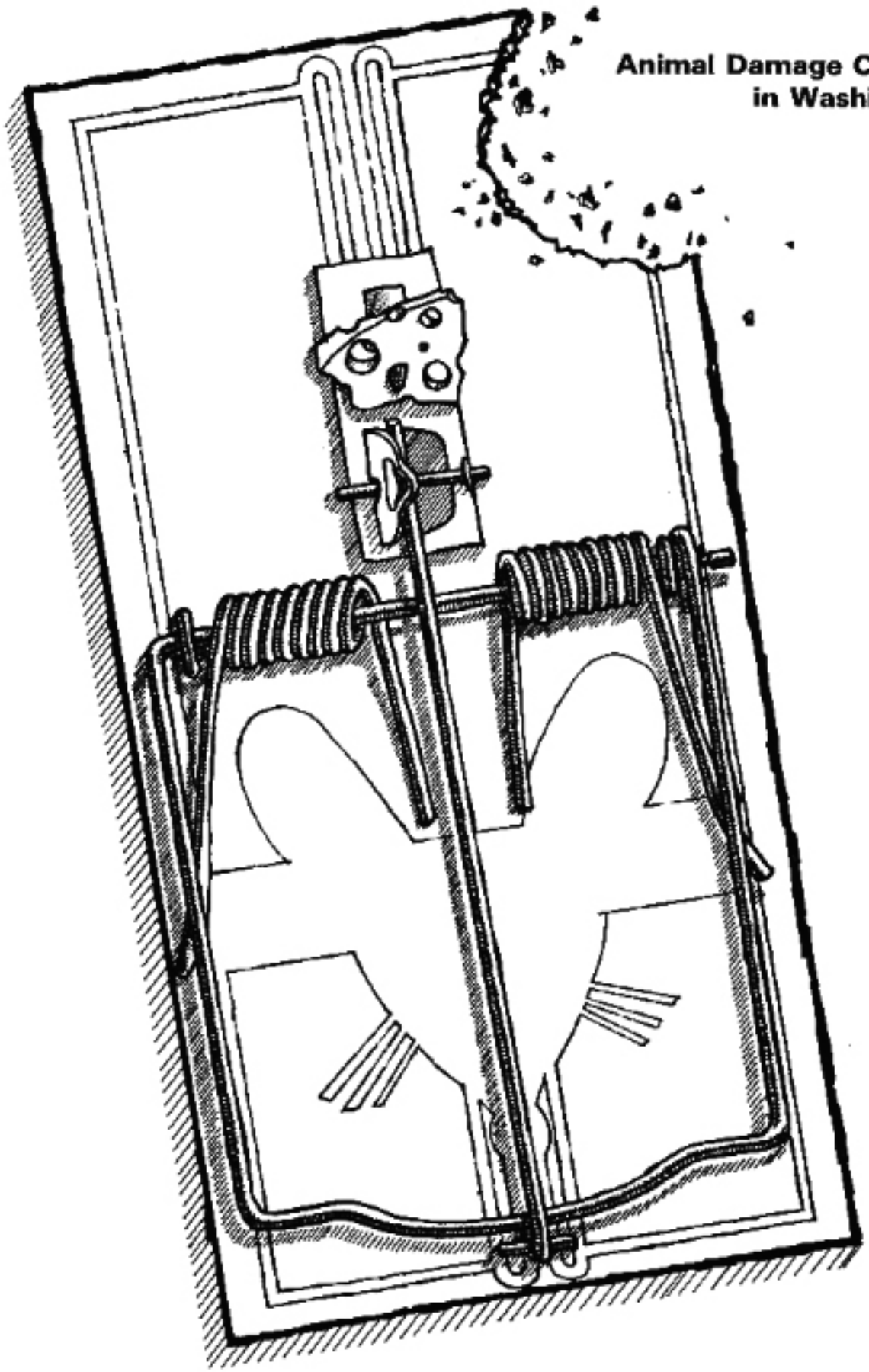
Animal Damage Control in Washington

EB 1147



Cooperative Extension College of Agriculture & Home Economics Washington State University Pullman, Washington

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Caution

To the best of our knowledge the suggested uses of pesticides in this publication are consistent with directions on product labels. If there is an apparent conflict between these suggestions and label directions consult your county Extension agent. The label is the legal and final authority. The law requires that *pesticides be used in accordance with directions on the label.* Uses against pests not named on the label and lower application rates are permissible exceptions.

Use pesticides with care. Apply them only to plants, animals or sites listed on the label. When mixing and applying pesticides, follow all label precautions to protect yourself and others around you. It is a violation of the law to disregard label directions. If pesticides are spilled on skin or clothing, remove clothing and wash skin thoroughly. Store pesticides in their original containers and keep them out of the reach of children, pets, and livestock.

Compiled by David M. Baumgartner, Extension Forest Resources Specialist, and Leonard R. Askham, Vertibrate Pest Management Specialist. Reviewed by the Fish and Wildlife Service, U.S. Department of Interior. Issued by Washington State University Cooperative Extension, J.O. Young, Director, and the U.S. Department of Agriculture in furtherance of the Acts of May 8 and June 30, 1914. Cooperative Extension programs and policies are consistent with federal and state laws and regulations on nondiscrimination regarding race, color, religion, national origin, sex, age, and handicap. Trade names have been used to simplify information; no endorsement is intended. Chemical registrations are subject to change. Before using any chemical, be certain that chemical is registered for the intended use. Replaces EM 3908. Revised July 1985. $2.50.

INTRODUCTION

Vertebrates, such as rats, mice, coyotes, deer, bats, and snakes, sometimes become pests requiring control. Chemicals are a frequently chosen alternative for control. Chemicals used to control all vertebrates, including rodents, are subject to registration under provisions of the Federal Insecticide, Fungicide, and Rodenticide Act. Under this act—"the term rodenticide means any substance or mixture of substances intended for preventing, destroying, repelling, or mitigating rodents or any other vertebrate animal which the Secretary shall declare to be a pest."

Before initiating any control action, a person should be absolutely certain that these actions are necessary. The following factors should be evaluated:

1. Identify the animal causing the damage.

2. The amount of damage occurring and anticipated to occur without control.

3. Benefits of control vs. their cost.

4. Any aesthetic or recreational value of the species involved.

5. The effect of a control program on nontarget animals and the environment.

Once the decision has been made to initiate control actions, alternative methods of control should be evaluated. With the growing concern over the use of chemicals and their effects on the environment, mechanical control techniques should be strongly considered. Depending on the situation and the pest involved, traps, physical barriers, noisemakers, shooting, or other nonchemical control methods may be suitable.

Before initiating chemical control activity, the appropriate regulatory agency should be contacted about registration status and use limitations of chemicals under consideration.

The perfect chemical is one which will eliminate, repel, or change the habits of the animal for which it was intended without endangering man, other animals, or the environment. A good rodenticide is toxic enough to kill pests with small amounts and it should be acceptable to the pest so it will be taken in lethal portions. There are many characteristics that may serve as a basis to qualify, limit, or restrict the use of a rodenticide. For example, relative toxicity, selective animal toxicity, speed at which it kills, secondary poisoning, mode of action, and hazard to the operator are important traits. The chemical properties, such as solubility, corrosiveness, odor, compatibility, stability to air, temperature, and sunlight must also be considered.

Agricultural Animal Damage Control

Rats

Most rats live in the slums and sewers of the major urban centers, true?

False! That's a common belief, but one that is simply not so. Most sources agree that the United States has a rat population roughly equal to the human population, or about 240 million rats. It's estimated that about half of the rat population lives on farms, with the rest split between large urban areas and the suburbs.

City rats get more attention. Federally-subsidized programs have poured millions of dollars into rat control in the major urban centers. State, county, and city governments spend additional hundreds of thousands of dollars annually.

Meanwhile, America's farmers often live in peaceful coexistence with sizeable rat populations–spending many times the cost of control, but never knowing it. The World Health Organization estimates rats devour or spoil more than three million tons of stored grains around the earth each year–enough to feed 200 million people. In this country alone, the Public Health Service blames rats for property losses of up to one billion dollars annually. The Department of Agriculture says each rat on a farm can cost the farmer $25 a year–far more than the cost of control.

Rats gnaw through electrical cables, causing fires and the resultant loss of animals, feed, equipment, and buildings. They maim and kill poultry and other farm animals. They spread human diseases like salmonellosis, rabies, tularemia, leptospirosis, amoebic dysentery, typhus, jaundice, and trichinosis, as well as many others which affect livestock.

Loss to farmers from these and other diseases is immeasurable. Often, farmers spend many dollars in programs to keep livestock buildings disease-free. Equipment and facilities are sterilized. New livestock is segregated. Health papers are demanded. Visitors to and from the farm are required to wear sterile boots or walk through a pool of disinfectant. And the rats are allowed to come and go at will.

Even when livestock buildings are rat-proofed, feed, bedding, and equipment are often stored in rat-infested areas and provide a continuing source of contamination to the livestock. So a farmer doesn't have rat control anywhere until he has it everywhere.

The rats themselves provide most of the rat control in force on most farms. The size of any rat colony is dependent on how much food, water, and shelter are available close at hand. The number of rats the "life support system" sustains is absolute–it may be 100, 500, or 1,000. The rats are always working to maintain that number, alternately building up and cutting down the population.

This material covering Farm Rat Control is adapted from the publication *Farm Rodent Control* prepared by Reiman Associates of Milwaukee, Wisconsin, for the Velsicol Chemical Company. Our sincere appreciation for the use of this material goes to Rieman Associates and Velsicol.

This fact is well illustrated when you consider the estimated farm rat population, and the ability of the rat to reproduce. They can start to breed as early as a month after birth, and females usually have from 7 to 10 litters of 8 to 12 or more per year. If they lived for three years, a pair of rats could theoretically produce 350 million offspring–or some three and a half times the present estimated farm-rat population.

When the birth rate spurts and the colony overpopulates, the strongest rats kick the weaker ones out. These castoffs either die from exposure or lack of food or water, are eaten by predators, or migrate to other spots where food, water, and shelter are plentiful. This is frequently a farm where a good, rat-control program was started, then stopped, and so made room for more rats. A new colony is started and the cycle repeats itself.

Characteristics of Norway Rat and Roof Rat

The most common U.S. rat is the Norway rat, *Rattus norvegicus*. Norway rats vary in color from reddish brown to grayish and almost black; they weigh from 10 to 17 ounces. It is also called the brown rat, house rat, barn rat, sewer rat, wharf rat, etc. It's found nearly everywhere, and picks up local names accordingly. The roof rat, *Rattus rattus*, distinguished by having a tail larger than its head and body, is present in lesser numbers, primarily along the coast.

Their front teeth grow at the phenomenal rate of five inches per year, so they have to gnaw constantly to keep their incisors worn down. If they don't, the teeth curve back and jam their mouths open–permanently, and they die of starvation. Consequently, you'll find evidence of rats chewing through pipes, several inches of concrete, bricks, hardwood planks, metal siding, etc., simply as a matter of survival. While they're traveling or nesting, they're continually gnawing and gobbling.

Norway rats generally build their nests in burrows or at ground level; whereas, roof rats make nests in trees, dense vegetation, or attics of buildings. Young rats are born in a nest about 21 to 23 days after mating. They are naked and their eyes are closed. The mother may mate again within a day or two of littering. When this occurs, the gestation period may be a few days longer than normal.

The young rats develop rapidly, growing hair within a week. At 9 to 14 days their eyes open, and they begin to explore for food and move about near the nest. In the third week they begin to eat solid food.

Young rats may continue to nurse until 4 or 5 weeks old. By this time they have learned a good deal about what is good to eat by experimenting with potential food items and by imitating their mother. If a mother rat has become shy to a specific kind of bait or rodenticide, many of the young will learn to avoid eating it.

At about 3 months of age, they are completely independent of the mother and are reproductively mature. The females come into heat every 4 or 5 days and remain receptive to males for a day or two. Breeding seasons vary in different areas. In warm regions the season may be continuous, but litter sizes may be smaller. In much of the temperate region there may be peaks in the breeding in the spring and fall. There is a lessening of breeding in the hot summer, and nearly a complete cessation in winter, depending on the habitat.

The size and number of litters depends on the species of rat and varies with the climate, availability of food, density of the local rat population, and age of the rat. Norway rats generally have litters of 6 to 12.

Most rats are quite omnivorous, eating nearly any type of food, although each kind of population has its own preferences. The Norway rat is an avid consumer of man's garbage; whereas, the roof rat generally prefers more natural plant food, if available. They all feed to varying degrees on cereals, nuts, fruits, vegetables, invertebrates, fish, and even manure, depending on the habitat conditions.

The only sure way of determining the preferred food of a local population of rats is to conduct bait acceptance or feeding tests with nontoxic foods. There seems to be no universally preferred diet. For example, Norway rats in eastern United States seem to prefer cornmeal over oats, whereas, the reverse is true in at least part of the western United States and Canada.

Rats usually begin searching for food shortly after sunset. When hungry, or under crowded conditions, they may also be seen in daylight. If food is in an exposed area and too large to be eaten quickly, yet not too large to be moved, they will usually carry or drag it to a hiding place before eating it. Many rats will cache or horde considerable amounts of solid food, which they may or may not eat later. The water requirement varies with species and diet, but most rats drink water regularly if it is available.

When rats approach a food item for the first time, they may be cautious feeders. For this reason, prebaiting with a nontoxic bait will often enhance later acceptance of a toxic bait. The most acceptable bait is frequently a local food the rats have already become accustomed to. Totally different types of food may be highly preferred, particularly if they fulfill a dietary need for the particular rat population.

Rats are considered to be colorblind, responding only to the degree of lightness and darkness of colors. Thus, for safety reasons, baits can be made various colors without modifying their acceptability by rats, assuming the coloring agent does not have an adverse taste or odor. Rats see poorly, relying more on smell, taste, touch, and hearing.

They use their keen sense of smell to locate food items and apparently to recognize other rats, especially those of the opposite sex. Taste perception of rats is quite good, and Norway rats can easily detect some nontoxic compounds at extremely low levels (0.5 ppm) in their diets. Once they have tasted a food item, taste probably overshadows any affect of the odor.

Rats recognize noises and use their acute hearing to detect and escape danger. Another important sensory factor with rats is touch. The long, sensitive whiskers (vibrissae) near their nose and the guard hairs on their body enable them to travel in the dark adjacent to walls and in burrows.

Keeping the barn door closed won't keep rats out. In fact, it's nearly impossible to rat-proof many older farm buildings when you consider that rats can do the following:

- Gain entrance through any opening that is larger than 1/2 inch (1 1/4 cm) square.
- Climb both horizontal and vertical wires.
- Climb the inside of vertical pipes that are 1 1/2 to 4 inches (4 to 10 cm) in diameter.
- Climb the outside of vertical pipes and conduits up to 3 inches (7 1/2 cm) in diameter.
- Climb the outside of vertical pipes of any size if the pipe is within 3 inches (7 1/2 cm) of a wall or other continuous support of the rodent.
- Crawl horizontally on any type of pipe or conduit.
- Jump vertically as much as 36 inches (.9 meter) from a flat surface.
- Jump horizontally 48 inches (1.2 meters) on a flat surface.
- Jump horizontally at least 8 feet (2.4 meters) from an elevation 15 feet (4.5 meters).
- Drop 50 feet (15 meters) without being killed or seriously injured.
- Burrow vertically in earth to a depth of 4 feet (1.2 meters).
- Climb brick, or other rough exterior walls which offer footholds, to gain access to upper stories of structures.
- Climb vines, shrubs, and trees, or travel along telephone or power lines to gain access to upper stories of buildings.
- Reach as much as 13 inches (33cm) along smooth, vertical walls.
- Swim as far as 1/2 mile (0.8 kilometers) in open water, dive through water plumbing traps, and travel in sewer lines even against substantial water currents.
- Gnaw through a wide variety of materials including lead sheeting, sun-dried adobe brick, cinder blocks, and aluminum sheeting.

Determining Presence of Rats

Following are eleven signs which can alert farmers to the presence of rats:

Sounds. Gnawing, clawing, climbing in walls. various squeaks and fighting noises.

Droppings. May be found along runways, near shelters, or other places rats frequent. Fresh droppings are soft in texture.

Holes. May be found under edges of buildings and along fences.

Urine. Wet and dry rodent urine stains on various material will fluoresce under ultraviolet light. Remember that some other materials also may fluoresce in ultraviolet light, which can be confusing.

Smudge marks. May be found on pipes and beams where dirt and oil from their fur leave smudge marks.

Runs. May be found next to walls, along fences, under bushes and buildings, and where their feet make beaten paths on the ground or through grass. Runs within buildings may be well-polished trails that are free of dust.

Tracks. Footprints or tail marks may be found on dusty surfaces. The use of nontoxic tracking dust, such as talc, will help determine the presence of rats within buildings. When used outdoors, the dust must be protected from wind, rain, and other animals.

Gnawing. May be indicated by wood chips around baseboards, doors, windows and frames, stored materials; around pipes in floors and walls; and wherever rats might try to enlarge a crack or enter something. Tooth marks on gnawed materials provide evidence of rodent damage. Frequently the size of the tooth marks will assist in identifying the species involved.

Visual sightings. Observation of rats during daylight hours generally indicates that a high or moderately-high population exists in that area. Nighttime observations with the aid of a powerful flashlight or spotlight is often helpful.

Nests and food caches. Can sometimes be found when cleaning garages, attics, basements, closets, and other storage places. Roof rats, as well as other rodent species (i.e., squirrels, and packrats), often store food in attics of buildings.

Pet excitement. Cats and dogs may excitedly probe an area of floor or wall where rats are present, especially if rats have just recently invaded the premises.

Rat odors. The presence of rat odors in a room may provide a clue to their presence. With a little experience, the odors of house mice can be readily differentiated from those of rats.

Rats feed almost invariably at night. Any food that you or domestic animals eat is good fare. And they have excellent taste! While they can thrive on garbage or tainted food, they'll choose fresh meals when given the choice. This means that if you are going to poison them, you must use a bait that tastes as good or better than anything else around. If you're feeding a 22 percent protein poultry ration, the rat bait should contain at least 24 percent protein if you expect it to be eaten.

Rats are careful about eating strange foods, and may sample it in small amounts. If it is poisoned, and there are any side effects, a rat will eat no more. What's more, he'll warn other rats not to eat it. Even if a rat dies of the poison, his remains can serve as a warning to others. This is why a fast-acting toxicant will not give needed control.

Another problem with highly toxic baits is the high birth rate which follows an apparently successful 70 or 80 percent kill. Unless there is continuous follow-up, the rat population skyrockets beyond what it was in the beginning. Then it works its way down again, and you have what you started with.

The use of acutely toxic poisons should be left in the hands of professional, pest-control operators. Besides the problems of safety, bait shyness usually prevents achieving acceptable control in the hands of an amateur.

There is a greater hazard in using quick-kill rat baits. Most acute rodenticides are very dangerous to humans and nontarget animals. There can be cases of secondary poisoning, in which a cat or dog dies after eating a rat that has been poisoned. Absorption of the poison through the skin can be a problem to humans.

Steps to Control

Keeping rats from gaining a foothold on a farm is a year-round job involving proper use of rodenticides *plus* denying the rodents food and shelter. This involves four basic steps:

1. A continual cleanup campaign around the farm, to deny rats comfortable living and breeding places.

2. Rat-proofing home and out-buildings mechanically.

3. Baiting the home, barns, garages, corn cribs, chicken houses, hog houses, machine sheds, etc.

4. Perimeter baiting on the outskirts of the farmyard, at least 100 feet from buildings.

Many rodent control experts recommend using anticoagulant baits. All are readily available in ready-made baits.

With anti-coagulants, rodents die slowly and painlessly enough that they never really catch on to what is happening. This eliminates the problem of bait shyness.

