Pest Notes, Publication 7438
Revised December 2018

UC IPM

Integrated Pest Management for Home Gardeners and Landscape Professionals

UC PEER REVIEWED

Ground Squirrel

Ground squirrels (Figure 1) are troublesome rodent pests for many home gardeners. The California ground squirrels, *Otospermophilus beecheyi* and *Otospermophilus douglasii*, are the most common species in and around homes and gardens. The two are usually not referred to as separate species, so in this publication they are referred to as "California ground squirrel" or simply "ground squirrel."

Figure 1. California ground squirrel, *Otospermophilus* sp.

The California ground squirrel is found throughout most of California and extends south into the northwestern part of the Baja peninsula (Figure 2). It is also found in western Nevada and can be found north of the Columbia River in south central Washington and throughout western Oregon.

The California ground squirrel can invade and colonize residential areas that have open grassy areas, sometimes causing considerable damage.

Authors:

Niamh M. Quinn, UC Cooperative Extension, San Diego, Orange, and Los Angeles Counties and South Coast Research & Extension Center.

Monica J. Dimson, UC Cooperative Extension, Orange County.

Roger A. Baldwin, Dept. of Wildlife, Fish, and Conservation Biology, UC Davis.

Although California ground squirrel populations generally thrive where the winters are mild, there are known populations in the central Sierra Nevada Mountains at altitudes of over 7,000 feet.

IDENTIFICATION

It is easy to identify ground squirrels since they forage above ground near their burrows. Their body measures 14 to 20 inches, which includes their tail. Adult squirrels weigh between 21 and 30 ounces. The males are somewhat larger than the females.

Ground squirrel fur is mottled brown, with some white and gray markings on the back (Figure 1). Their belly and underside have a combination of lighter browns, grays, and white. California ground squirrels have a white ring around each eye. Their tails are somewhat bushy (but less so than those of tree squirrels) and their ears are erect and conspicuous.

Although ground squirrels look similar to tree squirrels and can climb trees, when frightened they generally will retreat to a burrow, whereas tree squirrels will climb a tree or tall structure and never use a burrow. For information about tree squirrels, see the UC IPM *Pest Notes: Tree Squirrels*.

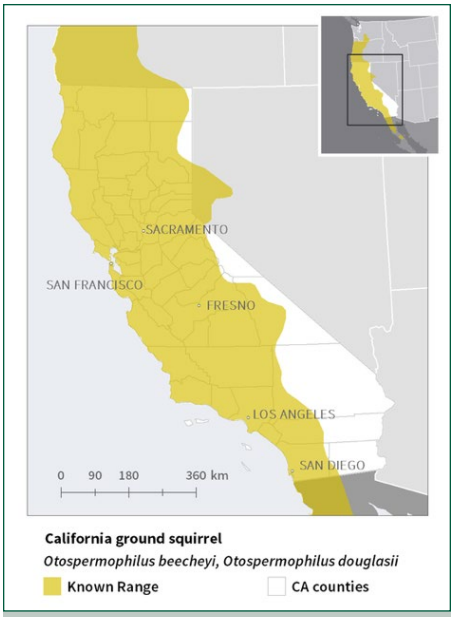

Figure 2. Range of the California ground squirrel.

BIOLOGY AND BEHAVIOR

California ground squirrels live in colonial burrow systems where they sleep, rest, rear young, store food, and avoid danger. Their burrows are about 4 inches in diameter, although older burrow entrances can occasionally be quite a bit larger (Figure 3). The length of burrow systems usually ranges between 5 and 30 feet. Most burrow systems are within two to three feet of the surface of the ground, but they may occasionally be up to 6 feet or more in depth. Burrows can be single tunnels or complex branching systems. They may be occupied by a single squirrel or occupied by many.

California ground squirrels are active during the day, mainly from midmorning through late afternoon, especially on warm, sunny days. They have two periods of dormancy during the year. During winter months, most ground squirrels hibernate, but some young can be active at this time, particularly in areas where winters aren't severe.

During the hottest times of the year, most adults go into a period of inactivity, called estivation, that can last a few days to a week or more. During these periods, the burrow appears open at the entrance, but the squirrel plugs it with soil near the nest.

