

Meadow Voles and Pocket Gophers: Management in Lawns, Gardens, and Cropland

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Introduction

MEADOW VOLES AND POCKET GOPHERS cause significant damage to rangeland, alfalfa, pastures, and other agricultural crops. Combined or alone, forage losses from pocket gophers and/or voles have been estimated at 10%–50% in pastures and alfalfa. These rodents also cause significant damage in orchards, nurseries, turf farms, ornamental flower plantings, landscapes, lawns, and vegetable gardens.

Both voles and pocket gophers damage plants by eating roots, trunks, stems, tubers, and leaves. Their tunneling habits also cause damage. Large mounds of soil left by rodents, particularly pocket gophers, can dull knives and discs on harvesting equipment. Soil from mounds also contaminates hay bales. Underground rodent burrows and tunnels interfere with irrigation practices and equipment. The burrowing and mounding capabilities of pocket gophers encourage weed invasion through ground disturbance and can cause injury to people, horses, and livestock that step into holes.

Although voles reproduce more rapidly than pocket gophers, both have remarkable reproductive capacity. Population surges can occur frequently when adequate forage and habitat are available.

Voles and pocket gophers are considered nongame mammals in most states and can be legally managed on private property and public lands. Check with your state wildlife agency or department of agriculture regarding legal control methods in your area. Management options depend on the pest, the situation, cost limitations, and equipment and labor availability. It is important to understand the target pest's biology and habits before implementing management strategies.

Voles

Vole Biology

Several species of voles exist in the Pacific Northwest. It can be difficult to distinguish among them.

The meadow vole or meadow mouse (*Microtus pennsylvanicus*) is the most common species in pastures, rangelands, crops, and lawns. Meadow voles are heavy-bodied, small rodents with short legs and tails; small, rounded ears; and coarse, blackish to grayish-brown fur with black-tipped hairs and bicolored tails. When fully grown, voles generally average 4½–5½ inches long, including the tail (Figures 1 and 2). Under good weather and feeding conditions, voles can reach 7 5/8 inches in length.

Voles can reproduce year-round, with a peak breeding period in the spring followed by a second, smaller breeding period in the fall. Females reach reproductive maturity in 35–40 days. They average one to five litters per year, with three to six young per litter. Gestation length is approximately 21 days.

Vole populations are cyclic and can fluctuate dramatically from year to year. During most years, voles are not a significant problem and their



Figure 1. Vole (meadow mouse). Photo by Danielle Gunn.



Figure 2. Vole (meadow mouse). Photo by Danielle Gunn.

populations are partially controlled by predators such as snakes, coyotes, foxes, hawks, owls, and domestic cats.

If habitat is abundant and provides adequate protection from predators, weather conditions are ideal, and high-protein food sources exist, vole populations can quickly reach damaging levels. Minor peak populations occur approximately every 4–6 years and epidemic populations occur about every 10–12 years. However, these cycles are not regular. Population explosions last about a year before the population crashes. Population explosions can result in significant economic and aesthetic losses.

Very few references document the cost of vole damage in field crops and nursery stock due to the cyclic nature of vole populations and the potential for explosive epidemics. Economic losses can be severe, but are often not quantified. A simple calculation to determine alfalfa or other crops losses is to determine how many acres were lost to vole damage times the average yield of the field times the price of the yield minus harvest costs per acre. For example, one-acre loss of alfalfa yielding four tons/acre x \$150/ton = \$600 minus harvest costs of \$60/acre = a loss of \$540 per acre. Please consult with your county Extension office or field consultant for current information regarding actual annual crop values and harvesting costs for your particular situation.

Vole Behavior

Most damage caused by voles is the result of feeding activity. Voles weigh 3–4½ oz and can eat nearly their own body weight daily. Voles damage crops by feeding on roots and stems, grass, seeds, and underground reproductive structures such as bulbs and tubers. They damage and kill trees and shrubs by girdling and removing the bark from the trunk or stems near the base (Figure 3). Damage to trees and shrubs normally occurs in the winter, when voles are foraging under snow cover.

Voles do not hibernate. They are active year-round, but are most active in the spring and fall. They are most active at night, but can also be seen during the day.

Voles are normally found in areas of dense ground cover. Vegetation greater than 6 inches in height, snow cover, brush piles, leaves, and low-hanging tree limbs provide protection from predators. Rangeland, alfalfa and grass hayfields, pasture, orchards, and home lawns and gardens provide ideal habitat and food sources for these pests.

Voles do not like crossing bare ground and prefer cover when feeding. Feeding activity is easily recognized by the presence of shallow tunnels and runways in vegetation and by underground nests of grass, stems, and leaves. Runways are approximately 1–2 inches wide, with an entrance hole leading underground (Figures 4 and 5). Around frequently used runways, grass and other vegetation may be clipped very close to the ground. Feces and small pieces of clipped vegetation may be found in runways. Voles seldom stray from their usual travel routes.



Figure 3. Bark removed by a vole. Photo by Bill Lord, University of New Hampshire Cooperative Extension Specialist Emeritus. Reproduced by permission from UNH Extension.



Figure 4. Example of vole infestation: feeding area, runways, and entry hole. Photo by Danielle Gunn.

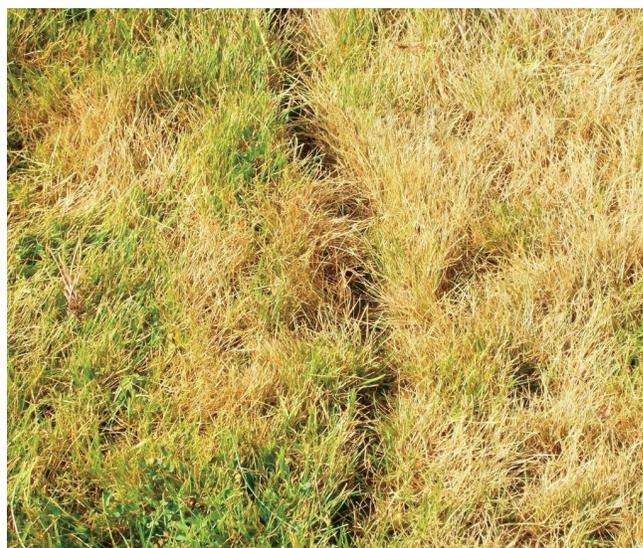


Figure 5. Vole runway. Photo by Danielle Gunn.

