

Minutes
Contra Costa County IPM Advisory Committee
Subcommittee on IPM Decision-Making
August 15, 2019

Members Present: Larry Yost, Andrew Sutherland (Chair), Jim Donnelly, Susan Captain

Members Absent: None

Staff Present: Teri Rie, Public Works; Jill Ray, Supervisor Andersen's Office

Members of the public: Shirley Shelangoski (PASE), Susan JunFish (PASE), Dave Shoemaker (PASE), KO (PASE)

1. Introductions

2. Public comment on items not on the agenda

3. Approve minutes of July 11, 2019

A motion was made and seconded (JD/SC) to approve the minutes as written.

Ayes: Captain, Donnelly, Sutherland, Yost

Noes: None

Abstain: None

Absent: None

4. Approve Final Report from the Decision-Making Subcommittee to the full committee

The committee discussed the report and approved it with several changes.

5. Report from Jim Donnelly and Susan Captain on counties using CO and CO₂ fumigation on roadsides to control ground squirrels

Jim Donnelly and Susan Captain presented their report. See attached.

6. Report from Public Works Maintenance about vegetation management programs and staffing issues

Summary of Public Works Maintenance Report:

Teri Rie, representing the County Public Works Department, reported that the department continues to have challenges with recruitment and retention of vegetation management and other staff positions. They have already lost entry-level maintenance staff recently hired. Currently, the department does not have a certified pest control advisor and is exploring options to use contractors to produce use recommendations. All contracts would be subject to meet and confer requirements with the unions. We are currently managing the vegetation with goats and mechanical means but are not currently using herbicides.

One considerable challenge concerns the invasive weed, *Dittrichia*, growing in road cracks. They cannot use goats or mowing to control these weeds. That species drops its seeds in the summer, so they expect to see more plants next year. Eradication on the roads by hand is not feasible or cost effective.

There are many agencies using the services of Goats R Us, which increases the competition in terms of scheduling the herds. In addition, many of their animals have a disease called foot rot (hoof infection) and are currently receiving treatment by veterinarians. The late rain this past spring created wet soil conditions that lasted longer than usual for the grazing animals. These are also challenging for the vegetation management program as a whole.

It was suggested that it would be a great opportunity for the Public Works Dept to track the cost and efficacy for abating weeds without herbicides during this period (perhaps over 12 months) where herbicides were not sprayed.

7. Discuss recommendations associated with County ground squirrel management programs and methods of communication and extension of these recommendations

The committee discussed the decision document and agreed to several final changes.

8. Plan next meeting agenda

The next meeting will be September 26, 2019, 1:00 pm to 2:00 pm.

- Report from the new IPM Coordinator (20 min)
- Discuss priorities for subcommittee (20 min)
- Regular business (20 min)

DRAFT Report of the Decision-Making Subcommittee to the Contra Costa County IPM Advisory Committee.

Prepared by Andrew M. Sutherland, Subcommittee Chair, and Tanya Drlik, IPM Coordinator - August 2019

Members

Susan Captain, Jim Donnelly, Gretchen Logue (vice chair), Andrew Sutherland (chair), Larry Yost

The Decision-Making Subcommittee, as a service to the Contra Costa County IPM Advisory Committee and the residents of the County, works to document situation-specific pest management decision-making processes and to revise existing County decision documents. The subcommittee is charged with making recommendations that may improve the County's pest management processes while preventing or minimizing associated negative impacts.

Since our last report (September 2018), the Subcommittee has met eight times: November 6, 2018 and January 8, February 21, March 11, April 25, May 30, July 11, and August 15, 2019. Elections were held on February 21, with Andrew Sutherland elected as Chair and Gretchen Logue elected as Vice-Chair, both to serve until December 2019. For this report, recent activities have been grouped into three broad themes below: ground squirrel management by the Department of Agriculture, (generalized) vegetation management programs, and methods of communication and extension for the Subcommittee's recommendations.

