



Rats

Integrated Pest Management for Home Gardeners and Landscape Professionals

Rats are among the most troublesome and economically significant pests in the world. Two introduced species of rats, roof rats (*Rattus rattus*, Figure 1) and Norway rats (*Rattus norvegicus*, Figure 2), are present in almost all cities across California and are commonly referred to as commensal rats. Commensal rodents are those that are found living in association with people. Contrary to some misconceptions, the two species cannot interbreed. Pack rats (*Neotoma* spp.), some species of which are native to California, may also be found in and around homes.

Rats are pests because they may eat and contaminate food and damage structures and other property. Rats can also transmit parasites and diseases to humans and other animals and have been associated with medically significant allergic responses in humans.

Rats typically live and thrive near humans and can be found in and around homes, schools, restaurants, and other commercial settings as well as food processing plants, storage areas, and warehouses. They can also be found outdoors in yards, gardens, parks, and farms.

IDENTIFICATION AND BIOLOGY

Except for within seriously infested areas, people don't often see rats, but signs of their presence may be easily detected. See page 4: *How to Spot a Rat Infestation*. Of the two commensal rat species listed above, it is important to know which is present to choose effective control strategies.

The roof rat (also called the black rat, house rat, or ship rat) is smaller and sleeker than the Norway rat, with a tail that is longer than the head and body combined. Roof rats are agile climbers and usually live and nest aboveground in shrubs, trees, or dense vegetation such as ivy. Residential and industrial areas with mature landscaping provide good habitat, as does vegetation on riverbanks and streams.



Figure 1. Roof rat.



Figure 2. Norway rat.

As their name implies, roof rats typically nest in enclosed and elevated spaces, such as attics, wall voids, ceiling voids, and cabinets. Periodically, roof rats will also burrow into soil and may even occupy sewers, especially when elevated nesting sites are unavailable. Roof rats prefer warm climates and coastal ecosystems. However, the documented range of roof rats is expanding.

Roof rats eat a wide variety of foods, but they prefer fruits, tree nuts, berries, slugs, snails, young birds,

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and bird eggs. They consume avocados and citrus fruits, often while still on the trees. When feeding on mature oranges, they usually make small holes through which they completely remove the contents of the fruit, leaving only hollowed-out rinds hanging on the tree. They'll often eat the rinds of lemons, leaving the flesh of the fruit still hanging.

Roof rats routinely travel up to 300 feet or more for food. They may live in the landscaping of one residence and feed on fruit trees at another residence. They can often be seen at night running along overhead utility lines or fence tops. They have excellent balance and use their long tails to steady themselves. Roof rats are very agile climbers, which enables them to quickly escape predators. When nesting in trees or attics they will climb down to the ground to forage, or they may forage within the trees. The average number of litters is generally 3 to 5, with up to 8 offspring in each litter.

The Norway rat (also called the brown rat, sewer rat, or barn rat) is a burrowing rodent that is generally larger and stockier than the roof rat. Their burrows may be found along building foundations, beneath rubbish or woodpiles, and around gardens and fields (Figure 3). Nests may be lined with leaves, shredded paper, cloth, or other fibrous material. When Norway rats invade buildings, they usually dwell in the basement and ground floor areas, but as with roof rats, infestations within ceiling voids are not uncommon. Norway rats live throughout the 48 contiguous United States. While generally found at lower elevations, this species can occur wherever people live.

Norway rats eat a wide variety of foods but prefer cereal grains, meats, fish, nuts, and some fruits. However, they tend to accept whatever food is abundant and readily available to them, such as food waste around untidy properties or commercial dumpsters. The nightly foraging ranges of Norway rats vary significantly depending on local conditions and may be anywhere

