DRAFT Minutes

CONTRA COSTA COUNTY INTEGRATED PEST MANAGEMENT DECISION-MAKING SUBCOMMITTEE
A subcommittee of the IPM Advisory Committee

April 17, 2025
10:00 AM

Held at the Agricultural Commissioner's office at 2380 Bisso Lane in Concord

Members Present: Carlos Agurto (Chair), Susanna Thompson, Gabe Chan, Andrew Sutherland

Members Absent: Chris Lau

Staff Present: Jen Quallick, Wade Finlinson

1. **Convene and introductions**
   The Chair called the meeting to order at 10:04 AM.

2. **Public comment on items not on this agenda**
   None

3. **Consider approval of the July 10, 2024 and November 6, 2024 Decision-Making Subcommittee**
   A motion was made and seconded (AS/ST) to approve the July 10, 2024 minutes as presented.
   Ayes: Chan, Sutherland, Thompson, Agurto
   Noes: None
   Abstain: None
   Absent: Lau

   A motion was made and seconded (AS/ST) to approve the November 6, 2024 minutes as presented.
   Ayes: Chan, Sutherland, Thompson, Agurto
   Noes: None
   Abstain: None
   Absent: Lau

   Subcommittee members requested an item be placed on the next agenda to receive an update on the Public Works hiring challenges as directed by the Transportation, Water, and Infrastructure Committee of the Board of Supervisors on December 9, 2024.

   Public Speakers: None

4. **Review ground squirrel decision documents and advise staff on potential revisions and the process for revising the documents.**
The IPM Coordinator introduced the item by referencing several changes that have occurred since the document was last revised. While staffing and operational changes since 2019 have impacted ground squirrel management efforts, recent rodenticide restrictions will dramatically limit access to effective tools previously available to local agencies to protect critical infrastructure from ground squirrel damage. Despite a few pilot efforts to implement burrow fumigation and trapping, toxic baiting has been the predominant method used by County departments.

Subcommittee members made the following observations:

- Either broaden the document to include ground squirrel management on all County property or clarify the definition of "critical infrastructure" and make sure document stays within those parameters.
- Include a section on management mandates near the beginning of the document.
- The updated version should clarify the Agriculture Department's role along with the responsibilities for each Public Works Division in the decision-making process.
- This is an opportunity to develop a new model for County properties since elements of the previous model no longer apply. Operational staff from each Public Works division may need to be trained to implement their own controls.
- Year-round monitoring protocols should be established in order for year-round control tactics to be effective.
- The IPM Coordinator was encouraged to obtain information from each operational division in order to clarify the next steps for revising the decision document.
- There was some discussion about alternative control tactics such as trapping, burrow fumigation, shooting, and burrow modification strategies.
- Since ground squirrels are keystone species, there will always be concerns about impacts to non-target species, particularly threatened and endangered ones. The revised decision document should reference the Department of Pesticide Regulation's PRESCRIBE tool. (PRESCRIBE stands for Pesticide Regulation's Endangered Species Custom Real-time Internet Bulletin Engine.)
- Since the last revision, University of California Agriculture and Natural Resources has hired a Human-Wildlife Interactions Advisor stationed in the Bay Area. She has indicated interest in supporting this effort.
- Now that the game has changed and the Ag Department is no longer able to support each operational division at previous levels, one draft recommendation should include the allocation of resources to focus on ground squirrel issues.
- The IPM coordinator indicated his interest in providing support to operational division' enhanced ground squirrel monitoring and control efforts.

Public Speakers: None

5. **Identify potential new items to be considered in future meetings**
It was requested that the IPM Coordinator provide an update on the work of the regional IPM Coordinators group at a future meeting, if applicable. It was also requested that the IPM Coordinator follow up on any updates pertaining to the Public Works hiring challenges highlighted in the addendum to the vegetation management document completed last year.

Subcommittee members also agreed to the following tentative work plan and meeting schedule which includes meetings of the full Committee later in the year:

- May 15, 2025 10:00 AM—Receive input from operational divisions and external agencies on ground squirrel management efforts and review draft revisions of ground squirrel document.
- June 19, 2025--**No meeting** due to Juneteenth holiday.
- July 17, 2025 10:00 AM--Finalize ground squirrel document; initiate review of commensal rodent and gopher documents.
- August 21, 2025 10:00 AM—Continue discussion on commensal rodent and gopher documents, finalize ground squirrel document (if necessary), initiate review of grazing documents and IPM Decision Tree after other applicable subcommittees have reviewed (Nature Based Solutions Subcommittee for the grazing document & IPM Training Subcommittee for the IPM Decision Tree).
- September 18, 2025 **meeting of the full IPMAC**—Provide status update and obtain feedback from other committee members, the public, and County staff.
- October 16, 2025 10:00 AM—Finalize all selected documents and subcommittee recommendations.
- November 20, 2025 **meeting of the full IPMAC**—Approve final documents and recommendations.

The meeting adjourned at 11:32 AM.