The onset of breeding in California ground squirrel populations can vary depending on weather, elevation, and latitude. Generally, populations at higher altitudes and in colder climates hibernate for longer periods and therefore breed later. Mating can start as early as January in warmer locations and continues until July. Peak mating occurs from March through June.

California ground squirrels only produce a single litter per year. The average litter has 5 to 8 young, but litters as small as 1 and as large as 15 have been observed. The young are born in the burrow and grow rapidly, emerging from the burrow when they are about 6 weeks old. At 6 months of age, they resemble adults.

Figure 3. California ground squirrel burrow opening under structure.

Figure 4. Ground squirrel damage to avocado.

Ground squirrels are primarily herbivorous, and their diet changes with the season. After emerging from hibernation, they feed almost exclusively on green grasses and herbaceous plants. When annual plants begin to dry and produce seed, squirrels switch to seeds, grains, and nuts, and begin to store food.

Ground squirrels usually forage close to their burrows. Their home range typically is within a 75-yard radius of their burrow.

DAMAGE

Ground squirrels damage many food-bearing and ornamental plants. Particularly vulnerable are grains, as well as nut and fruit trees such as almond, apple, apricot, avocado, orange, peach, pistachio, prune, and walnut (Figure 4).

In gardens, ground squirrels will eat vegetables in the seedling stage. They can damage young shrubs, vines, and trees by gnawing bark, girdling trunks (completely removing a strip of bark from a tree's outer circumference), eating twigs and leaves, and burrowing around roots. Ground squirrels will gnaw on plastic sprinkler heads and irrigation boxes and lines.

Burrowing can be quite destructive. Burrows and mounds make it difficult to mow lawns and other grassy areas, and they present hazards to machinery, pedestrians, and livestock. Burrows around trees and shrubs can damage and dry out roots; this can sometimes topple trees. Burrowing beneath buildings and other structures sometimes produces damage that necessitates costly repair.

Ground squirrels can harbor diseases harmful to humans, particularly when squirrel populations are high. A major concern is bubonic plague, caused by the bacterium *Yersinia pestis* and transmitted to humans, pets, and other animals by fleas associated with the squirrels. Ground squirrels are susceptible to plague, which has wiped out entire colonies. If you find unusual numbers of squirrels or other rodents dead for no apparent reason, notify public health officials. **Do not handle dead squirrels under these circumstances.**

LEGAL STATUS

The California Fish and Game Code classifies ground squirrels as nongame mammals. An owner or tenant can control ("take"), in any legal manner, nongame mammals that are injuring growing crops or other property. Some species of tree squirrels, on the other

hand, are classified as game animals (with a hunting season) that cannot be taken without a permit. See the *Pest Notes: Tree Squirrels* for more information.

No license is required for the management of California ground squirrels if it is the owner or tenant who is taking damaging ground squirrels. A trapping license from the California Department of Fish and Wildlife is required for those who are trapping squirrels for hire or profit.

The U. S. Fish and Wildlife Service classifies the Mohave ground squirrel, *S. mohavensis*, and the San Joaquin antelope squirrel, *Ammospermophilus nelsoni*, as threatened species. Therefore, both are protected animals. Although you are unlikely to mistake either of these relatively small squirrels for the much larger California ground squirrel, their ranges could overlap in some areas, so ensure proper identification before instituting control measures.

The endangered San Joaquin kit fox (*Vulpes macrotis mutica*), several endangered species of kangaroo rats (*Dipodomys* spp.), the riparian brush rabbit (*Sylvilagus bachmani riparius*), the riparian wood rat (*Neotoma fuscipes riparia*), and some endangered amphibians and reptiles also are within the California ground squirrels' range, so some squirrel management techniques could impact them as well. If the kit fox is found in your county, contact your county agricultural commissioner for additional information. For a range map, see the California Department of Pesticide Regulation's website (listed in References).

Before using pesticides for ground squirrel management, read the product

Table 1. Seasonal activity, diet, and optimum timing for management of California ground squirrels.