Warfarin is still just as effective as ever with the vast majority of common rats. There is no truth to opinions advanced in recent articles and promotional material that rats in general are becoming immune to Warfarin. The compound is as effective as ever in the United States, except with a particular strain of rat which has developed in an isolated area in North Carolina. This strain seems to be contained, and its members are short-lived. There is no real evidence at all that Warfarin is any less effective with most rats.

Outdoor Baiting Problem

The best-prepared baits made with table-grade materials are still subject to spoilage once they get wet. When this happens, rats will pass up the bait for other foods. Rats have to be desperate to eat anything that is moldy, rancid, or infested with insects. Weatherproof baits are therefore

very important for outdoor baiting. . .and good control is never achieved indoors unless it is also achieved outdoors. Under some conditions, even indoor placements might be made under conditions of high humidity, making the bait unacceptable. Baits are available that will maintain their acceptance and effectiveness outdoors for as long as 30 days.

Bait Stations

Using bait stations to hold bait will help keep it out of reach of children and nontarget animals. Stations should be made out of solid materials that won't be crushed or knocked out of place and should be firmly anchored to the ground, wall, or floor. Ready-made stations are available in most hardware and farm-supply stores, or plans for building them are usually available through county agents.

Bait stations are usually open at both ends, allowing rats to travel through them. Stations should be placed about 20 feet apart along walls in areas where rats are suspected. A rat will travel only about 100 feet to get food, but only a few feet if that's all that's necessary. So, the more stations, the better the chances of station traffic.

For perimeter baiting, waterproof stations should be placed along fences, waterways, woodpiles, drainage ditches . . . anyplace where wandering rats might find food, shelter, and water. Stations should also be placed where there is the least chance of disturbance by people or animals.

Rat-Proofing Buildings

Concurrent with a baiting program, it's advisable to close off any access routes into farm buildings, and to eliminate places where rats might find shelter. Here are some examples:

Close openings over 1/2 inch in diameter. Rats can get their teeth into these and enlarge them, thus gaining access. Cement up openings around pipes. Close holes around floor drains, and keep drains tightly covered.

Cover edges subject to gnawing with heavy sheet metal or wire mesh. The bottoms of doors are a good example.

Keep doors closed when not in use, using good springs to close them, and spring locks to make sure they stay closed.

To make sure rats don't climb, put a 12-inch band of sheet metal in corners, a foot or so above ground or floor level.

To rat-proof a slatted corn crib, put 1/2-inch wire netting aound it to a height of 2 feet from the top of the foundation. Above that, fasten an 8-inch band of sheet metal. Use galvanized sheet metal at the edges of doors.

Limit Food, Water, Shelter

Keep garbage and trash in tightly-covered metal or heavy plastic containers. Don't leave any feed in the open. Keep all feed in buildings that are as rat-proof as possible.

Limit the amount of shelter available. Keep floors free of piled boxes and other material. Store things a foot above the floor, leaving no place that can't be readily cleaned. Outside, keep crawl space under buildings open and clean. Don't pile lumber or other materials against the side of a building. Use sawhorses or other above-the-ground platforms. Eliminate rubbish heaps.

Limit the water supply as much as possible. Fix leaky faucets, tanks, etc.

In working with rat-proofing materials, use at least 2 inches of concrete if it is reinforced; 3 3/4 inches if not reinforced. Galvanized sheet metal should be 24 gauge or heavier; perforated sheet metal or grills, 14 gauge.

Wire mesh or hardware cloth should be at least 19 gauge, and openings no larger than 1/2 by 1/2 inch. If aluminum sheeting is used, it should be 22 gauge for frames and flashing; 20 gauge for kickplates; 18 gauge for guards.

Reasons for Failure

The most frequent causes of failure in farm rat control are either the use of an incomplete program or the use of improper materials. Baiting can't do the job alone; it takes baiting *plus* cleanup *plus* mechanical exclusion. And even the best baits are useless if not used in proper amounts. Many farmers make the mistake of buying one "household" size (1 pound) box of bait to handle the whole farm. He needs to provide all the bait the rats will eat for as long as they will eat it. Then he needs to keep some out for new rats migrating in.

It's often said that the farmer who pays for control can have it. The farmer who doesn't pay for control will pay much more.

Meadow Mice

The short-tailed meadow mouse (*Microtus* spp.) causes considerable damage to fruit trees throughout the orchard regions of Washington. Meadow mice damage trees by chewing and peeling bark from tree roots and trunks near ground level, often girdling them. This causes reduced tree vigor and fruit yield and may cause the death of the tree. Injuries caused by meadow mice can make trees more susceptible to attack by insects or disease organisms.

Damage to trees is usually more severe during winter under a cover of snow or litter that has accumulated at the base of the tree. In alfalfa, grass, or grain fields, meadow mice will form networks of runways which are mostly concealed by overhanging foliage. These runways cut through the vegetation and connect with subterranean burrows through the sod and among plant roots. Meadow mice feed on plant roots and stems.

Prepared by Raymond Hunter, Grant County Extension agent, Steve Howes, Extension assistant, and David M. Baumgartner, Extension forest resources specialist; Washington State University, Pullman. Vince Bogatich, USDI, Bureau of Sports, Fisheries, and Wildlife, Division of Wildlife Services, Yakima, Washington, is acknowledged for his help in the review and preparation of this publication.

To properly evaluate a meadow mouse problem, the orchardist should inspect areas around the bases of trees and in grassy field borders. Mouse presence may be determined by their narrow runways through the grass, and the small piles of brownish droppings and short grass clippings scattered along them. Another indication is trunk- or root-girdling at or just below the ground level.

The most effective means of obtaining a mouse-free orchard is year-round grass and weed control. This means application of weed control chemicals combined with frequent cultivations and/or grass clipping in both the orchard and surrounding borders. Often, this is neither economical nor feasible. Due to the use of grass cover crops in orchards, the possibility of damage to trees by mice has increased.

Description

Meadow mice are medium-sized, stout (1.5-2.0 oz.), with small, black, beadlike eyes and small, fur-covered ears. The tail is short (one-third of head and body length) and well-covered with hair. The fur is loose, rather long, blackish to grayish or yellowish brown, and heavily interspersed with black guard hairs resulting in a grizzled appearance. The fur is darkest on the back and shades into gray, ashy, or buffy on the underparts. The feet do not have black guard hairs. The tail is dusty-colored above, slightly paler below.

Breeding Habits

Meadow mice are very prolific as they breed several times a year and produce litters of up to eleven young each, with six being the average. The female is sexually mature at four weeks of age and may have as many as eight to ten litters per year. The gestation period is twenty-one days, and litters may follow each other at twenty-five day intervals.

At this rate, when conditions are favorable, mouse numbers can increase markedly in a short period of time, and population increase can occur so rapidly as to suggest an invasion. It is not surprising to have an orchard or field seem relatively mouse-free one season and be heavily infested the following season. One breeding pair of mice can produce up to 3,000 offspring in eight months.

Mouse populations are cyclic with peaks occurring approximately every four years. At peak population levels there may be as many as one to three thousand mice per acre. Each mouse consumes enough forage to equal its body weight each day.

Natural Enemies

Meadow mice have a host of natural enemies, including hawks, owls, shrikes, snakes, badgers, and skunks. These should be protected whenever possible.

Control

Before initiating any pest control measure, the grower should be absolutely certain his actions are necessary and should be sure to consider all alternatives. The following factors should be evaluated:

1. The amount of damage that has already occurred.

2. Damage anticipated to occur without control.

3. Benefits of control versus cost.

4. The effect of a control program on nontarget animals and the environment.

Poison Baiting

Hand baiting. Hand baiting is the most flexible method. It is particularly well-suited to areas where soils or soil-moisture conditions are not suitable for mechanical trail building. It is also well-suited for supplemental baiting during the winter when the ground is frozen or covered with snow, and at various times of the year when evidence of mouse activity is noted in small areas.

For fall baiting use the zinc phosphide treated prepared bait. For winter and spring baiting, zinc phosphide-treated fruit cubes, primarily apples are preferred where available.

Mechanical baiting. Mechanical baiting with a mouse trail builder is a fast, safe, and economical method of control. Mechanical baiting is especially well-suited for large orchards or other large areas. Prepared strychnine and zinc phosphide treated baits are recommended. Apply at the specified labeled rate within burrows at 2" to 4" in depth. A single trail should be made on each side of the trees as close to the trunks as possible and along the orchard borders or as required in other crops or adjoining areas. The soil should be moist enough so that the artificial runways will remain intact until the mice contact the bait through the intersecting natural runways. The ground should not be disturbed for several days following application.

Anticoagulant pellets such as Ramik Brown and Rozol are in wide use for control of *Microtus* sp in orchards after the fruit has been harvested. The pellets are mechanically applied to orchard ground cover. For specific uses refer to Extension Bulletin 419, *Spray Guide for Tree Fruits in Eastern Washington.*

Rozol Ground Sprays

Rozol Ground Spray Concentrate (chlorophacinone) is registered for use in apple, pear, and stone fruit orchards in Washington. This is an anticoagulant which kills only with repeated exposure in ground cover crops for a few days. Use 1 pint of Rozol concentrate per 100 gallons of water with 600 gallons per acre (6 pints concentrate per acre of treated ground). Where there is bare soil, apply only to adjoining ground cover. Apply late in the afternoon for best results.

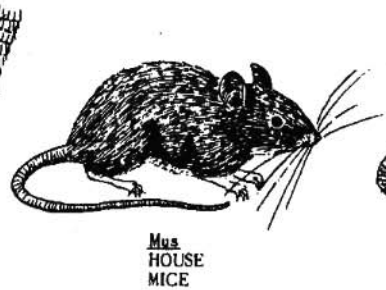
RODENTS: PICTORIAL KEY TO SOME COMMON UNITED STATES GENERA

Harold George Scott and Margery R. Borom

tail almost naked, scaly

large (9-17" long) — small (5-7" long)

Rattus
DOMESTIC
RATS



Mus
HOUSE
MICE

tail almost naked, annulate

tail long — tail short

Oryzomys
RICE
RATS

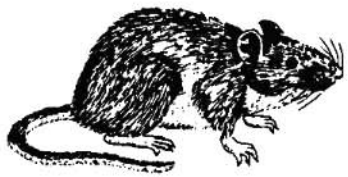
tail hairy

hair short — hair long

Sigmodon
COTTON
RATS

tail bones longer than 1/2 body

large (about 16" long) — small (7-9" long)

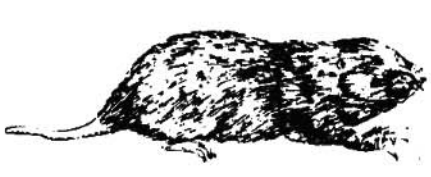


Neotoma
WOOD
RATS

Peromyscus
WHITE-FOOTED
MICE

tail bones shorter than 1/2 body

front feet enlarged — front feet not enlarged



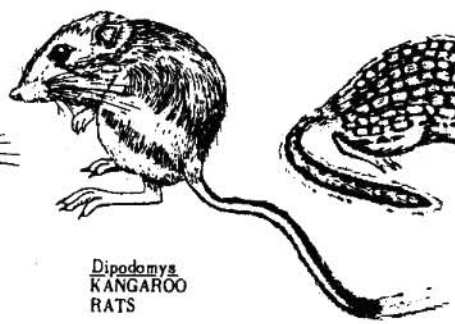
Geomys-East
Thomomys-West
POCKET GOPHERS

Microtus
MEADOW
MICE

tail bones longer than body

tail busny — tail not bushy

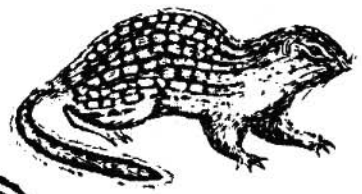
Sciurus
TREE
SQUIRRELS



Dipodomys
KANGAROO
RATS

tail bones shorter than body

large (about 15" long) — small (about 9" long) — very large (about 26" long)



Citellus
GROUND
SQUIRRELS

Tamias-East
Eutamias-West
CHIPMUNKS

Marmota
WOODCHUCKS

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE, PUBLIC HEALTH SERVICE, Communicable Disease Center, Training Branch, Atlanta, Georgia – 1962

Pocket Gophers

Pocket gophers cause extensive damage to farmers' crops and orchards, as well as being a plague to homeowners and landscape gardeners who desire to maintain well-manicured lawns and well-kept flower beds. These rodents thrive on semideserts, plains, on fairly high mountain slopes, and mesas, as well as in rather humid areas with moist soils.

Description

Pocket gophers are stout-bodied and short-legged with blunt heads. They have prominent, yellow incisor teeth and large, deep, fur-lined, external cheek pouches in which food is carried. The fur-lined (pocketlike) pouches are where the animal gets its name (Fig. 1).

They have brownish coats; small eyes and ears; short, nearly naked tails; and long claws on the front feet. The head and body usually measure 6 to 8 inches; the tail is 3 to 4 inches long.

Habits

The pocket gopher is strictly an inhabitant of the soil, living in burrows of its own construction, never climbing, and only seldom coming out on the surface of the ground.

These animals dig extensive tunnels or runways, which may extend as much as 800 feet and cover an acre of ground. Burrows vary from 2 to 4 inches in diameter. These are more or less parallel with the ground surface, usually at depths of from 6 to 14 inches, but deeper in places. The soil from these tunnels is pushed out on the surface through short, lateral tunnels made at frequent intervals (or forced into abandoned tunnels). This results in a series of rounded surface mounds which, by their position, usually give a clue to the location of the gopher's main tunnel. When putting soil out of a lateral tunnel, the gopher pushes the loads of soil into a more or less crescent-shaped pattern, and when the lateral is closed, a central depression in the mound usually indicates the location of the mouth of the lateral. Mounds are usually found in clusters and one gopher may produce 100 or more in a season.

Fresh mounds are often dark because of the moisture in the soil that has been recently pushed out. Any grasses or herbs covered over by a mound are blanched (by loss of chlorophyll) after a few days, which provides another indication of its age. Most mounds are made in late summer and fall when gophers are digging shallow burrows to get roots for winter, unless conditions are quite dry.

Gophers also make short, almost vertical, laterals in coming to feed on surface vegetation. These often are closed with earth that does not rise above the adjacent ground surface.

Gophers dig deeper tunnels in connection with their nests, and may dig short, steeply pitched "sumps," possibly to drain adjacent tunnels. The nest is usually in a chamber about 8 inches in diameter; it is constructed of fibers of grasses and other plants, shredded like fine excelsior. Food is often stored beside the nest or in other enlarged chambers of the tunnel system.

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Figure 1. Pocket gopher

Tunnel systems are usually occupied by a single gopher, although young may remain in the tunnel occupied by the mother for a time after leaving the nest. The system of adjacent gophers may be connected, but connecting tunnels and even portions of the workings of a single animal are often firmly plugged with soil. When a gopher is trapped out of a tunnel system, another animal may later move into and occupy that system. Moles or mice occasionally use gopher burrows. Pocket gophers are active throughout the year (even in the higher mountain areas, where they work beneath the snow and put the surplus soil into tunnels in the snow), and fresh workings may be found in any month. Surface activity is less on dry areas during the hot summer months; at this season new mounds may be entirely lacking on nonirrigated lands of the interior valleys. The animals are also less active during and just after heavy rains.

DAMAGE

Production in alfalfa fields can be seriously reduced by destruction of root crowns. Gophers damage truck plants by eating the roots. In flower gardens, valuable plants, especially those with bulbous roots, are often destroyed. Gophers cut roots of trees and vines and gnaw the bark of trees, at times completely girdling them so that they die unless saved by bridge grafts. Burrows in home gardens will often divert the relatively expensive metered water. Burrows in the banks of ditches and canals may lead to breaks in the earthwork through which water is lost and adjacent lands are flooded, making expensive repairs necessary.

The pocket gopher is gaining recognition as one of the most important factors in successful ponderosa pine forest regeneration. Pine is apparently one of the gopher's preferred foods, and although there may be an abundance of its natural food on the area, it will seek out the young trees. Because of its subterranean nature and the sometimes limited amount of surface sign, the damage caused by this animal is often unnoticed on a plantation until crowns turn brown during the summer. Occasionally trees will tip at odd angles and may be pulled up easily–roots completely eaten off. During the winter season, they do considerable feeding on the surface under snow cover. At this time, they will gnaw the bark from trees up to an inch or more in diameter. The damage may extend from the roots to about a foot above ground. This above-ground stem barking may be distinguished from porcupine barking by the size of the incisor grooves. Supplemental field signs, such as mounds and earth casts from winter snow tunnels, are good indicators of pocket gopher activity.

On wild land, gophers may be beneficial in the long run. Pasture lands cleared of them often show an immediate increase in the amount of forage available for livestock, but it is unknown whether this would continue for a series of years on unplowed land. Gophers "cultivate" the soil, often turning over large portions of the surface in a single year. Whether their burrowings contribute to or serve to check erosion on slopes probably depends upon local conditions. The rich sediments of valley bottom lands have resulted from erosion at higher elevations in past geologic times; to this process pocket gophers may have been a contributing factor.

Breeding Period

On pasture lands and on uncultivated and nonirrigated areas there is evidently a limited breeding season some time after the beginning of the spring rains, when green forage becomes available in quantity. On such areas there is probably a single, annual brood. But in irrigated regions, especially in alfalfa fields where green forage is always available, breeding occurs throughout the year. In such places, a female may bear up to 3 litters per year. The average litter is between 5 and 6, but may vary from 1 to 13.

The young remain in the nest for several weeks after birth, but eventually leave the parent tunnel system for an independent existence. They often wander some distance overland and start their tunnels in new places. Adults also sometimes move overland. Gardens and fields earlier free from gophers thus may become inhabited by young in the late spring or summer.

Moles or Gophers

The two species of mammals are compared here because they have a good deal in common, and it should be determined which is being dealt with in seeking control measures.

The key to identification is the mound. The mole mound is somewhat conical and not much over a foot in diameter. The hole is not evident when you look at the mound. Push the soil aside and you will find it under the center of the mound. Each mound is connected with another in a line by the moles' runway system.

The gopher mound fans out from a hole near one edge of the mound. This hole remains plugged while the gopher is in his runway system. The gopher mound is relatively flat compared to the mole mound. Gopher mounds vary from about 1 to 3 feet in diameter and 4 to 8 inches in height. Some of the smaller species merely plug the hole, leaving no mound. Several mounds will often be found grouped together. They are not regularly found in a line as are mole mounds.

Soil in a gopher mound is usually quite fine. A mole mound will often be more cloddy. Gopher runways and holes to runways vary from about 1 to 4 inches in diameter. Mole runways are seldom over 2 inches in diameter.

Methods of Control

Pocket gophers may be controlled effectively and even eliminated over rather large areas if a person uses care and is persistent. Control measures may be taken during any season. Upon first

evidence of pocket gopher activity in garden areas, control measures should be taken. This oftentimes save many valuable plants. The most desirable time to employ control measure prior to when the young are born. Every female caught means fewer pocket gophers in the n future.

Control operations can best be conducted during the seasons when the pocket gophers are m active near the surface. This is usually indicated by the presence of fresh mounds of dirt. other times, labor and material may be wasted in treating unoccupied systems of runw During the fall, when pocket gophers are usually most active, control operations also can carried on with the least interference to growing crops.

Trapping and hand placement of toxic baits are used to control pocket gophers in small ar whereas larger areas can be protected by use of mechanized equipment which properly pla the control agent.

TRAPPIN

The traps normally used for rats, mice, and larger mammals are not suitable for pocket gop control in that they must be caught in their burrows where space is limited. Several poc gopher traps have been designed (Fig. 2) and are of two types: those designed to spring whe pocket gopher pushes against the flat trigger pan of the trap, and those activated by a l trigger, which operates by the pocket gopher seizing the special bait.

Trapping is especially useful in gardens, orchards, small fields, and the banks of irrigation can It is as effective as any other control method. The traps which have been designed for poc gopher control are safe to handle and use and require little skill and effort to place properly.

