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SMALL GRAIN PRODUCTION MANUAL
PART 8

Pest Management of Small Grains—Vertebrates

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This publication, *Pest Management of Small Grains—Vertebrates*, is the eighth in a fourteen-part series of University of California Cooperative Extension online publications that comprise the *Small Grain Production Manual*. The other parts cover specific aspects of small grain production practices in California:

- *Part 1: Importance of Small Grain Crops in California Agriculture*, Publication 8164
- *Part 2: Growth and Development*, Publication 8165
- *Part 3: Seedbed Preparation, Sowing, and Residue Management*, Publication 8166
- *Part 4: Fertilization*, Publication 8167
- *Part 5: Irrigation and Water Relations*, Publication 8168
- *Part 6: Pest Management—Diseases*, Publication 8169
- *Part 7: Pest Management—Insects*, Publication 8170
- *Part 9: Pest Management—Weeds*, Publication 8172
- *Part 10: Small Grain Forages*, Publication 8173
- *Part 11: Small Grain Cover Crops*, Publication 8174
- *Part 12: Small Grains in Crop Rotations*, Publication 8175
- *Part 13: Harvesting and Storage*, Publication 8176
- *Part 14: Troubleshooting Small Grain Production*, Publication 8177

Small grain crops provide an attractive habitat and food source to a variety of vertebrate pests. The burrows and soil mounds created by some vertebrate pests cause problems with irrigation (primarily in flood-irrigated fields) and can damage harvest equipment and disrupt harvest operations. Meadow mice, ground squirrels, and pocket gophers are the most serious vertebrate pests in small grains in California. Rabbits, hares, deer, wild pigs, and migrating waterfowl can also cause serious damage. The potential for damage varies between fields and can depend on cultural practices (irrigation, field rotation), soil type, the location of the field, and the surrounding habitats. Fields near rangeland, forested areas, and other uncultivated weedy areas are generally at higher risk and are invaded more quickly than fields bordered by frequently cultivated land.

UC PEER REVIEWED

The most successful vertebrate control practices keep vertebrate pest populations below levels at which significant damage occurs. This requires knowledge of the biology and behavior of the potential pests and regular monitoring for them in and around fields. Historical records of pest population levels, control measures imple-

mented, and the success of methods used can help determine the best management approach, as can consideration of the presence of nonpest species. In many areas, the presence of endangered species limits the choice of control measures.

Because control options vary with the pest, it is important to correctly identify the species that is causing damage before implementing a management program. To identify pests, observe the location and type of damage within the field; examine signs such as feces, tracks, burrows, and mounds; and observe the animal itself if at all possible. More than one method (table 1) is available to manage populations of most vertebrate pests, and natural biological controls can help keep some vertebrate pests from reaching damaging levels. Predators such as hawks, owls, foxes, coyotes, and snakes feed on some of the vertebrate pests of small grains. Predators alone, however, usually cannot keep vertebrate pests from reaching damaging levels. The high reproductive rate of small rodents allows their populations to quickly compensate for losses to predation. In addition, a predator usually modifies its diet according to relative abundance of prey species. Therefore, enhancing habitat to attract predators should only be a small part of an integrated pest management program.

The legal aspects of vertebrate pest management must be considered before initiating control measures. Under the California Fish and Game Code, pocket gophers, meadow voles, California ground squirrels, black-tailed jackrabbits, and cottontails may be lethally removed at any time by the property owner or tenant if the vertebrate is causing or about to cause crop depredation. Deer and wild pigs may be lethally removed only during the hunting season or under a depredation permit obtained from the Department of Fish and Game. Only pesticides that are registered with the U.S. EPA's Department of Pesticide Regulation (DPR) can be legally used for vertebrate pest control (see the California DPR Web site at http://www.cdpr.ca.gov/). The use of certain vertebrate pest control measures may be restricted in areas where endangered species are present. Use restrictions are outlined in county bulletins that are available through the DPR's Web site or from county agricultural commissioners. Live traps are also sometimes used for managing vertebrate pests. Under the California Fish and Game Code, it is illegal to trap and relocate an animal. Live-trapped pest animals should be euthanized humanely. Methods considered humane by the American Veterinary Medical Association include gassing with carbon dioxide, shooting, or a sharp blow to the head (see Salmon et al. 2006 for more information).