Vole Management

Where voles are likely to be a problem, routinely monitor for signs of feeding activity from early spring until late fall. Runways, clipped forage, gnawed stems, bark, and roots are signs of possible vole activity.

Table 1 provides a summary of various measures to help manage damaging vole populations.

Habitat Modification

Habitat modification and/or population reduction strategies can prevent large population increases. Methods include the following:

- Mowing or burning ditch banks, barrow pits, and fence lines
- Clearing weeds and debris from windbreaks and other affected areas

- If practical, develop weed-free cultivated buffer strips around cropland. For large acreages, this is an effective method.
- Grazing or mowing alfalfa and pasture in the late fall when plants are not actively growing
- Light tillage of field perimeters and fields
- Aluminum flashing or other materials constructed around areas of concern to serve as entry barriers

Plant Protection

You can protect trees, shrubs, and flower beds by surrounding plants with netted wire. Install 3/8-inch netted wire from approximately 6 inches below soil level to approximately 6 inches aboveground.

Trapping

In the Pacific Northwest, homeowners with small infestations can trap voles with wooden mousetraps. Trap placement is crucial for optimum success. Place traps flush with the ground and at a right angle to surface runways (Figure 6). Use a small chain to attach the trap to a stake to prevent raptors or other predators from dragging away the vole and trap.

Bait is generally not needed because voles will trip traps during normal activity. If desired, traps can be baited with peanut butter, oatmeal, or apple slices. Voles occasionally learn to take bait without tripping the trap. To avoid bait loss, mix peanut butter with cotton wool or cotton balls and clamp the cotton into the tripping mechanism of the trap.

Table 1. Meadow vole management options.

Control Method	Rodenticide	Legal Constraints*	Timing	Comments
Habitat modification	n/a	n/a	Early spring through late fall	Mow, graze, or burn vegetation. Remove weeds and other debris.
Exclusions: use 3/8-inch netted wire extending 6 inches below and above desired vegetation.	n/a	n/a	Year-round	Excellent for protecting trees, shrubs, and flowers.
Trapping	n/a	Washington State does not allow the use of traps that grip or hold the body. Mouse and rat snap traps are exempt from this law and can be used to trap voles.	Year-round	Begin in early spring. Place traps at right angles in surface runways.
Hand and mechanical baiting	Zinc phosphide**	Check individual product labels. Some labels allow use on cropland, and some do not. Some formulations are restricted-use pesticides. Some states, such as Washington, do not allow homeowner use of zinc phosphide.	Early spring through late fall	Apply by hand or mechanically. Bait stations are useful for larger populations. Do not apply when moisture is anticipated.
	General-use anticoagulants: Chlorophacinone (Rozol Vole Bait), warfarin (Rodex, Kaput)	Available for purchase and use without a pesticide applicator license. For noncrop use only. Generally, for use around homes and buildings. Can only be used with a bait station.	Year-round	Requires multiple applications or doses.
	Restricted-use anticoagulants: diphacinone (Ramik Brown, Kaput-D) and chlorophacinone (Rozol Vole Bait)	A pesticide applicator license is required to purchase and use these products. For use in orchards, nurseries, turf, lawn, golf courses, tree and forestry plantations, and other noncrop areas. May be applied to dormant alfalfa.	Early spring through late fall	Requires multiple applications for voles to ingest multiple doses of the rodenticides.

*Pesticide license requirement for rodenticide baits: Note that some rodenticide baits are restricted-use pesticides (RUP) and can be purchased and applied only by a licensed pesticide applicator. **Oregon has additional restrictions on zinc phosphide use. Other states may have additional restrictions on the use of zinc phosphide. Be sure to follow the state's specific SLN (special local needs) label for directions of use. Contact your state department of agriculture for more information concerning pesticide licensing and use of rodenticides.



Figure 6. Proper trap placement, using a right angle to intercept voles using runways. (Note: Trapping is legal only in Idaho and Oregon, not in Washington, depending upon the trap type.) Photo by Danielle Gunn.

Examine traps daily and remove and bury dead voles. Like all rodents, voles can carry diseases, bacteria, and other organisms harmful to humans, so do not handle voles without wearing gloves. Trapping is best utilized in small areas, such as lawns, and is not effective or practical for large infestations.

Note: In Washington, it is illegal to use devices that grip or hold the body. However, mouse and rat snap traps are exempt from this law and can be used to trap voles.

Baiting

Toxic bait can successfully control voles in gardens, turf, rangeland, and cropland perimeters. Many of these baits must be placed in bait stations. Figure 7 illustrates a simple PVC pipe bait station. The plywood cover provides protection from predators or raptors, keeps bait dry so it does not lose effectiveness, and prevents access by children, birds, pets, and other animals. Although Figure 7 suggests a quarter sheet of plywood, any sturdy covering, such as a tarp, canvas, or metal roofing material, will suffice.

Do not apply bait when moisture is anticipated. Place bait stations in runways or next to burrows so voles will find them while traveling their normal routes. Bait stations can be prebaited with vegetables and peanut butter to attract voles, but this practice generally is not necessary unless voles are not consuming bait. If voles are not consuming bait products, prebaiting with nontoxic bait that is the same size, shape, and formulation as the toxic bait may increase consumption. Once voles are used to consuming the nontoxic bait on a regular basis, change to the toxic bait.

Always use fresh bait products. Old bait products may have an off odor or could be moldy or damaged and ineffective.

When using bait stations in turf, place them on the edges of turf where the most activity is apparent. Move bait stations regularly so that turf under the cover is not significantly damaged.

For range and pastures, bait can be placed around field perimeters. Lengthen the feeding tube to at least 12 inches and stake the bait station to the ground. The longer tube holds more bait since these stations cannot be monitored as often as those in lawns and gardens. The longer tube also reduces bait spillage. In these areas, bait stations do not need to be covered, since pets and children are not likely to be present and good vegetative cover encourages voles to visit. However, if safety is a concern, use a durable covering over the bait station. The cover will prevent nontarget poisoning and deter other animals from damaging the bait station.