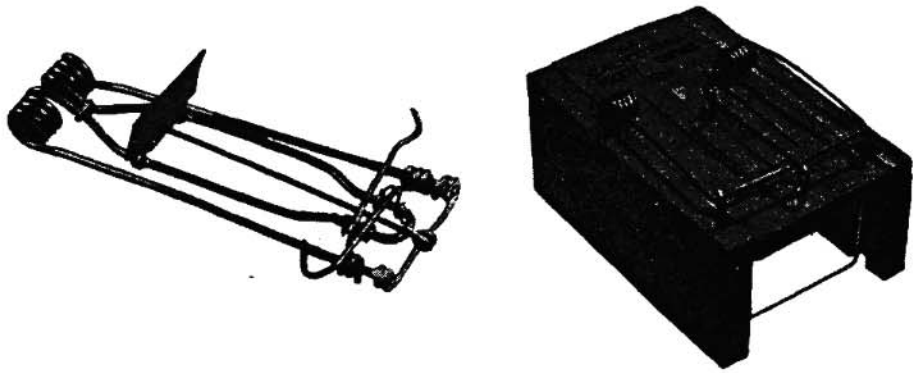

Figure 2. Traps for pocket gophers, shown as set for use. Left, Macabee trap; right, California pocket gopher trap of wood.

A commonly used trap is the Macabee-type spring trap, which is available through most hardw and farm supply stores. It is about 5 1/2 inches long and constructed of wire except for trigger. Another popular trap is the box type, which has a choker effect.

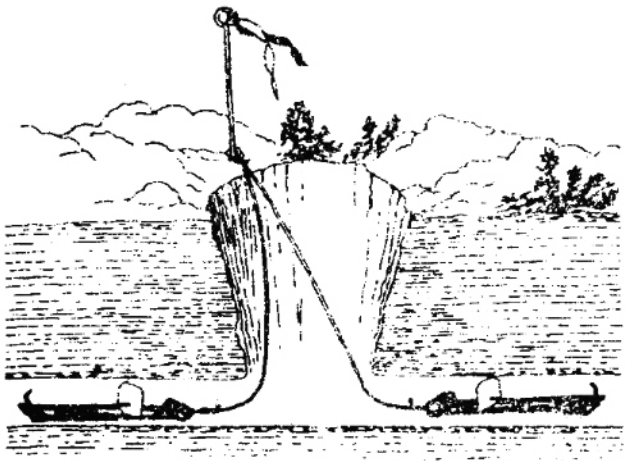

Figure 3. Proper way to set two traps in main runway.

The best placement of the Macabee trap is in the main runway, not in the lateral runways which lead to the surface mounds. Two traps should be used for each setting, one in each direction (Fig. 3). A shovel serves for digging down to the main run. A probe (Fig. 4) is useful in finding the main run. Proper location is determined by probing into the soil 12-18 inches back from the mound on the side where the horseshoelike depression is found. A stout garden trowel or shovel is needed to dig an opening into the main runway to insert the traps. Another method of locating the main runway and inserting traps is to scrape the dirt from a fresh mound until a round circle of fresh dirt is found plugging the lateral runway. Dig down the lateral to the main runway and place two traps back-to-back. Traps can be used in lateral runs by removing the soil plug and placing one trap with the claws away from the opening in the hole. However, this technique does not bring the success that the two-trap method does.

In probing, open runways can be found quite easily in that the probe will readily drop through the opening. If the runway is loosely filled with soil, the drop will be less noticeable but still plainly felt. If it is lightly plugged, dig down a short distance with a shovel and probe again. If this fails, a new mound should be used.

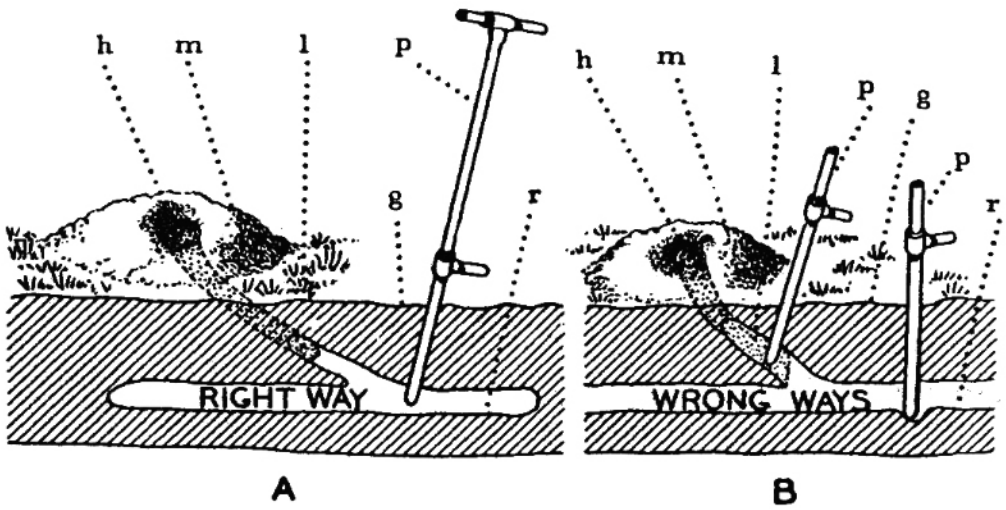

Figure 4. Right and wrong way of using runway probe. *h*, horseshoelike depression; *m*, mound; *l*, lateral runway; *p*, probe; *g*, ground surface; *r*, main runway.

How to Set Traps

When the main runway is located, dig it out so that a trap can be set in each direction. Clear out the runway with a spoon or by hand with as little disturbance as possible. Set the treadle, or pan, so that the trap can be sprung with a light touch. DO NOT TEST THE TRAP BY HAND. Place the jaws forward, well into the hole. A small amount of loose dirt may be left in the bottom of the tunnel to cover the prongs and front end of the trap when it is pushed into place. Press the trap down firmly so that it will not slide backward if a gopher pushes against it. Cover the hole into the burrow with a clod or vegetation so that light will not penetrate into the burrow system. Pocket gophers will close all open burrows very lightly to keep natural enemies from entering. Traps which are set and the holes left uncovered may be sprung by the soil which the gopher pushes ahead to plug the hole.

Attach to each trap a light wire or cord that can be fastened to a stake or other object to mark its location. This also prevents the loss of traps by wounded gophers dropping traps back into the burrows or by predatory animals taking traps with gophers in them. The use of conspicuous stakes is quite helpful in marking the locations of traps in alfalfa fields, truck patches, and other areas where vegetation is dense and/or tall. Traps are easily lost if not marked in such a manner. On farms or ranches, distinctive stakes enable employees to recognize gopher sets. For the most efficient use and best results, each setting should be checked each morning and evening, or even more often if possible.

When traps have been placed and set, tramp down or level the tops of mounds so that on future visits to the area it will be easy to determine where gophers remain and whether further effort is needed.

Poison Baits

The use of some poisons has been prohibited by law and others are for use only by licensed pest-control operators. Therefore, investigate local, state, and federal laws as to the use of poisons. All poison baits should be used with a great deal of care.

Pocket gophers may be killed in numbers by use of poison baits. However, their external cheek pouches or pockets are lined with fur and poisons are not readily absorbed through this lining. Because of this, dependence must be placed on stomach poisonings. There are commercial baits available for this purpose. The baits must be of some material that is desirable and must be placed in the main runways with as little disturbance as possible. Baits which are placed above ground are not often taken by gophers and are a menace to other wild or domestic animals. If baits are placed in the lateral runs or in open holes, they may be buried or pushed out by the gopher's activity. Some grains, such as corn, oats, barley, wheat, and grain sorghum are commonly used for baits. The gopher must consume grain baits to be poisoned. The most commonly used baits are prepared strychnine bait pellets or grain. In addition, 1080 grain baits have proved very effective where registered and applied by pest control operators.

Placement of Bait

Baits of any kind are placed in main runways by use of a gopher probe (Fig. 5), with which burrows can easily be located and the baits placed with a minimum of disturbance. The gopher probe is rather easily constructed. The main shaft is of 1/2-inch pipe about 40 inches long. On one end a conical point of solid metal is welded, which is the same diameter as the pipe. To the opposite end, a 12-inch length of 7/16-inch steel rod is welded. The free end of the rod is enlarged by adding a "hard suface" steel and grinding it to a carrot-shaped tip about 1/2 inch in diameter at the base and tapering to a sharp tip. To work in soils that are sandy or otherwise quite loose, the base may be slightly larger, and for very hard soil, the base may be omitted. One or two side arms are welded in place or connected by means of pipe T's. The side arms may be attached by use of a collar and set screw to permit adjustment from one end of the probe or the other to apply pressure with either hand or foot. A length of rubber hose may be slipped over each side arm as a convenience to the user.

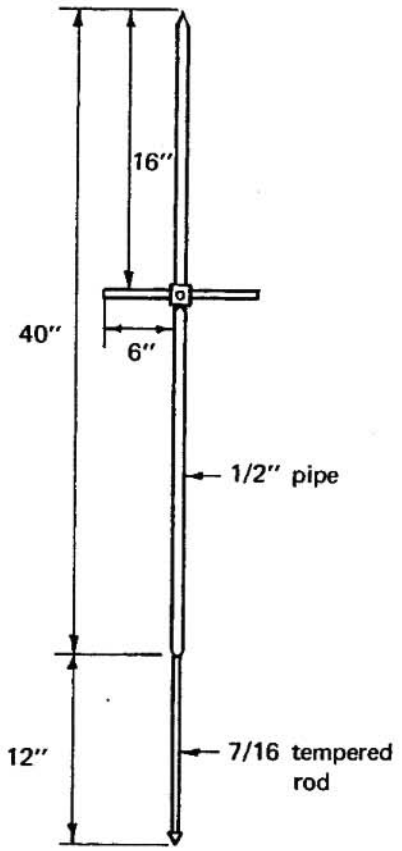

Figure 5. Gopher Probe

Locate the main runway by probing into the soil 12-18 inches back from the mound on the side where the horseshoelike depression is found. When the tunnel is struck, the probe will drop suddenly about 2 inches. Enlarge the opening by rotating the probe or by using the opposite larger end so that the poisoned bait may be easily dropped into the burrow. After placing the bait, carefully cover the hole made by the probe with your heel. Success is often much greater if two baits are placed in each tunnel at separate places. As bait is being placed, trample down or level off the tops of mounds. It is then easy to detect activity of gophers that escaped the previous treatment and to place baits only where they are needed.

Nearly 50 percent more baits are taken when a probe is used for placement than when main runways are opened with a shovel or spoon. A trained man using a probe can treat several hundred holes, over as much as 40 acres per day. The probe is easiest to use when the soil is damp and soft down to the level of the burrows and sometimes quite difficult in hard soils. It is unsatisfactory when used in sand. In finely cultivated fields, scrape back the dry surface soil before closing the hole; this can easily be done with a soil clod.

The best time to probe is in the fall during the first cool weather or just following the first good rains, and in the spring months. Main runways are easier to locate when mounds are conspicuous, before the vegetation becomes tall and abundant. The land should be gone over thoroughly at this time of the year. Alfalfa fields, due to the abundant and continuous food supply, are oftentimes more difficult to treat than orchards or open fields.

Gophers are most apt to gnaw on and girdle orchard trees during late summer, after the vegetation has become dry and green food is scarce. Therefore, when the gopher is doing the most serious damage, and quick destruction is most desired, the probing method is most difficult. At this time the operator may have to dig down to the main runways to place poisoned baits.

In dry soils, where the use of a probe is not practicable, the main runways can be opened in the same manner as for setting traps. By using slender, sharp sticks, poisoned baits can be placed about a foot back in each direction of the runway, which is then closed tightly. Open the hole two days later. If the bait has been removed and the hole remains opened, the gopher is probably dead.

Poisonous Gases

Poisonous gases have not proven to be consistently effective in controlling pocket gophers. Factors which cause the ineffectiveness of toxic gases are the extent of the burrow system, the leakage of gas through the loose soil of lateral runs, the nearness of the soil surface of main runways, and that pocket gophers may quickly plug a burrow system when poisonous gases are detected. In general, the use of poisonous gases have not proven to be economical or as effective as trapping or the use of toxic baits.

Several gopher "bombs" have been developed and are available for sale. When lighted and placed in burrow systems, the "bombs" generate a toxic gas. In general, these have not proven to be satisfactory for gopher control.

Exclusion

Small flower beds, vegetable gardens, and orchards, which are adjacent to wild lands often require special protective measures against invasion by pocket gophers either by burrowing or overland migration. Fences of small mesh, sheet metal, or concrete which extend 24 inches below the soil surface and about 12 inches above the soil surface are usually effective in protecting against pocket gophers. In light soils greater depth is often required.

Cementing ditches is effective where gophers are active in burrowing through the banks. Such costly preventive measures are advisable only where the usual control methods are ineffective.

Protection of young trees may be accomplished by use of a cylinder of wire netting (1 inch mesh or smaller). The cylinder, which should be at least 12 inches in diameter and 18 inches long, is sunk in the hole around the tree when it is planted. The top of the wire mesh should be just under the soil surface to avoid later difficulty in mowing and cultivating.

Trenching is successful for small-scale operations. A steep or vertical-walled ditch which is 18 inches wide and 24 inches deep is dug around the area that is to be protected. Five-gallon cans, with the tops removed and spaced at 25-foot intervals, are sunk into the soil so that the tops are level with the ditch bottom. Pocket gophers that get into the ditch are likely to fall into the cans and cannot escape.

Mechanical Bait Applicator

The mechanical, gopher-bait applicator offers a fast, inexpensive method of controlling large populations of pocket gophers with a once-over operation. This machine has largely replaced large-scale trapping and hand-baiting methods of control, which were time-consuming, costly, and oftentimes inadequate.

The bait applicator can be used in established pastures, alfalfa fields, and many rangelands, as well as orchards, vineyards, and open fields. It has also been used in cemeteries, golf courses, parks, and play areas. With proper adjustment, the damage caused by the machine is negligible in alfalfa fields, sod, and cover crops. For rangeland and forest use, there are more sturdy models available.

This tractor-drawn machine constructs an artificial burrow beneath the soil surface and deposits poisoned baits within the tunnels at preset quantities. The machine is driven back and forth across the field at regular intervals which makes a series of parallel burrows. The artificial burrows that are formed intercept, one or more times, the pocket gophers' tunnel system. Gophers, by nature, readily explore these artificial burrows and consume the bait they find within them.

Several commercial manufacturers[1] now build mechanical gopher-bait applicators. All of these machines operate on the same principle. Costs range from about $500.00 to $1,000.00 depending on on model and construction (Fig. 6).

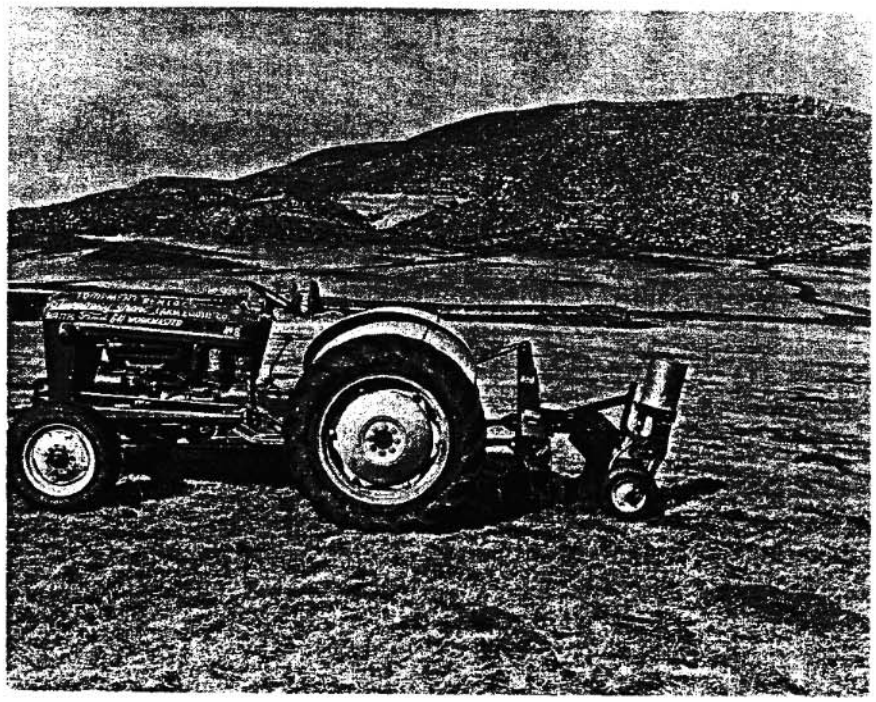

Figure 6. Burrow-builder as it would appear in operation.

[1] Mechanical-bait applicators which are commonly available throughout the west are manufactured by the following firms: Blackwelder Manufacturing Company, Rio Vista, California; Elston Co., Inc., Minneapolis, Minnesota; and Schneidmiller Industries, Fort Collins, Colorado.

Regardless of the manufacturer, all bait applicators consist of the same four basic components in addition to the supporting frame. These four basic components are (1) a depth-adjustable, burrow-forming shank, (2) a rolling coulter to cut surface litter and shallow roots ahead of the shank, (3) a bait-metering device, and (4) a press wheel to drive the bait-metering unit and to close the knifelike cut made by the upper portion of the shank (Fig. 7). The bait is dropped into the artificial burrow through a tube built or cast into the rear portion of the burrow-forming device. Special adaptations have been made for specific situations and for unusual local conditions. Figure 8 is a detailed drawing of the applicator.

Based on many trials and experience, it has been found that chromeplating is superior in wearing ability to hard-facing the shank, and in addition, provides improved scouring of the point, creating a better artificial burrow. Soil type is of prime importance in the wearability of the shank. Sandy and sand-clay soils cause the most abrasion.

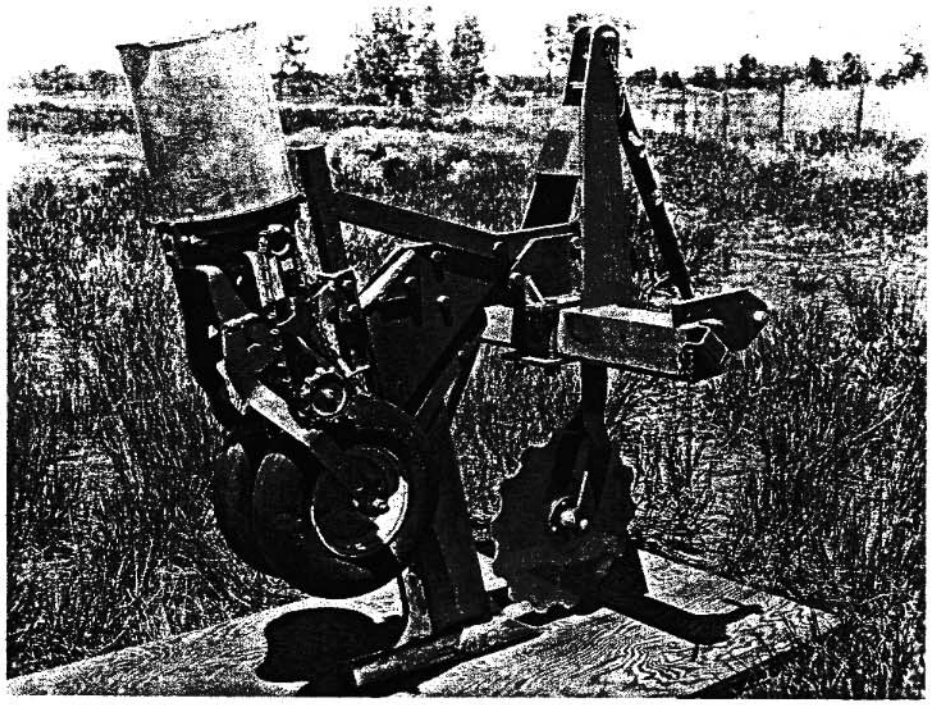

Figure 7. Burrow-builder

The bait-metering device is a conventional seed-planter hopper. Application rates and the intervals between bait discharges can be adjusted by changing the seed plates or the ratio between the press wheel and the seed hopper. Manufacturers generally provide instructions so that one can determine the rate most suited to the locality and types of baits that can be obtained.

