BIOLOGY, LEGAL STATUS, CONTROL MATERIALS, AND DIRECTIONS FOR USE

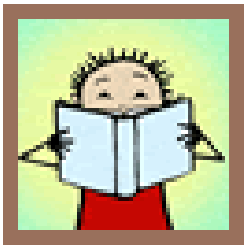
Meadow Voles

Family: Cricetidae

Fig. 1. Meadow vole (*Microtus* spp.)

Fig. 2. Meadow vole burrow opening

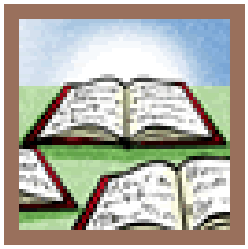
AUTHOR'S NOTE: The term "meadow vole" is applied to the entire *Microtus* genus. Species of voles from other genera found in California (California red-backed vole [*Myodes californicus*], sagebrush vole [*Lemmiscus curtatus*], Sonoma red tree vole [*Arborimus pomo*], western heather vole [*Phenacomys intermedius*], and white-footed vole [*Arborimus albipes*]) do not typically cause damage for humans, and as such, are not discussed in this chapter.



Introduction: Meadow voles are intriguing small mammals. Their population growth often fluctuates dramatically, causing sudden increases. This often catches landowners by surprise which is when their presence usually becomes problematic, whether to the individual or commercial landowner. After vole populations peak they generally subside even if no control has taken place. A low population may exist for 4 to 8 years before another resurgence is observed, although in some crops (e.g., artichokes and alfalfa) populations can remain fairly stable across years.

Five species of meadow voles of the genus *Microtus* occur in California. Two species of voles are responsible for the majority of damage in California; the California vole (*Microtus californicus*) and the montane vole (*M. montanus*). Voles do not normally invade homes and should not be confused with the common house mouse.

Identification: Meadow voles are small rodents with stocky bodies, short legs and tails, and short rounded ears. Their long, coarse fur is black-brown to gray. Adults are 4 to 5 inches long. They are larger than a house mouse but smaller than a rat. Meadow voles are active night and day, all year, and are found in areas of dense, grassy ground cover. They are relatively poor climbers and do not usually enter buildings. They dig short, shallow burrows with numerous openings about 1.5 to 2 inches across (Fig. 2). Runways (1 to 2 inches wide) of trampled vegetation or bare ground are often observed that connect various burrow openings. Voles do not like to deviate from these runways when traveling between burrow openings. As such, they can be used to more effectively manage problematic vole populations (details provided in Damage Prevention and Control Methods section).



Legal Status: Meadow voles are classified as nongame mammals by the California Fish and Game Code. Nongame mammals which are found to be injuring growing crops or other property may be taken at any time or in any manner by the owner or tenant of the premises. They may also be taken by officers or employees of the California Department of Food and Agriculture or by federal or county officers or employees when acting in their official capacities pursuant to the provisions of the Food and Agricultural Code pertaining to pests.

Damage: Many crops may be damaged by meadow voles including pasture, hay, alfalfa, artichokes, brussels sprouts, carrots, cauliflower, potatoes, sugar beets, tomatoes, grains, nursery stock, and the bark of apple, avocado, citrus, cherry, and olive trees. Alfalfa in particular receives substantial damage, particularly in northern California; estimates of vole damage average around 11% loss in revenue when voles are found in alfalfa. Common examples of damage are as follows:

In alfalfa: If left unchecked, voles will cause extensive damage to alfalfa. This damage includes consumption of tap roots and above-ground vegetation that can result in:

- reduced vigor, mortality of alfalfa plants, or both.
- loss of irrigation water down burrow systems.
- chewing on subsurface drip irrigation (SDI) lines.

In winter where alfalfa goes dormant, vole damage to roots and crowns is often not apparent until green-up the following spring. As such, much care must be taken to ensure low vole numbers heading into winter.

In orchards and vineyards: Voles can cause severe damage in orchards and vineyards by feeding on bark. Characteristic damage is complete or partial girdling of trunks from just below the soil line to usually no more than 5 inches high. In rare situations, voles climb higher on young trees or vines.

In addition to bark, voles also feed around the root crown, and sometimes chew holes in irrigation lines. Young trees or vines are more readily fed upon and most susceptible to being completely girdled and killed by voles. Large trees or vines can be damaged, but this is uncommon and rarely ends in death. For instance, after severe pruning, sufficient light penetrates the canopy for vegetation to grow near trunks, providing cover and food for voles. Voles live in areas where grass or other permanent vegetative cover remains year-round. Orchards or vineyards that have cover crops or those in which grass and herbaceous plants are left to grow next to trunks are most susceptible to damage.