Attachments:

Decision Documentation for Ground Squirrel Management on Critical Infrastructure (2019 Revision)
University of California Statewide IPM Program Ground Squirrel Pest Notes

—end of meeting minutes—

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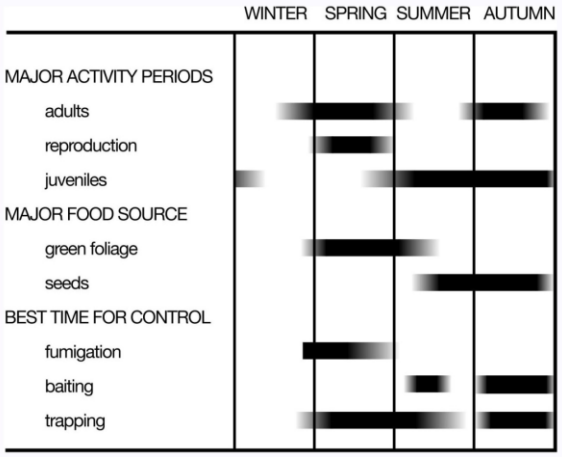
Contra Costa County
DECISION DOCUMENTATION for GROUND SQUIRREL MANAGEMENT on Critical Infrastructure

Date: 7/29/2013 (last revised on 9/5/19)

Department: Agriculture

Location: Countywide

Situation: Ground squirrel management to protect critical infrastructure and human health

What are the management goals for the sites?	Maintain a squirrel-free buffer area (generally 100 linear feet) around critical infrastructure (levees, earthen dams, canals, roadways, train berms, bridge abutments). Note that the size of the buffer area is site-specific.
Who has jurisdiction over the areas in question?	The Department is contracted by a number of entities to perform ground squirrel management on land under the jurisdiction of the following: CCC Public Works Department (including Flood Control), CC County Concord & Byron Airports, CC Water District, the U.S. Department of Interior Bureau of Reclamation, West County Wastewater Treatment Plant, Central Contra Costa Sanitary District, and Ironhouse Sanitation District. As a contractor, the Department is not always alerted to ground squirrel problems by the contracting agency in time to consider all control methods. Furthermore, budgets for these programs are set by the contracting agency and may preclude the Department from using some control methods.
How often are sites monitored?	Road and Flood Control crews are continually monitoring for ground squirrels throughout the year in order to alert the Agriculture Department to priority areas. These priority areas, along with sites where ground squirrels have been found historically, are monitored by Agriculture Department staff once annually prior to treatment between the months of June and October. This allows the Agriculture Department to determine where treatment is actually needed.
The problem species has been identified as the following:	**Ground Squirrel** (*Spermophilus beecheyi*) Burrowing by ground squirrels can be very destructive, and they can cause severe erosion and loss of structural integrity. Ground squirrels are a problem in levees, in flood control facilities and canals, in earthen dams, on roads, on railroad berms, around foundations and retaining walls, and in landscaping where they chew on irrigation lines. In addition, California ground squirrels are known to be carriers of many transmissible diseases, including bubonic plague and tularemia.  From Roger Baldwin's presentation entitled "Developing a management plan for burrowing rodents in organic production", February 2019.
What is the tolerance level for	**Tolerance level**: At the 2 County airports, FAA regulations require zero tolerance for grounds squirrels. For all other critical infrastructure, any activity within the desired buffer zone (generally 100 linear ft.) may warrant

this species?	treatment. Ground squirrels within this area have the potential to cause damage by burrowing. Burrows can destroy a levee system and can also create habitat for burrowing owls. When protected species are living in burrows on the levees, the Public Works Department cannot perform maintenance or other work on the levees. The Army Corps of Engineers regularly inspects Contra Costa levees. If the County does not manage ground squirrel burrowing on the levees, the Corps could view this as lack of due diligence on the part of the County and could decertify the levee system. Decertification of a flood control facility results in the denial of emergency funds to the County in the event of a serious flood. The County would have to provide all emergency management funds alone. The Bureau of Reclamation inspects Contra Costa Water District canals and requires the District to manage squirrels whose burrowing can compromise the earthen canal embankments and create pathways for water leakage that can undermine the structural integrity of the canals. Ground squirrel burrowing is the biggest threat to California levees. The burrow of one ground squirrel can be long enough to perforate a levee. Shorter burrows may be close enough to each other to perforate a levee. Many burrows in close proximity can create voids that are prone to collapse. High water can go into burrows and compromise the structure of the levee. Even one colony of ground squirrels can cause considerable damage. The longer a ground squirrel population inhabits a levee, the more likely the burrows are to be extended. Research has shown that burrows are shorter where squirrels are regularly controlled. Squirrel populations on levees that persist at high densities over time are more likely to make longer and more interconnected burrows. This same burrowing and resulting pathways for water erosion can cause damage to or sudden failure of roadsides and other structures.	
Are these sensitive sites?	Is there known or potential habitat for any endangered or threatened species at any of the sites? See below.	Yes
	Are any of the sites part of any of the court-ordered injunctions regarding threatened and endangered species? a) The San Joaquin kit fox has not been sighted in Contra Costa County since the 1980s. The habitat quality is considered poor according to the State Department of Fish and Wildlife. Restrictions prohibit use of aluminum phosphide, chlorophacinone, diphacinone, gas cartridges (and several rodenticides not used by the Department) within 700' of known San Joaquin kit fox dens. The Endangered Species Act requires prebaiting and carcass survey in habitat areas. b) Alameda whipsnake habitat is near some areas that are treated. Use of diphacinone and gas cartridges is prohibited within 100' of coastal sage and northern coastal sage flora in these areas. c) California tiger salamander habitat is near some areas that are treated. Use of diphacinone and gas cartridges is prohibited within 200' of certain water features in these areas, as listed in the injunction. d) California red-legged frog habitat is near some treated areas. Use of gas cartridges is prohibited by the Endangered Species Act within 500' of certain water features in these areas. Are there other species to be aware of? Burrowing owls live in abandoned ground squirrel burrows. These owls are predominantly, but not exclusively, in East County. In areas where burrowing owls are sighted, gas cartridges would only be used in ground squirrel inhabited burrows. Note that gas cartridges are rarely used by the Department because they must be used when the soil is moist and during that time, all Department staff are engaged in invasive weed control activities.	Yes
	Are any of the sites in or near an area where people may walk or children may play? The area adjacent to the EBRPD's trail along Marsh Creek is posted before it is treated. Bait is applied away from the trail.	Yes
	Are any of the sites near an above ground drinking water reservoir? Yes, the earthen dam sides (the sides away from the water) of Mallard reservoir and CC Water District canal embankments are treated.	Yes
	Are any of the sites near a creek or flood control channel?	Yes
	If any of the above answers is yes, follow currently established legal and procedural guidelines appropriate to the sensitive sites. See also the ground squirrel decision tree and the general pest management decision tree.	
Control Methods	**This is not an attempt to consider all control methods available. The following identifies the many types of controls that have been reviewed and/or used by the County. It is not an exhaustive list. For more information on controls see http://www.groundsquirrelbmp.com/** **The County continues to investigate and review new control methods as they become available.**	

