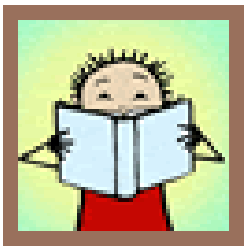
BIOLOGY, LEGAL STATUS, CONTROL MATERIALS, AND DIRECTIONS FOR USE

Golden-mantled Ground Squirrels

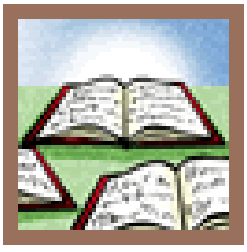
Spermophilus lateralis

Family: Sciuridae



Introduction: Often mistaken for a chipmunk the golden mantle ground squirrel is distinctive, with two black stripes running down the middle of its back. Unlike the chipmunk, it lacks stripes on its face. It is found throughout forest areas in North America, and shares territory with the Chipmunk.

Identification: While similar to a chipmunk in appearance. The biggest physical difference between the two is size; the golden mantled ground squirrel is much larger. A chipmunk is about 8 inches long and weighs around 2 ounces, while a golden-mantled ground squirrel is 9 to 12 inches long and weighs between 4 and 14 ounces. The squirrel's name comes from the golden brown or russet mantle over its head and shoulders. Whitish fur rings circle the eyes.



Legal Status: Golden-mantled ground squirrels 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 Department of Food and Agriculture or by federal or county officials or employees when acting in their official capacities pursuant to the

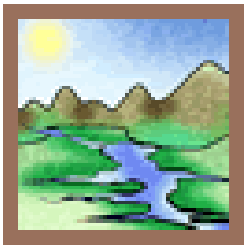
provisions of the Food and Agricultural Code pertaining to pests.

Damage: They may cause damage to reforestation attempts that utilize seeds, but because they inhabit high-altitude areas, are of little agricultural importance. If allowed to become too numerous, golden-mantled ground squirrels may become a nuisance to campground visitors by invading food stores and causing damage to facilities by gnawing or burrowing.

Golden-mantled ground squirrels are highly susceptible to sylvatic plague and present potentially major public health problems in campgrounds and other areas within national forests. Because they can become very numerous, very tame, and often in close contact with park or campground visitors, transmission of plague to humans is quite possible whenever an epizootic is occurring. They may also carry other diseases such as Rocky Mountain spotted fever, various tick fevers and others.

Range: The golden-mantled ground squirrel is found at higher elevations in the mountains of California, except for the Coast Range south of San Francisco. It inhabits the Sierra Nevada, Trinity and San Bernardino Mountains, including a wide area in the northern part of the state.

Golden-mantled Ground Squirrel



Habitat: *S. lateralis* inhabits mountains and higher northeastern plateaus. Moderately dense to open coniferous forest or forest mixed with brush. They show a decided preference for rocky slopes or forest floor littered with logs; but, at the same time, without heavy undergrowth. Open ground is preferred; keeping out of large grassy meadows except along the margins where they adjoin the woods. In the higher mountains they are often found inhabiting rock slides.

Biology: A small ground squirrel which appears like a large chipmunk, but having no stripes on the side of the face. The head and shoulders are golden or coppery, contrasting with the body; one white stripe bordered with two black stripes runs down each side of the body (chipmunks have two white stripes on each side). The hairy tail is fairly short and not bushy.

Rarely do golden-mantled ground squirrels assume the upright picket-pin pose so characteristic of some other of the species. They most often maintain crouching attitudes when at rest. When running, the gait is clumsy, as compared with the chipmunks. The tail is normally longer than other

small size ground squirrels, and is more conspicuously displayed, often up over the back.

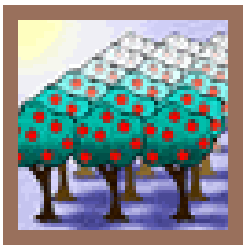
Golden-mantled ground squirrels are diurnal. They seek sun and warmth, becoming active around sunrise and disappearing quickly after sunset. They avoid the heat of the day and, in midsummer they may be inactive between 9:00 a.m. and 4:00 p.m. as a result. Golden-mantled squirrels undergo a winter hibernation beginning in late summer or fall. Adults generally enter hibernation one or two months before the juveniles. Some adults may undergo summer estivation in years of plentiful food. Some squirrels arouse periodically from hibernation and appear above ground in winter. Their tracks are frequently seen on top of the snow. They store up large quantities of fat underneath the skin and elsewhere in their bodies and are thus able to survive long periods of deep torpor without eating. It is believed that the burrow food caches are utilized only occasionally during the winter, mainly being used in early spring when hibernation is over. Emergence is in spring (March-May), and appears to be in response to an endogenous (internal) rhythm rather than in response to weather conditions alone.

Known predators of the golden-mantled ground squirrel include the coyote, fox, weasel, bobcat, red-tailed hawk, snake, and sometimes the striped skunk.

Golden-mantled ground squirrel burrows are located close to or beneath rocks, bushes, trees, logs, and stumps, although they may be out in the open as well. Burrow openings are inconspicuous as compared to those of other ground squirrels. Little or no excavated earth is left by the entrances. The openings are two to three inches in diameter, and often there are two or more openings to a burrow. The entire tunnel system may be 17 feet long, running, for the most part, about 8 inches deep. The burrow system may contain side tunnels and a nest chamber lined with shredded grass, bark, leaves, stems, conifer needles, and, perhaps, paper or cloth.

Breeding: Males are fertile on emergence from hibernation. Females come into estrous shortly afterwards. Mating occurs over a four-week period, mainly during the latter part of April and early May. However, there is a great deal of altitudinal and geographic variation in the timing of the breeding season. One litter is produced per year, with an average litter size of 5 (ranging from 2 to 8). The gestation period is 27-28 days. The young are born from mid-May to early June, with the juveniles appearing in the above-ground population about 5 to 6 weeks later. The young begin to eat solid food at 40 days of age, and are fully weaned 6 to 8 weeks after birth. Sexual maturity is attained the following spring.

Reportedly, leaves and hypogeous (i.e. subterranean) fungi constitute 87% of their diet. In some areas leaves of woolly mule ears (*Wyethia mollis*) were eaten more than any other plant. Later in the year, the golden-mantled ground squirrels feed on Wyethia flowers. They also favor bulbs of wild onion (*Allium* spp.). Fungi are of major importance in their diet, and the forest floor is often covered with holes where they have dug for these small modules. In September and October, the squirrels switch to feeding on the ripened conifer seed. In addition, golden-mantled ground squirrels will consume many other types of green vegetation, shrub and herb seeds, berries, insects, larvae, young birds and eggs, and when available, meat. Although they will readily feed on dead or trapped chipmunks, they apparently are seldom able to capture them under normal conditions. Golden-mantled ground squirrels gather food in well-developed internal (membranous) cheek pouches and store it in caches. Food may be temporarily stored in shallow pits and covered up with dirt, or it may be cached in more permanent hoards in the burrow system.



Damage Prevention and Control Methods

Trapping: Trapping is a practical means of control for ground squirrels where other methods are unsatisfactory or undesirable. Trapping golden-mantled ground squirrels requires a trapping license issued by the Department of Fish and Game (see California ground squirrel section for details).

Toxic Bait

CDFA labels 0.005% Chlorophacinone grain bait

0.005% Diphacinone grain bait

Grains: Crimped oat groats treated with 0.005% anticoagulant (diphacinone, chlorophacinone) is applied in bait stations.

Anticoagulant Baits

NOTE: Single feeding anticoagulant bait will not control ground squirrels. Anticoagulant bait must be eaten over a period of several days to give adequate control.

Bait stations: Place 1 to 5 pounds of bait in a covered bait box in areas frequented by golden mantled ground squirrels (near runway, burrows, etc.). Inspect bait stations daily and add bait as needed; increase the amount when all bait in containers is eaten overnight. Continue until all feeding ceases which may be one to four weeks. Initial acceptance may not occur until squirrels become accustomed to the bait box, which may be several days. Replace moldy or old bait with fresh bait. Baits should be picked up and disposed of upon completion of rodent control program. Bait stations should have entrance holes large enough to admit squirrels but not larger animals. Secure bait stations so that they cannot be turned over.

Exclusion

Ground squirrels can be excluded from buildings using the same techniques as for other commensal rodents such as mice or rats. However, exclusion using fences is rarely practicable because of the animals climbing and digging ability. Marsh 1994 states that ground squirrels can readily dig beneath fences buried several feet deep in the soil. The use of sheet metal to 'cap' off the top of a fence may help prevent them from climbing over but this method of control is not recommended.

Habitat Modification

Ground squirrels can be limited by frequent tillage; deep discing or plowing should be conducted as close to field borders and fences as ground squirrels like to live at the edge of fields and feed on crops.

Flood irrigation in orchards, alfalfa, and pasture land does discourage ground squirrels but will not eradicate them completely.

Good housekeeping by eliminating debris and removing abandoned irrigation pipes, farm equipment, and piles of rocks from field margins will assist as squirrels like to burrow beneath items.

Frightening

Not a recommended method.