Carefully read and follow all label instructions when applying bait. Use caution when applying baits where children, pets, and other nontarget animals are likely to be present. Dispose of dead voles and bait that may spill from the trap so there is no chance of poisoning pets, livestock, or wildlife.

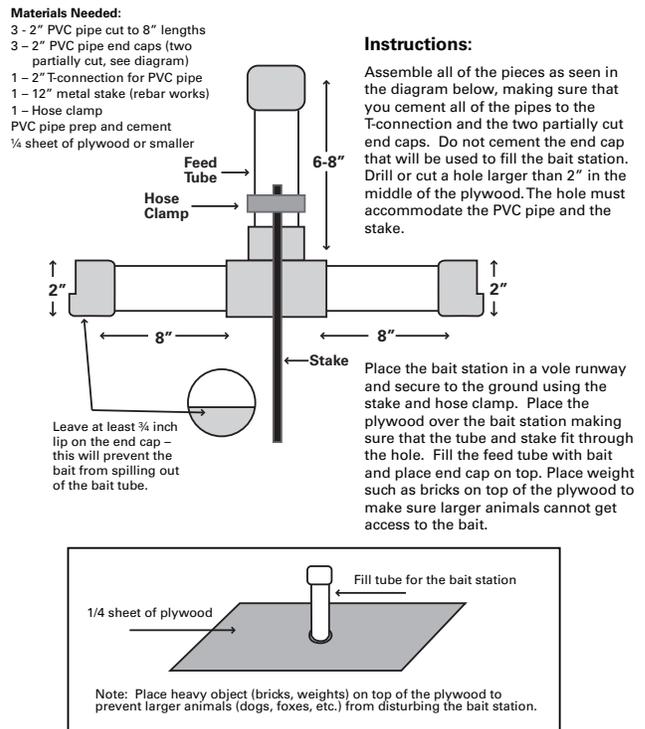


Figure 7. Bait station construction. Diagrams by Sherman Takatori.

Zinc phosphide baits: Zinc phosphide is sold under trade names such as Prozap and ZP AG. Some zinc phosphide products are combined with grains, while others are in pellet form. Zinc phosphide is a bait product and NOT a fumigant.

Some zinc phosphide products are restricted-use pesticides and require a pesticide applicator license to purchase and use. These products include those labeled for agricultural crops such as wheat, barley, alfalfa, potatoes, sugar beets, grape vineyards, orchards, and nursery stock. These products can be broadcast on the target site. Before purchasing, check the label to be sure the product can be used on the target crop.

Other zinc phosphide products are general-use pesticides and do not require a pesticide applicator license. However, some states may not allow homeowner use of zinc phosphide. These products can be used in turf, lawns, and other noncrop areas. They can be placed in runways, in or next to burrows, or mechanically broadcast in infested areas. In many areas, spreaders are available for rental from farm- or garden-supply stores. However, it is always a good practice to place zinc phosphide in a bait station to keep it out of reach of children and nontarget animals.

Be sure to keep zinc phosphide from getting wet. Moisture activates the chemical, rendering it ineffective very quickly.

Zinc phosphide acts rapidly. A single feeding is generally lethal to voles within twelve hours. In rare cases, voles may survive and become bait shy. For this reason, zinc phosphide should not be used in the same field more than once in a six-month period.

Zinc phosphide converts to phosphine gas when it is ingested by a vole, causing death. It does not accumulate in the vole's body tissues. Therefore, predators or scavengers such as dogs or cats are not likely to be affected by eating poisoned rodents. However, children, pets, birds, and other animals can be affected by direct contact with the bait. Store bait out of reach and use it carefully to minimize unintended access.

Oregon Restrictions on Zinc Phosphide Use

In order to combat rodent pressure while mitigating risks to wildlife, Oregon has issued several zinc phosphide Special Local Needs (SLN) registrations with specific application restrictions. Some SLNs allow aboveground applications on grass or clover grown for seed, but only during a certain time period (usually early May to mid-September). Other labels allow only belowground applications, but may be applied year-round. One SLN authorizes the use of zinc phosphide to kill Belding's ground squirrels (OR-130002), but may only be used in certain counties and after satisfying a training requirement. Read and follow all directions on the SLN and original container label. If you have any questions, please contact the Oregon Department of Agriculture Pesticides, Fertilizers and PARC Programs at pesticide-expert@oda.oregon.gov or (503) 986-4635.

Additional Cautions Regarding Rodenticide Use

Rodenticide baits may pose a hazard to federally designated endangered and/or threatened species and may not be used in any manner that harms or kills these species. It is the responsibility of the pesticide applicator to perform any application correctly so that it will not harm and/or kill any threatened and/or endangered species. Always follow the rodenticide (pesticide) label directions, especially the "Environmental Hazards" section of the label. The label may contain additional web-distributed information that will be the responsibility of the pesticide applicator to obtain and follow. If you have any questions or concerns regarding species that may be affected by the application, contact your local Extension office, state department of agriculture, or local fish and wildlife agency.

Due to the toxicity of zinc phosphide and the potential for secondary poisoning to geese, there may be additional restrictions for zinc phosphide bait in certain states and counties in the Pacific Northwest. Before purchasing or applying zinc phosphide baits for vole control, read and follow all use directions on the state-specific SLN label. Oregon and Washington labels can be found online on the PICOL database: <https://picol.cahnrs.wsu.edu/>.

Anticoagulant baits. Anticoagulants require multiple feedings by the rodent before a lethal dose is ingested. Anticoagulant baits are formulated using grain or other food sources to attract rodents. These baits are usually in the form of pellets and blocks and some are coated in paraffin to provide moisture resistance. Paraffin-coated baits are useful around ditches and other areas where moisture may cause other types of baits to spoil and lose potency.

Anticoagulant baits cannot be applied directly to food or feed crops. To avoid contact with a growing crop, these baits are used in areas adjacent to crop fields or during crop dormancy. Before purchasing any product, check the label to be sure it can be used on the target site.

Diphacinone bait products (Ramik Brown) are restricted-use pesticides available only to those who have a current pesticide applicator license. These products can be used in fruit and nut orchards, tree nurseries, and tree farms, but cannot be applied directly to food or feed crops.

