mice are not easily distinguished from those of other mice, all areas with rodent-sized droppings should be treated as potentially infectious.

Fortunately, despite its lethality, Hantavirus infections are relatively rare (Fig. 12). The virus is fragile, and lasts only a week at normal room temperatures. Direct sunlight destroys most Hantavirus particles within a few hours.

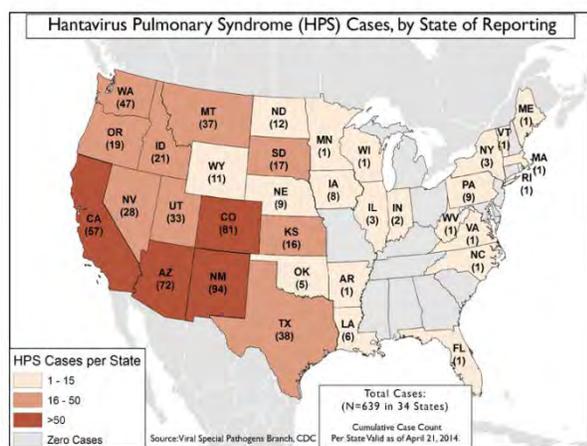


Fig. 12. Hantavirus cases in the U.S. as of April, 2014.

Clean up Procedures. If you are dealing with a site that has been unused for weeks or more or has droppings present, follow the advice in Appendix 1. For other situations, such as outdoor rodent control or isolated trapping, use the suggestions below:

1. Always wear rubber, nitrile, latex or vinyl gloves when handling traps and dead

mice. Clean them with disinfectant before removal as it is difficult to remove contaminated gloves safely.

2. Treat rodent contaminated areas (including traps) with disinfectant cleaning products such as Lysol® or similar commercial products, or 10% bleach (1:9 water: bleach; or 1½ cups of bleach to one gallon of water) solution. Spray droppings until they are wet, using a fine mist so as not to stir up dust. Let them soak for at least five minutes before handling or removal. Be aware that chlorine solutions will stain surfaces and fabrics.
3. Wet mop or wet wipe surfaces with disinfectant. Avoid activities that will stir up dust contaminated with rodent droppings or dust contaminated with urine. **Do not use a vacuum.**
4. Launder contaminated clothing in hot water and detergent. Treated feces and cleanup materials can be disposed of with other household wastes.
5. Wear protective waterproof gloves (latex or vinyl) when disposing of dead mice. Spray the carcass and trap with household disinfectant (e.g. Lysol®) or a 10 percent solution of bleach and water. Spray until wet. Turn a sealable plastic bag inside out, insert your hand, and grab and remove the mouse from the trap (Fig. 13). Turn the bag right side out so that the mouse is inside the bag. Seal the bag. Wrap the bagged mouse in newspaper or place it in a box and dispose of it with other household wastes. Spray the trap and area of the original set with disinfectant and let dry. Carefully remove your gloves by turning them inside out



Fig. 13. After spraying disinfectant on the mouse, pick it up with a gloved hand inside a plastic bag.

and dispose of them with other household waste. Wash your hands thoroughly. Be aware that some disinfectant may stain surfaces, carpets, and fabrics.

6. Monitor your health. If you feel ill (i.e., fatigued, aches in thighs, hips, back or shoulders), develop a fever or experience headaches, nausea, vomiting or abdominal pain within 45 days of handling mice and their droppings, seek medical attention immediately and inform them of your activities. Most professionals routinely mark their calendars to help remember if they have been potentially exposed to rodent-borne diseases.

Plague

Plague is a disease caused by the bacteria known as *Yersenia pestis*. Symptoms of plague include, fever, chills, extreme weakness, shortness of breath and abdominal pain. Without treatment, plague has a 60 to 100 percent mortality rate. The bacterium circulates in rodent populations, carried from individual to individual by fleas. While true “reservoir hosts” (i.e., animals that carry but do not experience the disease) do not exist in North America, plague circulates slowly

enough in the overall rodent population that some risk is always present.