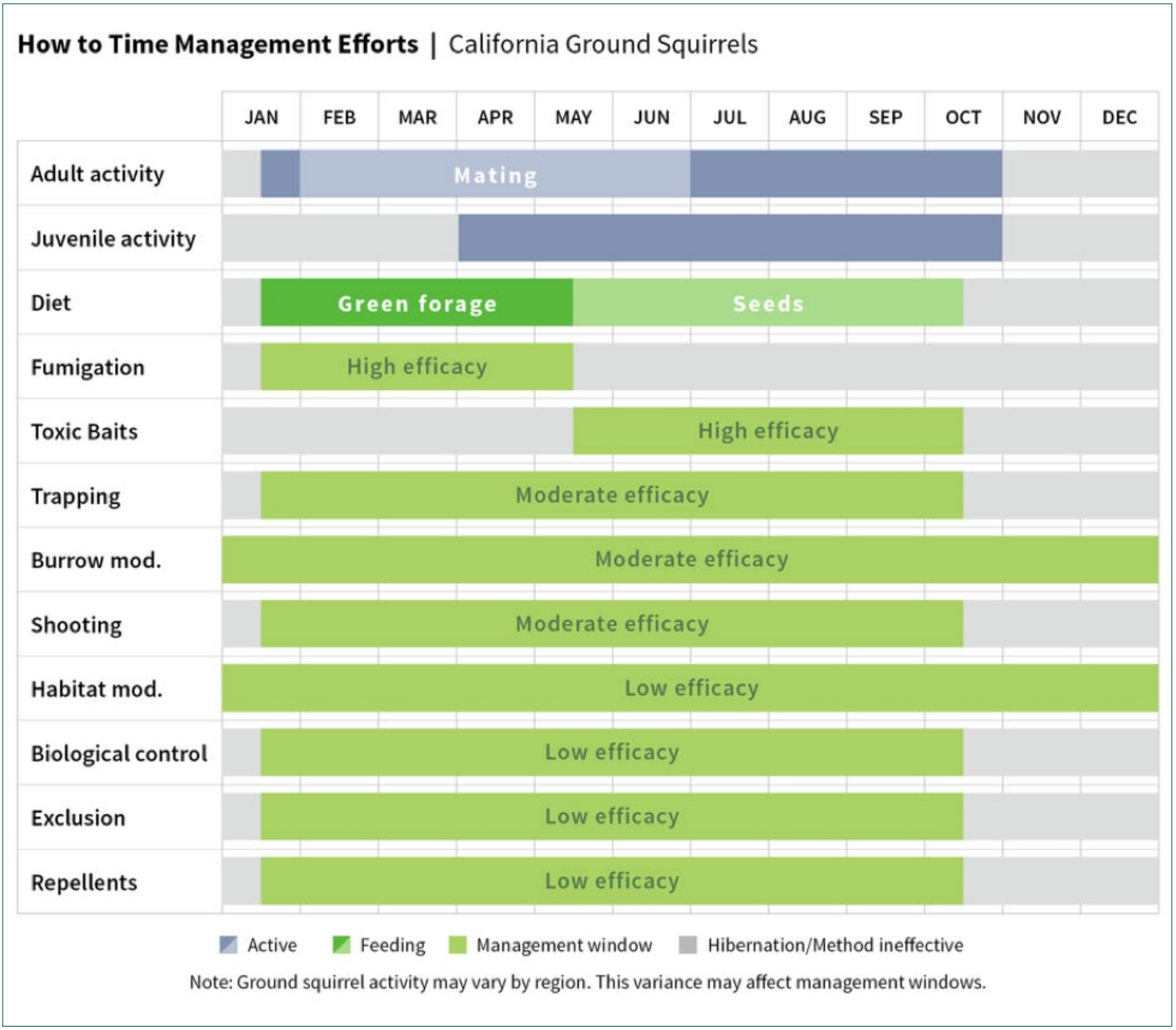

Figure 5. A pair of box-type gopher traps modified and set in the runway of ground squirrels.

Figure 6. The tunnel-type trap kills animals that pass through it.

Figure 7. A Conibear trap at the base of a structure. To use a Conibear trap, dig a slice of soil from the entrance so the trap will fit flush to the edges of the burrow entrance.

label to determine if any restrictions exist on rodent control within the ranges of these and other endangered and protected animals.

MANAGEMENT

Effective management depends heavily upon understanding the unique life cycle and behavior of the California ground squirrel. For example, baiting with treated grain is effective in summer and fall, because squirrels primarily feed on seeds during this period. Burrow fumigation is most effective in spring, when moist soil helps seal gasses in the burrow system. Fumigating at this time is also more effective in reducing ground squirrel numbers since squirrels die before they can reproduce.