Another restricted-use pesticide is Rozol Vole Bait (chlorophacinone). It can be used in noncrop areas, lawns, turf, ornamental flower and shrub plantings, orchards, nurseries, and tree and forestry plantations.

General-use anticoagulant pesticides include another formulation of chlorophacinone (Rozol pellets) and warfarin (Kaput, Rodex). These products can be used by the general public. They are intended for use around homes and buildings and must be contained in bait stations.

All anticoagulant baits are toxic to other animals, so take precautions to prevent nontarget animals from consuming the bait. Carefully read and follow the precautionary statements on the pesticide label. Bait must be used at the specific target site as indicated on the label.

Additional Cautions Regarding Rodenticide Use (cont.)

Rodenticide (pesticide) labels and uses are constantly changing. Specific product names and rates are not provided in this publication, due to the nature of changing labels and product availability. The following websites may be useful for checking on locally registered rodenticide products. Be sure you select a product that is allowed for your application site and target rodent pest.

In Idaho, the University of Idaho Pest Management Center maintains an annually updated table of rodenticides labeled for use to control meadow voles and pocket gophers in a variety of sites. The web address is <https://www.uidaho.edu/-/media/UIIdaho-Responsive/Files/Extension/topic/ipm/Rodenticide-table-PNW-627>.

- In Oregon and Washington, a searchable pesticide database, Pesticide Information Center OnLine (PICOL), is available online at <https://picol.cahnrs.wsu.edu>. This is a very detailed search engine and requires some additional knowledge. It is recommended that you seek advice from Extension personnel the first time you access information on it.
- Oregon Department of Agriculture has a public lookup site for pesticide labels for products registered in Oregon: http://oda.state.or.us/dbs/pest_productsL2K/search.lasso.

Predators

Owls, hawks, snakes, cats, dogs, and other predators utilize voles as a food source. However, predators alone will not eliminate damage to fields, rangeland, trees, or lawns, and often do not keep vole populations at an acceptable level.

Pocket Gophers

Pocket Gopher Biology

Pocket gophers (Figure 8) are one of the most prevalent and destructive vertebrate pests in the Pacific Northwest. There are three genera of pocket gophers in the United States, *Thomomys*, *Geomys*, and *Pappogeomys*, representing eighteen different species. Genus classification is based on the size of the forefeet, claws, and front surfaces of the incisors.

Identification of species can be difficult. Generally, only one species is found in a defined area.

Pocket gophers are burrowing rodents that get their name from the fur-lined, external cheek pouches they use for carrying food and nesting materials. Pouches are located outside the mouth on both sides of the face. Pocket gophers are 5–14 inches long and have soft fur, ranging in color from black to varying shades of brown. Some species can be yellow to almost white.

Pocket gophers are well equipped for digging and tunneling. They have powerfully built forequarters;



Figure 8. Pocket gopher. Photo by Glenn Shewmaker.

large-clawed front paws; fine, short fur that does not cake in wet soils; small eyes and ears; and flat heads and short necks. Pocket gopher lips close behind four large incisor teeth to keep soil out of their mouths while digging, leaving their big, yellow incisors visible. Highly sensitive facial whiskers and tails help pocket gophers move in the dark. The tail is sparsely covered with hair and has the unique function of helping to regulate body temperature. Pocket gophers have a keen sense of smell, which enables them to find food.

Pocket gophers become sexually mature at one year of age and can live for three to five years. They breed in the spring and produce one or two litters per year, averaging three to six young per litter. In irrigated alfalfa fields, it is not uncommon for pocket gophers to have up to three litters per year. The gestation period is twenty days for most species. Births occur from March through June.

Pocket Gopher Behavior

Pocket gophers do not hibernate and are active year-round. They are territorial and antisocial. There is normally only one pocket gopher per burrow system, unless it is mating or is a female raising a litter.

Pocket gophers reside in varying geographical elevations, soils, and conditions. They occupy rocky areas, but prefer fine-textured, deep, porous soils that are conducive to digging and feeding. Soils that do not hold tunnels (sandy soils) and those that do not diffuse air for breathing (high-moisture, clay-based soil textures) limit populations. Deep soils are also important for insulating pocket gophers from extreme temperatures. Vegetation with large, fleshy roots or tubers creates ideal habitat.

Burrows consist of a main tunnel and several lateral tunnels, which are linear or branched (Figures 9 and 10). Tunnels are about 2½–3½ inches in diameter. Tunnels always slope toward the ground surface because pocket gophers do not make straight vertical tunnels.

A pocket gopher's burrow system can cover an area that is 200–2,000 square feet. Typically, most feeding burrows are 6 inches or less below the soil surface. The nest and food storage chambers can be as deep as 6 feet.

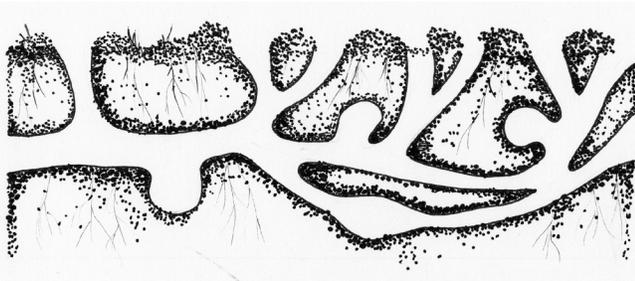


Figure 9. Pocket gopher burrow system, top (above) and side (below) views. Drawings by Betsy Morishita.

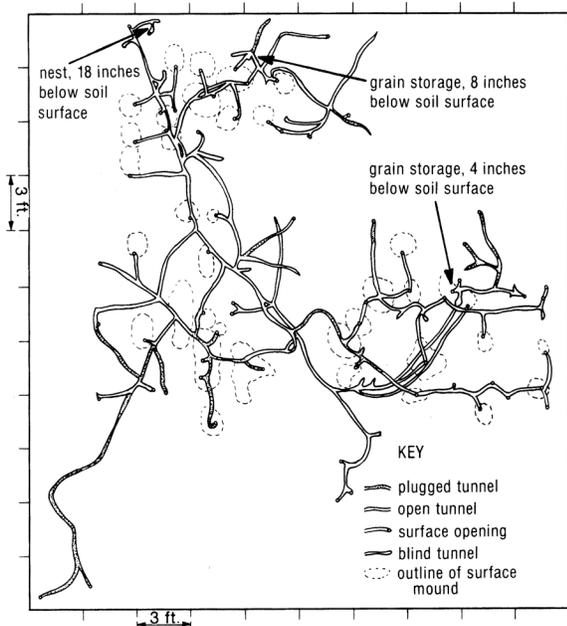


Figure 10. Underground view of a pocket gopher system. Copyright © 1997 Regents of the University of California. Reproduced by permission from Orloff et al. 1997. Intermountain Alfalfa Management. Publication 3366, University of California Division of Agriculture and Natural Resources.

