Ground Burrowing Rodent Biology and Management

Carolyn Whitesell, Ph.D.
Human-Wildlife Interactions Advisor

University of California
Agriculture and Natural Resources
Squirrels in California
Squirrels
Identification

- Tree squirrel
- Ground squirrel
Ground Squirrels
Why can’t we just move the animal causing problems?
465.5 (g)(1). Immediate Dispatch or Release

- All furbearing and nongame mammals that are legal to trap must be immediately killed or released. Unless released, trapped animals shall be killed by shooting where local ordinances, landowners, and safety permit. This regulation does not prohibit employees of federal, state, or local government from using chemical euthanasia to dispatch trapped animals........
• ......Trapped animals must be euthanized or released immediately on site. Relocation of trapped wildlife is prohibited.

ANIMAL RELEASE PROHIBITED
PROHIBIDO LIBERAR ANIMALES
Translocating wildlife

• Relocated animals must find new food sources in an unfamiliar environment

• Relocated animals must find new shelter in an unfamiliar environment, while avoiding predators.
Translocating wildlife

• Your relocation may result in the deaths of young through starvation that have now lost their mother from your relocating her away from her young.

• Relocating animals raises the risk of relocating a disease like rabies to new and uninfected locales.

• It is illegal!
If we can’t move them, what CAN we do?

Create a management plan
Current Control Strategies

• Currently, we focus on an integrated approach that utilizes a number of strategies and tools to control
CA Ground Squirrel—Common Control Options

- Baiting
- Fumigation
- Trapping
- Biocontrol, habitat modification
Importance of Biology/Ecology

- Understanding the biology and ecology of vertebrate pests will guide management decisions.
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Legend:
- Active period
- Feeding period
- Method effective
- Hibernation/Method ineffective
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- **Active period**
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- **Method effective**
- **Hibernation/Method ineffective**
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- **Active period**: Blue
- **Feeding period**: Green
- **Method effective**: Light green
- **Hibernation/Method ineffective**: Grey
Ground squirrel best management practices website

Ground squirrel management for California

What are BMPs?
Best Management Practices (BMPs): the most efficient, cost-effective, and environmentally-friendly management methods that can achieve successful ground squirrel management.

What is IPM?
Integrated Pest Management (IPM): a multi-faceted, long-term approach to pest management that minimizes risks to people and the environment.
Timing Management Efforts | California Ground Squirrels

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<th>Adult activity</th>
<th>Jan</th>
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Diet

- Green forage
- Seeds

Fumigation

- High efficacy

Toxic Baits

- Trapping

Burrow mod.

- Shooting
- Habitat mod.
- Biological control
- Exclusion
- Repellents

Management Method Efficacy | California Ground Squirrels

<table>
<thead>
<tr>
<th>Method</th>
<th>Time of Year</th>
<th>Efficacy</th>
<th>Cost</th>
<th>Labor</th>
<th>Restrictions</th>
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<td>HIGH</td>
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<td>Mid-May to Mid-Oct</td>
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<td>Mid-Jan to Mid-Oct</td>
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<td>Habitat modification</td>
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<td>Biological control</td>
<td>Mid-Jan to Mid-Oct</td>
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<td>Exclusion</td>
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<td>LOW</td>
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1 Management window may be longer if high soil moisture persists, particularly following substantial irrigation.
2 Dependent on which fumigant or bait is used.

Note: Ground squirrels

Step-by-Step Guides

Visual how-to’s for:
- Bait Station Construction
- Calculating CO2 Flow
- Spreader Calibration

Resources:

FAQs
Rules and regs and burrowing rodents
Restricted Materials Permit

• This is the responsibility of the owner of the property or business operator

• However, it is your responsibility to check that before you apply a restricted use material the owner of the property has the material listed on their permit

• You, not the property owner, will receive the violation
Notice of Intent

• You must give a NOI to your County Ag Commissioner’s Department at least 24 hours before the application of a restricted use material

• The applicator has up to four days after the planned date (the date on the notice) to begin the application.

• If the pesticide application is not started in four days, a new Notice of Intent must be filed.
Written recommendation

• A written recommendation is required for the application of any pesticide on any production or non-production ag site.

• One copy of each such written recommendation shall be signed and dated and shall be furnished to the operator of the property prior to the application.

