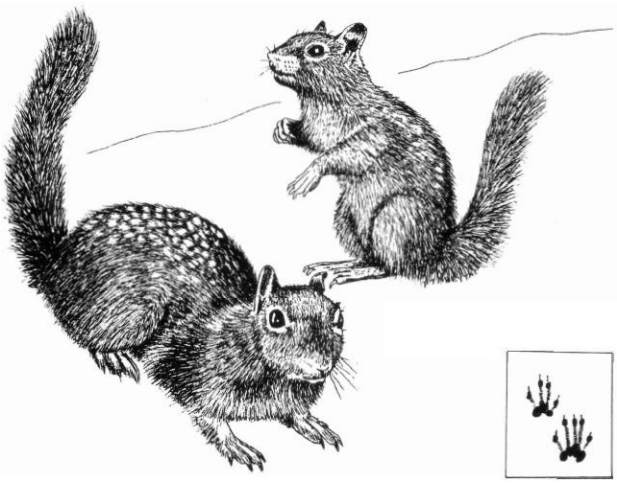
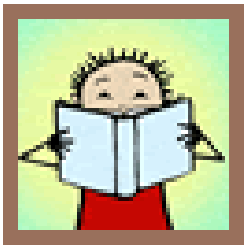
BIOLOGY, LEGAL STATUS, CONTROL MATERIALS, AND DIRECTIONS FOR USE

Ground Squirrels

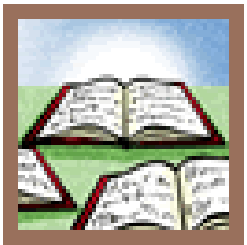
Spermophilus beecheyi **and its subspecies: Beechey, Douglas, Fisher, Sierra, Juarez, and Lesser California Ground Squirrel**
S. beldingi beldingi, **Belding Ground Squirrel, and**
S. beldingi oregonus, **Oregon Ground Squirrel**
Family: Sciuridae





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

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



Legal Status: Ground squirrels are classified as nongame mammals by the

California Fish and Game Code.* Nongame mammals which are found to be injuring growing crops or other property may be taken at any time or in any manner by the owner or tenant of the premises. They may also be taken by officers or employees of the Department of Food and Agriculture or by federal or county officials or employees when acting in their official capacities pursuant to the provisions of the Food and Agricultural Code pertaining to pests.

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

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

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

The threat of seepage or collapse of levees and ditch banks requires the elimination or control of these burrowing rodents where they inhabit such structures. Permanent exclusion of squirrels is possible by such devices as concrete linings, but the expense is usually prohibitive. Other areas where ground squirrel burrowing is unacceptable include golf courses, railroad rights-of-way, horse pastures and cemeteries.

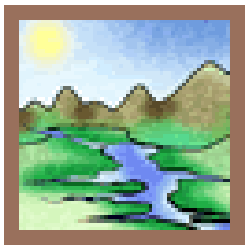
Ground squirrels are frequently named as causal agents in human cases of sylvatic (bubonic) plague in California. Circumstantial evidence points to ground squirrels as the host to plague-infected fleas in over half the reported human plague cases in California in the last 40 years. Ground squirrels are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

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

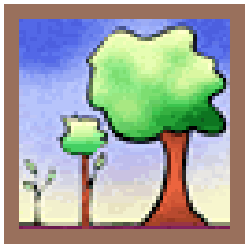
Range: *Spermophilus beldingi* in California is composed of two subspecies. *S. b. oregonus* inhabits Modoc, Lassen, and eastern Siskiyou Counties and *S. b. beldingi* the high Sierra Nevada south to Fresno and Inyo Counties. *S. beecheyi* is composed of three main subspecies: the Beechey ground squirrel,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

Belding Ground Squirrel

California Ground Squirrel



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



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

All species of ground squirrels dig burrows which are used for safety retreats, for shelter during very hot or rainy weather and during hibernation, for occasional storage of food, and for rearing young. Burrows are made in flat lands, in hillsides, or among rocks, and in embankments. There is no evidence that ground squirrels plug the entrances to their burrow systems. Surface plugs are probably the work of gophers that have intersected the burrow system.