As they dig tunnels, pocket gophers push loose soil to the surface, forming mounds that are 12–18 inches wide and 4–6 inches high. Typically, mounds are crescent- or horseshoe-shaped when viewed from above. These soil deposits are plugged lateral tunnels. A slight depression will be present on the plug side of the mound (Figure 11). Pocket gophers can create

several mounds in one day. Fresh soil mounds are evidence of recent activity.

For the most part, pocket gophers remain underground, although they are sometimes seen feeding at the edge of an open burrow, pushing soil out of a burrow, or moving to a new area. They rarely venture more than 2½ feet from a burrow entrance.

Pocket gophers feed underground on roots and tubers and cut plant stems belowground to pull plants into the burrow (Figure 12). They acquire water from the vegetation they feed on and do not need to leave the burrow to drink. Pocket gophers will consume any edible plant material, including green, succulent vegetation; roots; bulbs and tubers; grasses and seeds; forbs; tree roots and bark; and legumes with palatable roots, such as alfalfa and clovers. Annual crops, such as grains and annual grasses, are not ideal habitat for pocket gophers because their shallow, fibrous root system does not provide a good food source.



Figure 11. Fresh pocket gopher mound. The depression in the mound indicates a plugged hole. Photo by Danielle Gunn.



Figure 12. Pocket gopher cache of beans. Photo by Glenn Shewmaker.

Alfalfa is one of the best food sources and habitat for pocket gophers. Pocket gophers are very destructive to alfalfa fields, feeding on alfalfa taproots and killing the plants. Pocket gopher damage to alfalfa is permanent and will continue to affect field productivity throughout the life of the stand.

In irrigated cropping systems, pocket gophers damage irrigation lines, divert water by burrowing through ditches and dikes, degrade canals and levees, and cause soil erosion problems and various structural failures.

Pocket gophers can also be very destructive to tree nurseries, orchards, and vineyards, especially during the winter, when food sources are limited. Pocket gophers will gnaw and feed on the bark around the base of trees, shrubs, and vines, especially when there is snow cover. This damage will reduce plant health and may kill the plant.

The level of infestation required to produce economic damage depends on growing conditions, irrigation practices, and the type and economic value of the crop. In a high-value crop, as few as two pocket gophers per acre can decrease yield and plant viability.

Pocket Gopher Management

Understanding pocket gopher habits, especially the burrow system, is the key to effective control. Management methods include trapping, hand or mechanical baiting, fumigation, combustion, cultivation, and crop rotation. For the most effective control, use a combination of methods. In cases of heavy infestations, drag or harrow the field to eliminate mounds of soil and identify active burrows. See Table 2 for a summary of control measures.

Trapping

Trapping is a safe and effective control method for small areas or light infestations. It may not be practical or economical for large acreages or for heavy infestations. Trapping can be done year-round but it is difficult when the ground is frozen.

Note: In Washington, it is illegal to use devices that grip or hold the body. However, rat snap traps are exempt from this law and can be used. Washington has approved the use of the KORO Rodent trap to trap pocket gophers.

The most common type of trap is a two-pronged pincher trap. The trap is triggered when the pocket gopher pushes against a flat, vertical pan. Examples include the Cinch-, Macabee-, and Gophinator-style traps (Figures 13–15). The Gophinator trap is more effective for trapping larger pocket gophers than other pincher-type traps.

Another popular type is the choker-style box trap (Figure 16). Box traps are often easier to set, particularly for the beginning trapper, but require more digging. The Black Hole Trap is similar to a box trap, but is made with a plastic tube the same diameter as a pocket gopher burrow. It uses a spring-loaded noose instead of the box trap's spring-loaded ridged wire mechanism to catch the pocket gopher.

Generally, open-trigger-style traps (box, Cinch, Gophinator) are better for lateral tunnels and closed-trigger-style traps (Macabee and the Victor Ring) are better for main burrows. The GopherHawk Trap is a fairly new trapping device that is very effective and easy to use. The trap intercepts the tunnel vertically and is set aboveground. Shoveling or digging is not required. A wedge and probe are used to find the active tunnel. The trap has a yellow catch indicator to alert you when the trap has been activated (Figure 17).

To begin trapping, locate areas of recent pocket gopher activity based on the presence of fresh mounds of moist, dark soil. Mounds have a small, circular depression on one side, which is the plugged opening of a lateral tunnel. Pocket gophers may not revisit lateral tunnels, so trapping and baiting may be more successful in the main burrow. Beginning with a fresh mound, probe on the plug side of the mound with a pocket gopher probe or by digging with a shovel. If using a shovel, dig into the lateral tunnel plug until it can be opened. Then follow this lateral to the main tunnel; it will intersect with the lateral burrow approximately 8–12 inches from the soil plug and will be 6–12 inches deep. Often, the main burrow goes between two lateral tunnels.

Pocket gopher probes (Figure 18) can make it easier to locate the main tunnel. Probes can be purchased from farm-supply stores or constructed with pipe. It takes some practice to recognize when the probe enters the main burrow. When it drops approximately 2 inches, you have located the main tunnel (Figure 19).

Table 2. Pocket gopher–management options.