Efficacy of Management Methods

Management Method Efficacy | California Ground Squirrels

	Time of Year	Efficacy	Cost	Labor	Restrictions
Fumigation	Mid-Jan to Mid-May[1]	HIGH			[2]
Toxic Baits	Mid-May to Mid-Oct	HIGH			[2]
Trapping	Mid-Jan to Mid-Oct	MODERATE			
Burrow modification	Year-round	MODERATE			
Shooting	Mid-Jan to Mid-Oct	MODERATE			
Repellents	Mid-Jan to Mid-Oct	LOW			
Habitat modification	Year-round	LOW			
Biological control	Mid-Jan to Mid-Oct	LOW			
Exclusion	Mid-Jan to Mid-Oct	LOW			

[1] Management window may be longer if high soil moisture persists, particularly following substantial irrigation.
[2] Dependent on which fumigant or bait is used.

= Low
= Moderate
= High

* This table considers 'fumigation' broadly, encompassing gas cartridges, aluminum phosphide, carbon monoxide, and carbon dioxide. Efficacy, cost, labor requirements, and use restrictions may vary amongst these tactics, but the preferred application season ('Time of Year') is the same or very similar for all these fumigation tactics.

Chart is from UC Cooperative Extension Ground Squirrel BMPs (http://www.groundsquirrelbmp.com/management-cgs.html).

Which cultural controls were considered?

Planting desirable species: Research has indicated that tree cover and leaf litter have a negative influence on the probability of the occurrence of ground squirrel burrows on levees, and that the effect was significant on both the land side and the water side of the levee. This probably is the result of tall woody vegetation obscuring the view of the sky and hence of raptors that might prey on the squirrels.

CONCLUSIONS:

Planting desirable species is not compatible with the program due to expense. Also, at present, the Army Corps of Engineers does not allow trees on levees, but the research mentioned above may have implications for management in the future.

Which physical controls were considered?

Burrow modification: Ground squirrels work hard on their burrows and do not readily give them up. They continue to improve their burrows through multiple years and generations, creating complex systems that can be anywhere from 3 to 135 feet long and 2 to 4 feet deep. It has been observed that when burrows are abandoned, new squirrels will reinfest the area and occupy the old burrows. Modifying or destroying burrows can slow or prevent the reinfestation of ground squirrels.

Burrow Exploder: "A burrow exploder uses the force from the ignition of a gaseous mixture of propane and oxygen to create a concussive blast. It is less effective than most baiting and fumigation options and also requires a lot of equipment, including personal safety gear (hard hat, heavy gloves, safety glasses, ear plugs, ear protectors, and full body protective clothing), a fire extinguisher and shovels (highly recommended), and 50-foot hoses that feed the gases into the nozzle. Depending on the size of the gas canisters that you use, you may need a hand truck, ATV, or a vehicle to carry the equipment. Initial tests have not indicated this to be an effective removal approach (around 30-35% success rate), although destruction of burrow systems may have utility in some situations." (from Ground Squirrel BMPs http://www.groundsquirrelbmp.com/burrowmod-cgs.html).

Cement and Bentonite Grout: This mixture has been used by the California Department of Water Resources (DWR) and local agencies to repair levee damage caused by ground squirrel burrows. Data from research on DWR- and reclamation district-maintained levees in the Sacramento area in 2013 "suggest that through the implementation of a regular, ongoing grouting program the amount of cement bentonite grout needed to fill burrows decreases over time, which would correspond to reduced maintenance effort and reductions in yearly materials and manpower costs overt time….An important unknown is the long-term performance and effects of grouting on seepage and stability of a levee. After decades of injecting grout into levees, the conditions of the embankments will surely change as the levee material is replaced by grout."