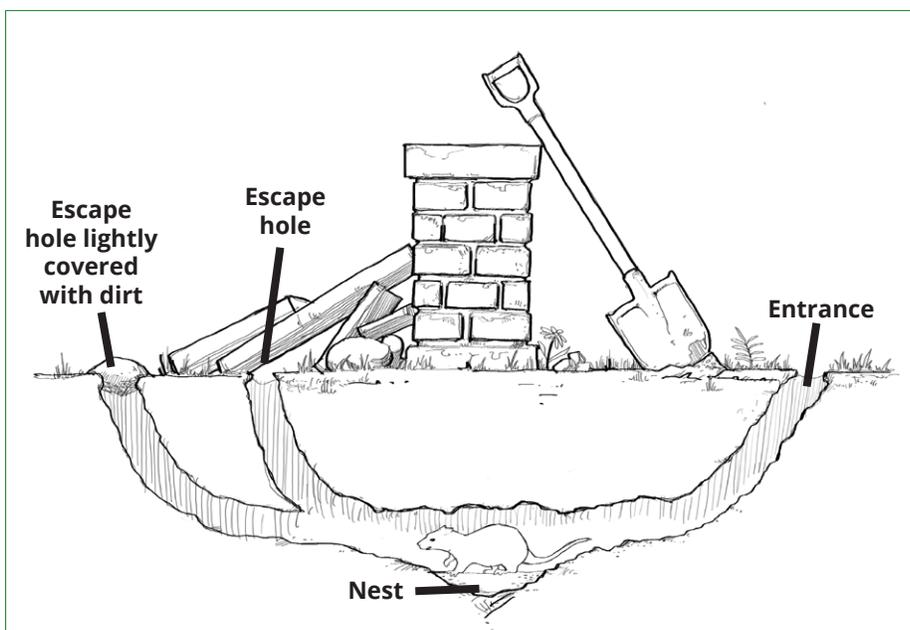


Figure 3. Norway rat burrow with entrance, nest, and escape hole.

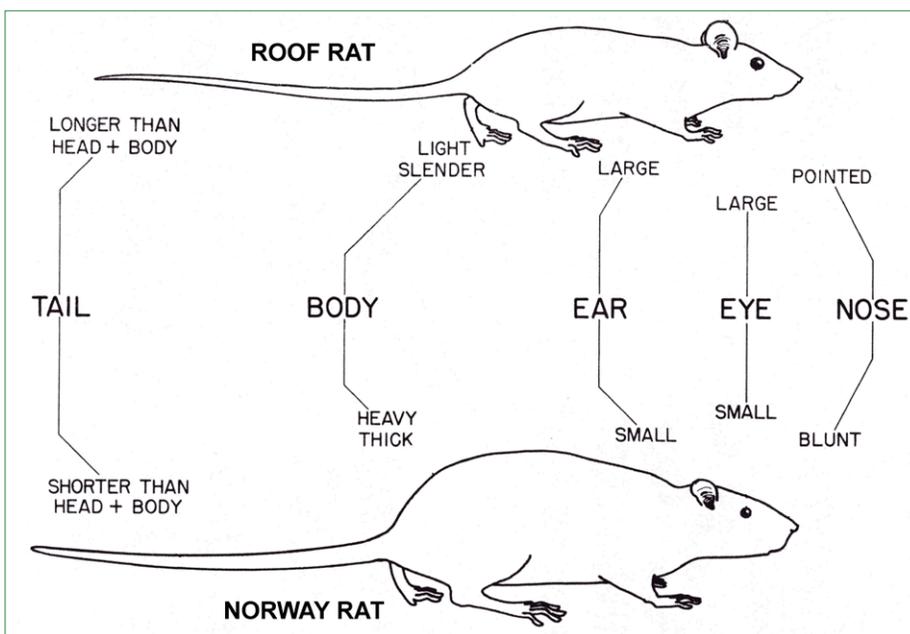


Figure 4. Key characteristics between Norway and roof rats.

from 100 to 500 feet from nests. When food sources and nests are in close proximity, however, rats usually stay as close to their nests as possible to reduce risks of predation and other dangers. The average female Norway rat has 4 to 6 litters per year and can successfully wean 20 or more offspring annually.

In some areas in California, both rat species may be present. If you are unsure of the species, observe the tail length relative to the head and body length of trapped individuals. Figure 4 illustrates the key physical differences between the two species, and Table 1 summarizes identifying characteristics for both species.

Table 1. Identifying Characteristics of Adult Rats.

Characteristic	Roof rat	Norway rat
general appearance	sleek, agile	large, robust
color of belly	gray to white	mostly gray
body weight	5 to 10 ounces	7 to 18 ounces
tail	(when pulled over the back towards the head) extends at least to snout, uniformly dark with fine scales	(when pulled over the back towards the head) extends to the middle of the skull; dark above and pale below, scaly
head	pointed muzzle	blunt muzzle
ears	long enough to reach eyes when folded over	don't reach eyes when folded over

When the two species occupy the same building, Norway rats typically occur in the basement and ground floors while roof rats occupy the upper floors. Rats of either species, especially young rats, can squeeze beneath a door with only a 1/2-inch gap. If the door is made of wood, the rat might gnaw it to enlarge the gap if necessary.

Although both species may eat some of the same food, they don't feed together. Roof rats commonly carry food items away from foraging locations to feed elsewhere, while Norway rats often feed while foraging.