Ground squirrel control by the Department of Agriculture

The subcommittee continued review of this pest situation and the associated decision document *Ground Squirrel Management for Critical Infrastructure*. This program is responsible for the only County use of anticoagulant rodenticides. In FY 2018-19, 0.96 lb of the active ingredient diphacinone was applied to control ground squirrels. The nontarget issues surrounding use of anticoagulants continue to be important to the County and its residents. The review process began on April 5, 2018 and continued formally until the decision document was approved (as revised) on March 11, 2019; the document is attached here. Key findings are as follows:

- The Agriculture Department manages ground squirrels as a service for the Public Works Department and, periodically, for other County entities through on-call services and vendor agreements. The decision document *Ground Squirrel Management for Critical Infrastructure* applies to services provided to Public Works. A related document, tentatively entitled *Ground Squirrel Management: On-Call Service*, remains to be created and reviewed by the IPM Coordinator and this Subcommittee.
- Fumigation (via gas cartridges, carbon monoxide, or carbon dioxide) is considered a very important alternative to anticoagulant rodenticide applications. The Subcommittee learned about various fumigation devices and products and interviewed several manufacturers and users. The Subcommittee worked with the IPM Advisory Committee to arrange two research presentations on carbon monoxide and carbon dioxide fumigation. Fumigation is most effective in spring when soil is moist. Agriculture Department staff are committed to weed management programs during spring. This labor shortage presents a major limitation to the adoption and widespread use of these alternatives by the Agriculture Department. Because of this limitation, the County has traditionally used diphacinone-treated grain bait to manage ground squirrels around critical infrastructure. Baiting is only effective from June through October when grasses are dry.
- Trapping, burrow destruction, burrow grouting, and conservation biological control (raptor perch programs) were considered as alternative management tactics. Several municipal agencies and other users were interviewed about these tactics. None of these appear to provide stand-alone control, but all should be considered as components of a robust integrated program for ground squirrel management in the County.
- The subcommittee decided to develop a decision tree that will be associated with *Ground Squirrel Management for Critical Infrastructure*. Work on this decision tree has not yet begun.
- Additional funding for the ground squirrel program will be needed to explore and implement alternatives.

Weed management programs

The Subcommittee continued some discussion surrounding vegetation management as conducted by the Department of Public Works along County rights-of-way. These programs have come under new public scrutiny due to recent litigation and public awareness of the broad-spectrum post-emergent herbicide glyphosate as a potential carcinogen. The Subcommittee reviewed these programs in detail during 2017-2018, culminating in approval of two revised decision documents: *Weed Management along Roadsides* and *Weed Management along Flood Control Channels*. Both programs have been significantly impacted by staffing challenges within Public Works; it was reported that no pesticide use has occurred within these programs since October 2018. The Subcommittee met with Public Works staff members several times during this review period to discuss these programs. Key findings and recommendations are as follows:

- Access roads associated with flood control channels are an integral part of the right-of-way. Therefore, pesticide use reported on flood control channels includes access roads, and the associated decision documents attempt to capture decision-making processes and management tactics chosen along those roads. Several questions about pesticide use along access roads have been posed by the community.
- The Subcommittee will continue to engage the Public Works Department in discussion about vegetation management on rights-of-way, hoping to advise and clarify based on the two documents recently revised.

Communication and Extension of the Subcommittee's Recommendations

The Subcommittee conducted several discussions about how best to communicate our recommendations to County decision makers. Our recommendations are captured within decision documents we review and in our annual reports, but we wonder if these are received and seriously considered by Department heads, the Board of Supervisors, and other decision makers. We outlined a process by which members of the Subcommittee may report directly to the Board via the Transportation, Water, and Infrastructure Committee. Several Subcommittee members expressed interest, and we may follow the process outlined in the future. During this review term, the sitting IPM Coordinator retired. The subcommittee will work with the incoming IPM Coordinator to identify processes and pathways by which we might extend our recommendations more broadly and impactfully.