The Burrow Blocker: "The Burrow Blocker system is a relatively new product. The system pumps a slurry of water and sand into ground squirrel burrows. The water is then absorbed into the soil and leaves the sand in the burrow, filling those portions of the burrow system into which the slurry can flow by gravity, thus trapping the ground squirrels underground. Research is needed to determine the efficacy of this product." (from Ground Squirrel BMPs http://www.groundsquirrelbmp.com/burrowmod-cgs.html)

Deep Ripping: "Deep ripping can be used to substantially slow the reinvasion of California ground squirrels once they have already been controlled in an area. However, destroying the burrow entrances without effectively controlling the ground squirrel population by other management methods significantly reduces the effectiveness of deep ripping. This method is generally unsuitable in areas that have large rocks or boulders or in orchards, where burrows are adjacent to trees. Deep ripping should reach a depth of at least 20 inches, or more if possible. Studies have shown that destruction of burrows at a depth of 12 inches did not result in a reduction in colonization time. One to three ripping shanks mounted on the hydraulic implement bar of a tractor works well. Space shanks approximately 3 feet apart." (from Ground Squirrel BMPs http://www.groundsquirrelbmp.com/burrowmod-cgs.html)

In an unpublished study conducted at UC Davis, it was found that of various methods of preventing reinfestation, ripping the burrows to a depth of 18 inches was a relatively effective method for reducing reinvasion into old burrows.

O_2/propane explosive devices: This method is more destructive, poses hazards to the applicator from flying debris, and would damage levees, berms and embankments. There is also the difficulty of getting the device to the burrows.

UC Extension's Ground Squirrel BMPs (http://www.groundsquirrelbmp.com/burrowmod-cgs.html) states the following:
"A burrow exploder uses the force from the ignition of a gaseous mixture of propane and oxygen to create a concussive blast. It is less effective than most baiting and fumigation options and also requires a lot of equipment, including personal safety gear (hard hat, heavy gloves, safety glasses, ear plugs, ear protectors, and full body protective clothing), a fire extinguisher and shovels (highly recommended), and 50-foot hoses that feed the gases into the nozzle. Depending on the size of the gas canisters that you use, you may need a hand truck, ATV, or a vehicle to carry the equipment. Initial tests have not indicated this to be an effective removal approach (around 30-35% success rate), although destruction of burrow systems may have utility in some situations."

Burrow modification by any method can kill any other species (including rare and endangered species such as the burrowing owl, San Joaquin kit fox, California red-legged frog, California tiger salamander and Alameda whipsnake) living in the burrows and/or will destroy potential habitat for them.

Shooting: Shooting controls squirrels in small numbers. Squirrels often come to recognize this activity and become gun shy. They may learn to retreat to their burrows any time a vehicle drives into the area or they hear a gunshot. There are safety concerns, and this is a time-intensive method.

Fencing: UC Extension's Ground Squirrel BMPs (http://www.groundsquirrelbmp.com/exclusion.html) states the following:
"While fences can be constructed to exclude squirrels, they aren't usually practical because of their expense. Ground squirrels can readily dig beneath fences that are buried several feet deep in the soil. Sheet metal caps atop a 4-foot wire mesh fence will prevent them from climbing over. For a fence to remain squirrel-proof, the squirrels that burrow near the fence should be eliminated. Experiments with a temporary low electric fence have been shown to seasonally discourage California ground squirrels from invading research or small garden plots from outside areas."

Trapping
California ground squirrels are considered nongame animals under the Fish and Game Code. A license is not required except if ground squirrels are being trapped for profit or for hire.

Live Trapping: Trapping can be done anytime squirrels are present. Most traps require the use of bait, which may be of limited effectiveness during certain times of the year. Bait must be at least as appetizing as what the squirrels are currently feeding on. Best overall results come from trapping squirrels just before they have their young, although trapping anytime squirrels are active can be effective. Trappers with SWAT Pest Control in Santa Clara County have found that July, August, and September are best for trapping ground squirrels. They find it very difficult to entice squirrels into traps in the spring because of the abundant green vegetation, which the squirrels prefer.

Live trapping requires a method of euthanization, since it is illegal to relocate trapped squirrels. Handling the traps prior to euthanization can expose staff to fleas and ticks living on the animals.

The Department's in-house trial of live trapping (see https://cchealth.org/ipm/program.php) showed this method to be very expensive and time consuming. California law mandates that traps be checked, and animals removed at least once a day, which was the protocol staff followed.

Besides the high cost, The Department found a number of other problems with live trapping in the 2012 experimental study that the Department performed:

- Squirrels fought inside the traps and were bloodied and wounded by these encounters.
- Four squirrels were found dead in the traps probably from either fighting or heat stress.
- Anxious squirrels gnawed on the bars of the trap cutting their mouths.