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

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

seed-eater that the California ground squirrel is.

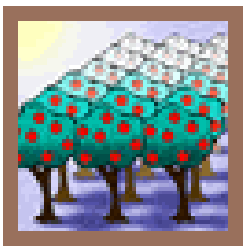
Hibernation and estivation: California ground squirrels may experience two periods of dormancy throughout the animals yearly activity cycle. Estivation or summer sleep generally occurs during July and August if it occurs at all. All California ground squirrels living at high altitudes and some of the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

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

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

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

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



Damage Prevention and Control Methods

Exclusion

Ground squirrels can be excluded from buildings using the same techniques as for other commensal rodents such as mice or rats. However, exclusion using fences is

rarely practicable because of the animals climbing and digging ability. Marsh 1994 states that ground squirrels can readily dig beneath fences buried several feet deep in the soil. The use of sheet metal to 'cap' off the top of a fence may prevent them from climbing over; the fence should be at least 4 feet height. Realistically, for a fence to remain squirrel proof the squirrels that burrow nearby should be eliminated.

Habitat Modification

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

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

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

Frightening

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

Fumigants:

Aluminum phosphide - 2-4 tablets per burrow opening.

Phostoxin®

Fumitoxin®

Detia® Rotox AT

Magnacide "H" - 20 cc per burrow opening.

Gas cartridges - 1 to 2 per burrow opening.

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

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

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

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

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

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

Acrolein - Magnicide "H"
Place nozzle applicator device as far into the active burrow entrance as possible. Shovel soil onto the applicator device and the burrow entrance to create a seal that will prevent loss of gas. Dispense fumigant at the rate of 20 cc per burrow. Withdraw application device and seal burrow opening by tamping it tightly.

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

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

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

Toxicants:

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

CDFA labels 2.0% Zinc phosphide Treated Grain

Spot baiting - 2.0%

Broadcast baiting - 2.0%

Anticoagulants - % on bait for:

Used in bait stations:

0.005% Chlorophacinone Treated Grain

0.005% Diphacinone Treated Grain

Spot baiting with repeated treatment:

0.01% Chlorophacinone Treated Grain

0.01% Diphacinone Treated Grain

Mechanical Spreader with follow-up

0.01% Chlorophacinone Treated Grain

0.01% Diphacinone Treated Grain

Fumigants:

Aluminum phosphide - 2-4 tablets per burrow opening.

Phostoxin®

Fumitoxin®

Detia® Rotox AT

Magnacide "H" - 20 cc per burrow opening.

Gas cartridges - 1 to 2 per burrow opening.

Directions for Use

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

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

at the rate of six pounds per swath acre through infested area.

Anticoagulant Baits:

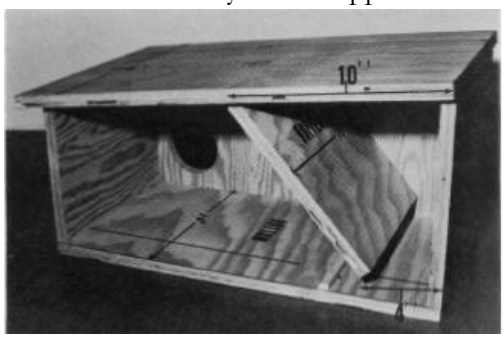
NOTE: A single feeding of anticoagulant baits (diphacinone or chlorophacinone), will not control ground squirrels. Bait must be eaten over a period of several days to a week or more to achieve adequate control.

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

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

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

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



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

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

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

placing them on a baseboard.

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

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

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

REFERENCES AND ADDITIONAL READING

Atwill, Edward R., R. Phillips, F. Rulofson, 2002. Environmental Loading Rates of the Waterborne Pathogenic Protozoa Cryptosporidium Parvum in Certain Domestic and Wildlife Species in California. Proc. 20th Vertebrate Pest Conf. (R.M. Timm and R.H. Schmidt, Eds.) Published at Univ. of Calif., Davis. Pp. 241-243.