Subcommittee Recommendations

The Decision-Making subcommittee recommends the following:

- The County allocate funding to the Agriculture Department to support ground squirrel management during spring, when fumigants such as carbon monoxide and carbon dioxide will be most effective. As a reminder, Department staff are all engaged in weed management programs in spring and unable to utilize these important alternatives to anticoagulants. This funding could be used to hire additional staff, purchase carbon monoxide fumigation equipment, hire a pest control contractor for springtime ground squirrel management, or to experiment with management protocols. The Subcommittee will work with the Department to determine the specific amounts that will required for these efforts and activities.
- The County allocate additional funding or establish alternative procedures whereby the Department of Public Works may procure a contractor to provide carbon monoxide fumigation services for ground squirrels along levees, irrigation canals, and flood-control channels during the spring. This would allow the Agriculture Department to continue focusing on their weed management programs during the spring.
- The County continue to evaluate new and existing ground squirrel management tactics, considering site requirements, efficacy, cost, impacts to the environment, and impacts to the community.
- The ground squirrel decision document be reviewed every three years, given ongoing development of new methods, changing environmental conditions, and potential changes to budgets.
- The County conduct detailed evaluations of the Public Works vegetation management programs along rights-of ways during the period October 2018 to present, given that no herbicides were applied. Have they met the control mandates set forth? Have they saved funds that may be used to evaluate and implement alternatives to herbicide applications along roadsides and flood control channels?
- The County continue to evaluate new and existing weed management tactics, considering site requirements, efficacy, cost, impacts to the environment, and impacts to the community.

- The roadside and flood control weed management documents be reviewed every three years, given ongoing development of new methods, changing environmental conditions, and potential changes to budgets.
- All IPM decision documents, once approved, be made publicly available.
- The County direct departments to annually propose and prioritize potential research projects associated with emerging and innovative strategies and tactics that will improve the County's IPM program.
- The County encourage departments to seek outside funding sources for these IPM research projects.
- The Board of Supervisors consider establishing funding to internally support such research projects.

Use of CO/CO₂ Fumigation for Burrowing Rodents in Various Jurisdiction

**Report from Jim Donnelly and Susan Captain
August 15, 2019**

The following were contacted to learn about their experience using CO fumigation for ground squirrel and rodent control

Jason Ward, Modesto Irrigation District, Irrigation Services Manager (209) 526-7637

The district began using CO fumigation about 4 years ago for ground squirrel control mostly on canal levies. The impetus for moving to CO was a reported dog death associated with rodent baiting. For three years they employed an outside contractor at an annual cost of ~\$5,000. Last year they spent ~\$10,000 to purchase a CO Fumigation system with three delivery hoses.

They are very satisfied with CO fumigation. They use it mainly on canal banks, especially in areas with high infestations. They still use broadcast bait in some areas. Using CO fumigation can achieve almost complete control: however, at a significant increase in manpower and cost when compared to baiting. They appreciate that no permits are required for its use and have seen no adverse effects. Many local almond farmers in the area contract out for CO fumigation services and appear very satisfied with its effectiveness.

They do not use the system where traffic is present and would be leery of using on roadsides.

Sherman Hanson, Santa Barbara County Parks (805) 568-2458

They have 2 PERC units (~\$15,000/unit) which they use mostly for gopher control and have been using CO fumigation for about 5 years. They use the system regularly for mostly open spaces. He stated they have to use regularly to control re-infestation. Initially they apply every 1-2 weeks and then less often after. They also use grout to seal dens in conjunction with CO. They are very satisfied with their PERC systems.

They have only limited experience with using CO for ground squirrel control as ground squirrels are located mostly in the north end of the county. He indicated that their system seems to be less effective for ground squirrel control. They do not have any experience with CO fumigation along roadsides.

Dennis Bradly, District Manager, Oregon State Parks (541) 519-6542

They have been using CO fumigation, for about 5 years, for ground squirrel control mainly in open spaces and a number of state parks. They are very happy with the process as it only takes about 20-30 minutes for treatment after a tunnel complex has been sealed at most openings. The treatments are nearly 100 % effective. However, he deals with rapid re-infestation as neighboring properties do not control ground squirrels. They do not have any experience with CO fumigation along roadsides.