Table 1. Control options for vertebrate pests in small grains

Pest	Habitat modification	Trapping	Fencing	Shooting	Baiting	Burrow fumigation
pocket gopher	X	X			X	X
meadow vole	X				X	
ground squirrel		X		X	X	X
rabbit/hare	X	X	X	X	X	
feral pig		X		X		

Figure 1. Voles (meadow mice). Photo by Jack Kelly Clark.

MEADOW VOLES

Meadow voles (*Microtus* spp.), also called meadow mice (fig. 1), feed on the succulent parts of small grains, cutting down older plants to feed on the seed. They may consume most of the grain in forage crops that are harvested and windrowed at the soft dough stage and then left in the field too long. Meadow voles have a body length of 4 to 6 inches (10 to 15 cm) when mature, heavy bodies, short legs and tail, small eyes, and small, partially hidden ears. Their soft, dense fur is blackish brown to grayish brown. Meadow voles are active year-round. They dig short, shallow burrows and make underground nests of grass, stems, and leaves. Well-worn trails 2

inches (5 cm) wide leading to unplugged entrance holes are a good indication that significant numbers of meadow voles are present. Meadow voles reproduce very rapidly, and populations fluctuate considerably. Populations usually reach high levels every 7 to 10 years. A female can produce from 2 to 5 litters per year, with an average of 4 or 5 young. In an expanding population, breeding occurs throughout the year, with peak reproduction evident in the spring.

Meadow voles invade crops from noncrop areas such as ditches, grasslands, and orchards that support them year-round. Practices that make surrounding areas less favorable to meadow voles, such as controlling weeds, reducing ground cover, and cultivating fence rows, roadsides, and ditch banks, can be effective in preventing serious problems. If a forage crop must be harvested at the soft dough stage, remove it from the field as quickly as possible. Where meadow vole problems are serious, applying bait is the only effective control. Zinc phosphide and the anticoagulants diphacinone and chlorophacinone are registered for meadow vole control but cannot be used within crops during growing periods. Bait may be applied mechanically or by hand.

Figure 2. Belding's ground squirrel. Photo by Jack Kelly Clark.

GROUND SQUIRRELS

Ground squirrels occasionally damage small grains that are planted adjacent to rangelands, orchards, or other squirrel-infested areas. Damage usually occurs only on the perimeters of crops, although populations occasionally spread to rainfed fields. Ground squirrels may cause damage any time during the year when they are active. They may remove seedlings shortly after planting and may also remove plants in mature fields. Damage can be especially severe in the vicinity of squirrel burrow systems. Ground squirrel burrows may interfere with irrigation and may damage ditchbanks and levees.

Belding's ground squirrel (*Spermophilus beldingi*) (fig. 2), found in northeastern California, is a relatively small squirrel with a head and body 5 to 9 inches (12.5 to 23 cm) long and a short tail that is not bushy. The California ground squirrel (*S. beecheyi*) (fig. 3), found throughout most of the rest of California, is a large ground squirrel with the head and body 9 to 11 inches (23 to 28 cm) long, gray-brown fur mottled by light flecks, and a semibushy tail. Belding's ground squirrel prefers to feed on green plants while the California ground squirrel prefers green foliage during the spring but generally eats seeds later in the season. As a result of these feeding differences, the Belding's ground squirrel is much more difficult to control with grain baits.

Figure 3. California ground squirrel. Photo by Jack Kelly Clark.