Fumigants

Fumigants can be an effective lethal control for golden-mantled ground squirrels but finding their burrows is difficult and the practice is not recommended.

Repellents

Chemical taste or odor repellents will not prevent damage, or cause squirrels to leave or avoid an area. Seed treatment repellents have offered limited protection to newly planted crops but no repellent is currently registered for this use.

Toxic Bait

Rodenticide baits are effective and economical, and most often used to control ground squirrels. Ground squirrel baits commonly used in agricultural settings may be labeled for golden-mantled

Trapping

Live trapping is not recommended because of the problem of disposing of the live ground squirrel. Releasing or relocating trapped animals away from the trap site is illegal in California without a permit from the Fish and Game Department. Doing so risks spreading disease, and may create a pest problem wherever the squirrel is released.

Kill trapping is labor intensive but an effective method for controlling low to moderate squirrel populations over small areas where poisons may not be appropriate. Several types of kill trap are available for control of ground squirrels. Trapping can be conducted anytime squirrels are not hibernating. The most biologically sound time is before young are born from a control point of view.

Most traps work best if placed on the ground a few feet in front of a burrow entrance. One trap for every 4 to 5 burrow entrances is sufficient, and will reduce populations over several weeks. To increase bait trap effectiveness do not set them for several days so that the squirrels become accustomed to them. Bait them while doing this. Once squirrels are readily taking bait from the unset traps, set them. Baits that be used include walnuts, almonds, oats, barley, melon rinds and orange slices.

Certain box type gopher traps can be used as squirrel kill traps. They can be improved by modifications; fasten the trap to a baseboard after removing the back, add a wire bait compartment, alternatively, anchor to modified traps back to back on the same baseboard. If a baseboard is not used then anchor the trap with a wire attached to a stake to prevent the trap and its catch from being carried away by a dog or other predator.

All metal tunnel or tube traps can also be used for ground squirrels. These can be set directly in the squirrels trail and can be baited with grain, oats, or barley. These traps offer protection to other non target animals that cannot access them, and are strong enough to be used in horse pastures or around domestic animals.

The Conibear 110 trap is an effective ground squirrel kill trap (available also under different product names). The trap has a catch opening approximately 4 inches by 4 inches (10cm by 10cm) with a single spring. A more powerful version has two springs. This type of trap can be used baited or without bait, and can be placed over a burrow entrance, without bait. It is best to set the trap over the burrow opening.

All ground squirrel traps have strong springs and are capable of killing animals of an equal size or injuring fingers (children). Do not place traps where they may pose a hazard to children, nontarget wildlife, pets or poultry.

Trapping ground squirrels requires a trapping license issued by the Department of Fish and Game (see ground squirrel section for details).

Other

Shooting: If local laws allow then shooting using a .22 rifle can provide some control, but is not effective where ground squirrels are present in large numbers. It is time consuming, squirrels become rapidly 'gun-shy, and upon the first shot, the remaining squirrels will be very hesitant to emerge from their burrows.

Biological Control: Many predators, including hawks, eagles, rattlesnakes, and coyotes, eat ground squirrels. In most circumstances predators alone will not be sufficient to keep ground squirrel populations below the level at which they become pests. Predators may sometimes be useful in keeping ground squirrels away from marginal habitats. Dogs may also keep them from entering small areas.

REFERENCES AND ADDITIONAL READING

Marsh, Rex E., Salmon, Terrell P., and Howard, Walter E., 1981. Integrated Management of Rodents and other Wildlife in Campgrounds. U.S. Department of Agriculture, Forest Service, Report No. 81-39.

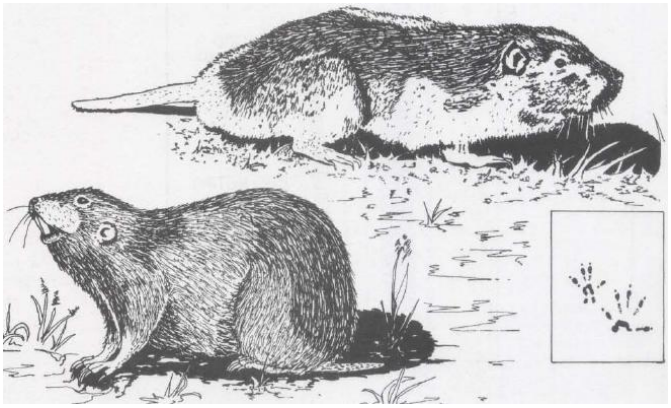
Smith, Charles R., 1992. Rodent Disease Implications Associated with Campground and Public Use Areas in California. Proc. 15th Vertebrate Pest Conf. (J.E. Borrecco & R. E. Marsh, Eds.) Published at Univ. of Calif., Davis. Pp.258-260.

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

Gophers (pocket gophers)

Thomomys spp.

Family: Geomyidae

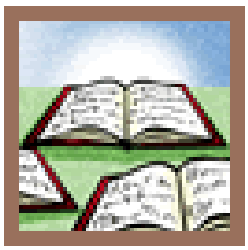


Introduction: Pocket gophers are burrowing rodents that get their name from the fur-lined external cheek pouches, or pockets, that they use for carrying food and nesting materials. They are well equipped for a digging, tunneling lifestyle with powerfully built forequarters, large-clawed front paws, fine short fur that doesn't cake in wet soils, small eyes and small external ears, and highly sensitive facial whiskers to assist movements in the dark. In California the Botta's pocket gopher (*T.bottae*) is the most common species (see picture above). Pocket gophers live alone in an extensive underground burrow system that can cover an area of several hundred square feet.

Identification: Pocket gophers range in length from 6 to 12 inches. They are stout bodied, short legged rodents. Eyes and ears are quite small, their front claws are curved. Their common name is derived from their fur lined external cheek pouches, or pockets in which they carry food or nesting materials. The pocket gopher's lips close behind its four large incisor teeth, keeping dirt out of its mouth when it uses its teeth for digging.

Pocket gophers rarely travel above ground except for when the young are dispersing to new sites. They are sometimes seen while feeding and pushing dirt out of their burrow system. The mounds of fresh soil that are the result of burrow excavation indicate their presence. Their mounds are usually crescent shaped and are located at the ends of short lateral tunnels branching from the main burrow system. One gopher may

push up several mounds in one day. They are active by day and night, year round. Note, the lack of fresh mounding is not an indication that they are not present and active, since gophers at times fail to produce mounds and in turn backfill old tunnels with the excavated soil.



Legal Status: Pocket gophers 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 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: Pocket gophers often invade agricultural crops where they feed mostly underground on a wide variety of roots, bulbs, tubers, grasses, and seeds, and even bark at the base of trees. Pocket gopher mounds interfere with the harvest of hay and grain crops and cover up plants. Gopher burrows may weaken banks of ditches and canals. Underground cables are sometimes gnawed by gophers. Their gnawing may damage plastic water lines and lawn sprinkler systems.

Range: The five species of pocket gopher found in California occupy all areas except parts of dry deserts, very rocky areas, and the highest mountain meadows. The Botta pocket gopher has the widest range within California covering most agriculturally important areas west of the Sierra crest.

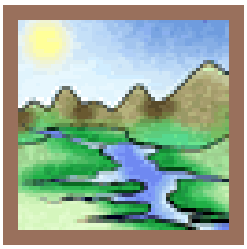
Botta Pocket Gopher

Mountain Pocket Gopher

Northern Pocket Gopher

Townsend's Pocket Gopher

Western Pocket Gopher



Habitat: Valleys and mountain meadows are the most typical pocket gopher habitats. The Northern pocket gopher also inhabits grassy prairies, brushy areas and open pine forests east of the Sierra and in northeastern California. Gophers are most abundant in better soils and where there is ample moisture and plant growth.

Biology: At altitudes of 5,000 feet or higher, breeding is mainly in June and July. In irrigated lands having continued green forage, gophers breed almost throughout the year and a female may bear three litters. Litters average five to six, but they vary from one to thirteen. The frequency of pregnancies increases with age and size of females. The gestation period for the Botta pocket gopher is about 19 days and the young remain in the nest for several weeks. After weaning, the young are expelled by the mother to wander overland to start tunnels in new places. They are particularly vulnerable to predation at this time. Hawks, owls, gopher snakes, badgers, foxes, weasels, and coyotes prey on gophers. Gophers rarely live beyond three years.

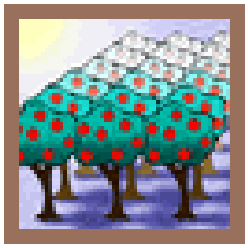
Gophers do not hibernate or become completely inactive at any time of year.

They continue their burrowing at ground level where snow covers the ground, retreating underground as the snow melts. Gnawing or girdling of young orchard trees is most likely to occur during late summer when the ground is dry and green vegetation is scarce. Surface activity decreases on hot, dry lowlands during summer and during and after heavy rains. Gopher burrows are sometimes utilized by other animals, including: salamanders, toads, snakes, mice, weasels and

some arthropods.