• Where a pesticide use is recommended a copy shall also be furnished to the dealer and the applicator prior to the application.
MUST have a copy of the label!
Endangered species considerations

• These must always be considered
• PRESCRIBE
DPR-PREScribe
Baiting

Poison Baits

Two main kinds:
- Anticoagulants
- Acute toxicant (Zinc Phosphide)

*California ground squirrel hibernation may differ by region*
Control Options—Baiting

• Two kinds of anticoagulants:
  - first generation
  - second generation

• First generation options
  - chlorophacinone
  - diphacinone

• Are now restricted-use
First generation anticoagulants

- Used for spot treatments, broadcast, or in bait stations
- Require multiple feedings
- Antidote available
- Check for and collect carcasses
How to Construct a Bait Station

Traditional T-type

**Materials**
- One T-junction
- Two 4-inch to 3-inch reducers
- One end cap
- PVC tape, PVC cement, or silicon glue
- Label

**Assembly**

1. Cut the PVC pipe into one 2-foot section and two 1.5-foot sections.

2. Attach the T-junction to the 2-foot pipe.

3. Attach the two 1.5-foot sections into opposite ends of the T-junction.

4. Place the reducers on the base legs (1.5-foot sections) and the end cap on top of the 2-foot section.

5. Attach a service container label near the top of the bait station.

Visit [www.groundsquirrelbmgps.com](http://www.groundsquirrelbmgps.com) for more information about ground squirrel management.
Acute toxin--Zinc phosphide

• Must be licensed professional
• Potential bait shyness
• Can be used for spot treatments and broadcast baiting
• No bait stations!
• Not permitted for use in or around buildings.

• Label is very species-specific for many locations
• Squirrel permitted in some areas
• Not in others
LAWNS, ORNAMENTALS, GOLF COURSES, PARKS AND NURSERIES

USE RESTRICTIONS: For control of meadow voles, prairie voles, pine voles, California voles, long-tailed voles, Oregon voles, mountain voles and Townsend's voles (Microtus spp.), Columbian ground squirrels (Spermophilus columbianus), Richardson's ground squirrels (S. richardsonii), thirteen-lined ground squirrels (S. tridecemlineatus), and California ground squirrels (S. beecheyi) in lawns, ornamentals, golf courses, parks, and nurseries. Bait must not be applied on roads, over water or where plants are grown for food or feed.

PREBAITING: Prebait by placing one teaspoon (4 grams) of untreated steamed crimped oats around each active burrow opening or in each active runway 2 or 3 days prior to using ZP AG OATS to enhance acceptance by ground squirrels or voles.

HAND BAITING: Place 4 grams (one teaspoon) of bait around each active burrow opening or in each active runway. Allow bait to fall through to the ground surface but do not apply bait to bare ground. Do not place bait in heaps or piles.
<table>
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<th>FGARs</th>
<th>Zinc phosphide</th>
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<tr>
<td><strong>Efficacy</strong></td>
<td>Highly efficacious</td>
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<td>Precipitation and other factors may influence efficacy</td>
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<td><strong>Bait acceptance</strong></td>
<td>Good bait acceptance</td>
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<td>Bait acceptance variable</td>
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<td><strong>Antidote</strong></td>
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<td>No antidote</td>
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<td><strong>Primary toxicity</strong></td>
<td>Lower nontarget risk</td>
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<td>Acutely toxic; risks can be high</td>
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<td><strong>Secondary Toxicity</strong></td>
<td>Some potential for risk</td>
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<td>Essentially no risk</td>
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<tr>
<td><strong>Cost</strong></td>
<td>Requires larger amount of bait, thus more expensive</td>
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<td>Less expensive than anticoagulants</td>
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<td><strong>Time to death</strong></td>
<td>Slower time to death than other toxicants</td>
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<td>Short time from consumption to death provides quick control</td>
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<td><strong>Restrictions</strong></td>
<td>Available for residential use without restriction</td>
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<td>Cannot generally be used in residential areas</td>
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<td>Field use is restricted</td>
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<td>Only one application allowed per year</td>
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Fumigation

Involves use of poison gas in burrows to control ground squirrels.

Works best when soil moisture is high (after ground squirrels emerge in spring).

Fumigants should not be used around buildings.

*California ground squirrel hibernation may differ by region*
Fumigation

Gas cartridges

Aluminum Phosphide

Carbon Monoxide

Pressure (Rodenator)

When is fumigation effective?

*California ground squirrel hibernation may differ by region

University of California
Agriculture and Natural Resources
Gas cartridges

Studies show 62–86% control for CA GS
Aluminum phosphide

- Aluminum phosphide is a restricted material
- Requires a restricted use permit to purchase and use.
- You must also be a qualified applicator or be supervised by a qualified applicator to use this material.