The bait-applicator machines are designed to be mounted on a tractor having a conventional hydraulic, three-point hitch or tool bar, or mounted on wheels and pulled from the tractor' drawbar. The shanks for burrow forming on wheel-mounted machines are usually designed to be lifted out of the soil hydraulically. Consult manufacturers or distributors to determine the most suitable model for your needs.

One man operating the mechanical-bait applicator and a wheel-type tractor (a minimum of 25 horsepower) can treat from 5 to 10 acres per hour, depending on conditions and the distance between burrows. Tractor speeds of 2 1/2 to 3 1/2 mph (220 to 308 feet per minute) are commonly used. Faster speeds are possible with some of the sturdier models and tractors with

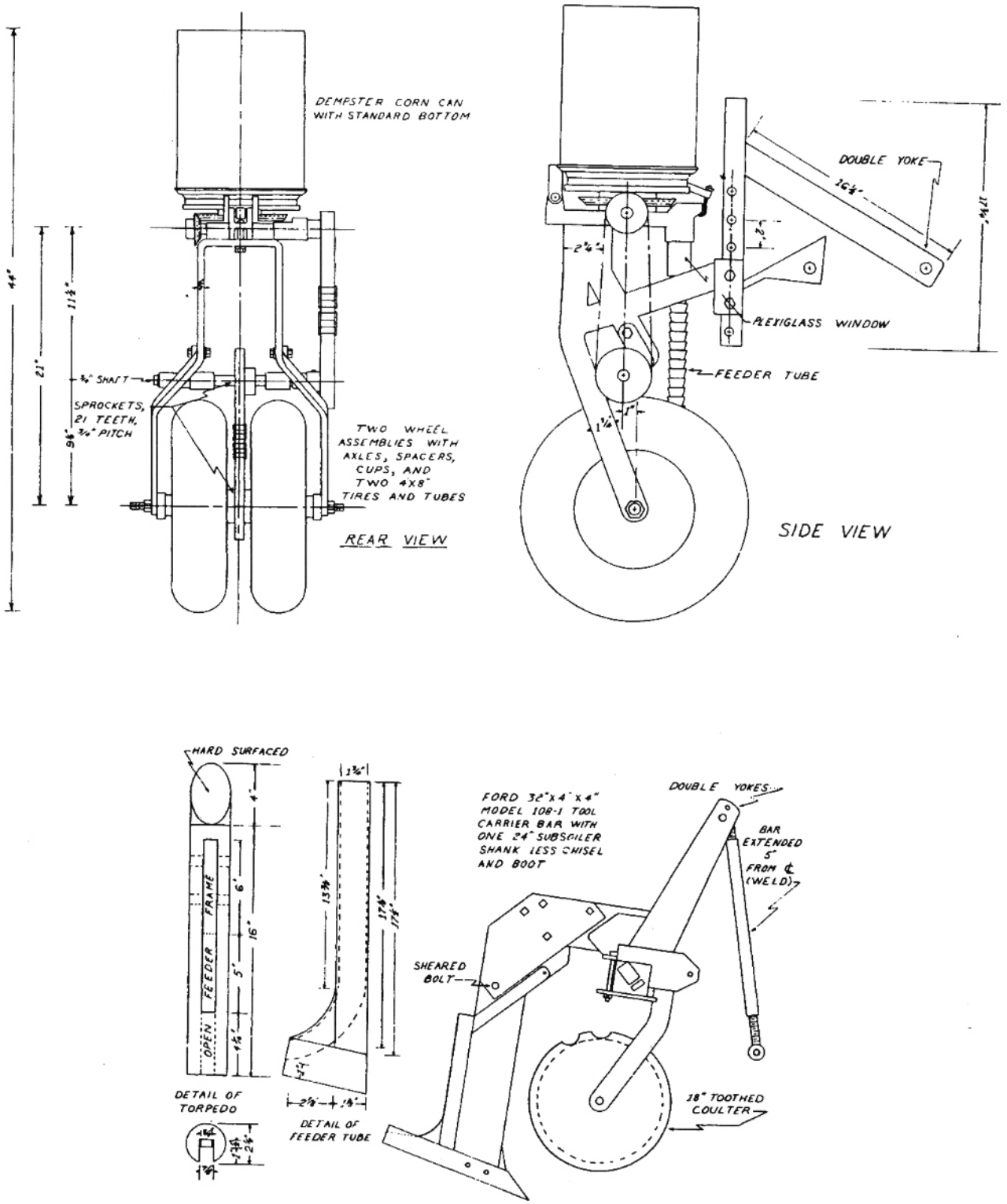

Figure 8. Parts of the burrow-builder.

sufficient horsepower, provided soil conditions are such that clean burrows can be made. The formation of clean burrows is important to good control and should not be sacrificed for speed. This is an important consideration in sandy or light soils.

While learning to operate bait-applicator machines, it is desirable to open a small section of the artificial burrow with a shovel to inspect the depth and condition of the burrow. A few trial runs may be needed to determine that the machine is adjusted properly.

Bait-applicator machines can be used in any area where soil condition and physical aspects of the land permit the formation of good artificial burrows 8 to 10 inches deep. For satisfactory results, the soil should be fairly firm below the top 3 or 4 inches and moist enough so that clean, smooth burrows are formed. Well-formed, artificial burrows are important in achieving a high degree of gopher control. In orchards, it is usually desirable to treat for gophers before spring discing. Orchard or vineyard cover crops do not ordinarily hinder the operation. The importance of proper soil moisture cannot be overemphasized. In normal situations, the soil moisture should be near the upper limit of the range for good plowing or cultivating. A handful of soil should retain its shape when squeezed but should not be so wet that it is sticky. Soils that are too wet tend to ball up the press wheel or cause a loss of traction. If the soil is too dry, the burrow will tend to be unstable and cave in. In most unirrigated croplands, the optimum soil moisture conditions for bait-applicator use prevail in the rainy months. On irrigated lands, the machine can be used at any time soil conditions are proper. However, in extremely sandy soils this is only a day or two following irrigation. If possible, avoid use of other implements for at least 10 days following treatment.

A distance of about 20 to 25 feet between artificial burrows will result in good control in most situations (Fig. 9). The burrows may be placed closer together where gopher populations are exceedingly high. In flood-irrigated croplands, gophers tend to concentrate along the levees, and therefore, parallel burrows should be made along one or both sides of the levee, or, if soil

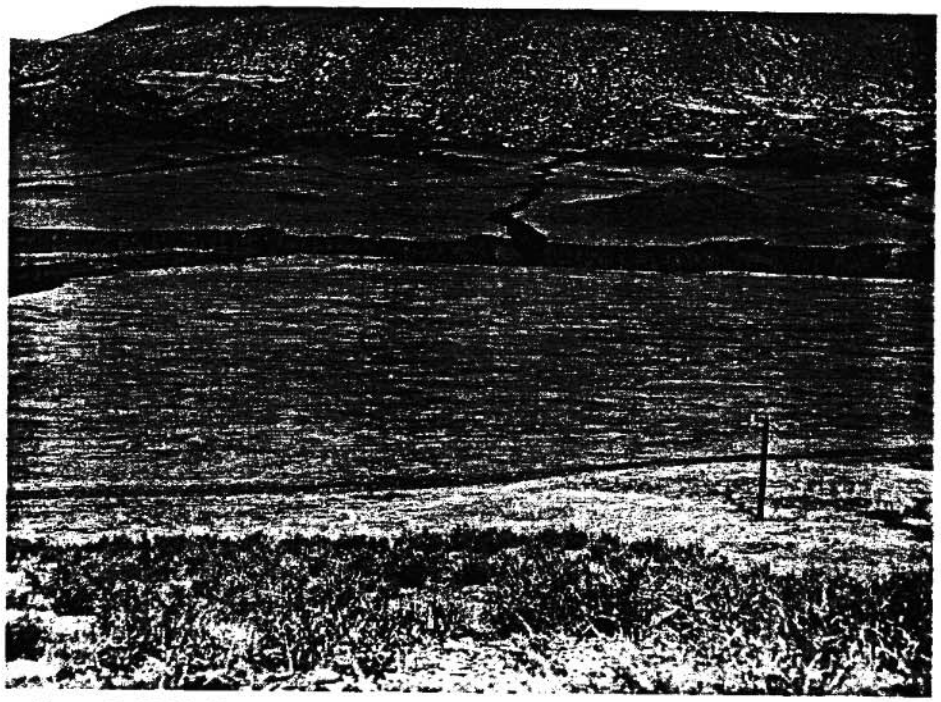

Figure 9. Field after treatment with burrow-builder, showing surface disturbance.

moisture is adequate, along the tops of the levees. In mature orchards, artificial burrows are placed in the center between each row of trees. In young orchards, it is often desirable to place the burrows fairly close to the trees but not so near as to cause root damage. The rows of grapes in vineyard plantings are often much closer together, and good control can be obtained with burrows being placed every second or third row. Burrows do not need to be continuous as short backs caused by having to raise the shank to avoid obstructions, or to free litter materials, will not adversely affect control. It is often desirable to make one or two additional burrows around an entire field to reduce invasion by gophers from adjacent areas. If a field is being treated for the first time by a mechanical bait-applicator, it is recommended that the entire acreage be covered. However, where previous control has nearly rid a field of gophers, re-treatment may be required only in isolated gopher-infested areas of the field.

The depth to the bottom of the artificial burrow should average 8 to 10 inches for most areas. The ideal depth can be determined by measuring the depths of natural burrows of presently active gophers and then adjusting the machine accordingly (Fig. 10). For formation of a smooth open artificial burrow, the depth should seldom if ever be less than 6 inches. Since the depth is less important than a well-formed burrow, it is better to set the shank too deep than too shallow. Numerous obstructions, such as rocks and tree roots, may limit the use of the machine in some forest and rangeland situations.

Figure 10. Artificial burrow intercepting natural pocket gopher burrow.

The rate of bait application within the artificial burrow, which is usually expressed in pounds per 1000 feet of burrow, is determined by two features: (1) the size (number of kernels) of each bait drop, and (2) the interval (distance) between bait drops. The machine can be adjusted for either one or both of these features to obtain the desired rate of bait application. Avoid heavily rolled, large-kerneled grains, or other large baits which do not readily pass through the

TABLE 1. Bait application computations for determining pounds of bait required per acre.

Pounds of bait applied per 1,000 feet of burrow	Spacing between rows of artificial burrows (feet)													
	10	12	14	16	18	20	22	24	26	28	30	32	34	36
0.1	.44	.36	.31	.27	.24	.22	.20	.18	.17	.16	.15	.14	.13	.12
0.2	.87	.73	.62	.54	.48	.44	.40	36	.34	.31	.29	.27	.26	.24
0.3	1.3	1.1	.93	.82	.73	.65	.59	.54	.50	.47	.44	.41	.38	.36
0.4	1.7	1.5	1.2	1.1	.97	.87	.79	.73	.67	.62	.58	.54	.51	.48
0.5	2.2	1.8	1.6	1.4	1.2	1.1	.99	.91	.84	.78	.73	.68	.64	.61
0.6	2.6	2.2	1.9	1.6	1.5	1.3	1.2	1.1	1.0	.93	.87	.82	.77	.73
0.7	3.0	2.5	2.2	1.9	1.7	1.5	1.4	1.3	1.2	1.1	1.0	.95	.90	.85
0.8	3.5	2.9	2.5	2.2	1.9	1.7	1.6	1.5	1.3	1.2	1.2	1.1	1.0	.97
0.9	3.9	3.3	2.8	2.5	2.2	2.0	1.8	1.6	1.5	1.4	1.3	1.2	1.2	1.1
1.0	4.4	3.6	3.1	2.7	2.4	2.2	2.0	1.8	1.7	1.6	1.5	1.4	1.3	1.2
1.1	4.8	4.0	3.4	3.0	2.7	2.4	2.2	2.0	1.8	1.7	1.6	1.5	1.4	1.3
1.2	5.2	4.4	3.7	3.3	2.9	2.6	2.4	2.2	2.0	1.9	1.7	1.6	1.5	1.5
1.3	5.7	4.7	4.0	3.5	3.1	2.8	2.6	2.4	2.2	2.0	1.9	1.8	1.7	1.6
1.4	6.1	5.1	4.4	3.8	3.4	3.0	2.8	2.5	2.3	2.2	2.0	1.9	1.8	1.7
1.5	6.5	5.4	4.7	4.1	3.6	3.3	3.0	2.7	2.5	2.3	2.2	2.0	1.9	1.8
1.6	7.0	5.8	5.0	4.4	3.9	3.5	3.2	2.9	2.7	2.5	2.3	2.2	2.0	1.9
1.7	7.4	6.2	5.3	4.6	4.1	3.7	3.4	3.1	2.8	2.6	2.5	2.3	2.2	2.1
1.8	7.8	6.5	5.6	4.9	4.4	3.9	3.6	3.3	3.0	2.8	2.6	2.4	2.3	2.2
1.9	8.3	6.9	5.9	5.2	4.6	4.1	3.8	3.4	3.2	3.0	2.8	2.6	2.4	2.3
2.0	8.7	7.3	6.2	5.4	4.8	4.4	4.0	3.6	3.4	3.1	2.9	2.7	2.6	2.4
2.1	9.1	7.6	6.5	5.7	5.1	4.6	4.2	3.8	3.5	3.3	3.0	2.9	2.7	2.5
2.2	9.6	8.0	6.8	6.0	5.3	4.8	4.4	4.0	3.7	3.4	3.2	3.0	2.8	2.7
2.3	10.0	8.3	7.2	6.3	5.6	5.0	4.6	4.2	3.9	3.6	3.3	3.1	2.9	2.8
2.4	10.5	8.7	7.5	6.5	5.8	5.2	4.8	4.4	4.0	3.7	3.5	3.3	3.1	2.9
2.5	10.9	9.1	7.8	6.8	6.1	5.4	5.0	4.5	4.2	3.9	3.6	3.4	3.2	3.0
2.6	11.3	9.4	8.1	7.1	6.3	5.7	5.1	4.7	4.4	4.0	3.8	3.5	3.3	3.1
2.7	11.8	9.8	8.4	7.4	6.5	5.9	5.3	4.9	4.5	4.2	3.9	3.7	3.5	3.3
2.8	12.2	10.2	8.7	7.6	6.8	6.1	5.5	5.1	4.7	4.4	4.1	3.8	3.6	3.4
2.9	12.6	10.5	9.0	7.9	7.0	6.3	5.7	5.3	4.9	4.5	4.2	3.9	3.7	3.5
3.0	13.1	10.9	9.3	8.2	7.3	6.5	5.9	5.4	5.0	4.7	4.4	4.1	3.8	3.6

Example: To determine the amount of bait that will be required if a mechanical baiter set to apply 0.5 poun per 1,000 feet of burrow is to be used between rows with 22-foot spacings, read down row spacing column 2 until opposite the designated 0.5 pounds. The answer (to the nearest hundredth) is 0.99 pounds.

delivery tube into the burrow. The quantity of toxic bait deposited in the artificial burrow determines how easily the entering gopher will find a lethal dose. The size of the holes in the hopper dispensing plate governs the amount of bait dropped, which can be adjusted as desired by changing plates. The intervals between bait drops are determined for some machines by the number of holes in the dispensing plate and on all machines by the sprocket ratio between the bait hopper and the drive-press wheel. The distance between bait drops is generally between 1

and 48 inches, depending on the desired application. The manufacturers usually provide the necessary instructions for presetting the machine to apply the desired rate. Where there is no information on the preset rate of bait application, the machine may be checked for the desired calibration by placing a weighed amount of clean, unpoisoned bait in the hopper and making a sample burrow for 1000 feet. The amount of bait applied can be determined by weighing the remaining bait in the hopper. If necessary, adjustments can be made to correct the rate of bait flow. By use of Table 1, the amount of bait per acre can be determined for any desired burrowing spacing.

Because of the gopher's solitary habits, the rate at which the bait is dispensed within the artificial burrow is independent of the gopher populations. Where populations are dense, more gopher systems are intercepted by the bait applicator. However, the distance between the burrows should be less, if possible, where large populations exist. In instances of high populations where inadequate control is achieved on the first treatment, a second application may be made; however, it is advisable to wait at least two weeks before re-treating an area. Table 1 can be used to determine the necessary pounds of bait required to treat each area of land.

Machine Operation Suggestions

In absence of specific manufacturer's instructions, the following suggestions may be of help when operation difficulties occur.

1. The burrow-forming shank must be thoroughly scoured before it will form a smooth burrow. The shank will scour more quickly if the coulter is temporarily set to cut shallow in the ground.
2. Adjust the machine so that the burrow-forming portion of the shank is drawn through the soil parallel to the surface.
3. Carefully align the coulter wheel to cut directly in front of the burrow-forming shank at a depth of from 4 to 6 inches to minimize soil and vegetation disturbances.
4. The press wheel should run firmly on the soil surface to close the narrow slits in the soil formed by the upper portion of the burrow-forming shank.
5. Lower the shank into the ground while the machine is in a forward motion; likewise remove it while still moving forward.
6. Raise the machine out of the soil to make turns. Some models will permit moderate turns; however, with all models, raise the shank out of the soil to make sharp turns.
7. Avoid stopping the tractor on an uphill pull with the shank buried, as a slight backward movement can clog the bait outlet.

Moles

Moles are abundant in suitable habitat (especially in moist, fertile, highly organic soils) throughout western Washington and Oregon. Additionally, they occur in local areas of central and eastern Washington and Oregon.

The Pacific Northwest is the home of three species of moles. Townsend's mole *(Scapanus townsendi)* is the largest mole in the United States and is found generally throughout western Washington and Oregon. The Coast mole *(Scapanus orarius)* is generally distributed in the coastal fog belt and in

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Prepared by David M. Baumgartner, Extension Forest Resources Specialist, Cooperative Extension Service, Washington State University, Pullman.

sections of southeastern Washington and northeastern Oregon. Townsend's and Coast moles, when found in the same locality, seem to live in close association. Townsend's mole is usually the more adundant of the two. The Klamath mole *(Scapanus latimanus)* is found in southcentral Oregon. Also, the Sheffer and Gibbs moles are found in eastern Washington and British Columbia.

Identification

Moles are primitive mammals belonging to the order Insectivora. They have velvety, blue-black to gray, mohair-like fur. The snout is slender and sparsely haired, with long slim jaws and abundant needlelike teeth. The tail is short and nearly hairless. The stout, short forearms are tipped with outwardly-turned flattened feet and claws. The hind feet are much smaller than the fore feet Ears and eyes are inconspicuous. Townsend's mole is 8 to 9 inches long. The Coast mole averages 6 to 7 inches.

Habits

Moles live in underground runways. These runways, in heavily infested areas, form a vast network of interconnecting highways. Runways are dug to search for food and to provide protection and living space for travel, resting, and nesting.

Some runways are major lanes of travel used by several moles. Major runways are often found under fence lines, leading to watering areas, under roads or along sidewalks, or in other generally protected situations. The main runways are usually about 6 inches under ground level, but may be as shallow as 2 inches or as deep as 20 inches.