The pocket gopher is named for its external fur-lined cheek pouches, one on each side of its mouth. Food consists mainly of the underground parts of plants, especially the succulent portions. Forbs, however, are often cut back above ground, around the mouth of a burrow, or pulled down through the surface soil into the burrow system. Stems are cut in short lengths and transported in the cheek pouches to storage chambers in the burrow system.

Pocket gophers lead an almost completely subterranean existence, venturing above ground only to push dirt out of the burrow, seek new territory after weaning or to graze on succulent plants near a burrow entrance. Except during the breeding season, gophers are anti-social; intruding gophers are viciously repelled. Burrow entrances are plugged to prevent entry and to stabilize temperature and moisture within the burrow system. Each gopher establishes its own territory covering from 200 square feet for a young gopher to 2,200 square feet for an old, established gopher. Burrows are dug mainly with long for claws though the incisor teeth are used to cut roots or dislodge small stones. The burrow system consists of main tunnels 2 to 2-1/2 inches in diameter, running more or less parallel with the soil surface. Gophers push accumulated dirt from their excavations out lateral exits, forming characteristic crescent-shaped mounds of soil which are soon plugged with fresh soil. Nearly vertical feeding laterals are also dug but these are inconspicuously plugged. The nest is a hollow ball of finely shredded plant fibers commonly filling a chamber about eight inches in diameter. It is deeper in the ground than most of the tunnels. Food is stored near the nest or in enlarged chambers.



Damage Prevention and Control Methods: Because of the nature of pocket gopher damage, a successful control program depends on early detection and prompt action. For limited infestation trapping or using poison baits placed by hand can be effective. For larger infestations, additional efforts are often necessary. Once pocket gopher damage has been controlled, establish a system to monitor the area for reinfestation. A monitoring program is important because pocket gophers may move in from other areas and cause more damage in a short time, probably by using old tunnels. Experience has shown it is easier, less expensive, and less time consuming to control gophers before their numbers build up.

Exclusion

Because of expense and limited practicality exclusion is only effective in limited areas. Temporary protection from gophers may be achieved by using a 3 foot or wider roll of ½ inch wire mesh buried to a depth of 2 feet with a 6 inch flare turned outward from the area to be protected. Unfortunately, this labor intensive below ground fence will over time be breached by the gopher's extensive burrowing activity (Salmon 1990).

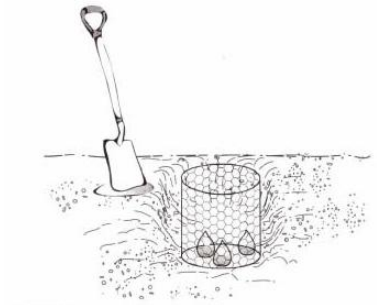


FIGURE 94.
Planting baskets made of 1-inch chicken wire protect bulbs from pocket gophers. Leave about 3 inches (7.5 cm) of the basket exposed above the ground.

Small areas such as bulb beds may be protected from pocket gophers by complete underground screening with wire mesh. If wire mesh is used place deep enough so that root growth is not restricted. Raised beds also offer excellent protection when the bottom of the bed is lined with wire mesh.

Plants and bulbs can be protected by using wire mesh baskets. Larger wire baskets can be made to accommodate fruit trees, but the basket can interfere with root growth. One way to install the basket is to line the planning hole with wire mesh. Common recommendation is a hole as deep as the root ball and twice its diameter. For bare root planting the hole should be large enough so the roots can be planted without restriction. For the best protection at least 6 inches of the wire basket should project above ground level.

Trenching may be successful for small-scale operations. A steep or vertical-walled ditch 18 inches wide by 24 inches deep is dug around the plot to be protected. Open-topped 5-gallon cans, spaced at intervals of 25 feet, are sunk so that their tops are level with the bottom of the ditch. Gophers getting into the ditch will be likely to fall into the cans, from which they cannot escape.

Habitat Modification

The following methods utilize knowledge of pocket gophers habitat requirements and feeding behavior to reduce or eliminate damage.

Flooding: When irrigated croplands and orchards are periodically flooded, some gophers are either drowned or forced out by the incoming water. Most survive in burrows in the levees. Others are driven into the open, where they are susceptible to predation (Loeb 1990).

Crop Varieties: Varying crop types can assist in dispelling gophers. For example, alfalfa; it is known pocket gophers do not like large root varieties.

Crop Rotation: Using a crop rotation scheme of grain crops and alfalfa, the resulting habitat is incapable of supporting pocket gophers, since the underground structures do not supply enough food for pocket gophers year round.

Grain Buffers: Similarly, planting 50 foot buffer of grain around hay fields provides unsuitable habitat and can minimize gopher immigration into the field.

Weed Control: Chemical or mechanical control of forbs can limit gopher populations in rangeland situations.

Frightening: Not Recommended. Sounds, vibrations, electromagnetic devices, or other means has not proven effective in driving gophers from an area or preventing their damage.

Fumigants

The extent of the burrow system, the chance for leakage of gas through the softer earth of laterals, the closeness of the main runs to the surface of the ground, and the fact that gophers may quickly plug off their burrows when a poisonous gas is detected and so escape destruction, makes use of many gases unsatisfactory (Matschke 1998). Aluminum phosphide tablets, however, have been found to be extremely effective with a 90% success rate if soil conditions are proper for a good gas seal (Baker 2004). Aluminum phosphide is a Restricted Use Material and a permit is required for purchase and use. Various gopher "bombs" are sold for gopher control. When lighted and placed in the burrows, they generate a gas

intended to overcome gophers. In general they are not very effective.

Aluminum Phosphide Treatment:

Aluminum phosphide is a highly toxic rodenticide and requires a 'Restricted Materials Permit' for use in California and must be used under the supervision of a certified applicator. All applicators must be trained in the use, according to the product label. Use 2 to 4 tablets per burrow opening. Place the label recommended amount (in the tunnel through the probe hole. Place a stone or dirt clod over baited probe hole and push down with boot heel to seal probe hole without collapsing the tunnel. Use lower rates in small burrows or under moist soil conditions and higher rates in large burrows or when soil moisture is low. Check treatment area after 72 hours and retreat as before all new gopher mounds.

Magnacide "H"

Restricted use pesticide with similar restricted use requirements. Use a professional licensed applicator. It is not generally used for pocket gopher control. Recent tests showed that it was relatively ineffective.

Repellents

Repellents are not effective in protecting areas from pocket gopher damage. The plant gopher (*Euphorbia lathyris*) has been suggested as a repellent, but no scientific evidence supports its effectiveness

Toxic Bait

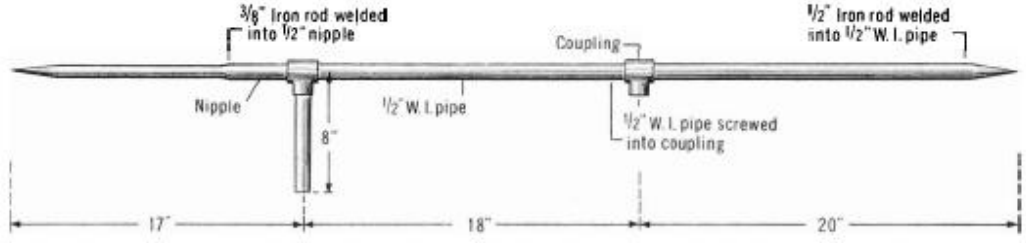
CDFA label 0.01% Chlorophacinone grain bait

All gopher bait is placed underground. Strychnine treated bait is the most common rodenticide used for pocket gopher control but zinc phosphide and anticoagulants are also registered for use. Despite the fact all gopher bait is placed underground animals such as dogs can dig it up and be exposed to bait in this manner.

Hand baiting (probe method): A probe is used to locate main runways so bait can be placed underground where gophers will find it. A runway usually runs in a straight line between two mounds at a depth of six to eight inches. Probe around fresh mounds or between two fresh mounds since these indicate the most recent presence of gophers. When the runway is located, the probe will give way and drop about two inches. If a bait dispensing probe is being used, deposit bait into the runway. If not, the opening to the runway should be enlarged by rotating the probe or by using the larger end of the probe. Bait may then be dropped in the burrow. Insert one teaspoon of grain bait at two or more places in each runway according to label instructions. When using the anticoagulant chlorophacinone, place a total of 1/2 cup of treated grain into the burrow runway. One quarter (1/4) cup of bait should be placed in two locations per gopher system. Cover the probe hole with a clod or rock to keep out light and prevent dirt from falling on the bait.