Baker, Rex O., R. Krieger, 2002. Phosphine Exposure to Applicators and Bystanders form Rodent Burrow Treatment with Aluminum Phosphide. Proc. 20th Vertebrate Pest Conf. (R.M. Timm and R.H. Schmidt, Eds.) Published at Univ. of Calif., Davis. Pp. 267-276.

Balliette, John, J.M. O'Brien, J.D. Eisemann, 2006. Efficacy of Strychnine and Zinc Phosphide Cabbage Baits in Controlling Ground Squirrels in Diamond Valley, Nevada. Proc. 22nd Vertebrate Pest Conf. (R.M. Timm and J.M. O'Brien, Eds.) Published at Univ. of Calif., Davis. Pp. 151-155.

Baroch, J.A., 1996. Field Efficacy of Diphacinone Grain Baits Used to Control the California Ground Squirrel. Proc. 17th Vertebrate Pest Conf. (R.M. Timm & A.C. Crabb, Eds.) Published at Univ. of Calif., Davis. Pp. 127-132.

Barnes, Allan M., 1990. Plague in the U.S.: Present and Future. Proc.14th Vertebrate Pest Conf. (L.R. Davis and R.E. Marsh, Eds.) Published at Univ. of Calif., Davis Pp. 43-46.

Borrecco, John E., H.C. Black, 1990. Animal Damage Problems and Control Activities on National Forest System Lands. Proc.14th Vertebrate Pest Conf. (L.R. Davis and R.E. Marsh, Eds.) Published at Univ. of Calif., Davis Pp. 192-198.

Bourne, John B., L.D. Roy, M. Hiltz, P.N. Merrill, W. Hoffmann, 2002. Strychnine Baits to Control Richardson's Ground Squirrels: An Old Story, A New Twist. Proc. 20th Vertebrate Pest Conf. (R.M. Timm and R.H. Schmidt, Eds.) Published at Univ. of Calif., Davis. Pp. 11-16.

Clark, Jerry P., 1994. Acrolein as a Ground Squirrel Burrow Fumigant. Proc. 16th Vertebrate Pest Conf. (W.S. Halverson & A.C. Crabb, Eds.) Published at Univ. of Calif., Davis. Pp. 78-79.

Doane, Becky, D. Blodget, B Bonnivier, 1996. How to Control A Pest's –Flea and Rodent Efficacy. Proc. 17th Vertebrate Pest Conf. (R.M. Timm & A.C. Crabb, Eds.) Published at Univ. of Calif., Davis. Pp. 197-198.

Edge, W. Daniel, 1990. A Comparison of Three Traps for Removal of Columbian Ground Squirrels. Proc.14th Vertebrate Pest Conf. (L.R. Davis and R.E. Marsh, Eds.) Published at Univ. of Calif., Davis Pp. 104-106.

Eisemann, John D., K.A. Fagerstone, J.R. O'Hare, 2006. Wildlife Contraceptives: A Regulatory Hot Potato. Proc. 22nd Vertebrate Pest Conf. (R.M. Timm and J.M. O'Brien, Eds.) Published at Univ. of Calif., Davis. Pp. 63-66.

Ellis, Tracy, T.P. Salmon, C. Wilen, 2006. Evaluation of Irrigation Valve Boxes as Underground Bait Stations for California Ground Squirrel Control. Proc. 22nd Vertebrate Pest Conf. (R.M. Timm and J.M. O'Brien, Eds.) Published at Univ. of Calif., Davis. Pp. 148-150.

Fagerstone, Kathleen A., 2002. Professional Use of Pesticides in Wildlife Management – An Overview of Professional Wildlife Damage Management. Proc. 20th Vertebrate Pest Conf. (R.M. Timm and R.H. Schmidt, Eds.) Published at Univ. of Calif., Davis. Pp. 253-260.