Control Method	Rodenticide	Legal Constraints*	Timing	Comments
Vegetation modification	n/a	n/a	Early spring through late fall	Mow, graze, or burn vegetation. Remove weeds and other debris.
Cultivation	n/a	n/a	Early spring through late fall	Cultivation destroys burrows and mounds.
Crop rotation to small grains	n/a	n/a	When possible	Pocket gophers do not prefer the shallow roots of small grain crops.
Exclusions: Use gravel around cables. Install 1/2- to 3/8-inch wire mesh around plants. Encase sprinkler lines in metal for protection.	n/a	n/a	Year-round	Helps protect ornamentals and underground structures.
Trapping	n/a	Washington State does not allow the use of traps that grip or hold the body. However, rat snap traps are exempt from this law and can be used. Washington has approved the use of the KORO Rodent trap to trap pocket gophers.	Year-round	Time consuming but effective. Use traps in pairs, facing opposite directions in the main burrow with the exception of the GopherHawk Trap.
Hand and mechanical baiting	Strychnine	Cannot be used aboveground.	Early spring through late fall	Very effective.
	Zinc phosphide**	Check product labels for usage information. Some formulations are restricted-use pesticides. Oregon State has additional restrictions. Washington State does not allow homeowner use of zinc phosphide.	Early spring through late fall	Apply by hand for small infestations or mechanically for large infestations. Do not apply when moisture is anticipated. Please note that zinc phosphide is not as palatable to pocket gophers as other rodenticides.
	Chlorophacinone (Rozol) and diphacinone (Answer), Ramik Brown, Ramik Green	For noncrop use only. Some rodenticides are general use and some are restricted use. Be sure to check the rodenticide label.	Early spring and late fall	Can be effective for small infestations.
Mechanical baiting with burrow builders	Chlorophacinone (Rozol Pocket Gopher Bait Burrow Builder Formula) and diphacinone (Kaput-D Burrow Builder Pocket Gopher Bait)	Restricted-use pesticide. Can be used in alfalfa, lawns, golf courses, rangeland, orchards and groves, and noncrop areas.	Early spring and late fall	For use with artificial burrow builders. Can be very effective.
Fumigation*	Aluminum phosphide (Phostoxin)	Aluminum phosphide is a restricted-use pesticide. An additional category for a nonsoil fumigation application is required on the pesticide license to use this product.	Spring through late fall	Works best when soil is moist enough to maintain tunnel structure. The applicator is required to write and follow a fumigant management plan with this product.
Carbon monoxide	n/a	Carbon monoxide–producing devices are not restricted-use products and do not require a license to use.	Year-round	Carbon monoxide is odorless, but the methods used to produce it can give off odors that do not appear to alert pocket gophers.
Combustion	n/a	n/a	Early spring through late fall	Use extreme caution with this management practice.

*Pesticide license requirement for baits and fumigants: Note that some baits and all aluminum phosphide fumigants are restricted-use pesticides (RUP) and can be purchased and applied only by a licensed pesticide applicator. An additional category for nonsoil fumigation is required for aluminum phosphide in addition to a completed fumigant management plan before use. Contact your state department of agriculture for specific pesticide licensing requirements and rodenticide use in your state. ** Some states may have additional restrictions on the use of zinc phosphide. Be sure to follow the state's specific SLN (special local needs) label for directions of use.

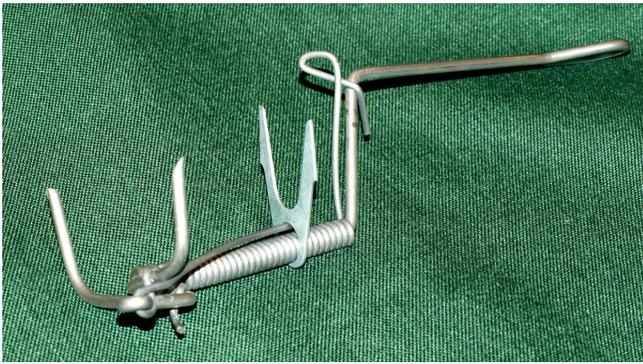


Figure 13. Cinch trap. (Note: This type of trap is legal only in Idaho and Oregon, not in Washington.) Photo by Sherman Takatori.



Figure 14. Improved cinch trap. (Note: This type of trap is legal only in Idaho and Oregon, not in Washington.) Photo by Sherman Takatori.



Figure 15. Macabee pocket gopher trap. (Note: This type of trap is legal only in Idaho and Oregon, not in Washington.) Photo by Sherman Takatori.

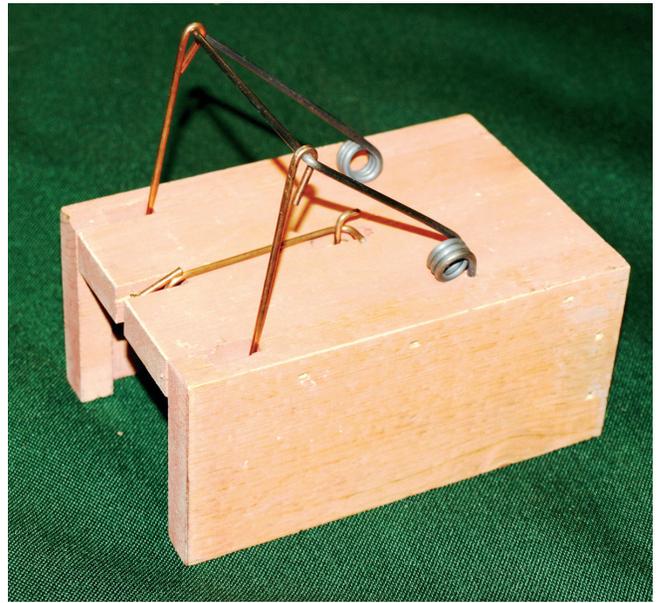


Figure 16. Box trap. (Note: This type of trap is legal only in Idaho and Oregon, not in Washington.) Photo by Sherman Takatori.



Figure 17. GopherHawk trap. (Note: This type of trap is legal only in Idaho and Oregon, not in Washington.) Photo by Danielle Gunn.



Figure 18. Pocket gopher probe. Photo by Danielle Gunn.



Figure 19. Pocket gopher probe in burrow. Photo by Glenn Shewmaker.

Although the main tunnel is generally the best place to trap, trapping in lateral tunnels may be effective if traps are placed where there is evidence of very recent activity. In fact, experienced pocket gopher trappers report more success trapping in actively used laterals than in main burrows. Laterals are used for maintenance of the main burrow system. Pocket gophers generally revisit a lateral a number of times to move soil and other materials to the surface.

One advantage of trapping in laterals is that it requires less digging. Trapping in main tunnels takes more time and significantly disturbs the burrow system. The pocket gopher may become aware of this disturbance and shy away from the trap. Also, when trapping an active lateral, there is no need to cover the opening, since pocket gophers usually leave laterals unplugged.