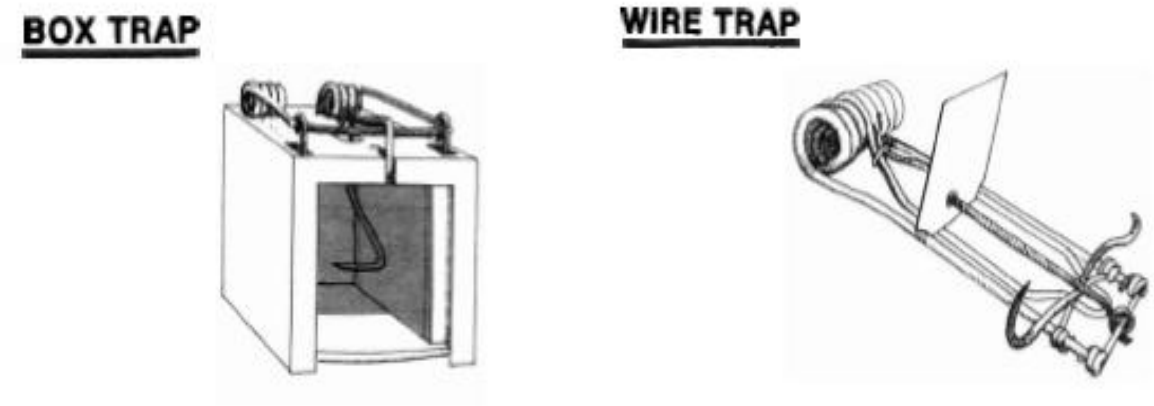
Probes: Simple gopher probes can are available commercially or can be made using a 1/4 inch steel rod, pointed at the tip. A larger rod or dowel can be used to enlarge the hole through which bait is deposited.

If larger areas are to be treated, a special metal probe may be constructed, being more effective, easier to use, and time saving.



Anticoagulant Bait Blocks: Paraffin bait bars or blocks containing an anticoagulant are generally available for pocket gopher control. When using anticoagulant bait blocks, open the burrow system as if setting a trap. Place bait blocks in two locations per gopher system. Close openings in system as above. Bait blocks are weather resistant and should be effective for some time.

Mechanical Burrow Builder Baiting: On extensive areas, use a "burrow builder" machine to make artificial burrows across the field at the same depth as the natural burrows. The machine drops bait automatically at 9-12 inch intervals in these tunnels. Strychnine is the common bait used in these devices. One to two pounds of this bait will treat one acre by this method. Consult the



machine operating manual for specific instructions such as rate of application and operations or adjustment procedures.

Trapping: Trapping is recognized as a safe and effective method to control pocket gophers when done in the context of an effective pocket gopher control program. However, it is time consuming and labor intensive.

Several types of gopher traps are available. Two common traps are the two pronged pincer trap and the squeeze type box trap. These traps are triggered when the gopher pushes against a flat vertical pan or wire trigger.

To place traps after you have opened a main tunnel, open it with a shovel or garden trowl and set traps in pairs facing opposite directions. This placement ensures the gopher will be intercepted from either end of the burrow. The box trap is generally easier to set but requires more excavation; this can be an important consideration in lawns and some gardens. Box traps are especially useful when the gopher's main burrow is less than 3 inches in diameter. This is because small burrows must be enlarged to install pincer traps. All traps should be wired to stakes to make them easier to locate. After setting the traps, exclude light from the burrow by covering the opening i.e. with dirt clods, sod, cardboard or some other material. Fine soil can also be put around the edges to form a seal. Note, if light enters the gopher may plug the burrow with soil, filling the traps and making them ineffective. Check traps often and reset them when necessary. If no gopher is caught within 2 to 3 days, reset the traps in a different location. Human odor on traps has no apparent effect on trapping success.

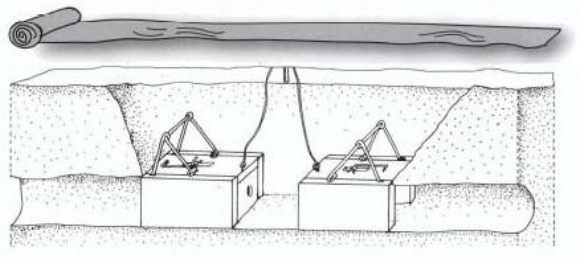


FIGURE 89.
After placing box-type traps for gopher control, fill in the openings so that no light enters the hole.

Directions for Use

All bait material is to be placed below ground.

Aluminum Phosphide:
Place the label recommended amount (2 to 4 tablets) in the tunnel through the probe hole. Place a stone or dirt clod over baited probe hole and push down with boot heel to seal probe hole without collapsing the tunnel. Use lower rates in small burrows or under moist soil conditions and higher rates in large burrows or when soil moisture is low. Check treatment area after 72 hours and retreat as before all new gopher mounds.

Hand baiting (probe method):
A probe is used to locate main runways so bait can be placed underground where gophers will find it. A runway usually runs in a

straight line between two mounds at a depth of six to eight inches. Probe around fresh mounds or between two fresh mounds since these indicate the most recent presence of gophers. When the runway is located, the probe will give way and drop about two inches. If a bait dispensing probe is being used, deposit bait directly into the runway. If not, the opening to the runway should be enlarged by rotating the probe or by using the large end of the probe. Bait may then be dropped in the burrow. Insert one teaspoon of grain bait at two or more places in each runway. When using the anticoagulant chlorophacinone, place a total of 1/2 cup of treated grain into the burrow runway. One quarter (1/4) cup of bait should be placed in two locations per gopher system. Cover the probe hole with a clod or rock to keep out light and prevent dirt from falling on the bait.

Probes: When only a few runways are to be treated, a 1/4 inch steel rod, pointed at the tip, will serve to locate the runnels and a larger rod or broomstick can be used to enlarge the hole through which bait is deposited.

If much treatment is to be done, a special metal probe may be constructed, being more effective, easier to use, and time saving.

Anticoagulant Bait Blocks: When using anticoagulant bait blocks, open the burrow system as if setting traps. Place bait blocks in two locations per gopher system. Close openings in system as above. Bait blocks are weather resistant and can provide control for some time.

Mechanical Burrow Builder Baiting: On extensive areas, use a "burrow builder" machine to make artificial burrows at the same depth as the natural burrows in areas where gophers are active. The machine drops bait automatically at 9-12 inch intervals in these tunnels. One to two pounds of strychnine bait will treat one acre by this method. Consult the machine operating manual for specific instructions such as rate of application and operations or adjustment procedures.

Until recently, two manufacturers dominated the market for building gopher machines; Rue R. Elston Co., Minneapolis, Minnesota, and Blackwelder Manufacturing Co., Rio Vista, California. Unfortunately, Blackwelder is no longer manufacturing gopher machines. The Elston machine is more popular in the Midwest but is also commonly used in the West.

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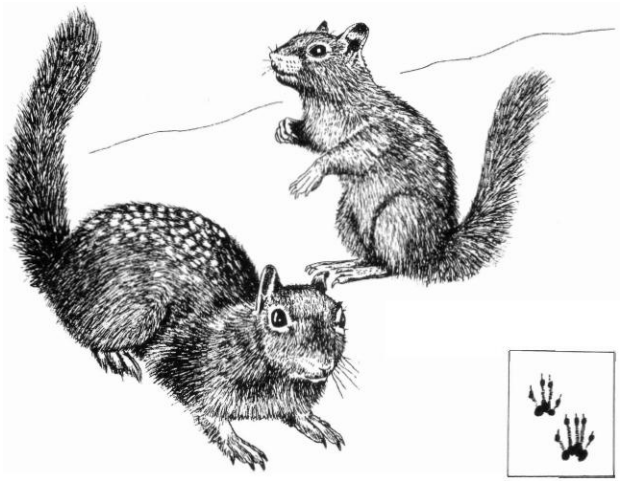
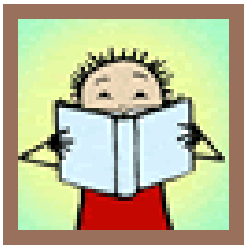
BIOLOGY, LEGAL STATUS, CONTROL MATERIALS, AND DIRECTIONS FOR USE

Ground Squirrels

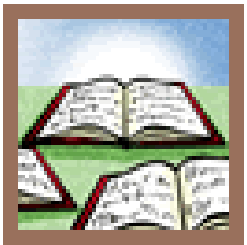
Spermophilus beecheyi **and its subspecies: Beechey, Douglas, Fisher, Sierra, Juarez, and Lesser California Ground Squirrel**
S. beldingi beldingi, **Belding Ground Squirrel, and**
S. beldingi oregonus, **Oregon Ground Squirrel**
Family: Sciuridae





Introduction: The California ground squirrel, *Spermophilus beecheyi*, is one of the most troublesome pests to California agriculture, homeowners and gardeners. It is found in nearly all regions of California, except for the Owens Valley southward into the desert regions. The Belding ground squirrel is a major pest in alfalfa and pasture areas in California's northeast.

Identification: Ground squirrels are easily identified as they forage aboveground near their burrows. The ground squirrel's body measures 9 to 11 inches. Its semi-bushy tail adds another 5 to 9 inches. The fur is brownish gray and speckled with off-white along the back; the sides of the head and shoulders are light gray to whitish. One subspecies that occupies most of northern California has a dark, triangular-shaped patch on its back between the shoulders; this patch is missing from other species. While ground squirrels are similar in appearance to tree squirrels and may climb trees, when frightened they will always retreat to a burrow, whereas tree squirrels will climb a tree or tall structure and never use a burrow.



Legal Status: Ground squirrels 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 Department of Food and Agriculture or by federal or county officials or employees when acting in their official capacities pursuant to the provisions of the Food and Agricultural Code pertaining to pests.