Gage, Kenneth L., J.A. Montenieri, R.E. Thomas, 1994. The Role of Predators in the Ecology, Epidemiology, and Surveillance of Plague in the United States. Proc. 16th Vertebrate Pest Conf. (W.S. Halverson & A.C. Crabb, Eds.) Published at Univ. of Calif., Davis. Pp. 200-206.

Gilson, Arlette, T.P. Salmon, 1990. Ground Squirrel Burrow Destruction: Control Implications. Proc.14th Vertebrate Pest Conf. (L.R. Davis and R.E. Marsh, Eds.) Published at Univ. of Calif., Davis Pp. 97-98.

Giusti, Gregory A., D.A. Whisson, W.P. Gorenzel, 1996. Rodents and Cover Crops-A Review. Proc. 17th Vertebrate Pest Conf. (R.M. Timm & A.C. Crabb, Eds.) Published at Univ. of Calif., Davis. Pp. 59-61.

Harrison, Jr., Frederick J., 1996. Managing Plague in Endangered Species Habitats. Proc. 17th Vertebrate Pest Conf. (R.M. Timm & A.C. Crabb, Eds.) Published at Univ. of Calif., Davis. Pp. 230-233.

Hueth, Brent, B. Cohen, D.Zilberman, 1998. Non-Predator Vertebrate Pest Damage in California Agriculture: An Assessment of Economic Impacts in Selected Crops. Proc. 18th Vertebrate Pest Conf. (R.O. Baker & A.C. Crabb, Eds.) Published at Univ. of Calif., Davis. Pp. 371-377.

Hygnstrom, Scott E., K.C. VerCauteren, J.D. Ekstein, 1996. Impacts of Field-Dwelling Rodents on Emerging Field Corn. Proc. 17th Vertebrate Pest Conf. (R.M. Timm & A.C. Crabb, Eds.) Published at Univ. of Calif., Davis. Pp. 148-150.

Kowalski, Victor J., R. Long, J. Sullins, S. Garcia, T.P. Salmon, 2006. Grower Evaluation of California Ground Squirrel (Spermophilus beecheyi) Control Using Anticoagulant Baits. Proc. 22nd Vertebrate Pest Conf. (R.M. Timm and J.M. O'Brien, Eds.) Published at Univ. of Calif., Davis. Pp. 142-147.

Lewis, Steven R., J.M. O'Brien, 1990. Survey of Rodent and Rabbit Damage to Alfalfa Hay in Nevada. Proc.14th Vertebrate Pest Conf. (L.R. Davis and R.E. Marsh, Eds.) Published at Univ. of Calif., Davis Pp. 116-119.

Loredo-Prendeville, Ivette, D. Van Vuren, A.J. Kuenzi, M.L. Morrison, 1994. California Ground Squirrels At Concord Naval Weapons Station: Alternatives for Control and the Ecological Consequences. Proc. 16th Vertebrate Pest Conf. (W.S. Halverson & A.C. Crabb, Eds.) Published at Univ. of Calif., Davis. Pp. 72-77.

Marsh, Rex E., A.E. Koehler, T.P. Salmon, 1990. Exclusionary Methods and Materials to Protect Plants from Pest Mammals—A Review. Proc.14th Vertebrate Pest Conf. (L.R. Davis and R.E. Marsh, Eds.) Published at Univ. of Calif., Davis Pp.174-180.

Marsh, Rex E., 1994. Current (1994) Ground Squirrel Control Practices in California.
Proc. 16th Vertebrate Pest Conf. (W.S. Halverson & A.C. Crabb, Eds.) Published at Univ. of Calif., Davis. Pp.61-65.

Nash, Paul B., D.K. James, L.T. Hui, L.A. Miller, 2004. Fertility Control of California Ground Squirrels using GnRH Immunocontraception. Proc. 21st Vertebrate Pest Conf. (R.M. Timm and W.P. Gorenzel, Eds.) Published at Univ. of Calif., Davis. Pp. 274-278.