Regardless of whether you trap in the main tunnel or in a lateral, use a shovel to open the tunnel wide enough to set traps. Place traps in pairs with their openings facing opposite directions (Figure 20) in order to intercept a pocket gopher coming from either end of the burrow. Attach traps to stakes with wire to prevent pocket gophers from moving them deep into the burrow system.

If trapping in main burrows, cover openings with plywood, soil clods, or other materials to exclude light. Pocket gophers do not like openings in the main burrow system and will promptly cover the source of light or leave, thereby avoiding the trap. If trapping in lateral tunnels, it is unnecessary to cover the opening. Move traps approximately every three days.

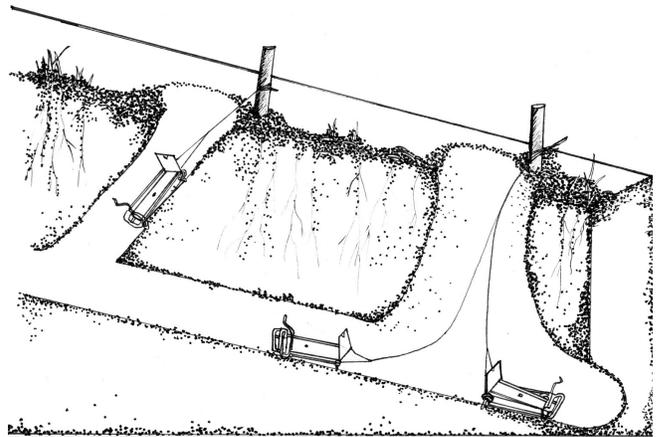


Figure 20. Proper trap placement in pocket gopher tunnels. Note stakes for the traps. (Note: Trapping is legal only in Idaho and Oregon, not in Washington.) Drawing by Betsy Morishita.

Hand Baiting

Bait must be placed in the main burrow where pocket gophers are active. If bait is placed in lateral burrows, the pocket gopher is more likely to push it up to the surface, increasing the chance of nontarget poisoning.

After locating the main pocket gopher tunnel as described on page 10, enlarge the opening by rotating the probe or inserting a rod or stick into the opening. Place the bait carefully in the opening using a long-handled spoon or other suitable device.

Note: See sidebar on page 6 for more information about using rodenticides.

Take care not to spill bait onto the ground. Handheld pocket gopher baiting equipment can be purchased online or from farm-supply stores. These devices consist of a probe and a bait reservoir (Figure 21). Use the device to probe for the pocket gopher burrow and place a premeasured amount of bait in the burrow by turning or depressing a lever.

Place the bait in the main tunnel in two or three locations. Close the probe holes with plywood, rocks, soil clods, or any other material that will exclude light and protect the bait. Take measures to prevent dirt from falling on the bait. Do not reuse the bait placement device for any other purpose.

After placing bait, use a shovel or spade to knock down or level existing pocket gopher mounds. This will make it easier to identify new pocket gopher activity and re-treat as necessary.

Rodenticide bait rates vary depending on the product type, location of use, and application method. Check the product label for rates.

Strychnine: Strychnine is the most common type of toxic bait utilized for control of small pocket gopher infestations in lawns and agricultural fields. It can be used only belowground. Strychnine baits are sold under many trade names, and most contain 0.5% strychnine. Contact your local Extension office for more information on these products.

Strychnine is lethal in a single feeding. It accumulates in body tissues; therefore, if a pet or other animal ingests a pocket gopher poisoned with strychnine, immediate death can result. Pick up and dispose of spilled bait according to label instructions. Although extremely rare, if deceased pocket gophers are found



Figure 21. Handheld pocket gopher–baiting apparatus. Photo by Danielle Gunn.

aboveground they should be buried away from children, pets, and livestock.

Zinc phosphide: Several zinc phosphide products are available. Check labels to be sure you select a product suitable for your needs. ZP Rodent Bait is labeled only for underground applications in rangeland, cropland, forest areas, parks, nurseries, lawns, golf courses, and around homes. Other zinc phosphide products can be used only on lawns, golf courses, and other noncrop areas. Some states may not allow homeowner use of zinc phosphide.

The State of Oregon may have additional restrictions on the use of zinc phosphide for pocket gopher control. Oregon has several Special Local Needs (SLN) labels for the use of zinc phosphide. (See the sidebar on pages 6–7 for more information.) Check with the Oregon State Department of Agriculture or their website (http://oda.state.or.us/dbs/pest_productsL2K/search.lasso) before purchasing or applying any zinc phosphide in Oregon and read and follow all zinc phosphide use directions on the Oregon SLN labels.

Anticoagulants: Anticoagulant baits are generally less effective than strychnine baits but are less toxic. Their lower toxicity makes them a better choice in areas where pets or other domestic animals might uncover the bait through digging. These products are multiple-feed baits and require more bait per application than single-feed baits such as strychnine.

Anticoagulant baits contain diphacinone (Kapat-D, Answer Pocket Gopher Bait) or chlorophacinone (Rozol). Diphacinone and chlorophacinone bait products can be used only on lawns, golf courses, rangeland, and other noncrop areas.

Note: See sidebar on page 6 for more information about using rodenticides.

Mechanical Baiting

Burrow builders (Figures 22 and 23) are an effective, time-saving method of baiting in large areas with significant numbers of pocket gophers. Burrow builders can be connected to a three-point tractor hitch. With this system, a tube or “torpedo” and colter cuts the soil and makes artificial burrows, a seeder or granular applicator dispenses bait into the artificial burrow at specific intervals, and a packer

wheel closes the furrow. Pocket gophers explore the new burrows, increasing their potential for bait consumption.

Baiting artificial burrows will not prevent pocket gopher infestations. Use the machine only where pocket gophers are present. Treat the perimeters of fields to delay reinvasion.

Use of a burrow builder requires significant knowledge. Consult the manufacturer or a knowledgeable person about proper use.