*The following squirrels have been designated as threatened species by the California Department of Fish and Game, the Mohave ground squirrel, (*Spermophilus mohavensis*), and the San Joaquin antelope squirrel, (*Ammospermophilus nelsoni*). Before implementing rodent control within the range of these threatened species, contact the Department of Fish and Game.

Damage: Grain (all types), fruits and nuts including almonds, apples, apricots, peaches, pistachios, prunes, oranges, tomatoes, and walnuts. Certain vegetables and field crops such as sugar beets, alfalfa, and cotton are taken at the seedling stage. Young orchards are sometimes damaged by gnawing of the bark.

Ground squirrels significantly reduce the amount of green forage available to grazing cattle during the winter period when plant growth is slow. In one experiment (Howard et al.. 1959), the reductions in daily weight gain by cattle due to California ground squirrel activity were 1.03 and 0.75 lbs. for the 93 and 62 day winter growth periods in successive years. Based on the amount of green forage (4 oz.) consumed daily by *S. beecheyi*, Grinnel and Dixon (1918) estimated that 20 squirrels eat as much as one sheep, and 200 squirrels eat as much as one steer. Although the loss represented here might not be felt by the rancher in years of adequate rainfall, the difficulty in predicting drought conditions leaves the stockmen vulnerable to competition for forage if squirrel populations are not kept in check. It should be remembered that the loss of forage to squirrels goes beyond the weight of green matter they consume. The most important competition occurs when squirrels feed on the tender young sprouts of annuals, whose growth may be retarded or stopped altogether by close grazing. Squirrels also eliminate vegetation by clearing and trampling areas around burrows and runways.

The threat of seepage or collapse of levees and ditch banks requires the elimination or control of these burrowing rodents where they inhabit such structures. Permanent exclusion of squirrels is possible by such devices as concrete linings, but the expense is usually prohibitive. Other areas where

ground squirrel burrowing is unacceptable include golf courses, railroad rights-of-way, horse pastures and cemeteries.

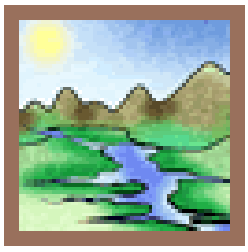
Ground squirrels are frequently named as causal agents in human cases of sylvatic (bubonic) plague in California. Circumstantial evidence points to ground squirrels as the host to plague-infected fleas in over half the reported human plague cases in California in the last 40 years. Ground squirrels are not the "reservoir" hosts of the disease; apparently native mice (and their fleas) are the reservoir hosts from which the disease periodically spreads to other rodents. Records of the incidence of plague in native mice and squirrel populations show some areas of the state to be "high risk" areas, while the disease is rare in other areas. Ground squirrels are themselves susceptible to plague, and insecticides have been used as a preventive measure in some recreation areas to kill the fleas, with the result that both human and squirrel populations were protected from the disease. Ground squirrels are also associated with the spread of Rocky Mountain spotted fever, rat bite fever, tularemia, Chagas' disease, adiospiromycosis and encephalomycarditis.

Ground squirrels also eat the eggs of ground-nesting birds, such as pheasant and quail. In a study on the nestings of California Valley Quail made on the San Joaquin Experimental Range in 1937 by the State Department of Fish and Game, it was concluded that 30 percent of the unsuccessful quail nests resulted from ground squirrel predation.

Range: *Spermophilus beldingi* in California is composed of two subspecies. *S. b. oregonus* inhabits Modoc, Lassen, and eastern Siskiyou Counties and *S. b. beldingi* the high Sierra Nevada south to Fresno and Inyo Counties. *S. beecheyi* is composed of three subspecies: the Beechey ground squirrel, *S. beecheyi*, is found along coastal California from the Golden Gate and Carquinez Straits south, nearly to San Diego; the Fisher ground squirrel, *S. beecheyi fisheri*, inhabits the greater part of central California east of the Feather and Sacramento rivers south to the southern end of the San Joaquin Valley; and the Douglas ground squirrel, *S. beecheyi douglasii*, occurs northward from San Francisco Bay throughout the region west and north of the Sacramento and Feather rivers, extending north beyond the Oregon line. Sierra ground squirrels, *S. b. sierrae*, occur in the higher parts of the northern Sierra Nevada, from Plumas County south to Mariposa County. Lesser California ground squirrel, *S. b. parvulus*, cover the desert ranges of southern California, north to the Owens Valley, south to the San Jacinto Mountains. The Juarez ground squirrel, *S. b. nudipeds*, occurs in the southwest corner of the state, including most of the western half of San Diego County. The taxonomic differences between the subspecies of *S. beecheyi* are not important; however, control techniques may have to be varied for some.

Belding Ground Squirrel

California Ground Squirrel



Habitat: *S. beldingi* inhabits meadows and green fields or along their edges. *S. beecheyi* lives on natural rangeland, pastures, grain fields, slopes with scattered trees, and rocky ridges. It avoids thick chaparral and dense woods.

Biology: All ground squirrels are diurnal and prefer fair weather. They love sunshine and may often be seen basking in the morning or later afternoon warmth. During spring and summer they come out of their burrows soon after sun-up. They are at those seasons most active during the middle of the morning and again during the late afternoon, but they avoid the intense heat of midday. During midwinter, those squirrels which do not remain underground altogether make their appearance only late in the forenoon of bright sunny days. Although they climb trees for almonds, pistachios, walnuts, and fruits, they are basically ground-living foragers. Douglas ground squirrels are more prone to climb trees, stumps and fencepost.

All species of ground squirrels dig burrows which are used for safety retreats, for shelter during very hot or rainy weather and during hibernation, for

occasional storage of food, and for rearing young. Burrows are made in flat lands, in hillsides, or among rocks, and in embankments. There is no evidence that ground squirrels plug the entrances to their burrow systems. Surface plugs are probably the work of gophers that have intersected the burrow system.

The burrows of California ground squirrels average about 4 inches in diameter, and individual burrows are 5 to 30 feet or more in length. Most tunnels are within 2 to 3 feet of the ground surface. The estimated volume of representative burrows may range from 1 to 18 cubic feet. Some are simple short tunnels, but others have many branches. Often there are two or more openings. Some are colonial burrows occupied by several squirrels. Each squirrel constructs a nest of finely shredded grass or other material, which is located in a globular chamber slightly above and to one side of the main runway and well back in the burrow. The nest affords warmth and dryness, but it may become so infested with fleas that the squirrel will build a new burrow and nest, leaving the bulk of the fleas behind.

The California ground squirrel has two thin, moist, internal cheek pouches, one on either side of the mouth, which are used to carry food. During the rainy months, November to March or April, ground squirrels feed chiefly on green herbage such as filaree. Seeds lying on the ground surface are hulled and eaten as found. Later, when the new seed crops begin to ripen, the squirrels gather seeds without hulling and put them in their cheek pouches, to carry off and hide in shallow caches excavated in the ground, or in crevices between rocks. Some are carried into the burrows for later use. Seeds of both wild and cultivated plants, particularly grains, are taken in quantity. Damage to truck crops, grain, nuts, or fruit crops may occur through the growing season. The Belding ground squirrel feeds chiefly on grasses, pasture vegetation, and the leaves and stems of alfalfa and grain. Its cheek pouches are small, and it is not the great seed-eater that the California ground squirrel is.

Hibernation and estivation: California ground squirrels may experience two periods of dormancy throughout the animals yearly activity cycle. Estivation or summer sleep generally occurs during July and August if it occurs at all. All California ground squirrels living at high altitudes and some of the population, mostly mature adults, at lower elevations hibernate for a part of each year. Before this period of inactivity, each animal acquires body fat. After going below ground, the squirrel plugs part of the tunnel just above the nest with earth to as much as three feet in length, and curls up in its nest below the tunnel plug. The burrow entrance remains open. While the squirrel hibernates, the rates of heartbeat and respiration are greatly reduced, and body temperature drops nearly to that of the burrow. Emergence occurs in winter or early spring. Squirrels have been seen above ground by late January and all are out by March.

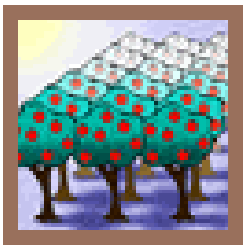
Breeding: In central California the beechey ground squirrel breeds mainly during the first half of the year, but some young are produced later in the season. In the interior valleys, females carrying young are most numerous in February and March. In Los Angeles County, regular breeding activity begins by December; along the coast and in the mountains, the breeding season comes somewhat later.

Immediately following hibernation, males are usually more active than females. As the peak breeding season nears, the ratio of males to females in the above-ground population tends to equalize and control undertaken at this time will give maximum results. Shooting a representative number of squirrels will

indicate the arrival of this period; the males are easily distinguished by their enlarged testes.