In artichokes: Vole populations are known to cause severe damage to the crown, roots, and the chokes themselves. Special bait has been developed using treated bracts, as acceptance of grain or pellet baits has been problematic. Treatment in early crop-development stages is critical, as the burrows are very difficult to detect and bait as the crop matures.

In potatoes: Voles move into potato fields when nearby infested grain or alfalfa fields are harvested, usually in August or September, burrowing into hills for shelter and to feed on tubers. Their feeding damages tubers directly and their burrows may expose tubers to sunlight or freezing temperatures,

causing additional losses. Damaged tubers have gnaw marks about 0.12 inch wide and 0.36 inch long at various angles. Damage may also be caused by predators that dig into potato hills in search of voles. If vole numbers are high at harvest, they may be carried into storage, where they will continue to feed on tubers and also contaminate the crop with urine and fecal matter.

Range: Of the five species of *Microtus* found in California, only the California vole and montane vole are economically important. The California vole is found in the Owens valley, various lowland valleys, and the Coast Range areas. The Amargosa vole (*M. californicus scirpensis*) is an endangered subspecies of the California vole found in only a few bulrush marshes along the Amargosa River in southeastern Inyo County. The montane vole inhabits northeastern California and the eastern Sierra slope. The long-tailed vole's (*M. longicaudus*) range largely approximates the montane vole's range but includes an extension into northwestern California. The creeping vole (*M. oregoni*) and Townsend's vole (*M. townsendii*) are found only in northwestern California.

California Vole
Creeping Vole
Long-tailed Vole
Montane Vole
Townsend's Vole

Habitat: Meadow voles are likely to be found where there is good vegetative cover. They generally do not invade cultivated crops until the crop is tall enough to provide food and shelter. California voles are historically found in marshy ground, saltwater and fresh wet meadows, and dry grassy hillsides. They are also found in any agricultural crop that provides sufficient cover and food. In natural environments, montane voles are found near springs and in wet grassy meadows of the yellow pine, red fir, Engelmann spruce, hemlock, and lodgepole forests. They are also quite common in alfalfa and hay crops in northern California, particularly in Scott Valley and the Klamath Basin. Long-tailed voles are found near stream banks and mountain meadows. They are occasionally found in dry brushy habitats and croplands. Creeping voles are common in herbaceous and shrubby understories of coniferous forests. Townsend's voles prefer moist fields, sedges, tules, and meadows, usually near water.

Biology: Meadow voles are active all year round, irrespective of weather. They forage at any time during the day or night but are chiefly diurnal. They are usually found in colonies marked by numerous 1 to 2 inch wide surface runways through matted grass. Small piles of brownish feces and short pieces of grass stems along the runways are evidence of activity. In areas of winter snow, round burrow openings leading to the surface of the snow also reveal their presence. Their burrows consist of shallow underground tunnels, nest chambers, and storage chambers. Montane vole females are territorial and, except during their short period of reproductive activity, all strangers of either sex are driven away from the home range around the burrow. Home range is small, usually less than a 60-foot radius in the case of California voles. All meadow voles swim well, so streams and irrigation canals are not effective barriers.

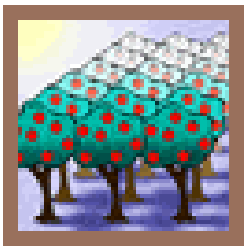
There has been disagreement as to feeding habits, but observations of montane voles indicate that meadow voles do forage beyond their sheltered runways. Food consists of tubers, roots, seeds, grain, and succulent stems and leaves.

Females of California voles are reported to have bred at 22 days of age (average around 29 days), but males attain sexual maturity at 6 to 8 weeks. The average litter size for California and montane voles usually ranges from around 4 to 6 young. The gestation period is 21 days, and the young are weaned at about 2 weeks of age. Under natural conditions, a female vole may produce from 5 to 10 litters a year. Females may breed again shortly after birth. The reproductive potential of voles is extreme, with one study showing that 100 pairs of montane voles in April can result in potentially 8,900 individuals by September.