	• The traps consistently needed maintenance and modification in order to attract squirrels. At the end of the study, the traps had to be thoroughly cleaned because of the dried blood and powerful smell. • Although signs were posted warning the public to leave traps alone, two traps were found with their tops open in what must have been an attempt by passersby to release the squirrels. This vandalism is worrisome not only because it impeded the trapping, but also because it exposed the public to bites, scratches, and zoonotic diseases. In addition, it is an indication that trapping would not be well-accepted by the public and would result in complaints. • The week after the trapping trial, ground squirrels were back using the burrows in the buffer zone. Costs: The 2012 study showed that the cost for the Department to live trap ground squirrels along one linear mile of roadway was $5,074 compared to $220 per linear mile for the current diphacinone treatment. For comparison purposes, quotes were obtained from commercial pest control operators that could treat using non chemical live traps or other methods. The quotes ranged from $90 to $125/hr plus mileage for nonchemical ground squirrel control using live traps or other methods. At 139 hours per linear mile for the five days of trapping this would amount to $12,524 to $17,394 per linear mile plus mileage. The Department also received two quotes of $20 and $25/ground squirrel captured. These quotes on the per squirrel basis convert to a per linear mile rate of $13,360 and $16,700 respectively considering that the equivalent of approximately 668 squirrels were captured per linear mile in the trial. From UC Agriculture and Natural Resources Best Management Practices for Ground Squirrels: "Trapping is not the most effective method of control, mainly because of the high labor required to achieve good results. But it may be an ideal method to use when other methods are not appropriate." **Kill trapping**: As with live trapping, kill trapping can be done any time of year. Box and tunnel traps are baited to entice squirrels in, and Conibear traps are placed over the burrow entrance and the squirrel passes into the trap on exiting the burrow. Kill traps are very strong and can injure fingers and hands. **CONCLUSIONS:** **Burrow modification: The Agriculture Department does not currently use deep ripping or burrow explosion because it is impractical in the areas the Department manages, such as next to roads and in levees and earthen dams. There is also the danger of killing or displacing rare and endangered species. Burrow destruction may damage the infrastructure the Department is trying to protect. If the area is preferred ground squirrel habitat, they would return and dig new burrow systems. The efficacy of the Burrow Blocker is untested. The County does not currently use cement bentonite grout to fill burrows.** **Shooting: The Department does not use this method. It is impractical on a cost basis and is not effective over large areas. There are also safety concerns.** **Live trapping: The Department does not currently use this method. Live trapping may be a viable option for small, especially sensitive sites that require treatment, but over large areas (in 2012, the Department surveyed 925 linear miles of critical infrastructure buffer area), the high cost of trapping makes the method prohibitive. Furthermore, the method was not found to be effective in the treatment area due to the rapid reinfestation of the burrows by ground squirrels from the surrounding area. This does not happen with baiting. There are also issues with theft and vandalism.** **Ventura County has stated that trapping would play a small role in their ground squirrel IPM plan because of the extensive labor required.** **Kill trapping: The Department does not use this method. With kill trapping, there is too much risk of capturing nontarget animals, and kill traps present a danger to children or adults who might tamper with traps. It would also be very costly, perhaps even more costly than live trapping since 1 live trap can capture numerous squirrels at a time.**
Which biological controls were considered?	**Biological controls available:** There are no biological controls currently available that can be manipulated by humans to manage ground squirrels. There are a number of animals that prey on ground squirrels, including rattlesnakes, coyotes, bobcats, mountain lions, red-tail hawks, red-shoulder hawks, and golden eagles. According to UC Cooperative Extension's Ground Squirrel BMPs, "As ground squirrels and their native predators have evolved over hundreds of years, ground squirrels have developed behaviors and abilities to avoid predation. In certain habitats, ground squirrels are frequent prey of rattlesnakes, though some ground squirrels have evolved a resistance to snake venom. Owls are nocturnal and do not generally prey on diurnal ground squirrels….In the majority of situations, predators are not able to control ground squirrel populations. Dogs may discourage ground squirrels from entering yards and other small areas, but they cannot control established squirrel populations." Staff monitored the raptor perches that the Department erected in 3 areas in 2009 until 2011 but not find that they attracted the larger raptors that could feed on ground squirrels in the numbers that would be required for the degree of control necessary. Ground squirrels have constructed burrows at the base of some of the perches. **CONCLUSIONS**: **Predators can reduce the ground squirrel population, but they cannot provide the degree of control necessary in the specific locations the Department is contracted to treat.**
Which chemical controls were considered?	**Repellents**: UC Extension's Ground Squirrel BMPs (http://www.groundsquirrelbmp.com/repellents.html) states the following: "There are no effective repellents available for California or Belding's ground squirrel control. Ground squirrels are not easily driven out from their burrow or home range area. When scared, they retreat to their burrows, but it is very