Ground squirrels produce one litter a year. Litter sizes vary according to population density and other factors, 7 or 8 being an average size litter (range 1 to 15), of which 5 or 6 probably survive long enough to appear above ground. The average litter size may be larger where control has been practiced and there is more food for those remaining. The gestation period is 25 to 30 days and the young usually remain underground about six weeks. The young grow rapidly and are seen in greatest numbers from late April until June, when they may scatter out to new territory or move to unoccupied old burrows.

The home range of the California ground squirrel is normally less than 150 yards across. High winds cause squirrels to remain close to the burrow entrance and limit foraging to that area. While most squirrels travel only short distances, some have been known to move from one to five miles into new areas. Ground squirrels may live five years or more in the wild. Outbreaks of epizootic sylvatic plague periodically reduce ground squirrel numbers in some areas. Natural enemies which prey on ground squirrels include the coyote, badger, weasel, bobcat, red-tailed hawk, golden eagle, rattlesnake, and gopher snake.



Damage Prevention and Control Methods

Exclusion

Ground squirrels can be excluded from buildings using the same techniques as for other commensal rodents such as mice or rats. However, exclusion using fences is rarely practicable because of the animals climbing and digging ability. Marsh 1994 states that ground squirrels can readily dig beneath fences buried several feet deep in the soil. The use of sheet metal to 'cap' off the top of a fence may prevent them from climbing over; the fence should be at least 4 feet height. Realistically, for a fence to remain squirrel proof the squirrels that burrow nearby should be eliminated.

Habitat Modification

Ground squirrels can be limited by frequent tillage; deep discing or plowing should be conducted as close to field borders and fences as ground squirrels like to live at the edge of fields and feed on crops.

Flood irrigation in orchards, alfalfa, and pasture land does discourage ground squirrels but will not eliminate them completely.

Good housekeeping by eliminating debris and removing abandoned irrigation pipes, farm equipment, and piles of rocks from field margins will assist as squirrels like to burrow beneath items. This will also make detection of squirrels easier.

Frightening

Not a recommended method. Ineffective, ground squirrels cannot be frightened from their burrows by the use of propane exploders or flagging, Marsh 1994.

Fumigants:

Aluminum phosphide - 2-4 tablets per burrow opening.

Phostoxin®

Fumitoxin®

Detia® Rotox AT

Magnacide "H" - 20 cc per burrow opening.

Gas cartridges - 1 to 2 per burrow opening.

Gas Cartridge:
NOTE: Gas cartridges are mixtures of active ingredients and sawdust compressed in a tube. When ignited by a fuse, they give off smoke and toxic gases that are effective only when confined spaces such as in burrows.

With a nail or sharp object about the diameter of a pencil, puncture cartridge cap end at marked points. Rotate nail to loosen material inside. Insert fuse in one end using one of the center holes. Insert cartridge into active burrow entrance as far back as possible and light fuse. Push down into burrow with the shovel handle. Quickly seal burrow opening with earth and tamp tightly. Close or treat nearby connected burrows where smoke is seen escaping. Well established burrow systems usually require two or more cartridges.

CAUTION: A flame sometimes shoots out from the end of a smoke cartridge and may set dry grass on fire. Never try to ignite a cartridge while holding it and never use where a fire hazard exists.

NOTE: Cartridges absorb moisture readily so they must be kept dry at all times. Do not store in damp places.

Aluminum Phosphide:
Place the label recommended amount (2 to 4 tablets) as far in each active burrow opening as possible. Seal tightly by shoveling dirt over the entrance after first packing the opening with crumpled newspaper. This will prevent soil from covering the tablets. Use lower rates in small burrows or under moist soil conditions and higher rates in large burrows or when soil moisture is low. Check treatment area after 48-72 hours and retreat all opened burrows. Do not add water to the treated burrow or wrap the tablets in wet paper. If the soil moisture is adequate, adding moisture is not necessary. If the soil is dry, the gas will disperse out of the burrow and the treatment will not be very effective.

Label directions shall be followed to insure applicator safety, protection of non-target species and to achieve a thorough population reduction. Particular attention should be paid to factors that influence the generation and retention of the gas within the ground squirrel burrow system after its introduction. The soil moisture and temperature are critical factors. If the soil is not moist enough, the rate of gas produced is reduced and is more likely to be lost through the soil structure instead of within the target area. If the soil is not warm enough the process of releasing the gas is slowed and might not produce the desired results.

Acrolein - Magnicide "H"
Place nozzle applicator device as far into the active burrow entrance as possible. Shovel soil onto the applicator device and the burrow entrance to create a seal that will prevent loss of gas. Dispense fumigant

at the rate of 20 cc per burrow. Withdraw application device and seal burrow opening by tamping it tightly.

GENERAL NOTE: Fumigants are most effective when the soil has a high moisture content to hold the gas within the burrow system. Retreatment of burrows where ground squirrels have dug out is necessary when using fumigants. Check treatment area after 72 hours and retreat as before all opened burrows.

As with all pesticides, follow label directions for use, storage and disposal. Before fumigation, check that there are no restrictions on fumigant use because of endangered and threatened species. Also, make sure the burrow is not inhabited by other animals such as burrowing owls.

Repellents: None registered and not recommended as an effective method of control.

Toxicants:

Grains: Crimped oat groats is the most commonly used bait and is usually accepted well by squirrels.

CDFA labels 2.0% Zinc phosphide Treated Grain

Spot baiting - 2.0%

Broadcast baiting - 2.0%

Anticoagulants - % on bait for:

Used in bait stations:

0.005% Chlorophacinone Treated Grain

0.005% Diphacinone Treated Grain

Spot baiting with repeated treatment:

0.01% Chlorophacinone Treated Grain

0.01% Diphacinone Treated Grain

Mechanical Spreader with follow-up

0.01% Chlorophacinone Treated Grain

0.01% Diphacinone Treated Grain

Fumigants:

Aluminum phosphide - 2-4 tablets per burrow opening.

Phostoxin®

Fumitoxin®

Detia® Rotox AT

Magnacide "H" - 20 cc per burrow opening.

Gas cartridges - 1 to 2 per burrow opening.

Directions for Use

Spot baiting (zinc phosphide- ZP): Evenly scatter a tablespoon quantity of bait (about 60 baits per pound) on bare ground to cover 2 to 3 square feet at the side or behind each active burrow entrance. Do not overbait, and do not place in piles.

Broadcast baiting using zinc phosphide baits: Spread bait evenly by hand, machine spreader, or aircraft at the

rate of six pounds per swath acre through infested area.

Anticoagulant Baits:

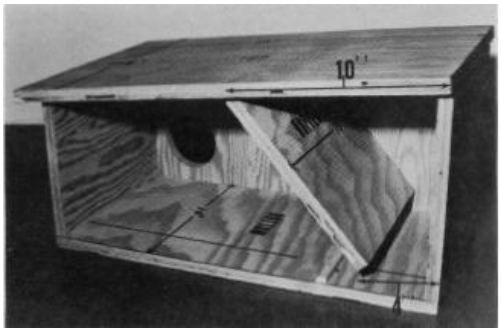
NOTE: A single feeding of anticoagulant baits (diphacinone or chlorophacinone), will not control ground squirrels. Bait must be eaten over a period of several days to a week or more to achieve adequate control.

Bait Station for Anticoagulants: Place one to five pounds of bait in a posted covered bait box or ii PVC bait station in areas frequented by ground squirrels (near runways, burrow entrances, etc.). Inspect bait stations daily and add bait as needed; increase the amount when all bait in containers is eaten overnight. Continue until all feeding ceases which may be one to four weeks. Initial acceptance may not occur until squirrels become accustomed to the bait box, which may take up to ten days.

Replace moldy or old bait with fresh bait. Baits should be picked up and disposed of upon completion of the rodent control program.

Bait stations should have entrance holes large enough to admit squirrels but not larger animals. Generally, 3 inches is adequate. The entrance shall be constructed so that bait cannot be readily scattered from the trap to the surrounding area. Secure bait stations so they cannot be turned over.

Spot and Broadcast baiting (with repeated treatments): Scatter a 1/3 cup of bait (about 10 baits per pound) evenly over 40 to 50 square feet near active burrow entrances or runways. Bait applied with a mechanical broadcaster should be applied at 10 pounds per swath acre. Retreat after 4 days. If the squirrel population is heavy, an additional treatment may be necessary.



An uninterrupted supply of bait should be available for six to eight days. Don't pile bait. The scattering of bait takes advantage of the squirrel's natural foraging habits and limits domestic livestock and wildlife from picking it up.

Trapping: Trapping ground squirrels requires a trapping license issued by the Department of Fish and Game. Live trapping is not recommended because of the pest status of ground squirrels. California Fish and Game Code prohibits transporting and releasing squirrels without a permit. Trapping can be effective when the squirrel population is fairly limited or in situations where other control methods are not appropriate.

Trap Construction: The wooden box-type traps, such as the "Critter Getter" manufactured by P-W Manufacturing of Henryetta, OK, should be purchased with the trigger configured so that a pull motion on the trigger activates the catch wire. A trap that kills quickly can be constructed economically by modifying two box-

type gopher traps and then placing them on a baseboard.