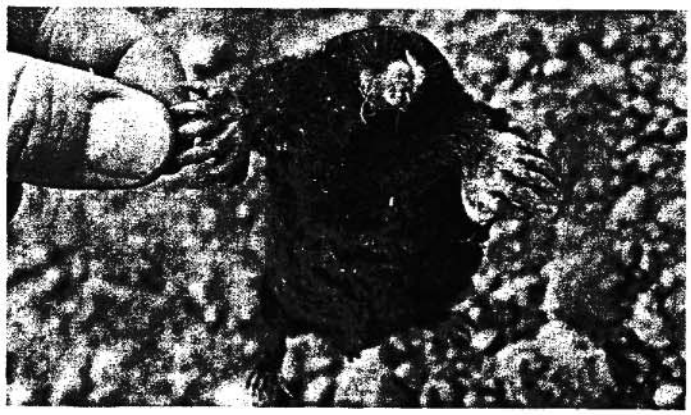

Figure 11. Mole

Extremely shallow runways, immediately under lawn turf, for instance, are feeder offshoots from a main runway and are probably used only once.

The annoying mole hills are external evidence of the moles' underground tunneling activities. Moles eject surplus dirt from tunnel workings through a lateral chimney to the surface.

Moles come to the surface occasionally, mainly at night, to search for food, water, and nesting material. Migrations may occur overland also. Moles are most active in the months of June and July.

Annual Cycle

Moles are active throughout the year. They do not hibernate or estivate. During extremely wet or dry periods, mole activity–by external evidence–seems to be lessened. Control programs will be most successful if carried on during periods of heavy mole activity.

Food

The principal diet of moles consists of earthworms, grubs, beetles, and insect larvae. Vegetation occasionally makes up a small portion of their diet through ingestion of worms whose stomachs contain vegetation.

Moles require large quantities of food, spending perhaps half their lives searching for something to eat. The estimated yearly intake of food for a single mole is about 40 pounds. Moles travel extensively in searching for food–up to a half a mile a day. Most of this travel, luckily, is back and forth in the burrow and not in a straight line. Extensive movement contributes to the control problem, because the neighbor's moles may move right in.

Breeding Period

Moles mate from late February to early March, producing young only once a year. The young, averaging three to the litter, are born from late March to early May. Young moles spend about one month in the nest and are nearly full grown when they leave. They may sometimes be distinguished from adults by a shorter snout, slightly smaller size, and pearly-gray fur.

Nests are constructed underground in a fortess-like arrangement in fence lines and well-drained, slightly raised sections of fields. Large molehills (30 to 40 inches in diameter) or areas of intensive mound-building activity are probably nesting sites.

Nest cavities average 9 inches in diameter and about 6 inches in height. Normally, three or four runways lead into the nest. The nest is composed of grasses or moss with a dry, inner pocket surrounded by wet, coarser grasses. Nests will normally be found 5 to 18 inches under ground level.

Moles or Gophers

Moles should not be confused with pocket gophers. Pocket gophers are rodent root eaters. While molehills are built like a volcano, by upthrust of earth plugs through the center and rolling down the sides, gopher mounds are built like a mine dump, by loose dirt pushed out away from the exit at one side. Gophers are different from moles in their habits. It is important to distinguish between them because each requires special control techniques.

Control

The mole is here to stay. Extermination is impracticable, if really desirable. The very nature of its food habits makes it hard to poison, even if poisoning methods about gardens, lawns, and home

premises were really desirable. Fumigation with lethal gases is sometimes successful against the mole, but more often it is a waste of time trying to fill the porous soil of the intricate and connecting runway systems with the deadly fumes. Fumigation may also destroy beneficial bacteria and roots.

The use of deterrents, obnoxious substances placed in the mole runs, has the local and temporary advantage of driving the animal elsewhere to find new hunting grounds. This may indeed serve the purposes of the keeper of the home premises or of the kitchen gardener. Use lye, creosote, tar, carbide, sink flush, preferably in the deeper runways where the moles enter the premises from wastelands or borders—not where the substances will injure plants or contaminate the soil for long.

Other control methods that may have individual application include digging out mole nests and shooting or stunning individuals that are found working. Moles are sensitive to concussion. Smacking a shovel on the ground near a working mole often will stun or kill it.

Unless most of a population of moles is taken, no residual control is effective. Some farmers have trapped 100 or more moles annually, only to be faced with the original amount of infestation the following season.

Trapping

Successful mole trapping depends upon learning and practicing a few fundamental techniques.

Traps must be set to form an integral part of the runway system. Set them at least 1 foot away from molehills to assure trapping main runways. Probe to locate the runway, as in poison baiting, and probe again to determine the direction of the runway.

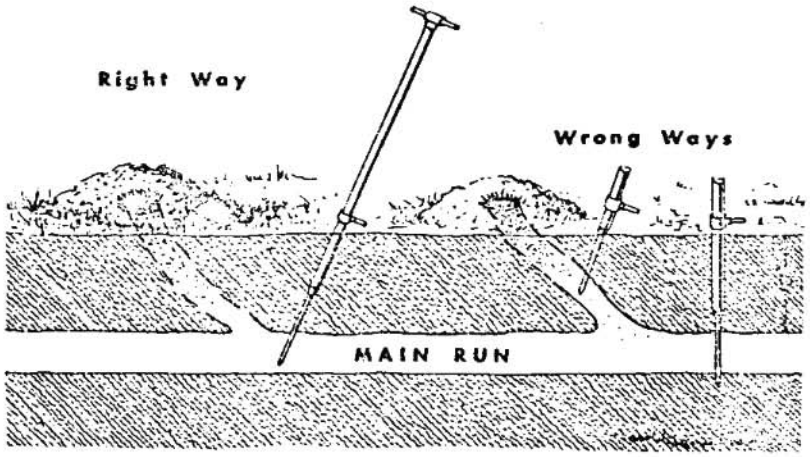

Figure 12. Cross-section of mole runway system showing how to probe.

Using a sharp, straight-edged shovel or trowel, cut out a section of runway—exactly the width of the trap. Loosen the dirt under the trap jaws to facilitate trap action. In rocky soil, remove all rocks that may bind the trap.

If you are using a scissors-jaw trap, build a firm plug of dirt for the trigger pan to rest on. Insert the trap into the hole. Make sure the trigger set wire (wire that binds trap bows) can

function. Press the trigger pan firmly on the dirt plug with the trap jaws straddling the runway. Remove the trap safety catch. Sift loose dirt onto the set to exclude light. It is advisable to reset traps daily during wet weather.

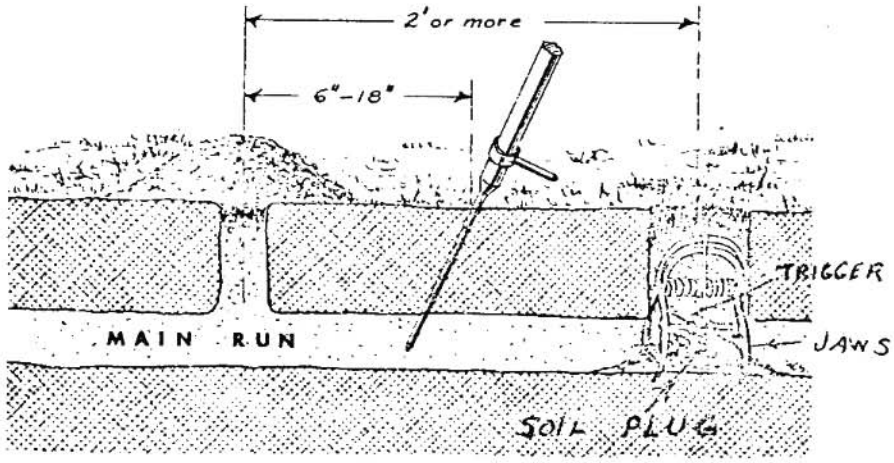

Figure 13. Cross-section of mole runway showing trap placement.

The proper way to set a scissor-jaw mole trap is shown at the right. Note the plug of soil under the trigger and the points of the trap slightly embedded in the bottom of the runway. Sift fine soil around the jaws to exclude light and mark its location.

Moles will plug, spring, heave out, or go around faulty trap sets. More than 40 moles have been caught in the same set on a major runway. If a main mole arterial is located, moles may be controlled over an area of several acres by trapping this one runway.

Trapping the smaller Coast mole sometimes requires a modified technique. The scissors-jaw trap may be used on the small Coast mole by constructing a wider bridge under the trigger or inserting a small piece of shingle under the trigger Either adaptation effectively gives the trigger a broader working surface.

The diamond-loop trap appears to be an excellent tool for capturing the Coast mole. This trap is set in the runway with the diamond opening centered on the tunnel. Loose dirt is sifted onto the set.

Ground Squirrels

The Columbian ground squirrel is a large, heavy-bodied, short bushy-tailed, ground-dwelling squirrel. The body of an adult measures about 10 inches and the tail about 4 inches. The upper parts are grayish buff, mottled with round, white dots. The face, thighs, feet, and tail are reddish.

These squirrels are common throughout the northeastern portion and along the eastern border into the extreme southeastern part of Washington. They occupy meadows and grasslands in the valleys, openings in coniferous forests at higher altitudes, and parks and alpine meadows almost to timberline. Although preferring a rather humid climate, this squirrel is well-known in the grasslands and wheat fields of the Palouse country. Where small meadows or pastures occur, the squirrels live in dense colonies; in extensive grasslands or in the mountains, they may live in loose colonies or small groups.

The Columbian ground squirrel emerges in late February or early March. Hibernation dates vary, depending on elevation and climate conditions. In the lowlands, the squirrels begin to disappear in mid-July. In the mountains of northeastern Washington, they may be active until late August. Mating occurs in late March and an average of five young are born about the middle of April.

Most green vegetation occurring in its habitat is food for the Columbian ground squirrel. Bulbs, seeds, fruit, berries, grain, clover, alfalfa, and garden truck are eagerly eaten. The squirrels are especially fond of grain and great damage can result from their depredations.

Trapping

Use with small populations or where other methods have not completely eliminated all animals.

Recommended Procedure—Close all known openings with a shovel late in the afternoon or early in the evening. Place the trap directly over newly opened holes early the next morning. Any animal leaving or entering the burrow will be caught. Stake the trap to the ground so that it cannot be moved by the struggling animal.

Recommended Device—Conibear #110 traps (single spring).

Available from: Joseph A. Garcia & Son
3641 Fairfield Rd.
Hollister, CA 95023
(408) 637-5211
Other sources may be available within the state.

Poisonous Gasses

Use with small to medium size populations as either primary control method or where other methods have not eliminated all animals.

Recommended Procedure—Close up all burrow openings either with a drag (for large areas) or shovel early in the morning. Place the selected chemical well into each reopened burrow late the same afternoon. Add a crumpled piece of paper (to prevent the animal from pushing the pellets out of the hole) in the burrow and close by shoveling dirt into the hole and tapping it down. Repeat every day until all sign of activity has stopped.

Poisonous Baits

Recommended Procedure—Pre-bait area with untreated material two days before placing poisoned bait in the field. Place material in the middle (inside) of the 3-foot length of 4-inch perforated plastic drain pipe. Do not broadcast-apply any material in crop or forage production areas. Read individual labels for specific instructions. Place each bait station no closer than 20 feet from the entrance to an open burrow and between 50 and 200 feet apart (depending on the number of animals seen in the colony) on runs between burrows. Refill each station once a day until the bait is no longer consumed. Remove all unused bait from the area immediately after all signs of activity have stopped. Inspect the field each day for dead or dying animals. Bury or burn all animal carcasses.

Prepared by Leonard R. Askham, Vertebrate Pest Management Specialist, Washington State University, Pullman.

Baits should be placed in areas inaccessible to children, pets, and domestic animals. Read all labels before using.

Restrict all grazing animals from the pasture for at least 30 days after completing the baiting operation.

Coyotes, Foxes, Bobcats, Bears and Mountain Lions

Introduction

Coyotes and other carnivores consistently provide interest and recreation for a substantial segment of the public–a positive social value. They are also an integral part of the ecosystem and aid in management of other wild species. Individual animals, however, do cause economic loss.

Description

Coyotes are members of the dog family and resemble small German Shepherds. Both males and females are primarily gray-colored, with variations from nearly white, to reddish brown, to nearly black; the underbelly is a lighter color. Color variations seem somewhat related to the type of habitat in which they live.

Weights vary with areas and food supply, but most adults weigh from 20 to 35 pounds; males are usually slightly heavier. Individuals may be larger–a 75-pound male was reported in Wyoming in 1937. Body proportions are somewhat more slender than those of shepherd or collie dogs of similar size. Coyote tracks are similar to those of greyhounds, but are narrower and less rounded than those of common dog breeds. The coyote howl, a series of barks that ends in a wail, is distinctive and is most commonly heard during evening and early morning hours. They have other howl patterns that are not often heard.

Food Habits

As carnivores, 98 percent of the average coyote diet is animal matter and 2 percent is vegetable matter. Individuals, however, feed heavily on fruit or other vegetable matter at times. Juniper berries, prickly pear fruits, wild plums, cantaloupes, and watermelons are some of the fruits utilized. Analyses of stomach contents of 8,263 coyotes from several western states indicated that approximately 50 percent of the diet was rodents and rabbits and 25 percent was carrion. Remains of domestic animals, deer, and birds amounted to 20.5 percent and other food items, including vegetable matter, amounted to 4 percent. However, individual coyote diets often vary a great deal from the average.

Reproduction and Mortality

Coyotes usually breed in February and March and produce litters about 9 weeks later, in April and May. Females sometimes breed the winter following their birth, at less than one year of age, particularly if the food supply is plentiful. Average litter size is 5 to 7 pups, although up

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From *Control of Damage by Coyotes and Some Other Carnivores,* prepared by Dale Wade, Extension Wildlife Specialist (Animal Damage Control), University of California, Davis. At the time of this publication, Mr. Wade was Extension Wildlife Specialist, Colorado State University, Fort Collins.

to 19 in a litter have been reported. More than one litter may be found in a single den—at times these may be from a single male parent. Coyotes crossbreed with dogs to produce the coy-dog hybrid. Hybrids are fertile, although their breeding seasons do not usually correspond to those of coyotes.

Distemper and mange are the most common coyote diseases. Rabies and tularemia also occur and may be transmitted to other animals and humans. Some parasites of coyotes are mites, ticks, fleas, worms, and flukes. Mortality is highest during the first year of life and few coyotes live more than 10 to 12 years in the wild. Death caused by human activity is probably the greatest single cause of mortality.

Habits

Coyotes are found in nearly all types of terrain, although populations are probably highest in the western states. Timber, brush, open prairie, and desert areas are favored habitat types, but coyotes are highly adaptable and are also found in farming areas, suburbs, and cities.

Coyotes are most active at night and during early morning hours, especially where human activity occurs, or during hot summer weather. With minimal human interference, or during cool weather, they are active throughout the day. They bed in sheltered areas, but do not utilize dens except when raising young. They may seek temporary shelter underground in severe weather or when closely pursued. Dens are found in steep banks, rock crevices, sinkholes, and underbrush, as well as open areas, but usually are in areas selected for protective concealment. Coyote dens are often holes that have been used by badgers, skunks, foxes, or other animals, with entrances enlarged to about one foot in diameter. Dens vary in depth from 4 or 5 feet to as deep as 50 feet and may have several openings.

Both parents hunt and bring food, usually regurgitating food for the pups until pups are several weeks old. Pups begin coming out of the den by 3 weeks of age, and within 2 months they follow adults on short hunting trips or to feed on large prey. Pups are normally weaned by 6 weeks of age and are frequently moved to find larger living quarters. Extensive travel is common in hunting, although coyotes hunt the same areas regularly if plenty of food is available. They occasionally bury food remains for later use. The family usually remains together until late summer or fall, when pups become independent, although occasionally they are found as groups until breeding season begins.

Their physical abilities include good eyesight and hearing and an exceptionally keen sense of smell. Documented recoveries from severe injuries give testimony to great physical endurance. Although not as fleet as greyhounds, they have been measured at speeds up to 40 miles an hour and can sustain slower speeds for several miles.

Economic Importance

Coyote predation on rodents and rabbits may not affect man's interests in wilderness areas but is beneficial in agricultural areas. Feeding on carrion can also be helpful. Coyotes adversely affect human interest by preying on domestic animals—poultry, hogs, sheep, goats, and cattle are most often the prey species. They sometimes damage domestic fruit crops, such as, cantaloupe and watermelon.

Livestock losses to coyotes are usually most serious during spring and summer months because of extra food needed for their young. Sheep on open range usually suffer the heaviest losses. The male parent generally kills more often than the female and may travel ten miles or more from the den to kill. Removal of adults doing the killing usually solves the immediate problem. Coyote predation on game animals and birds is condemned by some as being detrimental to game species and the sportsman's interest. Others support predation as being beneficial to preservation of desirable qualities in game animals. In most cases, there is probably no detrimental effect on game species, although coyote predation may conflict with attempts to introduce or reestablish game populations and may depress established populations. Depending on local conditions, initial plants of turkeys, antelope, or other species may require control of predation for an increase in game populations to occur. Coyotes usually prey on smaller animals but are capable of killing adult deer and antelope. Several coyotes often cooperate in such cases.

Appearance of Animals Killed by Predators

Coyotes normally kill smaller mammals by biting the head or neck, but on older lambs and adult sheep, kills are usually made by biting the throat just back of the jaw and ear. Small calves may be killed in a similar fashion. The major cause of death is probably damage to the trachea and/or to nerves affecting respiration, blood pressure, and heart rate, rather than loss of blood.

Coyote kills usually have clean puncture wounds in the head or throat, although coyotes, especially inexperienced pups, occasionally attack the flank or hindquarters. Dogs usually kill by attacking the hindquarters, flanks, and head and rarely kill as cleanly as coyotes. Badly torn and slashed animals with damage to the head, ears, and sides are typical of dog predation. Red foxes kill and feed on small lambs much as coyotes do, but larger sheep often show many teeth marks in the throat. Occasionally, foxes pull wool loose from flanks and hindquarters or damage the head as dogs often do.

Bobcats kill much like coyotes, but larger victims may have claw marks under the skin of the neck and/or shoulders. Kills by mountain lions will have teeth marks that are larger and further apart than those made by smaller animals. Larger animals killed by lions usually have claw marks on the neck and/or shoulders and are often left partially or entirely covered by dirt, leaves, and twigs.

Black bear kills will have large teeth marks that are further apart than those made by coyotes, foxes, and bobcats and usually are on the back of the head, neck, or shoulders. Bears also tend to "skin" the animal when feeding, leaving the inverted skin attached to the bones. Bruises to the back and flank areas would probably be caused by a bear. In addition, the udder of lactating female animals is often eaten first by black bears.

It is important to realize that appearance of the prey animal is not always adequate to determine which species is responsible. Particularly in sheep, kills by coyotes, bobcats, dogs, lions, and bears can be very similar in appearance, depending on the method of attack by the individual animal. Many animals that were not killed by predators are fed on as carrion and will not normally have marks on neck and shoulders from teeth or claws. Also, animals fed on as carrion usually do not bleed.

Feeding habits by various predators are often similar enough that it is difficult to determine the predator involved from the appearance of the carcass. Also, an animal may be killed by one species and fed on by one or more different species. Feeding by coyotes, bobcats, and foxes might be particularly difficult to separate. Heavy feeding on sheep by coyotes usually results in substantial scattering of wool. When bears feed heavily, the hide is peeled back from the legs and head, and wool is scattered less than when coyotes feed. Attempts by lions to cover the carcass also help in determining predator species.

Similar appearances in kills and feeding habits point out that additional evidence is necessary to determine predator species. Fresh tracks and droppings in the surrounding area are helpful. Coyote tracks are typically narrower and more compact than dog tracks; whereas, bobcat tracks are round and show no claw marks.

Adult lion tracks are similar to bobcat tracks, but are much larger. Bear tracks are large and distinctively different. Such evidence is necessary to help verify conclusions derived from appearance of the carcass.

Control Measures

State Regulations

It should be recognized that state statutes and regulations vary regarding methods that can be employed in controlling problem animals. Responsibility rests with the individual to become aware of laws and regulations relating to trapping, hunting, and other methods. He should also be aware of regulations relating to protected species and seasons of the year when other species may be taken.