For more information on pesticides listed here visit the National Pesticide Information Center (NPIC). This a joint project of Oregon State University and the US EPA. http://npic.orst.edu/ You can communicate with an actual person at **1.800.858.7378** or **npic@ace.orst.edu** They are open from 8:00AM to 12:00PM Pacific Time, Mon-Fri.	unlikely that they will move to a new area all together. Thus, repellents and frightening are not effective methods for ground squirrel control." *Burrow fumigation methods:* **Gas cartridge**: The cartridge (made from sodium nitrate, charcoal, and cardboard) releases carbon monoxide gas into the burrow system. This method is only effective when the soil moisture is high in either winter or spring. Gas cartridges are more effective when used prior to breeding or emergence of young. The timing, though, conflicts with other programs for which staff are needed such as the noxious weed program, the pesticide use enforcement program and the pest exclusion program. There are endangered species restrictions and concerns to consider prior to use. **Aluminum phosphide**: Aluminum phosphide reacts with moisture in the soil and in the atmosphere to produce phosphine gas. This fumigant is only effective when soil moisture is high and so has the same timing issues as above. Aluminum phosphide is a restricted use material and is a hazard to the applicator. There are also endangered species concerns and restrictions to consider prior to use. **CO and CO_2**: These fumigants require a CO or CO_2 generating device, which must be moved from burrow to burrow and site to site during treatment. These are most effective when soil moisture is high, and they have the same timing issues as gas cartridges and aluminum phosphide. Devices using CO, including the PERC machine, are in use and considered "highly effective" by other county and municipal programs in CA in parks and open spaces as well as along canals and flood-control channels and associated access roads (but not along roadsides). Devices using CO_2 to kill ground squirrels are not yet registered through the Department of Pesticide Regulation. *Anticoagulant treated grain bait:* **Diphacinone treated grain bait**: Diphacinone is applied to oat kernels that are rolled and dyed blue to make them less attractive to non-target species. Treated grain baits take advantage of the ground squirrel's highly developed seed foraging abilities. Diphacinone is a first generation anticoagulant that prevents blood from clotting and causes death by internal bleeding. First generation anticoagulants require multiple feedings over several days to a week to kill. This is different from second generation anticoagulants that are far more toxic and can kill within days of a single feeding if enough bait is ingested. Second generation anticoagulants pose a greater risk to animals that eat poisoned rodents. If the rodent continues to feed on the single-dose anticoagulant after it eats a toxic dose at the first meal, it may build up more than a lethal dose in its body before the clotting factors run out and the animal dies. Residues of second generation anticoagulants may remain in liver tissue for many weeks, so a predator that eats many poisoned rodents may build up a toxic dose over time. However, even the first generation anticoagulants may be poisonous to animals that eat poisoned rodents. The first generation materials break down much more rapidly in animal tissues and have a much reduced potential for secondary kill when compared to second generation materials. To mitigate for this, the Department performs carcass surveys in all areas treated whether or not it is required by endangered species restrictions. **CONCLUSIONS:** **Gas cartridges: The department uses these in some instances, but the cost is high, there are endangered species restrictions to consider prior to use, and staff is generally engaged in other program critical activities in winter and spring when gas cartridges can be used effectively. The Department does use this method in certain instances in late winter/spring. Major considerations for use are sensitivity of the site and available staff time. Staff are specifically trained to distinguish the difference between active and inactive ground squirrel burrows. Due to concerns over burrowing owls, staff only treat active burrows and will not use gas cartridges in sensitive areas of other endangered species that may inhabit ground squirrel burrows.** **The Department does not use other fumigation methods because they have the same limitations as gas cartridges. Gas cartridges are much safer than aluminum phosphide. CO & CO_2 devices are emerging technologies that may be impractical due to the difficulty in getting a CO or CO_2 producing device to the burrows.** **Diphacinone is the Department's material of choice. It is both effective and is labeled "Caution" which is the least toxic pesticide label category. In certain areas there are endangered species considerations/mitigations that staff follow.**
Which application methods are available for this rodenticide?	Methods available: **Bait Station**—.005% diphacinone is registered for use in bait stations (and for broadcast baiting small areas by hand) **Broadcast**—.01% diphacinone is registered for hand or mechanical broadcast baiting over larger areas **CONCLUSIONS:** **Bait Station: The Department does use this method in a very few specific situations. In general, though, there are several concerns with this method: bait can spill or be kicked out of bait stations; cattle can**

	damage stations resulting in spillage; children or adults may tamper with bait stations; dominant ground squirrels may gorge on bait and prevent other squirrels from eating it. Individual ground squirrels consuming large quantities of bait increases the risk of higher exposure levels to non-target predators; much larger quantities of bait are used in bait stations as compared to broadcast treatment; rain damaged or moldy bait must be disposed of as hazardous waste. **Broadcast: This is generally the method of choice.** **The Department's typical protocol for ground squirrel baiting is as follows:** **1. Ground squirrel work is conducted beginning in June, after forage grasses have dried, to early October depending on when fall rains begin.** **2. On day 1, staff "prebait" by putting out untreated, clean rolled oats. This increases foraging activity so that treatment can be more highly focused, and the least amount of treated bait can be used.** **3. Approximately 2 days later, staff make the 1st application of treated bait along a 12 to 15 ft. swath around/along the critical infrastructure to be protected. Applications are made only where ground squirrels are observed actively taking the "prebait."** **Bait is spread at the labeled rate, which equates to 2-3 treated kernels per square foot. The oat kernels have been rolled and dyed which makes them less attractive to non-target animals.** **Bait applications are made using a Hurd Spreader mounted on the back of a truck or an ATV. Some smaller applications are made by hand spreading the bait. Two staff members ride in the truck so that one person can focus on looking for squirrel activity and operating the spreader while the other drives.** **4. About 2 days after the 1st bait application, staff broadcast the 2nd application of treated bait to the same 12 to15 ft. swath.** **5. Around 2 days after the 2nd application, staff perform a survey of the treated areas to remove any squirrels that may die above ground. This reduces non-target exposure potential. In 2012, on 925 linear miles of roadway, staff found only 6 squirrel carcasses. In Ventura County's 2007 Field Trial using broadcast baiting, they found no above ground carcasses at any of their 3 test sites.** **6. Any heavily infested areas with continued squirrel activity are treated a 3rd time**
What factors were considered in choosing the pesticide application method?	Safety to the applicator, the environment, and nontarget species; endangered species considerations; the effectiveness of the method; and the cost to the Department.
What weather concerns must be checked prior to application?	**Fumigation methods**: Dry weather and dry ground greatly decreases effectiveness. At the same time the potential of starting a wildfire from this method increases. **Dipacinone**: The main concerns are rain or heavy dew that will render broadcast bait ineffective and can cause the bait in bait stations to mold.
Recommendations from the IPM Advisory Committee	• Allocate additional funding and / or additional staff resources to the Department to support management during spring, when fumigants such as CO will be most effective. • Allocate funding for purchase of CO fumigation equipment and to develop associated operational protocols. • Consider contracting for ground squirrel management services, including CO fumigation, during spring. • Monitor ongoing studies involving raptor perches and grouting for ground squirrel control along levees. • Continue to review all ground squirrel management methods available for critical infrastructure considering efficacy, cost, impacts to the environment and the human community. • Encourage investigation into, and experimentation with, new methods • Review this document every 3 years
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Ground squirrel and burrow under Empire Mine Road near Antioch in eastern Contra Costa County