First step is to remove the back of the two gopher traps. The traps are then mounted on the baseboard (1"x8"x24") with brass wood screws. The holes should be predrilled to avoid splitting the baseboard. The traps should be centered on the board with at least 4 inches between the traps at the center. The center space area between the two traps shall be covered with half inch galvanized hardware cloth. The hardware cloth can be secured with double pointed tacks. A 3/8" hole can be bored at each of the four corners so the trap can be secured at the site. For ground squirrels the trap can be secured with re-bar stakes or tent stakes. When using the trap for tree squirrels, bungee cords can be hooked in the holes and wrapped around the tree limb.

Trap Use: Place traps on the ground in the vicinity of active ground squirrel burrows. They should be secured with stakes to keep raptors or other predators from taking catch and trap from the site. Baiting is accomplished by placing baits within the hardware cloth center section with some scattered on the outside of the trap to lure in the ground squirrels. Once the bait is fully consumed on the outside of the trap, the ground squirrel then enters the trap to eat the bait and is caught when the trigger is activated. Cull walnuts, almond meats, oats barley, and melon rinds are attractive baits.

Conibear Type Trap: A body gripping trap commonly referred to as the Conibear® 110 is effective in controlling ground squirrels. The trap can be set at the burrow entrance, along runways, or in concealed areas such as plastic utility boxes or wooden boxes. Before placing trap, an evaluation of non-target species should be conducted to reduce the threat of trapping the non-targets.

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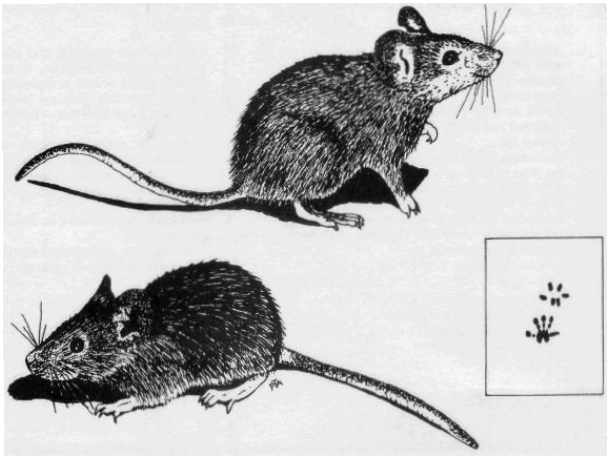
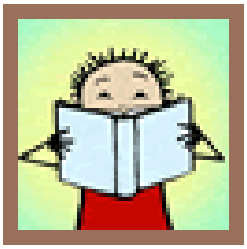
BIOLOGY, LEGAL STATUS, CONTROL MATERIALS, AND DIRECTIONS FOR USE

House Mice

Mus musculus

Family: Muridae





Introduction: House mice are not native to North America but are classed as an invasive species imported on early settler and trade ships. Worldwide house mice are some of the most troublesome and damaging rodents. In Australia they are a preoccupation of the agricultural community costing millions of dollars in damage. Population explosions can see as many as 1000 mice per hectare. The West coast of the United States is no exception, although, as yet, not to the same epic proportions seen in Australia. House mice transmit parasites and diseases to other animals (including people), consume and contaminate food, and damage structures and property as a result of their gnawing activities. They are resilient and thrive under a wide variety of climates and conditions. They are well adapted to living in close contact with humans and thrive in the conditions that man provides, particularly where hygiene and housekeeping standards are low. House mice are much more common in residences and commercial structures than rats (Brooks 1973). It is important that mouse infestations are controlled.

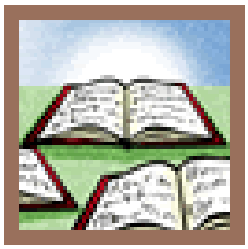
Identification: House mice are small and agile rodents with a slightly pointed nose, and small black protruding eyes. They are usually a uniform grey/ grayish brown color, and sometimes the lower half of their bodies may be a slightly lighter shade. They have slender bodies, 5 to 7 inches long, and weigh ½ to 1 ounce. They have

rather large sparsely haired ears for their body size, and a semi hairless tail which is about as long as the entire body and head.

House mice nibble on many foodstuffs, discard partially eaten items and create a mess with droppings, urine, and hairs. They will nest build. Outside house mice living in fields may dig up and feed on newly planted grain, or cause damage by eating crops before harvest. Because of the similarities with deer mice and meadow voles; correct identification before embarking on any pest control plan will ensure efficient control.

Visual sightings of mice are of limited value in accurately estimating the population present. Search premises thoroughly when looking for mice, in structures, attics, basements, around foundations, crawl spaces, and behind and under stored materials.

It may be possible to detect house mice presence using non toxic tracking dust or alternatively flour or talcum powder at 20 – 30 foot intervals throughout a structure (Salmon, Whisson, Marsh, 2006)



Legal Status: House mice are classified as nongame mammals by the California Fish and Game Code. House Mice threatening or injuring growing crops or other property of which you are the owner or tenant, you may control them using any legal means. They may also be taken by Department of Food and Agriculture, federal state, and county officers or employees, when acting in their official capacities.

Damage: House mice will contaminate the environments in which they live. House mice are omnivorous; they consume and contaminate stored grain and cereal products as well as fruit, vegetables, cheese, meat, and hay. They are often a pest in poultry facilities where they consume the chicken feed, and can damage electrical equipment.

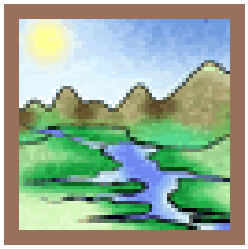
House mice carry a wide range of diseases which can be passed on to humans. House mice and their ectoparasites are involved in the transmission of diseases: salmonella food poisoning by infected rodent feces on suitable foods; rickettsialpox by the bite of the house mouse mite; and lymphocytic choriomeningitis, a virus infection of house mice, may be transmitted to man by means of food or dust contaminated with respiratory droplets or powdered feces of infected animals.

House mice will inevitably cause physical property damage whenever present in and about buildings. This may be costly and potentially dangerous creating fire or safety hazards. The damage is seen in the form nest building and gnawing of structures, electrical wire insulation, rubber insulation, stored items in basements, attics, garages i.e. paintings, books, clothing, furniture, family heirlooms.

House mice damage can be identified by referencing: feces/droppings, gnawing, markings or smudges against solid structure (wood beams), nests, odor, sounds, track, visual sighting.

Range: House mice are found throughout the entire United States and are considered the most common mammal in cities, except for humans (Brooks 1973).

House Mice

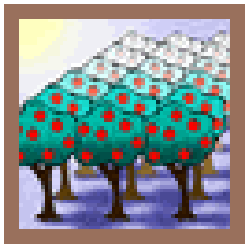


Habitat: Occasionally found in fields, but usually in buildings. House mice build nests in boxes and crates as well as stationary objects, enhancing their rapid distribution along transportation routes.

Biology: House mice live in a wide variety of man-made structures as well as in open fields. Mice living in the open may move into buildings when weather becomes severe. House mice soon become accustomed to ordinary noises and, as a result, may be active in areas near people, animals, or machines.

House mice have poor vision but a keen sense of smell, taste, hearing and touch. The long whiskers on the nose and above the eyes serve the sense of touch. Mice

normally make their runways close to walls, using their whiskers as feelers. House mice eat the same foods as man, showing a preference for foods high in protein or carbohydrates. Different environments offer varied diets and sometimes mice will feed upon such things as live insects, starch in clothing, and glue in bookbinding's. They require very little water and can live for many months on a dry grain diet. Because of their small size, they must feed several times during a 24-hour period. This means they will be active during the day as well as the night. Their range is normally 10 to 30 feet from the nest. The nest is lined with soft material such as cotton or paper and may be built in walls, cabinets, upholstered furniture or other convenient space. The usual length of life is about one year. During this time, a female house mouse will raise an average of 30 to 35 young; sexual maturity is attained at 1-1/2 months; gestation period is 18-21 days; and several litters (up to 8 per year) of 3 to 11, usually 5 or 6, young are raised. The young are born blind.



Damage Prevention and Control Methods: Controlling house mice differs substantially from controlling rats. Essentially house mice are smaller, have a smaller home range, reproduce faster than rats, and in many cases are less susceptible to rodenticides. Any control program should integrate three components: sanitation measures and habitat modification, structure proofing and exclusion, and population control.

Exclusion: Physical barriers can prevent mice from gaining entry to structures where food and shelter are available. "Rodent proofing" is an important and often neglected aspect of rodent control. It is a relatively permanent form of control which can prevent damage from occurring.

To exclude mice, seal all holes and openings larger than 1/4-inch across. Rodent proofing should be done with heavy materials that will resist rodent gnawing. These include concrete mortar, galvanized sheet metal, and heavy-gauge hardware cloth.

Habitat Modification and Sanitation: Sanitation, which includes good housekeeping practices, proper storage and handling of food, feed and garbage, is stressed as a method of rodent control. Unfortunately, even the best sanitation will not eliminate house mice. It will, however, aid in control by permitting easier detection of mouse sign, increasing effectiveness of traps and baits by reducing competing food items, and by preventing mice from flourishing and reaching high populations.