Many states have damage-control programs conducted by state and/or federal agencies. These can often provide advisory or direct assistance in damage-control procedures. The state wildlife management agency can provide information relating to such programs and to damage control and harvest regulations.

Chemicals and Aircraft

Laws and regulations affecting the use of chemicals and aircraft in control of problem animals vary from state to state. Many states prohibit their use entirely, while others have permit systems to govern their use. Both methods can be effective and selective when employed with professional ability under suitable conditions, but are not suited for use by the amateur.

Aerial hunting is most effective in open and flat terrain with only limited amounts of brushy cover. It is rarely very useful in heavy brush and timber during summer months as a direct control measure, but may have limited use with a heavy snow cover since snow aids in observation of animals and tracks in all terrain. It is an extremely dangerous method for the individual with limited experience.

Chemical control requires licensing or registration prior to application. Check with the State Department of Agriculture for specific requirements. Formal training is helpful to insure proper chemical application to protect humans and non target species. The lack of this knowledge and nonprofessional use of chemicals has caused much of the opposition to damage control programs.

Hounds

Hunting with hounds is both a sport and a control measure. Hounds that hunt by sight are usually hauled (caged) in a vehicle until the coyote is seen and then are released to catch and kill the coyote. This is not very effective in areas with brush and timber or in heavily settled areas where there are many fences. Trail hounds have been used to aid in locating coyote dens and in conjunction with aircraft to remove individual coyotes from areas where cover prevents good visibility. They are rarely able to catch healthy adult coyotes in open country, but can be highly effective in finding coyotes in dens in heavy cover.

Calling Coyotes

Calling coyotes by simulating distress calls of a rabbit is often effective in taking the problem animal. Predator calls are available in most sporting-goods stores but require some practice to be used effectively. Records of rabbit distress calls are available. These devices, or assistance by experienced callers, should be used as a guide before one attempts to call animals that are causing damage. Electrical or electronic calls and recordings can be effective in calling coyotes and other animals, but some states prohibit their use. Other states allow them to be used under specific conditions. Check with the wildlife management agency regarding their use in your state. A good field of view is important. Animals often attempt to approach the call while remaining in cover and detect the caller before they are seen. Wind can also ruin a good opportunity by carrying the caller's scent to the animal, so it is best to call crosswind or upwind.

Suggestions for calling:

1. Early morning and evening hours are best.

2. A rifle is best for open country or long shots, while a shotgun is recommended for brushy areas or close shots.

3. The caller should be concealed by brush or other camouflage to avoid detection and should avoid movement.

4. The call should closely mimic the rabbit distress call.

5. The caller must be patient; although coyotes normally respond in 10 to 15 minutes, 30 to 40 minutes may be required to coax the animal within range.

6. If the animal does not come to the call, the caller should move at least a mile before trying again.

Calling either in the area where livestock killing occurs or near the den can be successful in taking the problem animal. It should be emphasized, however, that carelessness in calling or in approaching the area can nullify calling efforts and force use of other control measures.

Denning

Coyote denning habits are roughly similar in most areas and the same general methods of den hunting can be employed in mountains, deserts, and plains.

"Den sign" is a term used to describe physical evidence that a den exists in an area. This evidence includes "clean-out" holes (holes that have been dug out and explored by coyotes during selection of the original den where pups are born), large numbers of adult coyote tracks in a small area, or even a worn path leading to the den. Dens are usually within a mile of clean-out holes made during selection of the original den site. Loose hairs and tracks are often found in the mouth of the occupied den. Pup tracks are often present nearby in soft dirt or mud. Fecal droppings will also be present, but food remains are not commonly found at coyote dens.

Adults with pups usually return from a successful hunt by the easiest direct route; therefore, direction of travel from kills is important in determining den location. Coyote travel routes follow game and livestock trails, canyons, dry washes, woods roads, low saddles on watershed divides, or even highways in settled areas.

Frequent sightings of adult coyotes in the same general area during daylight hours are also an indication of dens. Howling near the den during evening and morning hours also occurs, especially after pups become older and more active.

Clean-out holes and coyote tracks do not always lead to a den since "dry" (barren) females often travel with a male and sometimes do clean-out holes as if preparing to raise a litter. "Dry pairs" tend to move more during denning months, however, while coyotes with pups return daily to the den. Therefore, regular appearance of adults in the same local area tends to confirm that the den exists.

Hunting dens by tracking is easiest after a rain or windstorm when tracks are more distinct. Waterholes and springs are good places to begin. Although coyotes will travel long distances to water when necessary, hot weather increases the need for frequent drinking, and pups are often moved close to watering areas. As pups become older, they usually occupy several holes and are scattered along a creek bed or dry wash, rather than being restricted to a single location.

Good binoculars are especially helpful in finding dens by allowing the hunter to watch large areas from observation points. Close watch during early morning or late evening hours in areas of coyote activity usually results in sightings of adults and/or pups. Adults are often seen returning to feed the pups during early morning hours.

When coyotes are killing domestic animals, it is best to locate dens from a distance and avoid disturbance until the adults can be trapped or otherwise removed. Human activity close to the den, especially within about one-quarter mile, will often cause coyotes to move, particularly when the pups are older, if the adults observe the hunter, or if the den is in an open area with little protective cover.

Trapping Coyotes

Coyotes have an acute sense of smell and are highly suspicious of unnatural odors. Those that have been exposed to careless trapping methods or have been trapped and have escaped are difficult to take without extra care in making trap sets. Success with these requires trapping experience and knowledge of coyote behavior.

Regulations. Since regulations may change annually, it is best to request current information from the wildlife conservation officer or other personnel who have responsibility in animal control. Trap sets should be placed to avoid livestock and other nontarget animals, and neighbors should be informed of their presence. Many states have specific regulations on the number and type of traps that can be used as well as the time periods in which they must be checked. Traps should be checked daily to be most effective.

Release of nontarget animals and prevention of unnecessary cruelty are primary reasons for these laws. Careful observation of these regulations improves efficiency of trapping and aids in avoiding opposition to the use of traps. Steel traps have been used by many generations of trappers and no other practical or better device is available to take their place. They are still considered essential to control of problem animals.

Traps. Traps should be clean with no foreign odor. New traps have a thin coating of grease and should be simmered clean in water with a little lye added, or allowed to "age" and develop a thin coat of rust before use.

Supply houses for trapping materials sell log wood chips and crystals for dyeing traps a blue-black color, a practice that adds to trap life and may aid in catching trap-shy animals. After dyeing them, some trappers also wax traps to increase their life.

The Number 3-N trap with double springs and offset smooth jaws is a good choice for trapping coyotes, foxes, and bobcats, although the Number 4 is also used. Number 2 traps are large enough to trap foxes but are usually considered too small for coyotes and bobcats. Single or double trap sets may be used, but two traps increase the chance of catching and holding the animal (see illustration).

Trap Scents. Coyote urine alone is often adequate as a trap scent, but other scents may be used. Coyote gall and anal glands added to urine also make an effective scent. Adding 1 part glycerine to 4 parts scent will prevent rapid evaporation. Dog urine may be used if necessary. One or two drops of skunk musk adds attraction to nearly any scent used. Fetid (food) scents made from fish, such as carp, buffalo, or suckers are also effective. The fish is chopped or ground into small pieces and placed in a glass jar at room temperature. Gases form rapidly as the fish decomposes, so the jar must be vented to prevent explosion. The top should be screened to prevent flies from depositing eggs in the fish, since larvae reduce scent quality. This scent can be used in 3 or 4 days, but is longer-lasting and more effective if allowed to age for a month or more.

A small amount of ground beaver castor or Tonquin musk may be added to increase its attraction. Many different scents are also available from trapping supply companies for those who prefer not to make their own. Scent should always be carried separately from other equipment.

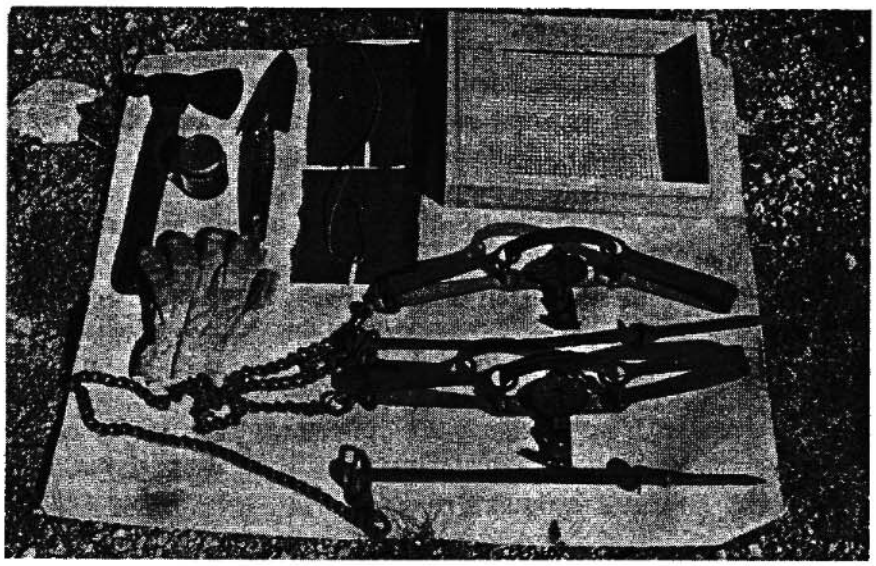


Figure 14. Trapping equipment on setting-cloth: digging tools, dirt sifter, trap pads, gloves, short wire, scent and Number 3-N traps with stakes attached.

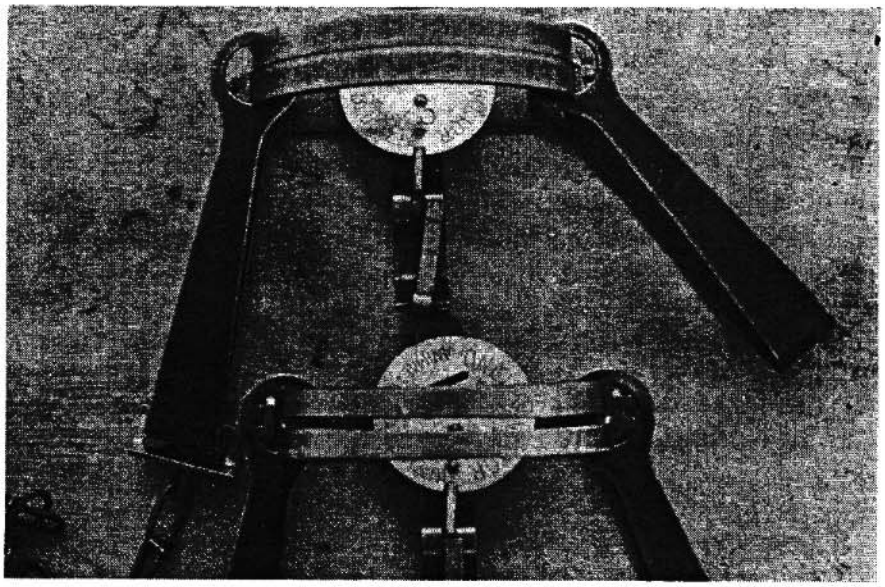


Figure 15. Number 3 Victor traps showing standard jaws (top) and offset jaws (bottom) made by using a 3/16-inch saw gumming or cutoff wheel to grind the jaws. The offset jaw is required by law in some states.

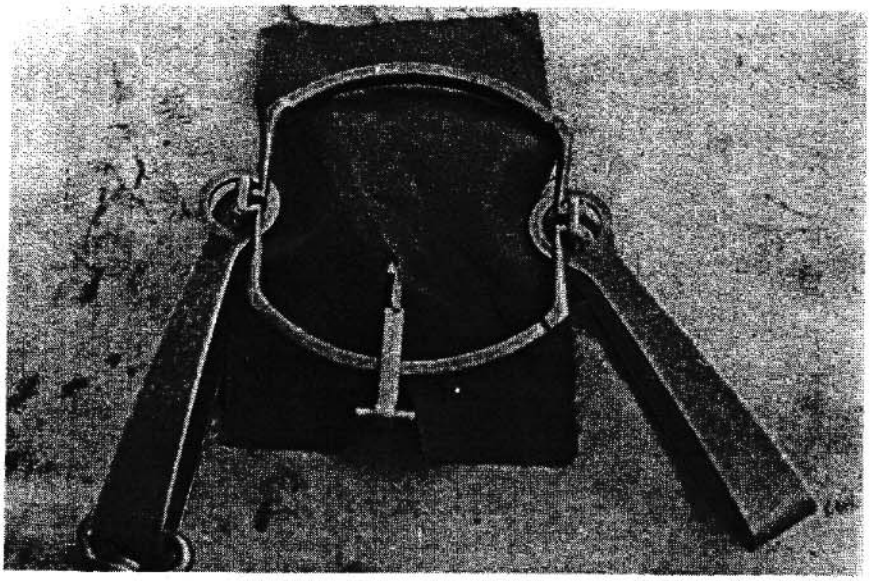


Figure 16. Number 3-N Victor trap with offset jaws showing pan cover correctly placed and slotted to clear the trigger.

Figure 17. Coyote trail through brush (dotted line).

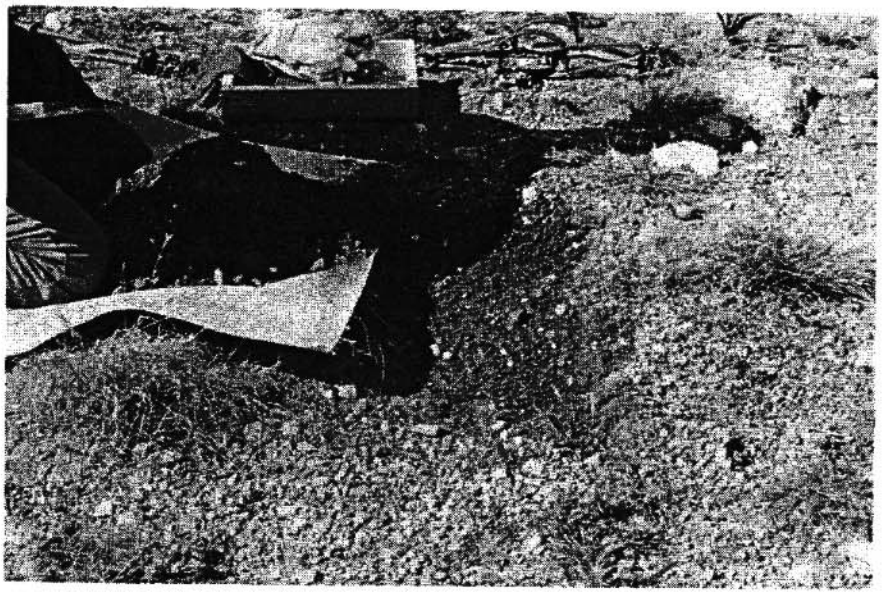


Figure 18. Digging trap bed. Dig a shallow trench about two inches deep and place dirt on the setting-cloth.

Figure 19. Driving trap stakes for double trap set. Tops of stakes should be about one inch below soil surface.

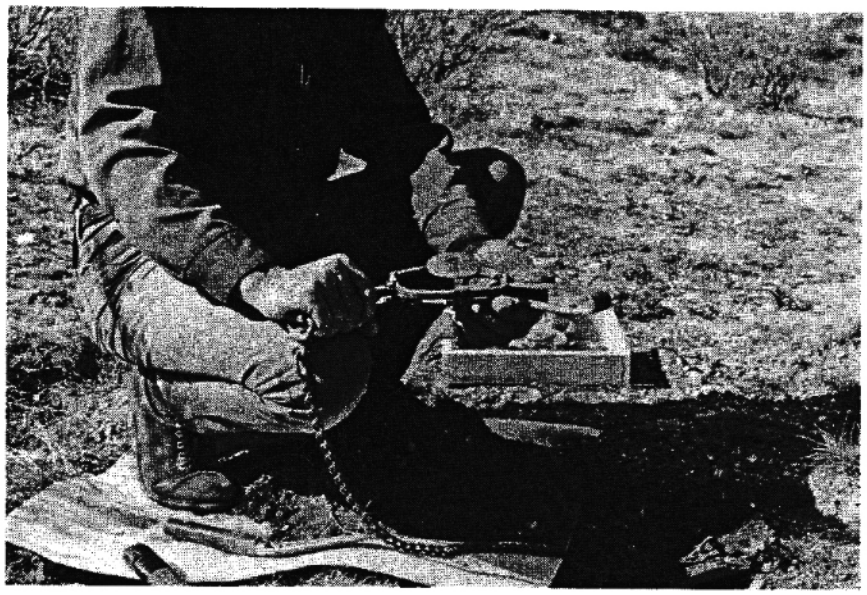


Figure 20. Setting trap. Note that springs are turned so that the jaw opposite the trigger will lie flat.

Figure 21. Double trap set in position beside bunch-grass scent post (arrow). Springs are turned about 45 degrees and traps are bedded to set flat.

Figure 22. Double trap set solidly bedded with trap pads over the pans and under trap jaws. Note that trap pads are slit over the triggers to allow traps to spring when pans are depressed. The small stone (arrow) is placed between the traps to guide the animal over the traps.

Figure 23. Double trap set in place with traps covered. Blending cover with short, curved wire has not been done.

Scent Post Sets. Natural scent posts where coyotes urinate or defecate along travel routes are good locations for trap sets. Scent posts can be established by placing a few drops of coyote urine and/or coyote droppings at the base of a tuft of grass or a small bush beside trails used by coyotes. Adults are often trapped as far as a mile from the den. Other good locations include places where animal carcasses have been present for several weeks, since coyotes regularly investigate these sites. It is best to establish scent posts a few yards from carcasses and a few feet off trails to avoid catching nontarget animals.

Figure 24. Adding scent to base of scent post. Note coyote droppings at scent post and that blending cover to camouflage traps has not been done.

Dirt Hole Sets. These sets are also effective in trapping carnivores since their attention is readily drawn by strange odors. A tuft of wool or cotton containing a few drops of fetid scent is placed in a hole a few feet off the trail and traps are set in front. Holes 3 to 5 inches in diameter and 6 to 8 inches deep are as good as natural holes dug by badgers or other animals.

Blind Sets. Trap sets made without using scent are effective where coyotes go through or under pasture fences. Traps are set 18 to 24 inches from the fence in the path the coyote uses. It is best to use double trap sets with trap pans about 10 inches apart. A small stone or stick is placed on the trail between the traps to guide the animal into the traps. Occasionally, it may be necessary to make similar type sets in trails at other locations. These are often called "blind" sets and are employed when coyotes have become wary of scent sets.

Other Locations. Elevated areas, such as cutbanks or knolls, in sight of the den and within about one-quarter mile are regularly used as observation posts by adult coyotes. These are good locations for dirt hole and scent post sets if pups are removed first, or if the den is plugged so they cannot escape.

Figure 25. Completed double trap set at scent post. Larger stones have been removed and cover over traps has been blended with short, curved wire to match surrounding area. Note location of the small stone placed between traps to guide the animal over the traps (arrow).

Figure 26. Single trap set at scent post to show location of trap pad and pan.

Figure 27. Single trap dirt hole set next to bush on coyote trail. Note that stake has not been driven. Scent will be placed in the hole after the set is completed.

Setting Traps. Gloves are not essential in trapping, but if they are used, they should not be used for other purposes. In setting traps, a shallow trench the length and width of the trap with the jaws open is dug with a trowel, hatchet, or other digging tool. While digging, the trapper stands or kneels on a "setting-cloth" about 3 feet square to avoid leaving excessive amounts of human scent. The setting-cloth of canvas, sheep hide, calf hide, or plastic is also used to hold dirt removed from the trap bed. The trap is then placed in the trench and firmly bedded to rest level with the pan about 6 to 8 inches from the scent post or the dirt hole. Experienced trappers differ somewhat in placement of traps and may prefer to set further from or closer to the scent post or hole.