University of California
Agriculture and Natural Resources
• Aluminum phosphide must only be used out-of-doors for control of burrowing pests on
  – agricultural areas
  – orchards
  – non-crop areas
  – pastures
  – rangeland
  – golf courses
  – athletic fields
  – airports
• And......
  – cemeteries
  – rights-of-ways
  – earthen dams
  – parks and recreational areas
  – other non-residential institutional or industrial sites and,
  – on residential or other commercial properties
• Aluminum phosphide cannot be applied on school grounds except on athletic fields

• Can only be applied in burrow systems that are more than 100 feet from a building that is, or may be, inhabited by people or domestic animals.

• May be applied in athletic fields or parks associated with schools.
A reminder on the dangers when using aluminium phosphide – two USA child deaths

If any reminder is needed as to the dangers associated with the incorrect use of these gassing products, look no further than the USA where two children were killed.

A former pest control technician in Salt Lake City, Utah admitted his actions led to the deaths of two young girls following incorrect usage of aluminium phosphide pellets (trade name Fumitoxin) following treatment to eliminate rats in their garden.

Nocks admitted he placed the pesticide too close to the house, exceeded dosage requirements and did not provide the Toone family with the Material Safety Data Sheet and other information as required by Fumitoxin’s labeling.

The treatment was carried out on 6 February 2010. The Toone family began to get ill that night. Four-year-old Rebecca Toone died the following day and her 15-month-old sister Rachel died three days later. Rebecca and Rachel had been exposed to phosphine gas, which was given off by the aluminium phosphide pesticide pellets.

An April 2010 report from the Utah State Medical Examiner’s Office said the Toone sisters had high levels of phosphorous in their bodies and had sustained extensive lung damage as a result of their exposure to the gas.

In early January 2012 the technician, Coleman Nocks, 64, was given a sentence of 36 months probation after he pleaded guilty to a misdemeanor count of unlawful use of a registered pesticide. His employer, Bugman Pest and Lawn, was also placed on probation for 36 months and was ordered to pay $3,000 in fines.

As UK readers will be well aware, as from January 2015 all users of aluminium phosphide will need to hold the Level 2 Award in the Safe Use of Aluminium Phosphide for Vertebrate Control.

To read about the training requirements for this Award click here.
Fumigation Management Plan

DANGER

POISON GAS
KEEP AWAY

PHOSPHINE FUMIGATION IN PROGRESS

<table>
<thead>
<tr>
<th>Fumigation:</th>
<th>Start date</th>
<th>End date</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td></td>
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</table>

<table>
<thead>
<tr>
<th>Ventilation:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</tbody>
</table>

Do not access this storage during fumigation and ventilation

Ventilation period: One day with aeration fan or five days without aeration fan
Withholding period: Two days
Place warning signs at all storage access points during fumigation

Warning sign only - see label for use

University of California
Agriculture and Natural Resources
Carbon Monoxide Machines

- Potential advantages for CO:
  - Safer for use
  - Multiple applications

- Will now be regulated by CDPR—keep eye out for new regulations
# Carbon Monoxide Machines

<table>
<thead>
<tr>
<th>Species</th>
<th>Device</th>
<th>Authors</th>
<th># of fields</th>
<th>Efficacy</th>
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</thead>
<tbody>
<tr>
<td>Belding’s GS</td>
<td>PERC</td>
<td>Orloff</td>
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<tr>
<td>California GS</td>
<td>PERC</td>
<td>Baldwin</td>
<td>2</td>
<td>66%</td>
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<tr>
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<td>PERC</td>
<td>Baldwin</td>
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<td>100%</td>
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<tr>
<td>California GS</td>
<td>Cheetah</td>
<td>Baldwin</td>
<td>3</td>
<td>-7%</td>
</tr>
<tr>
<td>California GS</td>
<td>Eliminator</td>
<td>Baldwin</td>
<td>2</td>
<td>44%</td>
</tr>
</tbody>
</table>
Other strategies—Rodenator (Gas explosive device)
Trapping

Control of small populations of ground squirrels is possible with traps

Is effective during times of year when ground squirrels are not hibernating (winter)

*California ground squirrel hibernation may differ by region*
Who can trap damaging ground squirrels?

• Trapping license is required if trapping for profit.
• No trapping license required if you’re the homeowner
• County employees don’t need trapping license, but DO need notices and written recs
Control Options—Trapping

• Body-gripping traps, tube traps, and box-type squeeze traps are common kill traps.

• Wire cage traps are common live traps.

• Live traps require euthanization of vertebrate pests. No drowning!

• Wear gloves
Trapping
Control Options—Trapping

- Conibear traps can be placed at burrow entrances.