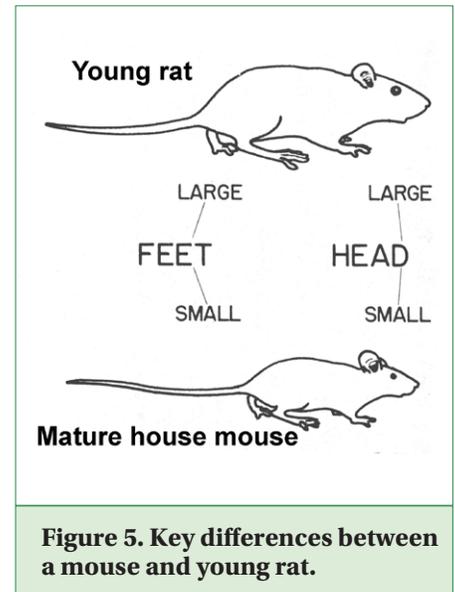
While rats are much larger than house mice and meadow voles, a young rat can be confused with a mouse. In general, very young rats have large heads and feet in proportion to their bodies, while those of adult mice are proportionately much smaller (Figure 5). Both rats and mice gnaw on wood, but rats leave larger tooth marks of 1/8 inch (4mm) versus a mouse's "scratchy marks" of only 1/12 inch (2mm). For more information on mice, see *Pest Notes: House Mouse* and *Pest Notes: Voles (Meadow Mice)* listed in References.

Rats are mostly active at night. They have keen senses of hearing, smell, taste, and touch. Rats constantly

explore and learn, memorizing the locations of pathways, obstacles, food, water, shelter, and other features of their environment. They quickly detect and tend to avoid new objects and new foods. Thus, they often avoid traps and baits for the first several days (and maybe weeks) following the initial placement. This neophobia (fear of new objects) is thought to be more pronounced in roof rats than in Norway rats.

Rats can gain entry to structures by gnawing, climbing, jumping, or swimming through sewers and entering through toilets or broken drains. Norway rats are more powerful swimmers, but roof rats are more agile and are better climbers.

The pack rats (also called woodrats) are a group of native rats that include several species, the most common being the dusky-footed woodrat (*Neotoma fuscipes*) and the desert wood rat (*Neotoma lepida*). Like commensal rats, pack rats consume various food items, including fruits and nuts. An easy way to distinguish pack rats from Norway and roof rats is to visually examine their tails. Woodrats have furry tails, while commensal rodents have scaly and mostly hairless tails.

**Figure 5. Key differences between a mouse and young rat.**

DAMAGE

Rats consume and contaminate a wide variety of foodstuffs and animal feed and may also damage the storage containers of these items. Rats may also cause problems by gnawing on electrical wires and wooden structures such as doors, ledges, corners, and wall trimmings, and by shredding insulative materials in walls and ceilings for use in their nests.

Norway rats can undermine building foundations and slabs with their burrowing activities and can gnaw on all types of materials, including soft metals such as copper and lead as well as plastic and wood. If roof rats are living in the attic of a residence, they may cause considerable damage and present safety concerns (electrical sparks and fires) due to their gnawing and nest-building activities. Rats may even chew directly on natural gas lines, creating explosions and fire hazards.

Rats commonly gnaw on the insulative sheaths of engine wires in cars leading to significant malfunctions and expensive mechanical repairs. Rats may cause similar damage to trucks, tractors, and farm equipment of all types. In gardens, rats will consume ripening vegetables, fruits, and flowers. They

will also gnaw on the roots and stems of some ornamental plants, sometimes severely stunting or killing the plants. Occasionally, rats burrow beneath or around compost piles, particularly if residents add meat, fish, eggs, or eggshells to the compost.

Rats have the potential to carry and transmit diseases to people, their pets, and livestock (poultry, swine, horses). The most common rat-transmitted diseases are typhus, leptospirosis, food borne illnesses (caused by pathogens such as salmonella, *E. coli*, and campylobacter), and rat bite fever. Plague is a disease that rats can carry, but it is very rarely found in commensal rodent species. However, plague occurs in California within wild populations of ground squirrels, chipmunks, and, sometimes, woodrats. Unlike wild raccoons, skunks, foxes, bats, and some other wild animals, commensal rats (and mice) do not carry or transmit rabies.

How to Spot a Rat Infestation

Because rats are active throughout the year, periodically check for signs of their presence. Once rats have invaded your garden or landscaping, unless your house is truly rodent proof, it is only a matter of time before you find evidence of them indoors. Experience has shown that less time and effort are required to control rodents when their numbers are low, and fewer traps and less toxic bait will be required if control measures are started early.

Inspect your yard and home thoroughly. If you notice the following signs, you may have a rat problem.