Although a trap drag may be used to prevent escape of the animal, a stake to anchor the trap is more commonly used. Stakes should be long enough to prevent any possibility of escape. Sixteen-inch stakes are usually adequate in hard ground, but longer stakes are needed in soft soil. Two stakes for each trap, driven at angles to each other through the ring on the trap chain, are often used in sand. Steel rods one-half inch in diameter with nuts or washers welded on one end are good stakes. Military-surplus, steel bolts are often available and threaded ends aid in preventing stakes from pulling out. After stakes are driven below the surface of the ground, a trap pad of canvas, waxed paper, or soft plastic, about 5 by 7 inches, is placed over the pan and under the jaws. This prevents dirt from working under the pan, which would prevent the trap from springing. The pad must be slit over the trigger to allow the jaws to spring when the pan is depressed. With the trap bedded and the pad in place, the rest of the dirt, preferably dry, is used to cover the trap about one-half inch deep. A sifter made with 1/4-inch hardware cloth is useful to remove rocks and sticks. A twig or wire may be used as a brush to blend soil over the trap to match the surrounding area. A few drops of scent are applied to the scent post or into the hole and the set is complete. Surplus dirt from scent post sets should be scattered some distance away. Additional scent be added each 4 or 5 days for as long as traps are in place.

Figure 28. Typical coyote den in a sandy bank along a creek bed (Colorado).

Figure 29. Typical coyote den in a high rocky hillside with brush surrounding the den (Colorado).

Setting Snares. The use of wire neck snares is prohibited in some states, but where their use is allowed, they can be effective in removing problem animals that go through or under fences. In preying on domestic animals, coyotes and other predators often must enter fenced pastures. It is under these conditions and during winter months, when trap sets are difficult or impossible to maintain in working order, that snares are most useful. As a rule, they are more effective at woven wire fences than at those made of barbed wire, unless weeds or brush tend to restrict the animal to a specific point of entry. Snares can be set under the fence or between wires where animals pass through.

Figure 30 shows a neck snare set at a coyote crossing under a woven wire fence, where weeds and grass used to camouflage the snare have been removed. Several companies sell snares similar to the one shown here (a 30-inch Kleflock Number 2 with swivel for attachment) produced by Woodstream Corporation. The snare should have a swivel on the anchor end to prevent twisting and breakage.

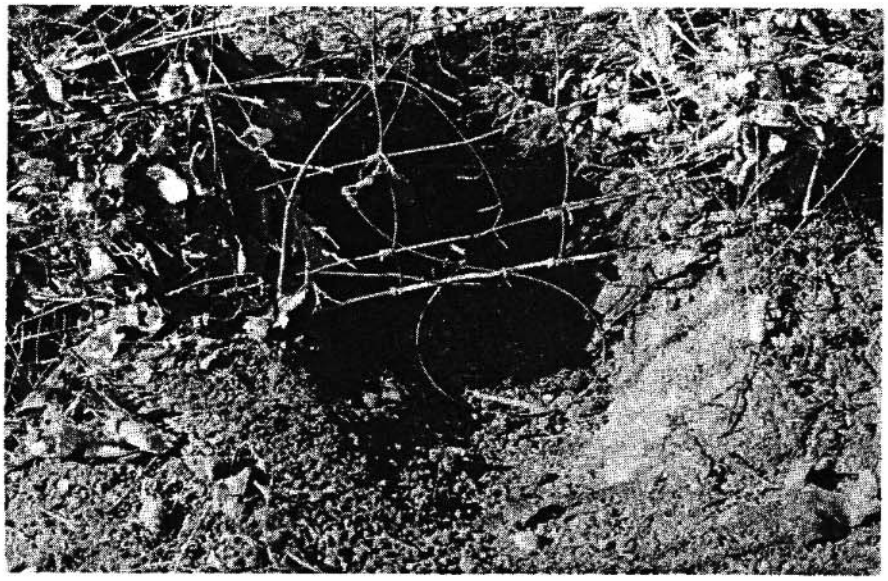


Figure 30. Number 2 Kleflock neck snare in position at a coyote crossing under a woven wire fence. Note that the swivel end is anchored with wire to the fence and camouflage has been removed for this photo. Some states prohibit this type of snare.

The swivel end of the snare is tied solidly to the fence with wire and a 6- to 7-inch loop is formed and held in place with light thread. The loop must be camouflaged, and some trappers spray the snare with white paint when the crossing is snow-covered. The loop should be large enough and placed correctly to allow only the animal's head to enter. The animal tends to jump forward when the snare hits the shoulders, causing the snare to tighten and lock around the neck. Unconsciousness occurs rapidly as asphyxia begins.

Because the neck snare kills the animal rapidly, it must be used with caution. Placement sites should be carefully selected to avoid nontarget animals and it must be set correctly. The snare should not be used where other methods are effective.

Trapping Foxes

The red fox is the species normally involved when the farmer loses poultry, lambs, or pigs to foxes. Red foxes are smaller than coyotes, averaging 10 to 15 pounds in weight, although individuals over 20 pounds have been reported. Foxes mate somewhat earlier than coyotes and produce young about 9 weeks later, usually from mid-March to mid-May. Their denning habits are roughly similar to those of coyotes although they may den much closer to humans. Foxes are usually less sensitive than coyotes to human disturbance at dens and are less likely to move litters, but care should be taken in approaching a fox den if adults are to be trapped before pups are removed.

Trap sets similar to those employed in catching coyotes are also effective in taking foxes. Trap sets without scent should be placed at all den entrances after pups are removed, and two or three sets should be placed in the surrounding area to insure capture of the adults. Trails approaching the den are good locations for trap sets with scent. Calling is also effective in taking adult foxes.

Trapping Bobcats

Bobcats are considered a sensitive species by many state wildlife management agencies. Before conducting a trapping effort the concerned state agency should be consulted.

Although bobcats rarely develop the habit of killing larger domestic animals, they do become involved in taking sheep or poultry and in killing domestic cats. Calling is not as effective in taking bobcats, but trapping is relatively easy and one of the most effective methods of removing the problem animal. Bobcats are much less sensitive to errors in trapping and may be readily taken in trap sets that would not take adult foxes or coyotes. Trap sites similar to those selected for coyotes are suitable, in addition to sites around rocky rims.

Bobcat urine, oil of catnip, and fetid scents are all effective in trapping bobcats. In addition, they are easily trapped when they return to feed on a kill. Trap sets should be placed off the trail and several yards from carcass baits.

Baits sets made with rabbit or rodent carcasses hung on trees have been used effectively in the past, but because of danger to eagles and other nontarget species, they are not desirable sets. In addition, scent sets are equally as effective.

Bears and Mountain Lions

Bears and mountain lions are game animals in some states and may be fully protected in others. Since regulations are often different than those covering coyotes, bobcats, and foxes, it is best to notify the state wildlife management agency when these animals cause damage. The agency can provide necessary information regarding control procedures.

Sparrows and Starlings

The English sparrow and the starling often become numerous enough to cause serious losses and problems. Ways to discourage or control them become essential.

Noisy and hardy, the English sparrow adapts quickly to most any situation and is found throughout the United States and Canada. It reproduces at a high rate and tends to suffer only slight losses to natural enemies.

Prepared by William L. Stewart, Extension Assistant, and David M. Baumgartner, Extension Forest Resources Specialist, Washington State University, Pullman.

Starlings have spread throughout the northern United States and Canada from coast to coast. Larger and chunkier than blackbirds, with which they are sometimes confused, starlings differ further by their yellow beaks and short tails, which give them a triangular appearance in flight. Starlings have a glossy, purple-green plumage with numerous white flecks in summer. In winter, the back feathers become darker and edged with light brown and the beak turns bluish black.

Habits

English sparrows defile buildings, ornamental trees, and shrubs with excrement and sometimes with bulky nests. More than 95 percent of their diet consists of various kinds of grains, weed seeds, garden products, and poultry and livestock feeds.

English sparrows eat large quantities of weed weeds, which is one of their desirable habits. They also have been of value in some localities by destroying certain insect pests through mass action of a dense bird population. This is particularly true during the nesting season when young are fed insects as the main constituents of their diet for about the first 10 to 12 days. The young then become as vegetarian as the adults.

The English sparrow does considerable damage to cherries, grapes, berries, and other small fruits. It also attacks the buds and blossoms of cultivated trees, vines, and shrubs. The species is also a pest in gardens, destroying tender garden plants as they come up and eating large quantities of seeds as they ripen. It also interferes with some desirable songbirds by taking possession of their nesting sites.

Activities of individuals and flocks are usually confined to a rather restricted range, even though the species is widely distributed. This is favorable to control, for when an area has been cleared of the birds, considerable time usually elapses before it is reinhabited.

Starlings, unlike English sparrows, almost always feed a relatively great distance from their roosting areas. They are important predators upon many soil-dwelling insects but also will feed heavily on berries, grapes, cherries, seeds, and stock feeds. Winter flocks will often concentrate at feedlots—2,000 will easily consume one to two tons of feed per month. These characteristics have made the starling a serious agricultural pest in the West.

Starlings are both aggressive and prolific. In the spring when the nesting season begins, the birds scatter to suburban and rural areas. They make rather coarse nests in tree holes, birdhouses, and crevices and cracks of buildings. One egg a day is laid until an average of six or seven have been deposited. They have at least two broods per year.

Starlings are also objectionable because of their habit of roosting together in large numbers on or near buildings. These roosts are the source of considerable noise and filth. Since starling control is largely preventing the birds from using buildings and certain trees as roosting areas, some knowledge of roosting behavior may be beneficial. Normal roosting behavior is such that during the breeding season when the mated birds are dispersed and caring for their young, a few unmated birds travel together between feeding grounds and roosts. As the young of the first brood learn to shift for themselves, they join the unmated birds. Later, the parent birds and second brood join these roosting flocks. The size of the starling flocks greatly increase about midsummer as a result of the parent birds and second brood joining the roosts. From this time until late fall, the summer roosts are utilized by large flocks.

Migration sometimes occurs as birds leave the summer roosts, but many individuals remain. Those that remain usually shift their roosts to city or farm buildings which they use throughout the winter.

The daily movement cycle is such that starlings leave their roosts very quickly about sunrise. They then fly in large flocks over fairly well established flight lines and for distances up to 50 or 70 miles. In the evening, those which are the greatest distance from the roost begin their return flight first so that all reach the area of the roost at approximately the same time. The schedule for leaving and returning to roosts is apparently controlled by light intensity.

Prevention of Damage

English sparrows and starlings are attracted to certain conditions. Reasonable time and effort to prevent damage frequently save on labor spent for control operations. Careless handling of poultry feeds and grains furnishes the birds with an abundant food supply. Crevices, copings, and ledges in and about buildings, vines on buildings and trees, evergreen hedges, trees, and ornamentals provide nesting sites and roosting shelter for the birds. Some of these may be decreased or eliminated.

Methods of Control

Where control is needed, elimination of nesting and roosting sites may offer the best permanent solution. To prevent recurring infestations, it may be necessary to remove vines from certain buildings. Coping and ledges of some buildings may require wood or sheet-metal strips placed at an angle to eliminate the roosting space. Steeples, towers, poultry houses, barn lofts, garages, and the like can be protected by screening openings with wire mesh which is no longer than 3/4 inch.

Destroying Nests

Local English sparrow populations can be greatly reduced or even eliminated by destroying nests and eggs at intervals of 10 to 12 days during the spring and summer. Fasten a hook to the end of a long pole to tear down nests under eaves, on rafters, and the like. Birdhouses of suitable size for English sparrows and starlings may be erected at convenient locations and visited regularly to destroy the nests and eggs.

Shooting

The most effective results are obtained by inducing the birds to feed at certain places by baiting with grain. Scatter the grain in long, narrow lanes along which shooting may be directed when the birds flock to feed. Number 10 shot is the most suitable. Shooting is a selective method and will eliminate infestations if persistently used. Destruction of English sparrows and starlings by shooting with low-power guns is hazardous in many locations and should be entrusted to those who are extremely careful. Shooting is usually prohibited by law in urban areas and therefore it is recommended that local regulations be checked.

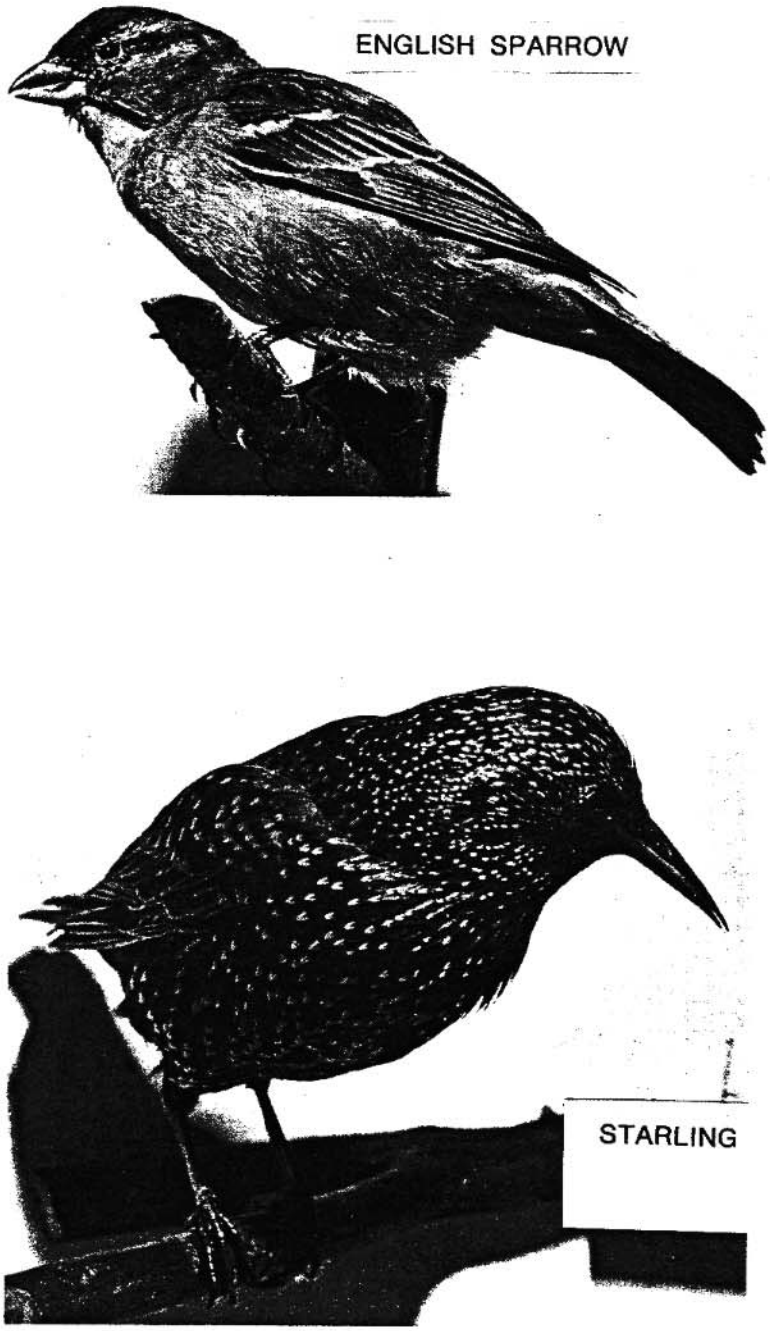


Figure 31. English sparrow (top), starling (bottom).

Trapping

Sparrow traps may be homemade, and anyone with a moderate degree of skill can make traps that cost very little and operate successfully. Traps are of two basic types: nesting-box traps which have had considerable success in reducing local populations during the nesting season, and bait traps which can be used any time.

Nesting-Box trap. A nesting-box trap, as the name implies, look like an ordinary nesting box. The weight of the bird upon entering such a trap puts into operation a mechanism that catches the bird and sets the trap for another. In designing and constructing nesting-box traps, the builder should keep in mind that English sparrows and starlings, like other birds, dislike drafty quarters. Also, a mechanism delicate enough to be operated by a sparrow's weight is apt to be inefficient and subject to breakdown unless parts are few, simple, and well-protected from the weather.

One of the simplest nesting-box traps is illustrated. This trap is a modification of a design by Charles H. Tesch of Milwaukee, Wisconsin. The essential parts of the trap are (1) a house, (2) a tipping chamber within the house, (3) a downspout below the tipping chamber, and (4) a receptacle at the end of the downspout to hold the captive birds.

The house is made of wood, the tipping chamber of tin, and the downspout of wood or tin. The receptacle can be either a detachable box with a door to open and close over the hole for attachment to the downspout and removal of captive birds, or a bag. Keep in mind that drafts should be avoided, so materials for building this receptacle should be nearly airtight. A nesting-box trap can be easily converted to a standard nesting box by inserting a stop-action pin which prevents the tipping chamber from working. This can be done when the English sparrow or starling population has been controlled to allow use by more desirable birds.

In building the trap, the front wall is the last piece to go on and should be fastened with screws for easy removal. A few feathers and pieces of straw can be glued to the floor of the tipping chamber near the rear to be more enticing.

Fasten the nesting-box trap to a pole or post or the side of a building. Place it where it is accessible so that sparrows can be removed frequently.

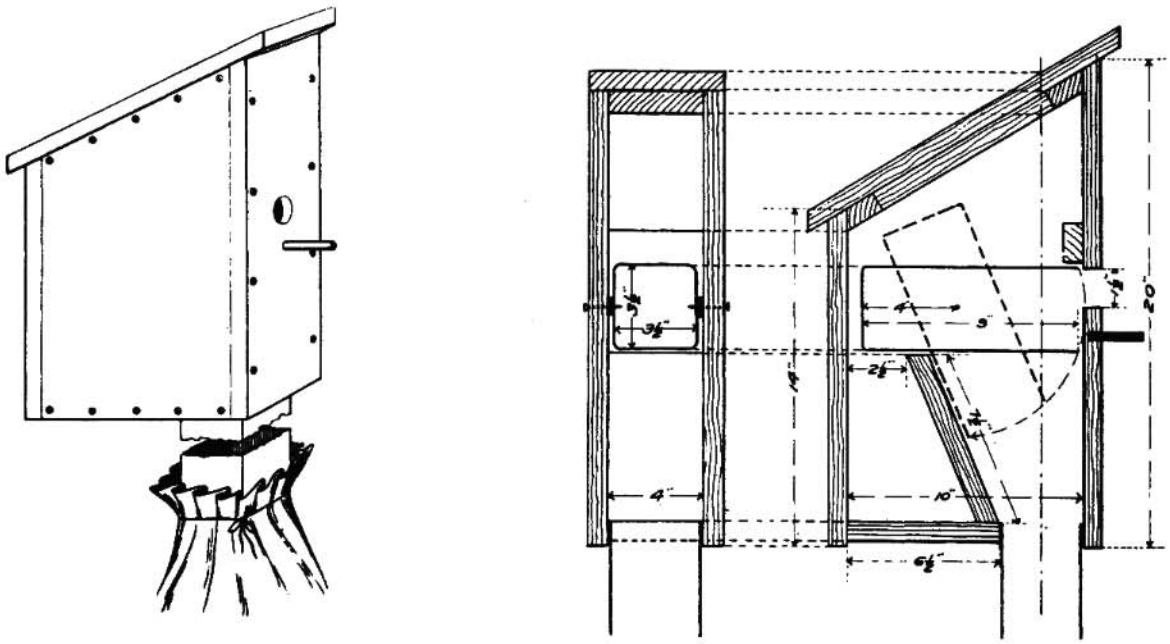


Figure 32. Nesting-box trap (left) and sections showing construction of nesting-box trap (right).

Sieve Trap. One of the simplest English sparrow traps is built similar to a sand sifter with a frame 4 feet square or larger and 6 inches deep. One side is covered with 3/4-inch mesh poultry netting or similar material. Make a small opening near a corner to permit removal of trapped birds. It is well to prebait for several days in a spot to attract the birds. To operate the trap, place it over the bait, raise and place an 18-inch stick (with attached cord) under one edge surmounted by a small chip to permit its easy withdrawal. Run the cord to a blind some distance away. The trap is sprung by pulling the cord. Two stakes at the back edge of the trap will keep it in alignment.