Although house mice are less dependent upon humans for their existence than are Norway rats, they are much more adaptable to living with people. They require very little space and only small amounts of food to exist. Mice have been known to inhabit buildings even before construction has been complete, living off the crumbs and scraps of worker lunches. In offices, mice may live behind cabinets or furniture and feed on scraps or crumbs from lunches and snacks and on food kept in desks. In homes, they may find ample food in kitchens, and in the garage, they will eat sacked or spilled pet food, grass seed, or insects such as cockroaches. Thus, no matter how good the sanitation, most buildings in which food is stored, prepared, or consumed will support at least a few mice. For this reason, a constant watch must be kept for mice which may invade the premises.

Where possible, store bulk foods in rodent-proof containers or rooms. Stack boxed foods in orderly rows on pallets in a way that allows for thorough inspection for evidence of mice. In such storage areas, keep stored materials away from walls. A 12-inch white band

painted on the floor next to the wall serves as a reminder to keep items away from walls. It will allow you to detect rodent droppings or other signs easily. Sweep floors frequently to permit ready detection of fresh droppings.

When storing food or feed on pallets, keep in mind that mice can jump up more than 12 inches from a flat surface. They are also good climbers and can walk up surfaces such as wood or concrete (unless they have a slick finish). Mice can live for a considerable period of time within a pallet of feed and only rarely come down to the floor.

Regular removal of debris and control of weeds from around structures will reduce the amount of shelter available to rodents. In some instances, a strip of heavy gravel placed adjacent to building foundations or other structures will reduce rodent burrowing in these locations. In any event, keeping the periphery of buildings and other structures clean of weeds and debris (including stacked lumber, firewood, and other stored materials) will discourage rodent activity and will allow easier detection of sign.

Frightening: This is not considered a practicable solution for house mouse control. Various commercial ultrasonic devices claim success at controlling house mice but no scientific research exists to support their effectiveness in controlling mice. What is known about ultrasound is that it is very directional and therefore does not travel well around corners; it also loses its intensity rapidly as it leaves its source. Testing has shown that house mice may be driven away for a few days but return and resume normal activity.

Fumigants: None registered and not a recommended method of house mice control.

Repellents: House mice like all rodents find some types of taste and odors objectionable. However, chemical repellants are not a practicable solution for mouse infestations. Moth balls (naphthalene) or household ammonia (bleach) may have a short term effect although they are not registered as repellents with the EPA. A number of repellents are available which claim to prevent gnawing by mice or other rodents but their effectiveness is questionable.

Trapping: Trapping can be an effective method of controlling mice, but it requires more labor than most other methods. Trapping is recommended where poisons are unadvisable or when mice need to be removed from inhabited buildings. It is the preferred method to try first in homes, garages, and other small structures where there may be only a few mice present.

Trapping has several advantages: 1) it does not rely on rodenticides; 2) it permits the user to view the results; and 3) it allows for disposal of the trapped mice, thereby eliminating odor problems from decomposing carcasses which may occur when poisoning is done within buildings.

The simple, inexpensive, wood based snap trap is available in most hardware and farm supply stores. Traps should be baited with a small piece of nutmeat, chocolate candy, dried fruit, or bacon, tied or glued securely to the trigger. Peanut butter or marshmallows also may be used as bait. Food baits that become stale lose their effectiveness. Set traps close to walls, behind objects, in dark places, and in locations where mouse activity is seen. Place the traps so that when mice follow their natural course of travel (usually close to a wall) they will pass directly over the trigger. Set traps so that the trigger is sensitive and will spring easily. When traps are set in runways or in travel routes, effectiveness can be increased by enlarging the trigger. This can be done with a square of cardboard, metal or screen wire that fits just inside the wire deadfall. Some traps are already equipped with this type of trigger.

Use enough traps to make the campaign short and decisive. Mice seldom venture far from their shelter

and food supply, so traps should be spaced no more than about six feet apart in areas where mice are active. Although mice are not nearly as afraid of new objects as rats, leaving the traps baited but unset until the bait is taken at least once will reduce the chance of mice escaping the trap and becoming trap-shy.

A variety of different mouse traps designed as lethal traps and also non lethal are available in most retail stores. The efficacy of these traps is dependent largely upon their placement. Use as many traps as practicable so that trapping time will be short. As many as a dozen or more traps may be necessary for a heavily infested home or other building structure. Mice rarely travel far from their shelter and food supply.

Dispose of dead mice by burying or placing them in plastic bags in the trash. When handling any rodent carcass always wear waterproof gloves to protect yourself from disease. Do not touch them with bare hands and wash thoroughly after handling traps.

Glue boards: An alternative to traps are glue boards, which catch and hold mice attempting to cross them much the same way flypaper catches flies. Place glue boards wherever mice travel -- along walls or in established pathways. Do not use glue boards where children, pets, or wildlife can contact them. Glue boards lose their effectiveness in dusty areas unless covered, and temperature extremes may affect the tackiness of some glue. They are considered less effective in capturing rats than mice. You can purchase ready-to-use glue boards, or you can buy glue to make your own boards or traps. Dispose of live trapped rodents in a humane manner.

Baits: Suggested baits for house mice include treated grains, pellets or meal. Sugar up to five percent by weight is sometimes added to improve bait acceptance.

Toxicants

Anticoagulants -- % on bait for:

CDFA Labels:

0.01% Chlorophacinone Treated Grain

0.01% Diphacinone Treated Grain

0.005% Diphacinone Rodent Bait Blocks

Broadcast baiting: Rarely used but may be used in some special situations where repeated applications of first generation anticoagulants can be made until control is achieved.

NOTE: House mice are naturally less susceptible to anticoagulants than rats and have different feeding patterns, thus first generation anticoagulant baits are sometimes prepared at double strength. Double strength baits increase the potential for hazards to pets and domestic animals and therefore, should be used with even greater caution than normal strength baits.

Fumigants

Practical use of fumigants for controlling house mice is limited to structure or containers (feed bins, railway cars, or other enclosed areas). Some fumigants are registered for rodent burrow use, however, house mouse burrows cannot be fumigated efficiently because they are small and difficult to locate.

Aluminum phosphide, is registered in California as a fumigant. Fumigants are hazardous materials and should be applied only by persons well trained in their use and who possess the necessary safety equipment and permits.

Directions for Use

Spot Baiting (zinc phosphide baits): Place tablespoon amounts (1/4 to 1/2 ounce) of bait in shallow containers spaced 8-12 feet apart. Place in dry locations such as in concealed places, in corners, or along walls, where house mice feed, drink, or frequent.

Bait placements should be inaccessible to children, pets or domestic animals. Bait should be picked up and disposed of upon completion of rodent control program.

Because of the potential of bait shyness, do not retreat with zinc phosphide bait for at least three months.

Anticoagulant Baits:

NOTE: A single feeding of second generation anticoagulant baits may be lethal to house mice. However, baits of first generation anticoagulants must be eaten over a period of several days to give adequate control.

Place tablespoon amounts (1/4 to 1/2 ounce) of bait in bait box or shallow container, preferably in protected feeder stations. Place bait stations at 8 to 12 feet intervals in dry locations such as in concealed places, in corners, or along walls where house mice feed, drink or frequent. Inspect stations daily and add bait as needed; increase the amount when bait in feeder is entirely consumed overnight. Replace moldy or old bait with fresh bait. An uninterrupted supply of bait should be maintained as long as any bait is taken which may be two to four weeks.

Where a continuous source of infestation is present, permanent bait stations should be established and the bait replenished as needed. Bait should be picked up and disposed of upon termination of control program.

Tracking Powders: Toxic dusts or powders have been successfully used for many years to control mice and rats. When mice walk over a patch of toxic powder, they pick

up some of it up on their feet and fur and later ingest it while grooming. Tracking powders are useful in controlling mice where food is plentiful and good bait acceptance is difficult to achieve. Mice are more likely to ingest a lethal amount of a poorly-accepted toxicant applied by this method than if it is mixed into a bait material. There is little likelihood of toxicant shyness developing when using tracking powders.

Because the amount of material a mouse may ingest while grooming is small, the concentration of active ingredient in tracking powders is considerably higher than in food baits which utilize the same toxicant. Therefore, these materials can be more hazardous than food baits. For the most part, tracking powders are used by professional pest control operators and others trained in rodent control. Tracking powders containing either single-dose poisons or anticoagulants are commercially available, although some are Restricted Use Pesticides.

Place tracking powders along runways, in walls, behind boards along walls, or on the floor of bait stations. Placement can be aided by using various types of sifters, shakers, or blowers. Dampness may cause the powder to cake and lessen its effectiveness. Care must be taken to place tracking powders only where they cannot contaminate food or animal feed, or where non-target animals cannot come into contact with them. Do not place tracking powders where mice can track the material onto food intended for use by man or domestic animals. Because of potential hazards to children and pets, tracking powders are not generally recommended for use in and around homes. Where possible, remove tracking powder after the rodent control program is completed. Tracking powders used in conjunction with baiting can provide very effective mouse control

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