- Rat droppings around dog or cat dishes or pet food storage containers
- Noises coming from the attic or drop ceilings
- Rat nests in your firewood stack
- Dead rat carcasses scavenged by pet cats and dogs
- Evidence of rodent feeding on fruit/nuts that are in or falling from the trees in your yard



Figure 6. A trap protector box with rodent traps set inside with the aim of decreasing nontarget interactions with the trap.

- Burrows among plants or damaged vegetables in the garden
- Rats traveling along utility lines or on the tops of fences at dusk or soon after
- Rat nests behind boxes or in drawers in the garage
- Smudge marks caused by the rats rubbing their fur against beams, rafters, pipes, and walls
- Burrows beneath your compost pile or beneath garbage cans
- Rat or mouse droppings in your recycling bins
- Drowned rat(s) in your swimming pool or hot tub
- Evidence of something digging under your garden tool shed or doghouse

MANAGEMENT

Successful rat control typically includes three elements: sanitation measures; structural exclusion (also called “rodent proofing”); and population control.

Sanitation

Sanitation is fundamental to rat control and must be ongoing. If sanitation measures aren’t properly maintained, the benefits of other measures will be lost, and rats will quickly return. Good housekeeping in and around buildings

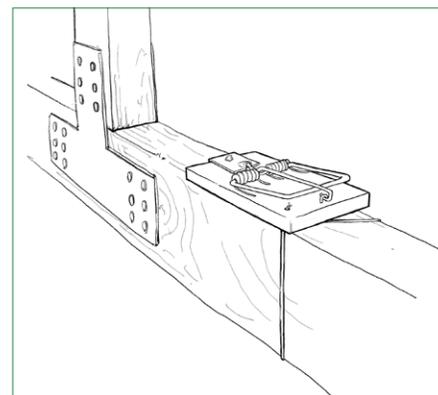


Figure 7. Snap trap secured to a wooden beam with a twisted wire fastened to an object below the runway.

will reduce available shelter and food sources for Norway rats and, to some extent, roof rats. Roof rats have very strong nest site affinity and evidence has shown that if nest sites are not removed during sanitation efforts, the rats will return to the site. Tidy, off-the-ground storage of pipes, lumber, firewood, crates, boxes, gardening equipment, and other household goods will help reduce the suitability of the area for rats and make them easier to detect.

Collect garbage, trash, and garden debris frequently, and ensure all garbage receptacles have tight-fitting covers. It is a good rat prevention tactic to keep all garbage receptacles clean of food residues (such as grease films), whether they are full or empty. Keep compost in rigid plastic or metal containers with tight-fitting lids, but keep in mind that rats can gnaw through plastic. Remove fallen fruit and nuts that have dropped from trees.

Where dogs are kept and fed outdoors, rats can become a problem if there is a ready supply of dog food. Feed your pet only the amount of food it will eat at a feeding, and store pet food in rodent-proof containers. Clean up feces from dogs, cats, and other animals since rats will eat feces. Feces can harbor pathogens, so always handle with gloves and be careful not to breathe in any aerosolized fecal material.

Both species of commensal rats are highly attracted to vegetation that is dense or close to the ground. Thinning dense vegetation renders the habitat much less desirable to rats. Climbing hedges such as Algerian or English ivy, star jasmine, and honeysuckle on fences or buildings are conducive to roof rat foraging and infestation and should be thinned or removed if possible. Overhanging tree limbs within 6 feet of roofs should be removed to prevent both rats and tree squirrels from accessing the roof top and entering attics and soffit vents. Prune the canopy of densely growing plants such as pyracantha and juniper away from one another and from buildings by 2 feet or more to make it more difficult for rats to travel unseen.

Structural Exclusion

The most successful and longest-lasting strategy for rat control around structures is exclusion, or “building them out.” Seal cracks and openings in building foundations and any openings for water pipes, electric wires, sewer pipes, drain spouts, and vents. All holes larger than 1/4 inch should be sealed to exclude both rats and mice. Make sure doors, windows, and screens fit tightly. Their edges can be covered with sheet metal if gnawing is a problem. Because roof rats are excellent climbers, openings above ground level must also be plugged. Rodent proofing against roof rats, because of their greater climbing ability, usually requires more time to find entry points than for Norway rats. If roof rats are traveling on overhead utility wires, contact a pest professional or the utility company for information and assistance to prevent this.

Rodent-proofing Homes and Buildings

- Ventilator grills (vent covers) should be enclosed with 18-gauge, ½-inch (13 mm) mesh, galvanized expanded metal or 16-gauge, ½-inch (13 mm) mesh, galvanized wire cloth.