Ground squirrels spend much of their time sunning, feeding, and socializing. Burrows provide protection as well as a place to sleep and rest, rear young, and store food. Entrances are always unplugged. Ground squirrels live in colonies. Females have 1 litter averaging 7 to 8 young per year in the spring. About 6 weeks after birth the young ground squirrels emerge from the burrows and begin to graze on green vegetation. During the hottest and driest part of the summer and fall, many adult squirrels go into a resting state (estivation) until temperatures become more favorable. Most squirrels, especially the adults, hibernate in the winter. Because of these periods of inactivity, ground squirrel numbers seem much greater in spring and early fall than at other times of the year.

Monitor fields and adjacent areas regularly for signs of ground squirrel activity and take control actions when populations are small.

Burrow fumigants, poison baits, and trapping are the three major control options. The success of these practices varies and depends largely on correct timing. Burrow fumigation is most successful in the spring or after irrigation, when soil moisture is high. Fumigation is not as effective during periods in the summer and winter when most of the ground squirrels are inactive. At these times the squirrels seal themselves in their nesting chambers in the burrows and are not exposed to the gas. Fumigants should be placed in burrows that show sign of recent squirrel activity, and the burrow entrance should be sealed with a wad of newspaper and tamped soil. Several fumigants are currently registered for ground squirrel control. Acrolein is a restricted-use material that is injected into burrows through a dispensing rod using nitrogen gas as the propellant. Aluminum phosphide in the form of tablets or pellets, also a restricted-use material, reacts with atmospheric and soil moisture to produce phosphine gas. Gas cartridges (smoke bombs) are relatively easy and safe to use.

Poison baits are either acute (squirrels die after a single feed) or chronic (squirrels need to consume bait over a period of up to 5 days). Zinc phosphide (a restricted-use acute poison) and the anticoagulants diphacinone and chlorophacinone (chronic poisons) are currently registered for ground squirrel control in California. The poison is applied on grain (loose or as a pellet), so it is most effective in the late spring and fall when seeds are the ground squirrels' preferred food. Baits are not registered for broadcast application on small grain fields, but they may be applied to noncrop perimeters. Where practical, anticoagulant baits offered in bait stations can be used within the crop. Ground squirrels may travel 500 feet (152 m) or more from rangeland to a grain field to secure a highly preferred food. Bait stations along the margins of the field are particularly useful for controlling these invaders.

Trapping sometimes provides satisfactory control of small numbers of squirrels in late summer or early fall. A number of kill traps (Conibear trap, modified pocket gopher trap) are available. Shooting may be effective where population levels are low or to control survivors of other control operations, but it is seldom effective with large infestations.

POCKET GOPHERS

Pocket gophers (*Thomomys* spp.) (fig. 4) are burrowing rodents whose name is derived from the pair of large, external, fur-lined cheek pouches in which they carry food and nest material. Adult gophers are 6 to 8 inches (15 to 20 cm) long and have bodies that are well adapted to an underground existence. They have small external ears, small eyes, and lips that close behind their large incisors, enabling them to keep soil out of their mouth while burrowing. They use their short whiskers and tails to help navigate tunnels. They seldom travel above ground, but sometimes may be seen feeding or pushing dirt out of their burrow system. They are generally more active excavating soil in the spring and fall than they are during the heat of summer. In uncultivated and nonirrigated areas, females normally produce 1 litter per year averaging 5 or 6 young during the rainy season when green forage is plentiful. In areas where a source of nutritious green vegetation is available year-round, pocket gophers may breed continuously.

Figure 4. Pocket gopher. Photo by Jack Kelly Clark.