Table 1 shows the yearly activities of the California ground squirrel and times when baiting, trapping, fumigation, and other management practices are generally most effective.

Habitat Modification

You'll generally find ground squirrels in open areas, although they sometimes use brush and other vegetation as cover during retreat. Remove brush piles and debris to make an area less desirable in this way. Brush removal also aids in detecting squirrels and their burrows and improving access during management operations.

California ground squirrels generally dislike dense vegetation, as it prevents their easy detection of potential predators. Therefore, avoiding mowing and grazing can discourage ground squirrel incidence. Keep in mind, however, that increasing the amount of vegetation in an area may encourage other pest species, like California field voles.

Ground squirrels can reinvade a site by moving into vacant burrows. Although not usually possible in urban areas, destroying old burrows by deep ripping them to a depth of at least 20 inches, using a tractor and ripping bars, can slow reinvasion. Simply filling in the burrows with soil does not prevent reinvasion, as ground squirrels easily find and reopen old burrows.

Trapping

Traps are practical for management when squirrel numbers are low to moderate. Live-catch traps are not often recommended, because they present the problem of animal disposal. **It is illegal to relocate wildlife in the State of California without a permit.** Live-captured ground squirrels must be released immediately on the property where they were caught, or they must be euthanized by legal and humane measures. Methods of euthanasia considered humane by the American Veterinary Medical Association include gassing with carbon dioxide and shooting. Drowning is not an approved method of euthanasia and is illegal in California (See References).

There are several types of traps that kill ground squirrels, including box traps, tunnel traps, and Conibear traps. For box traps (Figure 5) and tunnel traps (Figure 6), place them on the ground near squirrel burrows or runways, and bait them with walnuts, almonds, oats, barley, melon rinds or any other food source that the ground squirrels are eating. Place the bait well behind the trigger or tied to it. After you bait traps, place them out with triggers unset for several days so the squirrels can become accustomed to them. After the squirrels are used to taking the bait, rebait and set the traps.

To reduce hazards to children, pets, poultry, and nontarget wildlife, place box-type traps inside a covered box with a 3-inch-diameter entrance. Put the box near active burrows with signs of recent diggings. Inactive burrows will be filled with leaves or old straw, or have cobwebs across the entrance.

The Conibear trap No. 110 with a 4½-by 4½-inch jaw spread also is an effective kill trap (Figure 7). You can bait the wire trigger, but usually you'll want to leave it unbaited. Place the trap directly in the burrow opening, so the squirrel must pass through it, tripping the trigger.

It might be necessary to use soil to partially fill in the burrow entrance around the outer edges of the trap to prevent the squirrel from slipping around the outside of the trap. Closing all other burrows with soil might hasten success by directing the squirrel to the remaining open burrow, which contains the trap.

Attach the Conibear trap to a stake to prevent a scavenger from carrying off both it and the squirrel. With this type of trap, leaving the trap baited but unset has little effect on trapping success.

Inspect traps at least once a day and remove dead squirrels. Don't handle the carcasses without protective gear. You can use a plastic bag slipped over each hand and arm as a glove. Once you have removed the squirrel from the trap, hold the animal with one hand and turn the bag inside out while slipping it off your arm and hand.

Keep small children and pets out of the area while traps are in use. In kit fox areas, spring all Conibear traps before nightfall and reset them the following morning. Also, be mindful of nontarget species in the area (e.g., cats, wildlife) to avoid their inadvertent capture or harm when trapping.

Fumigation

Burrow fumigation can be a safe method for managing ground squirrels. Fumigation is most effective in spring, or at other times when soil moisture is high. Moist soil helps contain the gas within the burrow system or may be required to properly activate certain fumigants (e.g. aluminum phosphide). Do not fumigate in summer or when the soil is dry, because the gas more readily diffuses into small cracks present in dry soil, making it less effective. Do not fumigate during hibernation, because the ground squirrel plugs its burrow with soil, preventing fumes from reaching the nest chamber. You cannot see this plug by examining the burrow entrance.