- Windows that open near the ground can be protected with 19-gauge, ½-inch (13 mm) mesh, galvanized wire cloth.
- Never use lightweight “chicken wire,” since rats can easily pass through wire openings.
- Repair or replace damaged ventilation screens around the foundation, internal screens on roof and attic air vents, and under the eaves.
- Cover rooftop plumbing vent pipes more than 2 inches in diameter with screens over their tops.
- Provide a tight-fitting cover for the crawl space.
- Seal all openings around pipes, cables, and wires that enter through walls or the foundation.
- Be sure all windows that can be opened are screened and that the screens are in good condition.
- Cover all chimneys with a spark arrester.
- Make sure all exterior doors are tight fitting and sealed at the threshold. Double doors should also be sealed at the astragal gap (the space in-between two doors). Typical weatherproofing materials may not be sufficient to exclude rats and mice.

Rodent-proofing Vehicles

Use a weighted car cover to dissuade rodents from accessing the engine and chewing wires. To be effective, the cover must touch the ground, forming a seal all around the vehicle. Many styles and sizes of covers are available on the internet or from automotive stores. Be advised however that rodent management around the landscape and neighborhood will likely be needed for longer-term reduction of rat populations.

Population Control

When food, water, and shelter are available, rat populations can increase quickly. While the most permanent



Figure 8. Overhead traps are particularly useful for roof rats. Purchase traps with an expanded treadle (trigger plate) and fasten them to beams or studs with screws or wires so the treadle is directly in the pathway of the rat.

form of control is to limit food, water, shelter, and access to buildings, direct population control often is necessary.

Trapping. Trapping can be an effective method for controlling rats in and around homes, garages, and other structures. It is important to determine whether you have a rat or a mouse issue since mice (and small juvenile rats) often won't trigger a rat snap trap. Because snap traps can be used over and over, the materials for trapping can be less expensive than poison baiting but trapping will likely be more labor intensive. Traps can be set and left indefinitely in areas such as attics where rats have been a problem in the past.

Rat-sized snap traps are available in a variety of styles. They can be made of plastic or wooden, have larger or expanded triggers, or have bait reservoirs. Finding the best locations to set traps may be more important than what type of trap is used.

Nuts, dried fruit, bacon, or a piece of dry pet food can be attractive bait for traps. If using dry foods, you can fasten the bait to the trigger of the trap

with light string, thread, or fine wire so the rodent will spring the trap when attempting to remove the food. Even glue can be used to secure the bait to the trigger. Soft baits such as peanut butter can be used. Whatever bait matrix is selected, it is important to use just a pea-sized amount of bait. Set traps so that the trigger is sensitive and will spring easily.

The best places to install traps are in secluded areas where rats are likely to travel and seek shelter. Droppings, gnaw marks, and damage indicate the presence of rodents, and areas where such evidence is found usually are the best places to install traps, especially when these areas are located between their shelter and food sources. Place traps in natural travel ways, such as along walls, so the rodents will pass directly over the trigger of the trap.

For Norway rats, install traps close to walls, behind objects, in dark corners, and in places where rat signs (droppings, smudge marks, burrows, etc.) have been seen. Position traps along a wall so that they extend from the wall at right angles, with the trigger end nearly touching the wall (Figure 6). If traps are set parallel to the wall, they should be set in pairs to intercept rodents traveling from either direction.

For roof rats, traps often need to be installed both on the ground and aboveground (e.g., ledges, shelves, branches, fences, pipes, or overhead beams) (see Figures 7 and 8). If possible, traps should be secured to the surface on which they are set; this helps focus the force of the “snap” for better success. In areas where children, pets, birds, and other nontarget animals might encounter traps, set traps within boxes or stations, or use a barrier to prevent nontarget interactions. Trapping during the night can reduce interactions with birds.

Use as many traps as is practical so that trapping duration will be short and effective. A dozen or more traps for a heavily infested home might be necessary. Place rat traps about 10 to 20 feet apart. If a rat sets off a trap

without getting caught, it will be very difficult to catch the rat with a trap again. To reduce the likelihood of “trap shyness,” one strategy is to leave traps baited but unset until the bait has been taken several times. To avoid using too few traps, if bait is taken from all traps, double the number of baited traps exposed, and keep doing so until some traps remain with bait untaken; then bait and set all traps.

Electrocution Traps. Traps that kill rats by electrocution (e.g., Rat Zapper™ or Victor Electronic™ traps) are considerably more expensive than other traps. As with snap traps, for existing rodent populations it’s important to use enough traps to achieve control promptly. These traps need to be checked frequently, and dead rodents should be removed for disposal. Prebaiting is also necessary with these types of traps. Make sure that you read the safety guidelines before touching the interior of these traps.