It is unlikely that many individuals survive an entire breeding season. Though a few individuals will breed in any season, the major breeding season corresponds with the season of forage growth. In California voles, there is a major peak in late winter and early spring, and a lull in summer. Montane voles typically halt breeding during the cold winter months and resume with the return of warm weather in the spring.

Meadow vole populations generally build up to a peak every 3 to 5 years, followed by a rapid decline during the next breeding season. When an anticipated peak occurs in a dry year, it may be barely noticeable, but if it occurs during a wet year, it can lead to substantial damage due to extreme densities. The exact causes of the cycle of buildup and decline are not known, though disease, food shortages, physiological stress from overcrowding, and other factors may be involved. It should be pointed out that such cycles can be less obvious in some agricultural crops (e.g., artichokes and alfalfa), likely due to the abundance of highly preferred food sources that provide ample cover.

In cultivated areas, meadow vole populations are often permanently found in favorable habitat such as roadsides, canal banks, or adjacent non-cultivated land. Invasion into cultivated cropland occurs when the population builds up or when the wild habitat becomes unfavorable, as when range grasses dry up in summer. Serious invasions may be detected early by the use of strategically located drift fence pit traps or lines of snap traps.



Damage Prevention and Control Methods

The best management programs for voles keep numbers at low levels. Once vole numbers reach high levels, control becomes much more difficult and costly. Vegetation management and the proper use of exclusion keep damage to a minimum. Toxic bait (either multiple-dose anticoagulants or zinc phosphide) can control voles that reach harmful numbers. All field-use rodenticides for voles are restricted use materials that require the applicator to be a private or commercially certified applicator or to be under the supervision of a certified applicator. Some also require a permit from the county agricultural commissioner for purchase or use.

Exclusion: Cylindrical wire or plastic trunk guards to protect young trees or vines from voles are widely used. An effective guard can be a 24-inch-tall cylinder made of ¼- or ½-inch mesh hardware cloth that is of sufficient diameter to allow several years' growth without crowding the tree or vine. The bottom edge of the trunk guards should be buried at least 6 inches below the soil surface, but be aware that voles may dig beneath them. As such, the inside of the guards should be checked periodically to ensure that vole damage is not occurring within these exclusionary devices. If voles take up residence inside the cover, the damage is often greater than if the covers were not used. Good weed control around trunks improves the effectiveness of trunk guards.

Plastic, heavy cardboard, or other fibrous materials, such as milk cartons, can also be used to make trunk guards. These materials are less expensive, also provide sunburn protection, and are more convenient to use; however, they provide less protection against vole damage since the voles can chew through them and sometimes use them as a harborage.

Exclusionary fencing consisting of aluminum flashing can be used along field borders. The fencing should be buried at least 6 inches below ground and should extend 12 inches above ground. Drive rebar or wooden stakes into the ground every 15 feet to provide support for the fencing. The efficacy of such fencing is greatly increased if bare soil is present around the base of the fence. Be aware that equipment must frequently move in and out of fields, thereby limiting sites where fencing is practical. Fencing is expensive, so significant damage should be expected to justify the cost of installation.

Habitat modification: Cultural practices can significantly affect meadow vole numbers. Because voles travel only a few feet from their burrows to obtain food, any destruction of vegetation will make the area less favorable to them and results in burrow abandonment and/or mortality. Physically removing vegetation using herbicides or other methods to keep an area about 2 to 3 feet out from the trunks of trees and vines free of vegetation will generally reduce damage. If you maintain ground cover or resident weeds in the row middles of tree and vine crops, you should keep these middles mowed fairly short (< 2 inches) to be less attractive to voles.

Maintaining weed-free fencerows, roadsides, and ditch banks is also an important preventive measure. A vegetation-free zone 30 to 40 feet wide between a field and adjacent areas helps reduce the potential for invasion by voles, but such a wide area is rarely practical; bare soil borders may be undesirable where off-site movement of contaminated soil and water must be prevented with a vegetative border to filter runoff. Because of the vegetative nature of potatoes and alfalfa, habitat management is rarely a viable option in these crops.

Frightening: Frightening methods are ineffective and not recommended for vole control.

Fumigants: Fumigants are not usually effective because of the complexity and shallowness of vole burrow systems which allows the fumigant gas to escape. Aluminum phosphide can be effective in situations where the burrow openings are quite visible such as immediately after discing (e.g., artichoke production).

Repellents: Commercial repellents have not proven to effectively reduce damage from voles in agricultural situations.