As with any pesticide, read and follow label instructions, with particular regard for nontarget species and safety factors. Fumigants have restrictions that require products to be applied only within burrows that are greater than a certain distance from structures that may be occupied. Read the product label to determine the application distance requirements pertaining to your site.

Be aware of the signs of nontarget species inhabiting inactive ground squirrel burrows. Kit foxes will use an old burrow, enlarging the opening, and often creating a keyhole-shaped entrance. Active pupping dens might contain prey remains, droppings, and matted vegetation, and show signs of fresh paw prints. The burrowing owl (*Athene cunicularia*) is another potential occupant of abandoned ground squirrel burrows.

Do not treat a burrow if you suspect a nontarget animal is present. Fumigate only active ground squirrel burrows. County agricultural commissioners (cdfa.ca.gov/exec/county/countymap/) can provide additional information on how to recognize nontarget burrows.

The most readily available fumigant for most residential users is the gas cartridge. Some county agricultural commissioners' offices sell United States Department of Agriculture gas cartridges, which are designed for fumigating burrowing rodents. Other types of fumigation cartridges are also available at retail outlets.

Instructions for the use of gas cartridges are product-specific, so it is very important to consult the product label before use. Generally, to use a gas cartridge, puncture the cartridge cap and insert a fuse into the puncture hole. Place the cartridge into an active burrow entrance with the fuse pointing towards the interior of the burrow. Light the fuse and push the cartridge into the burrow with a shovel handle. Immediately seal and tightly pack the burrow opening with soil, but don't cover the cartridge itself with soil. Multiple entrances to the same burrow system do not necessarily need to be treated separately, but it is important to seal any additional openings. Use the smoke escaping from the burrow to identify these entrances. Larger burrow systems, however, may require two or more cartridges. After 24 hours, check for reopened burrows, and re-treat as needed.

Aluminum phosphide is another burrow fumigant that is very effective as a ground squirrel management tool. However, its use is restricted to licensed pest management professionals. Additionally, it cannot be used within 100 feet of any structure that is, or may potentially be, occupied by humans, pets, or livestock. This eliminates its use from most residential areas.

Pressurized exhaust systems that inject concentrated carbon monoxide into burrow systems are also legal for use in California. Of these devices, the Pressurized Exhaust Rodent Controller (PERC) machine has been extensively tested and has proven to be effective for the management of California ground squirrels. Devices that produce carbon dioxide for burrow fumigation are currently seeking registration in California and may be available soon. As with all burrow fumigation applications, these devices will be most effective under moist soil conditions.

Toxic Baits

Anticoagulant rodenticide options for residential use are limited to first-generation active ingredients such as diphacinone. These products must be applied in tamper-resistant bait stations, usually within a specified distance from a manmade structure. Check product labels for specific distances and application rates.

Diphacinone and other first-generation anticoagulant rodenticides (FGARs) are considered multiple feeding toxins, meaning that a ground squirrel must feed on the bait multiple times over several days to ingest a toxic dose. FGARs have low primary toxicity concerns (that is, mortality of nontarget wildlife that directly consume the toxicant), partly because they require multiple feedings to acquire a toxic dose and also because FGARs can be applied in bait stations that are

not generally accessible to nontarget species.

If bait is accessible to nontarget species, then alternative management options must be considered. Anticoagulants are the only rodenticide type registered in the United States which has an antidote available to reverse the effects.

FGAR baits generally require two to four weeks or more to control populations. Continue baiting until all feeding ceases and you no longer see any squirrels. Although few ground squirrels will die above ground, you should pick up and dispose of those that do, as described above in the Trapping section and in accordance with label directions. Also, be sure to pick up and dispose of unused bait upon completion of the management program, according to label instructions.

Toxic grain baits containing the active ingredient zinc phosphide can only be applied by licensed pest management professionals and are not available for use by residential users for ground squirrel management. Rodenticide products labeled for use against rats and house mice should never be used for the management of ground squirrels unless ground squirrels are specifically listed on the label as a target species.

Other Management Techniques

Shooting. Shooting squirrels with small caliber rifles can provide some ground squirrel control, but it is very time-consuming. Additionally, discharging a firearm is not legal in most municipalities.