Glue Boards. Glue traps are also available options for rat management. However, they are difficult to use and are not generally recommended for nonprofessional use. A thorough knowledge of rat behavior combined with a thorough assessment of the property to identify rat runways is essential for successful glue board trapping. Glue boards should never be used outdoors because nontarget wildlife can become stuck. When using glue boards indoors, cats and dogs may also be endangered if the traps are not placed within boxes or stations or installed within inaccessible spaces.

Live Traps. Live trapping of rats is not recommended for nonprofessionals because, legally, trapped rats must be humanely euthanized or released immediately in the area where it was trapped. Releasing rats is not recommended, as they will continue to pose health concerns to the residents and their neighbors. In addition, since neither roof rats nor Norway rats are native to the United States, their presence in the wild is detrimental to native ecosystems because they may harm local populations of birds and

other animals in the ecosystem.

Never touch rodents with your bare hands and wash thoroughly after handling traps. Use disposable gloves to handle dead rodents. Dispose of dead rats by burying them or by placing them in a sealed plastic bag and putting them in the trash.

Rodenticides (Toxic Baits)

Baits to control rodents are formulated with an attractant (generally food) and a rodenticide (toxin). Changes in rodenticide regulations went into effect in mid-2011 to mitigate rodenticide hazards to wildlife and pets and to reduce accidental exposure to children. These federal restrictions now permit manufacturers to produce for sale to the (general, residential) public only wax block, gel, or paste rat and mouse baits that are packaged in, or with ready-to-use, disposable bait stations. Professional pest control operators can obtain more types of rodenticides in various formulations, some of which are restricted-use pesticides.

In California, there is currently a prohibition on most uses of second-generation anticoagulant rodenticides. Except for a few minor exceptions, products with the active ingredients bromadiolone, brodifacoum, and difethialone cannot be applied in most areas of California. There are also restrictions on most uses of diphacinone, a first-generation anticoagulant rodenticide.

Anticoagulant Rodenticides.

Anticoagulant rodenticides interfere with the rat’s ability to activate vitamin K1. This vitamin is essential to help mammals with the blood clotting processes and without it, animals that consume anticoagulant rodenticide succumb to internal bleeding. These active ingredients are used at very low levels and the onset of symptoms is delayed for several days, so the rodent doesn’t avoid the bait because of its taste or the onset of illness.

The various anticoagulant active ingredients currently registered for use against rats in California are listed

Table 2. Anticoagulant rodenticides for rat control registered for use in California.**First-generation anticoagulants**

Common name	Example products (general public)	Example products (licensed professionals)*
chlorophacinone	Rozol Pellets	Rozol
diphacinone	not available	Ramik Green
warfarin	not available	Kaput, Rodex

Second-generation anticoagulants

Common name	Example products (general public)	Example products (licensed professionals)*
brodifacoum	not available	Final, Havoc, Jaguar, Talon
bromadiolone	not available	Boothill, Contrac, Hawk, Maki
difethialone	not available	Generation, Hombre

*Always check the label for the active ingredient. The same or similar trade names may be used for products with different active ingredients. No endorsement of named products is implied.

in Table 2. Anticoagulants fall into two groups—the older “first-generation” compounds such as warfarin, chlorophacinone, and diphacinone, which require a rodent to consume multiple doses over a period of several days; and the newer “second-generation” compounds such as brodifacoum, bromadiolone, difenacoum (not registered for use in California), and difethialone, which can be fatal after a single feeding. Since not all rats will consume bait when it first becomes available, bait application directions typically recommend providing an uninterrupted supply of fresh bait for at least 10 or 15 days or until evidence of rodent activity ceases. A rodent feeding on anticoagulant bait typically won’t die until about five to seven days following ingestion of a lethal dose.

The recommended strategy for bait application, which is often required for optimum rodent control, can result in a rodent ingesting an overdose of the second-generation anticoagulants. Second-generation baits may be more effective because they persist longer in the rodent’s body than do

the first-generation anticoagulants. However, this also presents a strong disadvantage, as these baits also have the potential to be hazardous to raptors (hawks, owls, eagles), predators (fox, bobcats, snakes) and scavengers (raccoons), all of which commonly consume rodents as part or entire portions of their daily or nightly food intake.

Moreover, because of higher toxicity and the potential hazards that may occur to children and household pets when these baits are applied incorrectly, second generation rodenticides are no longer allowed to be manufactured for sale to the general public. Unlicensed individuals can now buy only prepackaged, ready-to-use bait stations containing first-generation anticoagulants (i.e., warfarin or chlorophacinone) or non-anticoagulant baits (bromethalin or cholecalciferol).