Ground squirrel burrows along Empire Mine Road near Antioch in eastern Contra Costa County

Pesticide Profile for**: Diphacinone treated grain bait**

Active Ingredient	Diphacinone .01% or .005%
Injunction Restrictions	This chemical is enjoined in particular locations for the following endangered species: Alameda whipsnake, California tiger salamander, salt marsh harvest mouse, and San Joaquin kit fox. (For more information see https://www.epa.gov/endangered-species/san-francisco-bay-area-map-tool-identify-interim-pesticide-use-limitations)
Signal Word	Caution (the lowest hazard level in EPA's labeling system)
Federally, State, or Locally Restricted Use Material	Yes - federally restricted (can only be used by, or under the direction of, licensed or certified applicators)
Cancer	Not listed
Prop 65	Not listed
Known Groundwater Contaminant	No "Based on the available data, little if any contamination of surface and ground waters is expected for brodifacoum, bromadiolone, chlorophacinone and diphacinone. These chemicals, although persistent, tend to be relatively immobile in soil and fairly insoluble in water." [from USEPA Reregistration Eligibility Decision Facts for Rodenticide Cluster, July 1998]
Mammalian Hazard	Highly toxic by ingestion with oral LD_{50} values for technical diphacinone of 0.3 to 7 mg/kg in rats, 3.0 to 7.5 mg/kg in dogs. [EXTOXNET Diphacinone Pesticide Information Profile, 1993]
Bird Hazard	"Diphacinone is slightly toxic to birds. The oral LD_{50} for diphacinone in mallard ducks is 3158 mg/kg, and in bobwhite quail is 1630 mg/kg." [EXTOXNET Diphacinone Pesticide Information Profile, 1993]
Secondary Poisoning	"The Agency believes that there is a high risk of secondary poisoning, especially to mammals, from the use of these rodenticides outdoors (i.e., "around" buildings) in rural and suburban areas. The available data indicate that brodifacoum, bromadiolone, and 0.01% a.i. chlorophacinone and diphacinone baits may pose a secondary hazard to avian and/or mammalian predators that feed on poisoned rodents. Brodifacoum and bromadiolone likely pose the greatest secondary risks, because they are more acutely toxic, especially to birds, more persistent in animal tissues, and can be lethal in a single feeding. In contrast, chlorophacinone and diphacinone tend to be less toxic to birds, less persistent in the tissues of primary consumers, and must be eaten over a period of several days to cause mortality. Therefore, a predator feeding only once on a poisoned carcass may not die if the rodent was poisoned with diphacinone or chlorophacinone, but is more likely to die if the rodent was poisoned with brodifacoum or bromadiolone." [from USEPA Reregistration Eligibility Decision Facts for Rodenticide Cluster, July 1998]
Aquatic Organism Hazard	"Diphacinone is slightly to moderately toxic to fish. The 96-hour LC50 for technical diphacinone in channel catfish is 2.1 mg/l, for bluegills is 7.6 mg/l, and for rainbow trout is 2.8 mg/l. The 48-hour LC50 in Daphnia, a small freshwater crustacean, is 1.8 mg/l." [EXTOXNET Diphacinone Pesticide Information Profile, 1993]. The method of use of the treated bait will preclude waterway contamination.
Bee Hazard	No data found though bee hazard is not expected considering the treatment method
Persistence	"Diphacinone is rapidly decomposed in water by sunlight." [EXTOXNET Pesticide Information Profile, 1993]
Soil Mobility	"Diphacinone has a low potential to leach in soil." EXTOXNET Pesticide Information Profile, 1993]
Use in County by the Department	Ground squirrel management to protect critical infrastructure.
Method of Application	The Agriculture Department mechanically broadcasts the majority of the diphacinone treated bait it uses. Occasionally bait is applied in bait stations.
Special Cautions	Wear gloves and eye protection when directly handling or applying treated bait.
Rate Used in Co.	2-3 treated kernels of grain per sq. ft. (10 lbs. per swath acre)
Sources	Label; MSDS; EPA registration and re-registration documents; carcinogen lists from EPA, International Agency for Research on Cancer, National Toxicology Program; Prop. 65; California Department of Pesticide Regulation; Oregon State University Pesticide Properties Database; National Pesticide Information Center (Oregon State), EXTOXNET (a coalition of a number of Cooperative Extension offices across the country); Thurston Co., WA Terrestrial Pesticide Reviews; European Union; University of Hertfordshire, U.K. Pesticide Properties Database

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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.