O'Brien, John M., 2002. Fresh Cabbage Bait for Ground Squirrel Control. Proc. 20th Vertebrate Pest Conf. (R.M. Timm and R.H. Schmidt, Eds.) Published at Univ. of Calif., Davis. Pp. 7-10.

O'Connell, Ross A., J.P. Clark, 1992. A Study of Acrolein as an Experimental Ground Squirrel Burrow Fumigant. Proc. 15th Vertebrate Pest Conf. (J.E. Borrecco & R. E. Marsh, Eds.) Published at Univ. of Calif., Davis. Pp. 326-329.

O'Connell, Ross A., 1994. Trapping Ground Squirrels As A Control Method. Proc. 16th Vertebrate Pest Conf. (W.S. Halverson & A.C. Crabb, Eds.) Published at Univ. of Calif., Davis. Pp. 66-67.

Ramey, Craig A., E.W. Schafer, Jr., 1996. The Evolution of Aphis Two Gas Cartridges. Proc. 17th Vertebrate Pest Conf. (R.M. Timm & A.C. Crabb, Eds.) Published at Univ. of Calif., Davis. Pp. 219-224.

Salmon, Terrell P., D.A. Whisson, W.P. Gorenzel, 2000. Use of Zinc Phosphide for California Ground Squirrel Control. Proc. 20th Vertebrate Pest Conf. (R.M. Timm and R.H. Schmidt, Eds.) Published at Univ. of Calif., Davis. Pp.346-357.

Silberhorn, Eric M., D.L. Schnabel, T.P. Salmon, 2006. Ecological Risk Assessment for Use of Agricultural Rodenticides in California. Proc. 22nd Vertebrate Pest Conf. (R.M. Timm and J.M. O'Brien, Eds.) Published at Univ. of Calif., Davis. Pp. 458-462.

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

Sullins, Monty, D. Sullivan, 1992. Observations of A Gas Exploding Device for Controlling Burrowing Rodents. Proc. 15th Vertebrate Pest Conf. (J.E. Borrecco & R. E. Marsh, Eds.) Published at Univ. of Calif., Davis. Pp. 308-311.

Townzen, Kenneth R., M.A. Thompson, C.R. Smith, 1996. Investigations And Management of Epizootic Plague at Ice House Reservoir Eldorado National Forest, California, 1994 and 1995. Proc. 17th Vertebrate Pest Conf. (R.M. Timm & A.C. Crabb, Eds.) Published at Univ. of Calif., Davis. Pp. 68-74.

Van Vuren, Dirk, 1998. Manipulation Habitat Quality to Manage Vertebrate Pests. Proc. 18th Vertebrate Pest Conf. (R.O. Baker & A.C. Crabb, Eds.) Published at Univ. of Calif., Davis. Pp. 383-390.

VerCauteren, Kurt C., M.J. Pipas, J. Bourassa, 2002. Application of Burrow Cameras in Wildlife Damage Research. Proc. 20th Vertebrate Pest Conf. (R.M. Timm and R.H. Schmidt, Eds.) Published at Univ. of Calif., Davis. Pp. 17-19.

Whisson, Desley A., 1998. Modified Bait Stations for California Ground Squirrel Control in Endangered Kangaroo Rat Habitat. Proc. 18th Vertebrate Pest Conf. (R.O. Baker & A.C. Crabb, Eds.) Published at Univ. of Calif., Davis. Pp. 233-235.

Whisson, Desley A., T.P. Salmon, W.P. Gorenzel, 2000. Reduced Risk Anticoagulant Baiting Strategies for California Ground Squirrels. Proc. 20th Vertebrate Pest Conf. (R.M. Timm and R.H. Schmidt, Eds.) Published at Univ. of Calif., Davis. Pp.362-364.

Winchell, Clark S., 1994. Natural History and Protection of Burrowing Owls. Proc. 16th Vertebrate Pest Conf. (W.S. Halverson & A.C. Crabb, Eds.) Published at Univ. of Calif., Davis. Pp. 83-86.