The second-generation anticoagulants (i.e., brodifacoum, bromadiolone, and difethialone) have never been approved for use in field situations or for use against ground squirrels, meadow

mice (*Microtus*), pocket gophers, or any other rodents except house mice, Norway rats, and roof rats.

Symptoms of anticoagulant poisoning in mammals include lethargy, loss of color in soft tissues such as the lips and gums, and bleeding from the mouth, nose, or intestinal tract. Vitamin K1 is the antidote for anticoagulant rodenticides, although in cases of severe poisoning, whole blood transfusion may also be necessary. However, with the onset of symptoms, successful treatment is less likely. If an animal consumes bait accidentally, it is important to reach out to a veterinarian. (See Pet and Wildlife Hazards associated with Rat Control.)

Other Rodenticides. Three other active ingredients are registered for use as rodenticides to control rats and house mice in California: bromethalin, cholecalciferol, and zinc phosphide. (See Table 3.) Although not anticoagulants, application directions for bromethalin and cholecalciferol are similar to those for anticoagulant rodenticides. These two materials

Table 3. Other rodenticides for house mouse control registered for use in California.

Common name	Example products (general public)	Example products (licensed professionals)*
bromethalin	TOMCAT, Victor Fast-Kill Brand Rodenticide Bait Blocks	Assault, Gunslinger, Rampage
cholecalciferol	D-con	Agri3, Terad3
zinc phosphide	not available	Eraze, Prozap, ZP

*Always check the label for the active ingredient. The same or similar trade names may be used for products with different active ingredients. No endorsement of named products is implied.

are formulated to serve as chronic rodenticides so that rats will have the opportunity to feed on baits one or more times over a period of one to several days.

Zinc phosphide differs in that it is an acute toxicant that causes death of a rodent within several hours after a lethal dose is ingested. Because zinc phosphide baits often require pre-baiting to get adequate bait acceptance (offering rats similar but nontoxic bait before applying the zinc phosphide bait), it's not commonly used against rats and is infrequently available to consumers.

While the risk of secondary poisoning to predators and scavengers may be lower for bromethalin, cholecalciferol, and zinc phosphide than that of anticoagulants, primary poisoning of nontarget animals (pets, domestic animals, and wildlife) that consume these rodenticides can occur, especially when label precautions regarding bait placement are not followed. Furthermore, new evidence suggests that secondary exposure to bromethalin can occur, posing risk of secondary poisoning of nontarget animals.

Bait Placement and Bait Stations.

All rodenticide baits, regardless of the active ingredients and formulations, must be used carefully according to the label directions, which have become more specific and more restrictive. Some baits must be contained within bait stations (Figure 9) for all outdoor, above-ground applications. Place all bait stations in rat travel ways

or near their burrows and harborage. Don't expect rats to go out of their way to find the bait. For Norway rats, place bait stations near rodent burrows or suspected nest sites, against walls, or along travel routes. For roof rats, place baits in elevated locations, such as in the crotch of a tree, on top of a fence, or high in a vine. If you place bait stations above ground level, take care that they are securely fastened and won't fall to the ground where children or pets could find them. Because rats often are suspicious of new or unfamiliar objects, it might take several days to weeks for them to enter and feed in bait stations. Recent research has shown that roof rats may not enter bait stations even when stations are placed along established runways.

The use of bait and bait stations is subject to several regulations dealing with the location of the pesticide application. In general, tamper-resistant bait stations must be used if children, pets, nontarget mammals, or birds may access the bait. In California, almost all bait intended for use in and around structures must be in bait stations within 50 feet of a structure. When possible, bait should be placed in areas with signs of rodent activity (droppings, burrows, smudge marks, "runways" within vegetation, etc.). In all cases, pesticide users must follow label directions. Certain prepackaged bait stations intended for sale to residents can only be used inside structures. Remove and properly dispose of all uneaten bait at the end of a management effort. In addition, collect and properly dispose of any



Figure 9. A commercially made, tamper-resistant bait station made for rats. Entrances also will permit house mice to enter and feed. All baits placed in outdoor locations for rats and mice must be contained within EPA-approved, tamper-proof bait stations.

dead rodents found during a rodenticide application. Dead rodents can be collected using a sturdy plastic bag inverted over your hand, and then sealed in the bag for disposal within regular household garbage. Rodent carcasses can also be buried in a location where pets or scavengers can't easily dig them up.

Other Control Methods

Rats are wary animals, easily frightened by unfamiliar or strange noises. However, they quickly become accustomed to repeated sounds, making the use of frightening devices—including high frequency and ultrasonic sounds—ineffective for controlling rats in homes and gardens.

Rats have an initial aversion to some odors and tastes, but no repellents have been found to solve a rat problem for more than a very short time. There are no truly effective rat repellents registered for use in California.