Though only one person has contracted plague in Montana between 1970-2009, the presence of plague in the rodent population means that a future case is likely. Persons who control, handle or interact with rodents are at increased risk of contracting the plague, since they are also in contact with infected fleas. Since plague is carried by fleas, pets can be infected and transport infected fleas. Cats are particularly susceptible to plague, and cases in dogs are not unknown. As recently as 2014, four people in Colorado were infected by a dog that died of plague. Reduce your risk of contracting plague by wearing gloves when handling rodents and using repellents containing DEET.

For more information on rodent diseases visit the Centers for Disease Control web site—<http://www.cdc.gov> or contact your local Health Department.

Acknowledgements

Portions of this publication were adapted from “Controlling House Mice” by Stephen M. Vantassel, Scott E. Hygnstrom and Dennis M. Ferraro. NebGuide G1105. University of Nebraska-Lincoln. March, 2012.

DEPARTMENT SERVICES

As with most programs, rodent control will be most effective when all affected landowners work together. The Montana Department of Agriculture vertebrate pest specialist program will work with county commissioners, extension agents and landowners to establish a program suited to local and county needs. Field demonstrations are provided to inform

landowners how, when and where to control mice and other field rodent pests. Interested individuals should contact the Montana Department of Agriculture.

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Additional printed information on the control of ground squirrels and other vertebrates is available from the Montana Department of Agriculture website

<http://agr.mt.gov/Programs/Pesticides/VertebratePest/Bulletins/>

MONTANA POISON CONTROL
(Emergencies) 1-800-222-1222

MONTANA DEPARTMENT OF PUBLIC
HEALTH & HUMAN SERVICES

Injury Prevention Program
1-406-444-4126

<http://dphhs.mt.gov/publichealth/EMSTS/prevention.aspx>

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Fig. 1. George Shuklin; www.wikimedia.org

Fig. 2. Centers for Disease Control; cdc.gov

Figs. 3. Charles J. Homler;

www.wikimedia.org

Fig. 4. Andrew Hope; US Geological Survey

Fig. 5-6. Stephen M. Vantassel

Fig. 7. Stephen M. Vantassel; Montana
Department of Agriculture

Figs. 8-11. Stephen M. Vantassel

Fig. 12. Centers for Disease Control,
CDC.gov

Fig. 13. Stephen M. Vantassel

Appendix 1

Recommendations for Cleaning Homes or Buildings with Heavy Rodent Infestations

(source MMWR™ July 26, 2002 CDC.gov)

- If the building has been closed and unoccupied for a long period (weeks or months), ventilate the building by opening doors and windows for at least 30 minutes before beginning any work. Use cross ventilation if possible. Leave the area during the airing-out period. The ventilation helps to remove aerosolized virus inside the structure.
- Persons involved in the cleanup should wear coveralls (disposable if possible); rubber boots or disposable shoe covers; rubber, latex, vinyl, or nitrile gloves; protective goggles; and an appropriate respiratory protection device as detailed in Precautions to Limit Occupational and Recreational Exposure to Rodents.
- Personal protective gear should be decontaminated or safely disposed of upon removal at the end of the day. If the coveralls are not disposable, they should be laundered on-site. If no laundry facilities are available, the coveralls should be immersed in liquid disinfectant until they can be washed.
- Unless burned on-site, all potentially infectious waste material from cleanup operations should be double-bagged in appropriate plastic bags. The material in the bags should then be labeled as infectious and disposed of in accordance with local regulations for infectious waste.
- Persons involved in the cleanup who develop a febrile or respiratory illness within 45 days of the last potential exposure should immediately seek medical attention and inform the attending physician of the potential occupational risk of Hantavirus infection. The physician should contact local health authorities promptly if hantavirus-associated illness is suspected. A blood sample should be obtained and forwarded through the state health department for Hantavirus antibody testing.