Pocket gophers have a maximum life span of about 5 years. They are extremely territorial and antisocial. As soon as young are weaned, they leave their mother's burrow and establish their own territory. A burrow system can cover an area from a few hundred feet up to more than 1,000 square feet (93 square meters). Tunnels are 2 to 3 inches (5 to 7.5 cm) in diameter, and most are from 8 to 12 inches (20.5 to 30.5 cm) below the ground, with nests and food storage chambers somewhat deeper. Crescent-shaped mounds of fresh soil indicate their presence. The mounds are formed as the animals push soil out of their burrows through lateral tunnels up to the surface. They plug the burrow soon after digging it to preserve a fairly constant temperature and humidity within the burrow system. Gophers may dig secondary tunnels off the main burrow for occasional aboveground grazing. In these cases, no distinctive mounds are formed. Fresh mounds of loose, finely textured soil indicate an active pocket gopher system. Because gophers also backfill old tunnels, the number of fresh mounds is not an indication of the number of gophers in an area. Pocket gopher populations may reach high densities in small grains, especially when small grains are planted after alfalfa. High gopher populations should be controlled prior to the planting of small grains. Pocket gophers feed on grain plants, and the burrows and soil mounds they produce cause problems with irrigation and harvesting equipment.

Successful pocket gopher control depends on early detection of increasing populations. Limiting the number of burrow systems by controlling gophers as they appear reduces treatment costs in the long term. Most growers rely on poison baits or the fumigant aluminum phosphide for gopher control. Control efforts should be concentrated in late winter to early spring, before the gophers' main breeding period. Pocket gophers should be controlled around the perimeters as well as within the fields to reduce the potential for population increase by invasion. Place bait of an acute toxicant such as strychnine in the pocket gophers' main burrow, which is generally found 8 to 12 inches (20.5 to 30.5 cm) away from the plug on fresh, fan-shaped mounds. Treat two or three different places in the burrow system. If gopher activity continues for more than 3 days after treatment, the burrow should be treated again.

When large areas of a field are infested, mechanical burrow builders provide the most economical method of control. The burrow builder is a tractor-drawn device that constructs an artificial burrow and deposits poison bait at preset intervals and quantities. These artificial burrows are made at depths similar to burrows created by pocket gophers and in parallel rows spaced 20 to 25 feet (6.0 to 7.6 m) apart so that they may intercept many natural pocket gopher runways. The pocket gophers readily explore these artificial tunnels and consume the poisoned bait. The success of this method depends largely on soil moisture. If the soil is too wet, the tunnel may not close and may allow sunlight to penetrate the burrow; if the soil is too dry, the burrow may collapse. The burrow builder should be used only in areas where gophers are present, not as a preventative measure. The burrow builder is particularly useful for reducing populations prior to planting and to slow gopher invasion from neighboring fields following planting.

Trapping can control gophers over small areas and can remove animals remaining after a control program. It generally is more effective in spring and fall, when pocket gophers are most active. Several types and brands of gopher traps are available, the more common being the two-pronged pincer trap (Macabee) and the box trap. Traps should be inspected at least daily and moved to a different location if 3 days elapse without catching a gopher.

Burrow fumigation with aluminum phosphide or acrolein may be effective, depending on the soil type and condition and the extent of the burrow system. Fumigants are less effective if soils are dry or porous or if burrow systems are so extensive that it is difficult to maintain a toxic concentration. Sealing burrow openings after

treatment is recommended to maintain a high concentration of lethal gas inside the burrow system. Gas cartridges (smoke bombs) are not effective; pocket gophers detect the gas and quickly seal off that part of the burrow system.

Flood irrigation may reduce the potential for large pocket gopher populations to develop. Deep tillage when a field is taken out of production may also reduce the potential for pocket gopher problems by disrupting burrow systems.

HARES AND RABBITS

Hares (*Lepus* spp.) and rabbits (*Sylvilagus* spp.) occasionally feed on small grain seedlings or young plants along field perimeters. They are most active at night, with peak feeding periods at dusk and dawn. The blacktailed jackrabbit *(Lepus californicus)* (fig. 5), a true hare, has very long ears, short front legs, and long hind legs. The cottontail *(Sylvilagus audubonii)* (fig. 6), a true rabbit, is smaller than the jackrabbit and has much shorter ears. Rabbits and hares are classified as game mammals and can be taken by legal sport hunting methods during hunting seasons. Owners and tenants of agricultural lands may take hares or rabbits any time they cause or are about to cause agricultural damage.