Larry, Clark Pest Control, Livermore (209) 712-4663

They employ both a small and full sized PERC units. The large unit is equipped with 3 by 300 foot treatment hoses allowing them to treat more than one tunnel complex at a time. He stated the small unit is almost worthless; however, they are very happy with the large unit. They use it extensively for ground squirrel and gopher control at a number of parks and playgrounds. They do not have any experience using CO for levies or roadsides. They employ both CO fumigation and bait for control.

**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:	<p>Ground Squirrel (<i>Spermophilus beecheyi</i>)</p> <p>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.</p> <table style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 30%;"></th> <th style="width: 12.5%;">WINTER</th> <th style="width: 12.5%;">SPRING</th> <th style="width: 12.5%;">SUMMER</th> <th style="width: 12.5%;">AUTUMN</th> </tr> </thead> <tbody> <tr> <td>MAJOR ACTIVITY PERIODS</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>adults</td> <td></td> <td colspan="2" style="text-align: center;">██████████</td> <td style="text-align: center;">██████████</td> </tr> <tr> <td>reproduction</td> <td></td> <td style="text-align: center;">██████████</td> <td></td> <td></td> </tr> <tr> <td>juveniles</td> <td style="text-align: center;">██████████</td> <td colspan="3" style="text-align: center;">██████████</td> </tr> <tr> <td>MAJOR FOOD SOURCE</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>green foliage</td> <td></td> <td colspan="2" style="text-align: center;">██████████</td> <td></td> </tr> <tr> <td>seeds</td> <td></td> <td></td> <td colspan="2" style="text-align: center;">██████████</td> </tr> <tr> <td>BEST TIME FOR CONTROL</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>fumigation</td> <td></td> <td style="text-align: center;">██████████</td> <td></td> <td></td> </tr> <tr> <td>baiting</td> <td></td> <td></td> <td style="text-align: center;">██████████</td> <td style="text-align: center;">██████████</td> </tr> <tr> <td>trapping</td> <td></td> <td colspan="2" style="text-align: center;">██████████</td> <td style="text-align: center;">██████████</td> </tr> </tbody> </table> <p>From Roger Baldwin's presentation entitled "Developing a management plan for burrowing rodents in organic production", February 2019.</p>		WINTER	SPRING	SUMMER	AUTUMN	MAJOR ACTIVITY PERIODS					adults		██████████		██████████	reproduction		██████████			juveniles	██████████	██████████			MAJOR FOOD SOURCE					green foliage		██████████			seeds			██████████		BEST TIME FOR CONTROL					fumigation		██████████			baiting			██████████	██████████	trapping		██████████		██████████
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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																																																												

Agriculture Department Decision Documentation
Ground Squirrels, Revised 9/5/19

this species?	<p>treatment. Ground squirrels within this area have the potential to cause damage by burrowing.</p> <p>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.</p> <p>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.</p> <p>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.</p> <p>This same burrowing and resulting pathways for water erosion can cause damage to or sudden failure of roadsides and other structures.</p>	
Are these sensitive sites?	<p>Is there known or potential habitat for any endangered or threatened species at any of the sites?</p> <p>See below.</p>	Yes
	<p>Are any of the sites part of any of the court-ordered injunctions regarding threatened and endangered species?</p> <p>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.</p> <p>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.</p> <p>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.</p> <p>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.</p> <p>Are there other species to be aware of?</p> <p>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.</p>	Yes
	<p>Are any of the sites in or near an area where people may walk or children may play?</p> <p>The area adjacent to the EBRPD's trail along Marsh Creek is posted before it is treated. Bait is applied away from the trail.</p>	Yes
	<p>Are any of the sites near an above ground drinking water reservoir?</p> <p>Yes, the earthen dam sides (the sides away from the water) of Mallard reservoir and CC Water District canal embankments are treated.</p>	Yes
	<p>Are any of the sites near a creek or flood control channel?</p>	Yes
	<p>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.</p>	
Control Methods	<p>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/</p> <p>The County continues to investigate and review new control methods as they become available.</p>	

Efficacy of Management Methods	Management Method Efficacy California Ground Squirrels					
	Time of Year	Efficacy	Cost	Labor	Restrictions	
	Fumigation	Mid-Jan to Mid-May	HIGH			
	Toxic Baits	Mid-May to Mid-Oct	HIGH			
	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			

= Low
 = Moderate
 = High

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

* 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-ogs.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 over 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."