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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*.

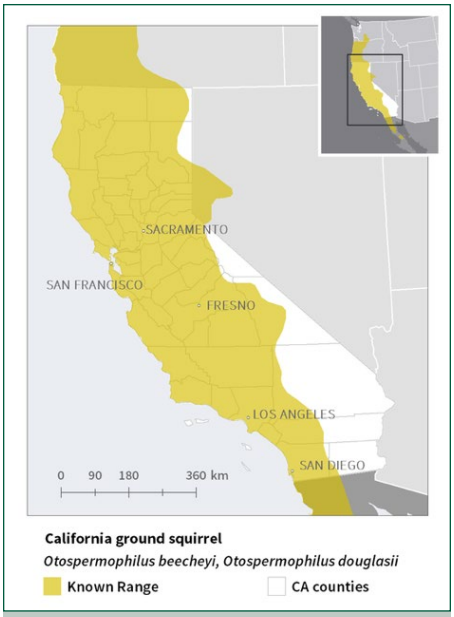

Figure 2. Range of the California ground squirrel.

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.

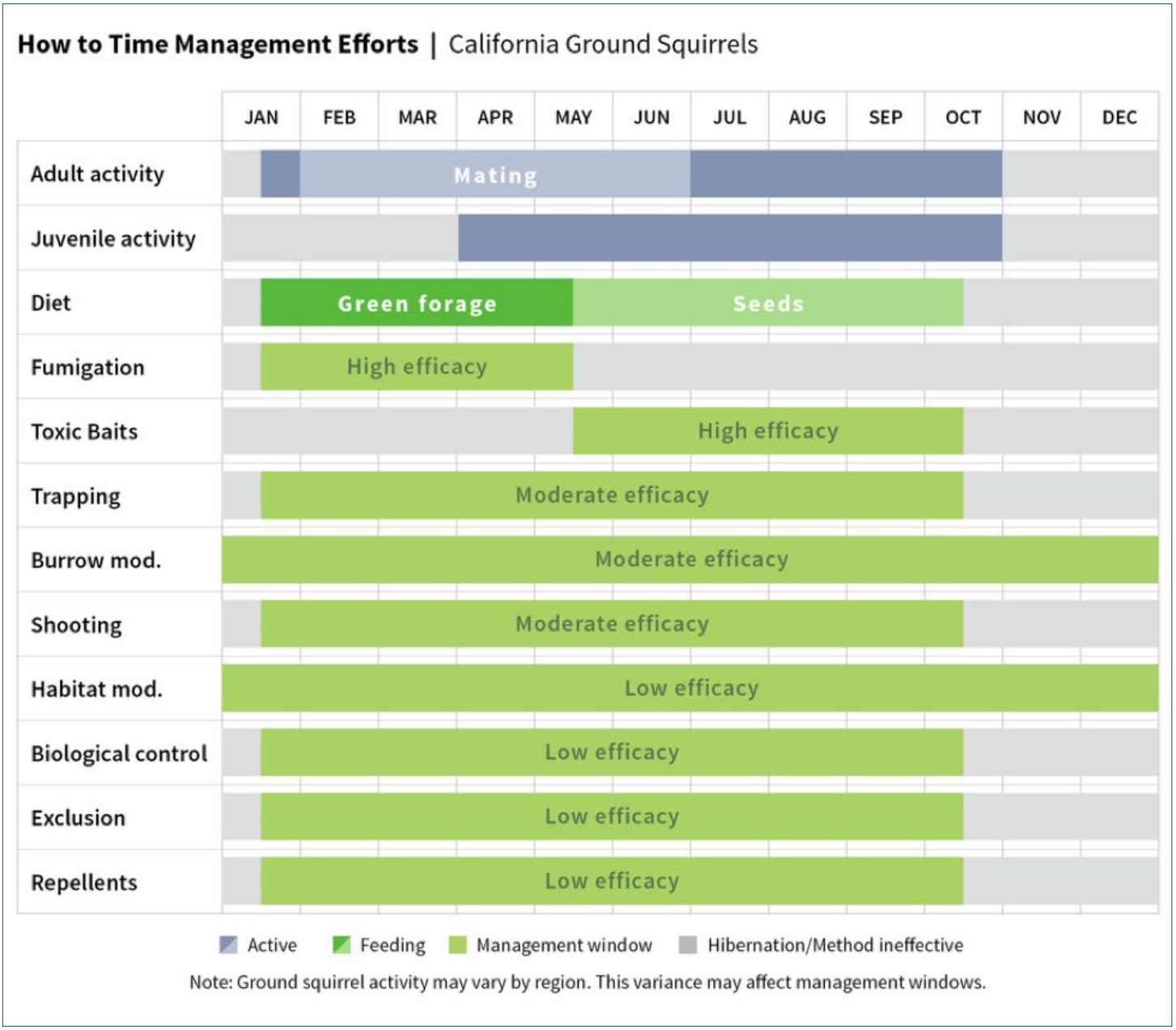

Figure 5. A pair of box-type gopher traps modified and set in the runway of ground squirrels.

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.

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WARNING ON THE USE OF PESTICIDES

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

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

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

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

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

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

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.

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