Toxic bait: If damaging infestations or large populations are found within orchard, vineyard, or vegetable crops, toxic baits can be used during the dormant season to greatly reduce vole numbers. Baiting can also reduce voles in adjacent areas before they have a chance to invade. Single- and multiple-dose baits are available, but there may be baiting restrictions in some areas to protect endangered species. It is imperative that you understand and follow the label directions for use. In particular, please note that toxic baits generally cannot be applied within orchard, vineyard, or vegetable crops from green up (spring) until after harvest occurs.

For small infestations, bait should be scattered in or near active vole runways and burrows according to the label directions. For larger areas and where the label permits, broadcast applications can be made using a belly grinder-type seeder or a vehicle with a tailgate seeder. Broadcast application rates vary depending upon estimated numbers of voles and type of toxicant. Both single-dose (e.g., zinc phosphide) and multiple-dose (e.g., first-generation anticoagulants chlorophacinone and diphacinone) toxicants are used for meadow vole control in orchard, vineyard, and vegetable crops. Multiple-dose

anticoagulants are EPA restricted materials, but not California restricted, and require the user to be a certified applicator or under the supervision of someone who is. Zinc phosphide is an EPA and California restricted use pesticide that requires a permit from the county agricultural commissioner for purchase or use as well as the certification. Application personnel should be trained in proper use and on potential hazards of these materials.

In ditchbanks and other non-cropland sites, bait should be applied in fall or spring before vole reproduction peaks to slow or prevent populations from expanding into the crop. However, application within an orchard, vineyard, or vegetable field is restricted to the nonbearing season, so timing is key to prevent a population explosion during the growing season. Bait acceptance will depend on the amount and kind of other food available. When baiting for voles with anticoagulants, you should remove all aboveground carcasses by burying them underground, or by bagging and disposing of them in the trash. This will reduce potential secondary poisoning hazards.

Within alfalfa fields, only zinc phosphide can be applied. Zinc phosphide is applied directly to vole burrows and runways through spot treatments or broadcast applications. If overused, problems with bait shyness can occur. As such, zinc phosphide should not be applied more than twice per year. Additionally, zinc phosphide must be applied when new growth is less than 2-inches tall, and it should not be applied when rainfall, dew, or fog are expected within a 24-hour period. Carefully read the label for more information on restrictions for zinc phosphide application in alfalfa.

In artichokes, pelletized bait is not overly effective. As such, growers use chlorophacinone-treated artichoke bracts. This bait is commercially mixed and distributed to local growers following CDFA's "Rodent bait chlorophacinone treated artichoke bracts (0.01%)" label. These bracts are placed at the base of artichoke plants in infested areas. Voles in some areas have begun to develop a resistance to chlorophacinone, so caution must be used to not rely exclusively on these bract baits. Also bract baiting is most effective in November through mid-February. By the first of March, voles switch to eating *Oxalis pes-caprae*, and as such, bract baits are no longer effective. See the rodenticide label for further application instruction.

In sugar beet fields, zinc phosphide bait can also be used, but there are specific label restrictions, and as with all pesticides, the label must be strictly followed.

Trapping: Trapping is not an effective method of control where population numbers are moderate to high. However, if dealing with very small populations, voles can be easily trapped using snap traps. Trap placement is important. Meadow voles do not stray far from their runways. As such, traps should be set at right angles with the trigger directly in the path of the vole. Bait is generally not needed as voles will trigger the traps by passing right over them. If bait is deemed necessary, potential options include peanut butter, oatmeal, or apple slices. For additional placements, look for nests, burrow openings, and runways in or around mulch or grass. Traps must be set in sufficient numbers to be effective and should be checked daily. Captured voles should be removed wearing plastic, latex, nitrile, or rubber gloves to prevent disease or parasite transmittance. Dead voles can be buried or placed in plastic bags and disposed of in the trash.

Flood irrigation: Where still feasible, flood irrigation can help control vole populations. When a field is flooded, the voles must come to the surface or drown. When at the surface, they can be picked off by a number of predators; growers and their dogs can also actively seek out voles at this time to further reduce population size.

Predators: Voles are prey for a number of predators including hawks, owls, herons, snakes, badgers, bobcats, weasels, and coyotes. Although relatively vulnerable to predation, predation does not generally have much impact on vole populations given their extreme reproductive capability.

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**Adapted from several previous editions authored by D.O. Clark, J.P. Clark, and T.P. Salmon, among others.