	<p>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)</p> <p>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)</p> <p>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.</p> <p>O₂/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.</p> <p>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."</p> <p>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.</p> <p>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.</p> <p>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."</p> <p>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.</p> <p>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.</p> <p>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.</p> <p>The Department's in-house trial of live trapping (see https://cohealth.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.</p> <p>Besides the high cost, The Department found a number of other problems with live trapping in the 2012 experimental study that the Department performed:</p> <ul style="list-style-type: none"> • 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.
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	<ul style="list-style-type: none"> • 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. <p>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.</p> <p>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 688 squirrels were captured per linear mile in the trial.</p> <p>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."</p> <p>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.</p> <p>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.</p> <p>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.</p> <p>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.</p> <p>Ventura County has stated that trapping would play a small role in their ground squirrel IPM plan because of the extensive labor required.</p> <p>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.</p>
<p>Which biological controls were considered?</p>	<p>Biological controls available: There are no biological controls currently available that can be manipulated by humans to manage ground squirrels.</p> <p>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."</p> <p>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.</p> <p>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.</p>
<p>Which chemical controls were considered?</p>	<p>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</p>

<p>For more information on pesticides listed here visit the National Pesticide Information Center (NPIC). This is a joint project of Oregon State University and the US EPA.</p> <p>http://npic.orst.edu/</p> <p>You can communicate with an actual person at 1 800 858.7378 or npic@ace.orst.edu</p> <p>They are open from 8:00AM to 12:00PM Pacific Time, Mon-Fri.</p>	<p>unlikely that they will move to a new area all together. Thus, repellents and frightening are not effective methods for ground squirrel control."</p> <p><u><i>Burrow fumigation methods:</i></u></p> <p>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.</p> <p>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.</p> <p>CO and CO₂: These fumigants require a CO or CO₂ 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 CO₂ to kill ground squirrels are not yet registered through the Department of Pesticide Regulation.</p> <p><u><i>Anticoagulant treated grain bait:</i></u></p> <p>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.</p> <p>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.</p> <p>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.</p> <p>CONCLUSIONS:</p> <p>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.</p> <p>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 & CO₂ devices are emerging technologies that may be impractical due to the difficulty in getting a CO or CO₂ producing device to the burrows.</p> <p>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.</p>
<p>Which application methods are available for this rodenticide?</p>	<p>Methods available:</p> <p>Bait Station— .005% diphacinone is registered for use in bait stations (and for broadcast baiting small areas by hand)</p> <p>Broadcast— .01% diphacinone is registered for hand or mechanical broadcast baiting over larger areas</p> <p>CONCLUSIONS:</p> <p>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</p>

	<p>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.</p> <p>Broadcast: This is generally the method of choice.</p> <p>The Department's typical protocol for ground squirrel baiting is as follows:</p> <ol style="list-style-type: none"> 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." <p>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.</p> <p>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.</p> <ol style="list-style-type: none"> 4. About 2 days after the 1st bait application, staff broadcast the 2nd application of treated bait to the same 12 to 15 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
<p>What factors were considered in choosing the pesticide application method?</p>	<p>Safety to the applicator, the environment, and nontarget species; endangered species considerations; the effectiveness of the method; and the cost to the Department.</p>
<p>What weather concerns must be checked prior to application?</p>	<p>Fumigation methods: Dry weather and dry ground greatly decreases effectiveness. At the same time the potential of starting a wildfire from this method increases.</p> <p>Dipacoinone: The main concerns are rain or heavy dew that will render broadcast bait ineffective and can cause the bait in bait stations to mold.</p>
<p>Recommendations from the IPM Advisory Committee</p>	<ul style="list-style-type: none"> • 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