Before using a burrow builder, dig around fresh pocket gopher mounds to determine the depth of the main tunnels and the soil conditions in the field. The burrow builder must be set at the same depth and perpendicular to existing burrows. Dig burrows 20–30 feet apart. Soil moisture must be adequate so the soil will hold the burrows. When crossing uninfested areas, raise the shank to avoid making



Figure 22. Burrow-builder applicator. Photo by Glenn Shewmaker.



Figure 23. Burrow-builder applicator. Photo by Glenn Shewmaker.

burrows; pocket gophers will invade a previously uninfested area to explore artificial burrows.

When applying bait, check frequently to ensure that tunnels are developing properly and that the bait dispenser is working properly.

Strychnine is the most common type of bait used with burrow builders. Chlorophacinone (Rozol Pocket Gopher Bait Burrow Builder Formula) and diphacinone (Kaput-D Burrow Builder Pocket Gopher Bait) are also approved for use with burrow builders on alfalfa and rangeland, in orchards and groves, and noncrop areas. They are restricted-use pesticides, requiring a pesticide applicator license to purchase and apply. Apply these products when soil conditions allow formation of good artificial burrows.

Always read label instructions when applying any bait. Pick up spilled bait and dispose of it according to label instructions.

Carbon monoxide–producing devices do not require a pesticide applicator license to purchase and use.

Carbon monoxide is odorless, but the methods used to produce it sometimes give off odors. Nonetheless, these odors do not seem to alert pocket gophers to danger, so they do not attempt to seal holes in the tunnel or try to escape.

Fumigation

Aluminum phosphide is a restricted-use pesticide and classified as a nonsoil fumigant. The applicator is required to be licensed and certified in the nonsoil fumigation category, which requires an additional category on the pesticide license. Nonsoil fumigation is the application of fumigants to structures, commodities, and rodent burrows. This application is uniquely different than applying soil fumigants. Check your state pesticide licensing rules to ensure you have the proper pesticide license for using restricted-use and nonsoil fumigation pesticides. When using aluminum phosphide, it is very important to treat each burrow system at three different locations. This will provide adequate gas dispersion throughout the burrow system. DO NOT add water to aluminum phosphide tablets or pellets in order to liberate the phosphine gas faster. The rapid release of gas could create a hazardous situation for the applicator. The applicator must

follow all label directions and complete a Fumigant Management Plan before beginning this type of application. Aluminum phosphide emits an odor, but it does not seem to alarm pocket gophers.

Combustion

A mixture of propane (or other explosive gas) and oxygen (Figures 24 and 25) can be very effective. The gases are forced into the burrow system and ignited. The combustion kills the pocket gopher and collapses the burrow. Collapsing the burrow or a portion of the burrow reduces the chance that another pocket gopher will reinhabit the burrow system.

The explosive gas is used in a very low concentration relative to the oxygen mix, but pocket gophers seem to avoid the gas mixture due to the odor.



Figure 24. Pocket gopher control in a large infestation using the Rodenator. The Rodenator uses a mixture of oxygen and propane to kill pocket gophers and collapse tunnel systems. Photo reproduced courtesy of Meyer Industries, Emmett, Idaho.



Figure 25. Use of the Rodenator to control pocket gophers. Photo reproduced courtesy of Meyer Industries, Emmett, Idaho.

Gas cartridges are available, but they are costly and time consuming to use and give varying results. Because pocket gopher tunnels are extensive, gas may not disperse through the entire system. Pocket gophers may smell the gas and plug the tunnel before it can reach them. Wet soils inhibit gas dispersal. Because of their higher cost and inconsistent effectiveness, gas cartridges are not recommended.

Using combustion for pocket gopher control can be hazardous to the applicator and must be done with extreme caution.

Cultivation

Tilling, disking, and plowing can inhibit pocket gopher activity. Cultivation destroys burrows and mounds and may drive pocket gophers to other locations.

Crop Rotation

Rotating alfalfa and pasture to small grains can be a very effective control measure. Small grains have small, fibrous root systems that do not sustain pocket gophers as well as fleshy, taprooted vegetation like alfalfa.

Growing a buffer strip of small grains around alfalfa and pastures can discourage large pocket gopher populations. Buffer strips are particularly beneficial if the field is adjacent to an area with a known infestation or to land where pocket gophers cannot be controlled, such as state or federal land. Buffer strips should be approximately 50 feet wide.

Some growers feel that buffer strips this large are not practical for perennial crop protection since they take land out of production. However, the purpose of the buffer is to protect the crop from heavy infestations that could be economically damaging. If pocket gopher infestations are particularly high, temporary buffer strips might be an economically viable option.

Predators

Predators that feed on pocket gophers include owls, hawks, badgers, coyotes, foxes, bobcats, skunks, weasels, bull snakes, and rattlesnakes.

However, these predators do not effectively control large populations.

Other Options

Fences can protect ornamental shrubs and trees. To protect flower beds and vegetable gardens, bury ½- to 3/8-inch mesh wire 2 feet deep, leaving one foot extending aboveground. Lay gravel around cables and encase sprinkler lines in metal for protection.

Pocket Gophers and Voles In Or Near Buildings Or Other Structures

Second-generation anticoagulant rodenticide baits can be used to control rodents in or within 100 feet of a building or other structure. The rodenticides must be placed in a bait station. The second-generation rodenticides are a single-dose application. They are more toxic. Rodent fatalities result from consuming a single dose of bait. These products are restricted use and require a pesticide license to purchase and apply. They are only allowed to be used within or near (100 feet of) buildings or structures and must be contained in a bait station. Examples of these single-dose, second-generation anticoagulants are bromadiolone (Contra Blox and Pellets); difethialone (First Strike, Generation Pellets, and Mini Blocks); and brodifacoum (Havoc).

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ALWAYS read and follow the instructions printed on the pesticide label. The pesticide recommendations in this UI publication do not substitute for instructions on the label. Pesticide laws and labels change frequently and may have changed since this publication was written. Some pesticides may have been withdrawn or had certain uses prohibited. Use pesticides with care. Do not use a pesticide unless the specific plant, animal, or other application site is specifically listed on the label. Store pesticides in their original containers and keep them out of the reach of children, pets, and livestock.

Trade Names—To simplify information, trade names have been used. No endorsement of named products is intended nor is criticism implied of similar products not mentioned.

Groundwater—To protect groundwater, when there is a choice of pesticides, the applicator should use the product least likely to leach.

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