Anticoagulant baits (diphacinone and chlorophacinone) are registered for use in bait stations against jackrabbits but are not registered for use against cottontails. Because jackrabbits will not enter enclosed stations, the bait should be presented in a feeder in areas frequented by jackrabbits such as runways or resting or feeding areas. Prebaiting with untreated bait may encourage jackrabbits to become accustomed to feeding from the station. Once they feed on the untreated bait (usually after 5 to 8 days) and begin to consume all untreated bait in a single night, replace the untreated bait with poison bait. Provide bait until all evidence of feeding has ceased. Cover bait stations during daylight hours to help exclude nontarget animals from the bait.

Rabbit fences may be the only effective means of minimizing damage due to rabbits, but they are usually too expensive to use on a large scale. The cost of such a fence could be justified if small grains were being rotated with a higher-value crop and rabbit damage were severe. Rabbit fences should be made out of 1-inch woven wire mesh supported by posts, with the top of the mesh at least 36 inches (90 cm) above the ground.

Figure 5. Jackrabbit. Photo by Jack Kelly Clark.

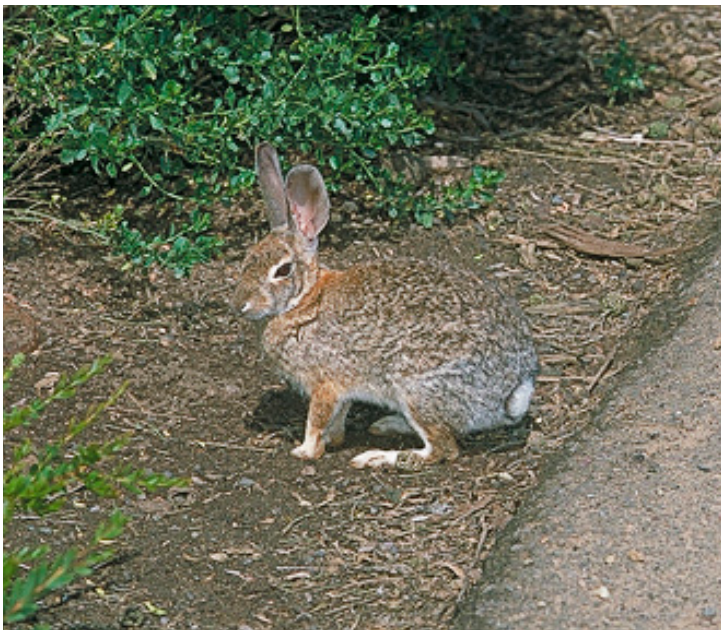

Figure 6. Cottontail rabbit. Photo by Jack Kelly Clark.

The bottom 6 inches (15 cm) of the mesh should be bent at a right angle away from the field and buried 6 inches (15 cm) beneath the soil surface.

Trapping, although labor intensive, may be a solution to cottontail damage. Cottontails, unlike jackrabbits, are easy to trap with Conibear traps in tap boxes or with cage-type live traps. Shooting, just prior to dusk, is effective for both jackrabbits and cottontails, but, like trapping, it is time consuming.

FERAL PIGS

Wild boars were brought from Europe to the eastern United States in 1912 and were subsequently introduced to Monterey County in 1925. Since then, they have interbred with feral (wild) pigs *(Sus scofa),* and these hybrids continue to expand both naturally and with the aid of humans throughout California. Wild boars are brown to blackish brown, with grizzled guard hairs, a mane of hair 3 to 6 inches (7.5 to 15 cm) long running dorsally from the neck to the rump, a straight and heavily tufted tail, and ears covered with hair. Hybrids take on the appearance of the wild boar. In this discussion, wild boars, feral pigs, and hybrids are referred to as feral pigs.