The California Department of Fish and Wildlife (CDFW) has prohibited the use of lead projectiles in some firearms within the range of the California condor. Likewise, leaving lead projectiles behind (within animal carcasses) can be hazardous since it may result in their ingestion by scavengers. Currently, the use of lead ammunition is permitted for take of small nongame animals such as ground squirrels. However, effective July 1, 2019, nonlead ammunition will be required when taking any wildlife with a firearm anywhere in California.

Frightening devices. There are no effective squirrel-frightening devices or repellents that will cause ground squirrels to leave their burrows or avoid an area or crop.

Burrow exploders. Devices that inject ignitable gasses into ground squirrel burrow systems are not generally recommended for urban use and have not proven to be effective.

Biological control. Many predators, including hawks, eagles, rattlesnakes, and coyotes, eat ground squirrels. In most cases, predators are not able to keep ground squirrel populations below the level at which they become pests for the home gardener. Dogs might prevent squirrels from entering small areas, but they cannot manage established squirrel populations.

Follow-up

For those who live next to wildlands or other areas where squirrels are common, an ongoing management program will be necessary, since squirrels will reinvade over time. Once you have controlled a ground squirrel problem, periodically monitor the area for reinfestation. Check for new burrows and start management actions as soon as you notice new arrivals. It is easier and less expensive to manage a small population rather than to allow it to build up to larger numbers.

More detailed information about identification, management, and other resources is available at the UC Ground Squirrel Best Management Practices website, groundsquirrelBMPs.com.

REFERENCES

American Veterinary Medical Association euthanasia guidelines. Online at avma.org/KB/Policies/Documents/euthanasia.pdf.

Baldwin RA, Meinerz R. 2016. *Assessing the efficacy of carbon monoxide producing machines at controlling burrowing rodents*. University of California, Davis. Final Report to CDFA.

California Department of Fish and Wildlife licensing website. wildlife.ca.gov/Licensing.

California Department of Pesticide Regulation. 1995. *Protecting Endangered Species: Interim Measures for San Joaquin Kit Fox*. Sacramento: Pesticide Registration Branch, Pesticides and Toxic Substances H-7506. 13 pp. Online at cdpr.ca.gov/docs/es/espdfs/sjkfall.pdf and cdpr.ca.gov/docs/es/espdfs/sjkfden.pdf. (Accessed October 15, 2018.)

Marsh RE. 1994. Belding's, California, and Rock Ground Squirrels. In Hygnstrom SE, Timm RM, Larson GE (eds.). *Prevention and Control of Wildlife Damage*. Vol. 1. Lincoln: University of Nebraska Cooperative Extension.

Salmon TP, Whisson DA, Marsh RE. 2006. *Wildlife Pest Control around Gardens and Homes, 2nd ed*. UC ANR Publication 21385. Oakland, CA.

Smith JE, Long DJ, Russell ID, Newcomb KL, Muñoz VD. 2016. *Otospermophilus beecheyi* (Rodentia: Sciuridae). Mammalian Species 48(939):91–108.

Yensen E, Sherman PW. 2003. Ground squirrels. Feldhamer GA, Thompson BC, Chapman JA (eds.). *Wild mammals of North America: biology, management, and conservation, 2nd ed.* Johns Hopkins University Press. Baltimore, Maryland.

WARNING ON THE USE OF PESTICIDES

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

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

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

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

Produced by the **Statewide Integrated Pest Management Program**, University of California, 2801 Second Street, Davis, CA 95618-7774.

Technical Editor: K Windbiel-Rojas

ANR Associate Editor: AM Sutherland

Editor and Designer: B Messenger-Sikes

ILLUSTRATIONS: Figure 1 and 3: MJ Dimson; Figure 2: UCCE Orange Co., range data source ICUN 2016; Figure 4 and 7: NM Quinn; Figure 5: Jack Kelly Clark; Figure 6: RE Marsh.

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

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

University of California scientists and other qualified professionals have anonymously peer reviewed this publication for technical accuracy. The ANR Associate Editor for Urban Pest Management managed this process.

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

This material is partially based upon work supported by the Extension Service, U.S. Department of Agriculture, under special project Section 3(d), Integrated Pest Management.

Suggested citation: Quinn NM, Dimson MJ, Baldwin RA. 2018. *UC IPM Pest Notes: Ground Squirrel*. UC ANR Publication 7438. Oakland, CA.