- Conibear traps can also be placed inside boxes to bait ground squirrels in while excluding larger animals.

- Wear gloves when handling all traps!
Control Options—Habitat Modification

- Involves altering habitat to reduce the desirability for pests.
- Example:
  - remove brush piles to control ground squirrels
  - destroy old burrows
Burrow Blocker system

Ground Squirrel Hole being filled by the Burrow Blocker.

Former Ground Squirrel Hole 1 year after being filled by the Burrow Blocker.

Diagram of how the Burrow Blocker effectively fills ground squirrel holes and burrows.

www.BurrowBlocker.com

University of California
Agriculture and Natural Resources
• Cost
• Logistics (other equipment)
• Limited site suitability
Control Options—Biocontrol

• Natural predators have been used to control vertebrate pests.

• Owl boxes are not appropriate for ground squirrels.

• Raptor perches appear ineffective.
Questions?

Dr. Carolyn Whitesell
Human-Wildlife Interactions
Advisor
cawhitesell@ucanr.edu
650-276-7424
Gophers

• Considerable research in the last 10 years on gophers
• Much of it carried out in California
Typical gopher mounds
Gopher mounds
Mole mound
Estimate loss in revenue in agriculture

- Alfalfa: 9%
- Grapes: 6%
- Nuts: 6%
- Vegetables: 5%
- Tree fruit: 5%
- Berries: 5%
Estimates of losses and costs in the urban environment
## Management options

An Integrated Approach

<table>
<thead>
<tr>
<th>Habitat modification</th>
<th>Baiting</th>
<th>Burrow fumigation</th>
<th>Trapping</th>
<th>Exclusion</th>
<th>Repellent</th>
<th>Frightening</th>
<th>Shooting</th>
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<td>✗</td>
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</tr>
</tbody>
</table>
Habitat modification

• Deep disking/ripping
• Not generally an option in urban California
Exclusion

- Baskets around particular plants
- Underground fencing
  - Hardware cloth
  - Wire mesh ½- ¾ inch
Baiting

• Mostly restricted use in CA (unless used by homeowner)
  – Anticoagulants
  – Zinc phosphide
  – Strychnine

• Avoid in gardens with root veggies; only place bait underground
Strychnine

- Acute toxicant
- Preferred bait for controlling gophers given its acute toxicity
- More palatable flavor than zinc phosphide
- Very effective
- Behavioral resistance to strychnine baits
- Current shortage of strychnine baits in the United States
Wilco Distributors, Inc., who has been the primary importer of strychnine for pest control purposes into the U.S., recently stopped the importation of strychnine and halted all production of strychnine baits.
Zinc Phosphide

- Need license
- Acute toxicant
- Can also be effective
- Gophers can develop bait shyness
- More readily available than Strychnine
Anti-coagulant rodenticides

- Diphacinone and Chlorophacinone
- First generation anticoagulant rodenticides
  - Multiple feeding
- Use when worried about primary toxicity from other products
- Risks of secondary toxicosis
  - Low
Bait application

• Using a bait probe or metal rod, probe 6-12 inches deep to locate the main tunnel.
• Drop 1/2 cup (CHECK LABEL) into the tunnel and cover the hole so that no light enters the tunnel system.
• Make 2-3 treatments per burrow system (CHECK LABEL).
• Maintain a constant supply of bait in the burrow system for as long as there is gopher activity.
• Do not apply bait on the surface of the soil.
• Be sure that bait is in the main runway - not in the laterals or imbedded in the bottom of the runway.
Step 1. **Open the burrow.**

Step 2. **Bait the burrow**

Step 3. **Close the burrow**
Fumigation

• Gas cartridges
  – Effective for ground squirrels (62–86% control).
  – Not effective for gophers.

• Aluminum phosphide
  – Highly effective for gophers (90-100%).
  – Is a restricted use pesticide.
Carbon Monoxide
Trapping

- Macabee vs Gophinator
- Covered vs uncovered
- Attractant vs no attractant
- Trained vs untrained
- Gloves vs no gloves
- “Above” ground traps vs “in” tunnel traps
Macabee vs Gophinator
Gophinator

• Powerful trap
• Grips the animal high on the body
• Trigger arm offset to prevent upward pressure on gopher
• Rotating pincer arm that clamps to stationary arm
  – More secure capture
Spring--Trap Type

- Gophinator
- Macabee

Capture rate vs Weight (g)

- 60-100
- 105-145
- 150-190
- 195-235
- 240-280
Types of trap

• Turf damage
  – Gophinator
  – Maccabee
  – Black hole and box

• Less turf damage
  – Cinch trap
  – Gopher Hawk