Smoke or gas cartridges are registered and sold for controlling burrowing rodents. When placed into the burrows and ignited, these cartridges produce toxic and suffocating smoke and gases. Because Norway rat burrows can extend beneath a residence and have several open entrances, toxic gases can permeate the dwelling. For this reason and because some fire hazard is associated with their use, smoke and gas cartridges aren't recommended for rat control around homes.

Carbon monoxide (CO) devices can be used to control burrowing rodents. When used to control Norway rats, however, they cannot be used within 65 feet of a structure, a restriction

which may limit their use in home gardens. The CO-generating device must be registered by the US EPA, meaning that it's illegal to use the exhaust from a gas-powered engine (e.g., automobile, lawn mower) to generate the CO. EPA-registered CO devices are intended for use by pest management professionals. CO inhalation can be lethal to people as well as rats. Carbon dioxide (CO₂) is registered for the use of burrowing rodents and is available from some rodenticide manufacturers via compressed gas cylinders.

Rat and mouse birth control products are also registered in California. These products contain the active ingredients 4-vinylcyclohexene diepoxide and triptolide. Birth control products are restricted to professional use only and must be applied within tamper-resistant bait stations indoors or within 1 foot of external perimeters of buildings.

Predators, especially cats and owls, eat rats and mice. However, predators in general cannot significantly control animals that are good colonizers and prolific reproducers (of which rats are extremely good examples!). Furthermore, if cats or other would-be predators are fed outdoors, their food serves as a strong attractant and a continuous food source for rats and mice in the surrounding environment.

Pet and Wildlife Hazards Associated with Rat Control

Many of the methods and materials used to control rats can affect pets as well. All rodent baits are toxic to dogs and cats, so be cautious when using these products. Because anti-coagulants are cumulative and slow acting to various degrees, depending on whether it is multiple or single feeding, dead rats can contain several lethal doses of toxicant, and secondary poisoning of pets and wildlife is possible if they eat rat carcasses. Most fatalities in pets involve dogs and are due to the animal eating the bait directly (primary poisoning) or a combination of direct bait consumption and secondary poisoning. Concerns about both primary and second hazards of second-generation anticoagulant baits led the EPA to restrict their retail sale in mid-2011, making them available only to agricultural users and professional pest control personnel. When such baits are in use, extra caution is needed, as exposure to even a single dead rodent might be enough to poison a pet.

The best precaution against accidental poisonings is to keep pets away from rodenticide baits and dead or dying rodents. Dispose of dead rodents by burying them or by placing them in a sealed plastic bag and putting them in the trash. Do not handle them with bare hands.

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WARNING ON THE USE OF PESTICIDES

Pesticides are poisonous. Some pesticides are more toxic than others and present higher risks to people, nontarget organisms, and the environment. A pesticide is any material (natural, organic, or synthetic) used to control, prevent, kill, suppress, or repel pests. "Pesticide" is a broad term that includes insecticides, herbicides (weed or plant killers), fungicides, rodenticides, miticides (mite control), molluscicides (for snails and slugs), and other materials like growth regulators or antimicrobial products such as bleach and sanitary wipes that kill bacteria.

Always read and carefully follow all precautions and directions provided on the container label. The label is the law and failure to follow label instructions is an illegal use of the pesticide. Store all chemicals in the original labeled containers in a locked cabinet or shed, away from food or feeds, and out of the reach of children, unauthorized persons, and animals. Never place pesticides in food or drink containers. Consult the pesticide label to determine active ingredients, correct locations for use, signal words, and personal protective equipment you should wear to protect yourself from exposure when applying the material.

Pesticides applied in your garden and landscape can move through water or with soil away from where they were applied, resulting in contamination of creeks, lakes, rivers, and the ocean. Confine pesticides to the property being treated and never allow them to get into drains or creeks. Avoid getting pesticide onto neighboring properties (called drift), especially onto gardens containing fruits or vegetables ready to be picked.

Do not place containers with pesticide in the trash or pour pesticides down the sink, toilet, or outside drains. Either use all the pesticide according to the label until the container is empty or take unwanted pesticides to your local Household Hazardous Waste Collection site. Contact your county agricultural commissioner for additional information on safe container disposal and for the location of the Hazardous Waste Collection site nearest you. Follow label directions for disposal of empty containers. Never reuse or burn the containers or dispose of them in such a manner that they may contaminate water supplies or natural waterways.

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This and other Pest Notes are available at ipm.ucanr.edu.

For more information, contact the University of California Cooperative Extension office in your county. See your telephone directory for addresses and phone numbers, or visit: ucanr.edu/County_Offices.

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