Feral pigs are most abundant in areas where a source of water and cover are present. When conditions are optimal (abundance of food resources, water, etc.), sows can produce 2 litters of 5 to 6 piglets per year; populations can triple every year. Feral pigs are omnivorous and consume a wide variety of available foods, including acorns, grasses, forbs, berries, bulbs, tubers, invertebrates, reptiles, birds, eggs, and animal carcasses. They cause damage by rooting in crops and pastures, and their activities can encourage soil erosion. A passel of 3 or 4 wild pigs may damage half an acre or more of a field or vegetable crop in a single night.

Feral pigs are classified as game mammals under the California Fish and Game Code. Except under certain circumstances (e.g., a feral pig encountered in the act of killing livestock or causing other agricultural damage; see the Fish and Game Code for other exceptions), it is unlawful to take any feral pig without first obtaining a permit from the Department of Fish and Game (DFG). Sport hunting can reduce wild pig densities in certain areas and can be a source of revenue for ranchers. As with all game species, feral pig behavior tends to change as hunting pressure increases. Where hunting is rare, feral pigs are active both night and day, though they become less active during the day in hot weather. Where hunting pressure is high, they generally feed only at night. Depending on the density and abundance of cover, feral pigs tend to leave an area where hunting pressure becomes severe. Consequently, crop depredations may cease after one or two pigs are shot or trapped or they are subjected to intermittent hunting pressure.

Trapping, especially where pig densities are high, is the most effective control method. Trapping is not effective, however, during fall and winter when acorns or other preferred foods are available. Stationary corral-type and box-type traps have been used with success. These traps are permanent and should be constructed in locations where large populations of pigs are evident. A portable trap with a drop gate also is effective and may be moved as necessary. These traps have been used successfully in California, with as many as 14 pigs caught in a trap in one night. Persistence and dedication are required if a control program is to be successful. Traps must be checked daily to be reset and to replace bait when needed. When conducting a trapping program, all hunting in the area should cease before traps are set up.

Fencing is generally not practical except in small areas around yards and gardens. Heavy wire and strong posts must be used; if feral pigs are persistent, exclusion is almost impossible.

REFERENCES

Clement, L. D., L. F. Jackson, T. E. Kearney, J. P. Orr, R. L. Sailsbery, and J. F. Williams. 1982. Wheat production in the Sacramento Valley. Oakland: University of California Division of Agriculture and Natural Resources Leaflet 21323.

Flint, M. L., ed. 1990. Integrated pest management for small grains. Oakland: University of California Division of Agriculture and Natural Resources Publication 3333.

Salmon, T. P., and W. P. Gorenzel. 2002a. Pest notes: California ground squirrel. Oakland: University of California Agriculture and Natural Resources Publication 7438. UC IPM Web site, http://www.ipm.ucdavis.edu/PMG/PESTNOTES/pn7438.html.

———. 2002b. Pest notes: Pocket gophers. Oakland: University of California Agriculture and Natural Resources Publication 7433. UC IPM Web site, http://www.ipm.ucdavis.edu/PMG/PESTNOTES/pn7433.html.

———. 2002c. Pest notes: Rabbits. Oakland: University of California Agriculture and Natural Resources Publication 7447. UC IPM Web site, http://www.ipm.ucdavis.edu/PMG/PESTNOTES/pn7447.html.

———. 2002d. Pest notes: Voles (meadow mice). Oakland: University of California Agriculture and Natural Resources Publication 7439. UC IPM Web site, http://www.ipm.ucdavis.edu/PMG/PESTNOTES/pn7439.html.

Salmon, T. P., D. A. Whisson, and R. E. Marsh. 2006. Wildlife pest control around gardens and homes. 2d ed. Oakland: University of California Agriculture and Natural Resources Publication 21385.

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