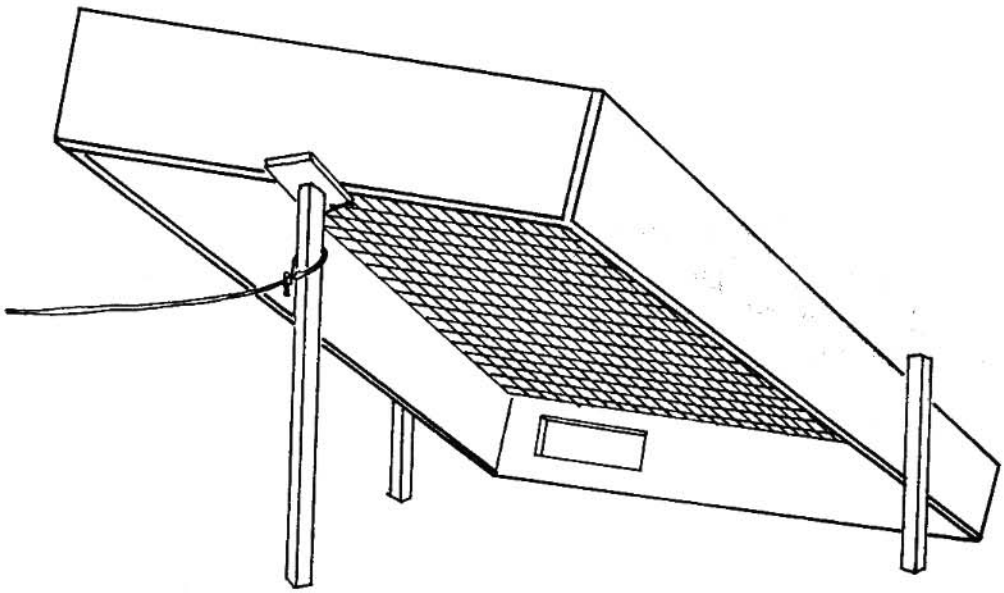


Figure 33. Sieve trap for sparrows.

Bait Traps. Selection of a bait trap depends somewhat upon the conditions under which it is to be used. Where food is plentiful, English sparrows as well as starlings have little incentive to enter a trap. Under these conditions, to be effective, a trap must be simple so as not to provoke suspicion. If extensive trapping is attempted, traps must be certain and prompt in action, portable, and inexpensive. All of these requirements are met by the "funnel trap," which has no loose parts and requires no special tools to set up and keep in order. It is somewhat bulky but is light, and when painted either gray or green is inconspicuous.

The funnel trap (Figure 34) is a development of the Newton trap used for birds and rats in Europe. The principle involved is very simple but effective. The birds are attracted by bait scattered in front of and inside the trap, and they enter the first of two chambers by passing through a small opening at the apex of a half-funnel which is the entrance (Number 15 of Figure 35). The size of the entrance can be adjusted by means of a set of five or six flexible wires woven into or soldered to the tip of the half cone. In their efforts to escape, the birds will find their way through the small opening at the apex of the second funnel (Number 16 of Figure 35) which is located above the floor surface. When birds drop to the floor of the second compartment, escape is nearly impossible since they will find the opening only by chance. A small door in the second chamber permits removal of the captured birds.

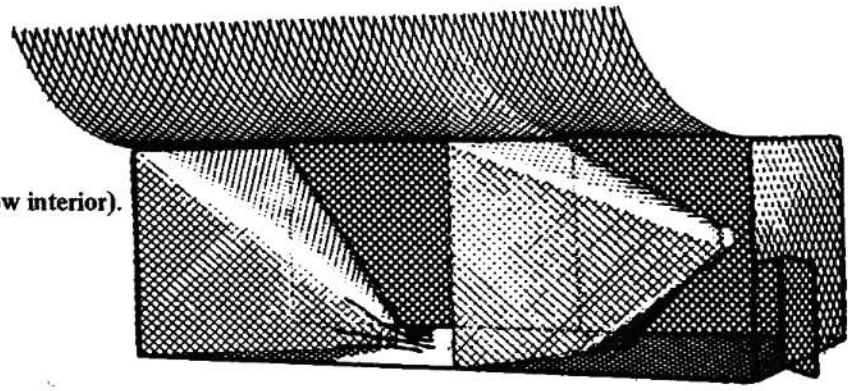


Figure 34. Funnel trap (side raised to show interior).

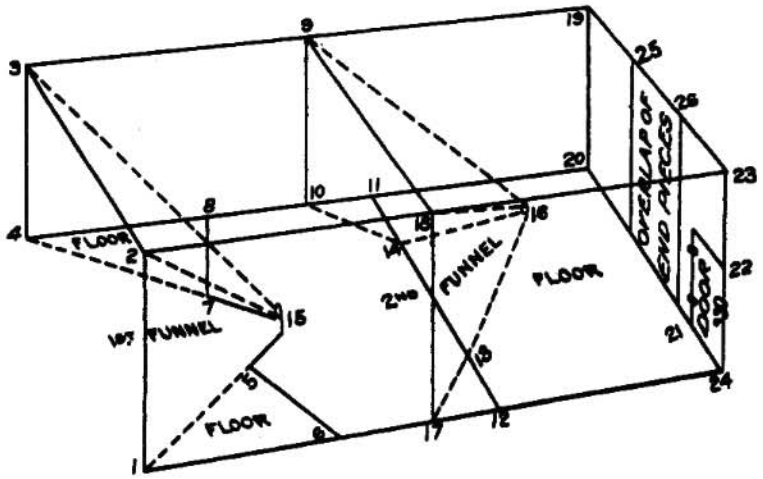


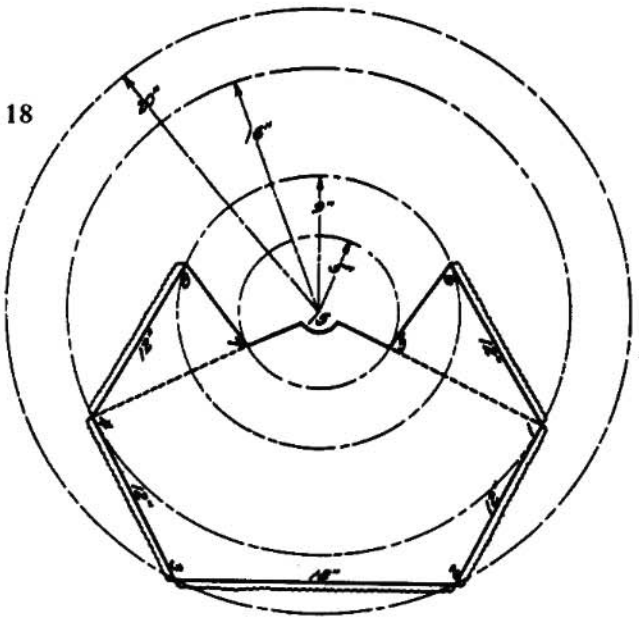
Figure 35. Diagram of funnel trap.

The funnel trap is easily constructed by anyone moderately handy with tools. Use 3/4-inch mesh, galvanized poultry wire and No. 8 or No. 10 wire for reinforcement along the edges and about the door to make it rigid. Figures 36, 37, and 38, along with the following description, give instructions for constructing a funnel trap either 3 or 4 feet long. The patterns in Figures 36, 37, and 38 are for making a trap 3 feet long, 1 1/2 feet wide, and 1 foot high. Make paper patterns for the two funnels by first drawing concentric circles, as shown in Figures 36 and 37, then lay off the straight lines beginning with the longest. The wavy outlines indicate that the pattern should be cut a minimum of 1 inch outside the straight lines to allow an overlap for fastening the cones to the sides and top of the trap. The second chamber and the angles between the first funnel and walls of the antechamber are floored with wire mesh.

The numbers at the angles in Figures 36 and 37 correspond with those in Figure 35 which shows the outline of the various parts when assembled. Figure 38 shows how a trap 3 feet long may be cut from a piece of wire mesh 6 feet long and 4 feet wide. The full lines indicate where the wire mesh should be cut and the broken lines indicate where it is to be bent.

Where English sparrows or starlings are abundant, a larger trap is recommended. A funnel trap 4 feet long, 2 feet wide, and 15 inches high can be made from a piece of wire mesh 10 feet long and 4 feet wide as shown in Figure 39. Paper patterns for the funnels are produced in the manner as those described for the smaller trap.

Figure 36. Pattern for first tunnel of a trap to be 36 x 18 x 12 inches.



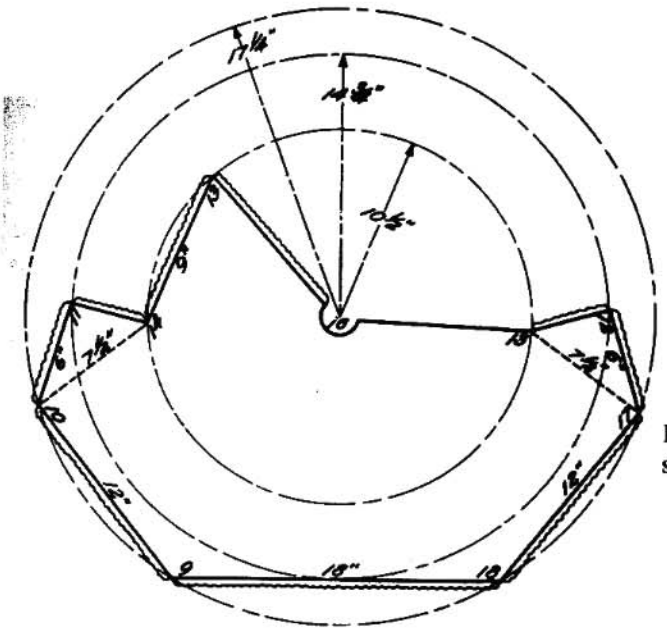


Figure 37. Pattern for second funnel of a trap of same size as in Figure 36

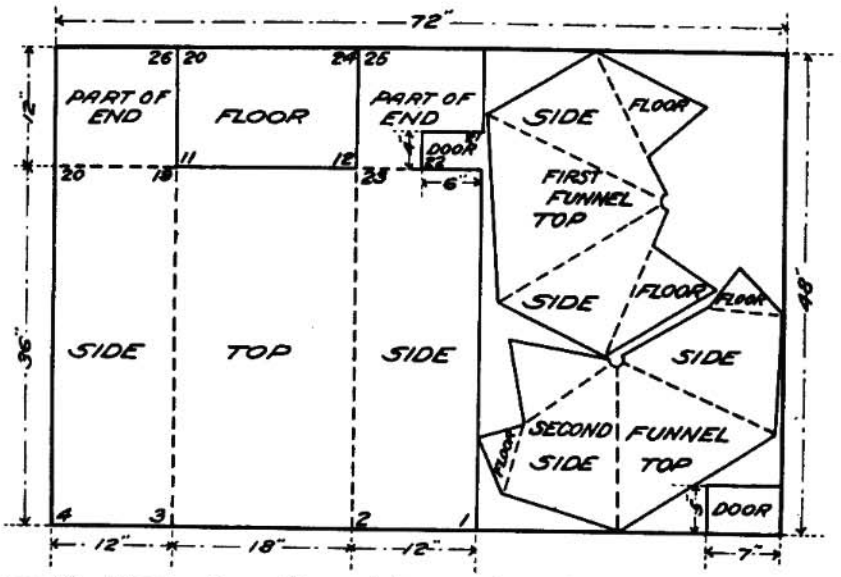


Figure 38. Diagram for cutting out from poultry wire parts of a funnel trap 36 x 18 x 12 inches.

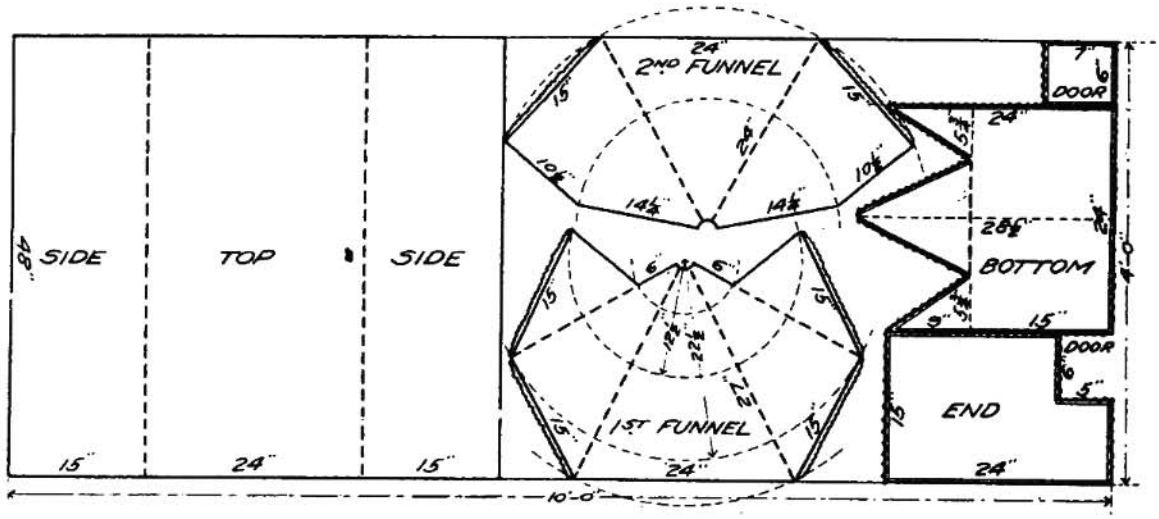


Figure 39. Diagram for cutting out the parts of a funnel trap 48 x 24 x 15 inches.

To remove the birds from the funnel trap, the receiving box shown in Figure 40 could be useful. It should be about 6 to 10 inches square and about 18 inches long. The door, which is hinged at the bottom and made to turn inward, is controlled by an extension of the wire frame that forms into a handle. The box is placed in front of the door on the funnel trap and the birds are driven into it.

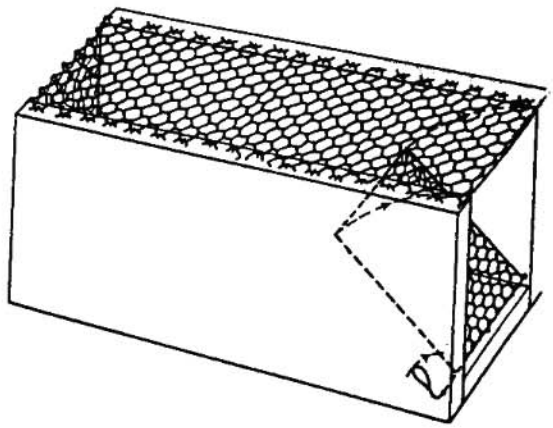


Figure 40. Receiving box for removing sparrows from traps.

When English sparrows infest an area, they usually gather in specific places on the ground or in low shrubbery on a regular basis. At or near these places, scrape the ground clean of vegetation and level so the trap will set firmly. As trapping progresses, the birds will oftentimes become suspicious and the trap should then be placed at another favored spot. Prebaiting is often helpful. Scatter bait on the inside of the trap in liberal quantities and rather sparingly in front of the entrance. Replace the bait in front of the entrance at frequent intervals. Bait, such as cracked grains, whole kernel grains, commercial poultry scratch feeds, weed seeds, and bread crumbs, are all excellent. In damp or rainy weather, replace bait both inside and in front of the trap frequently.

A few live decoy birds left in the trap often attract other birds into the trap. Provide food and water to decoy birds. Empty the trap except for decoy birds, at least once a day, since when a number of birds are trapped, their efforts to escape tend to frighten those which have not entered. The funnel trap can be used throughout the year but is most successful during middle and late summer when young English sparrows and starlings are not as cautious as mature adults. Trapping is quite successful whenever the natural food supply is low.

Starling Live Trap. Starling live traps are much larger than the traps previously described. This trap (Figure 41) has been quite successful in eliminating individual flocks. Starling live traps may be built either smaller or larger than the one described, but it is important that the width of the slots through which the birds enter the traps be exactly 1 3/4 inches wide and a 9-inch allowance at either end of the entrance panel to prevent escape.

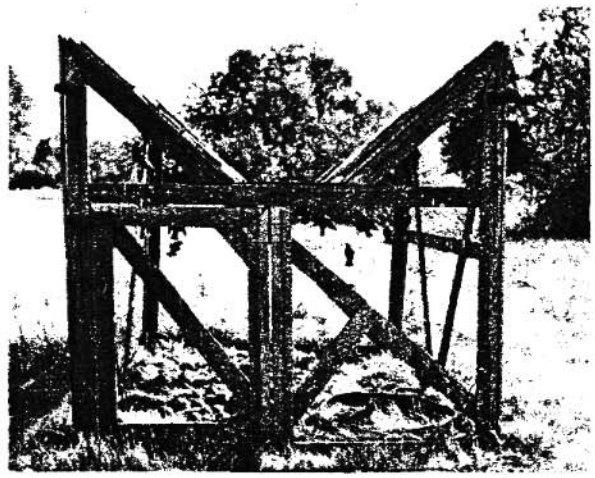


Figure 41. Starling live trap.

Place these traps where they will not be disturbed. It has been shown that traps must be situated at either feeding or watering places or on flyways between these points and the roosting sites.

Bait each trap with one or two boxes of cull apples, bread crumbs, or vegetable scraps from the kitchen. Live decoys will help to attract other starlings into the trap. Six to twelve birds are sufficient for this. The traps must not be placed among trees but in open areas on the flyways where starlings in flight can readily see the decoys and baited traps. The plans shown in Figure 42 can be used to construct this trap.

Liberating Protected Species

Birds of a number of ground-feeding species may frequently be caught in traps set for English sparrows. Among them are native sparrows, titmice, chickadees, and several others of similar size. The English sparrow and starling are generally the only species which need control. Nearly all of the other species that may be caught are protected by state or federal laws. These birds must be released unharmed unless justification for the control of the particular species involved has already been produced and permission obtained from state and federal authorities.

Repellents

Repellents are used primarily on roosting areas which are frequented by English sparrows or starlings. Repellents serve the temporary purpose of driving the band elsewhere to find new

Top panel (make two)

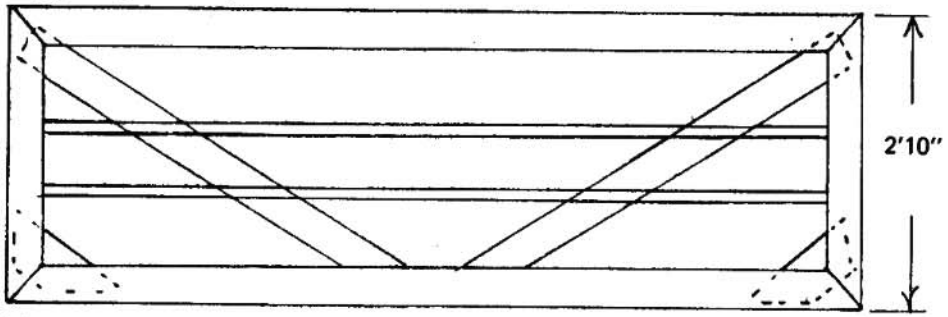
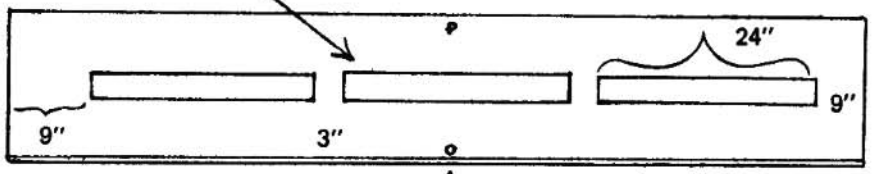


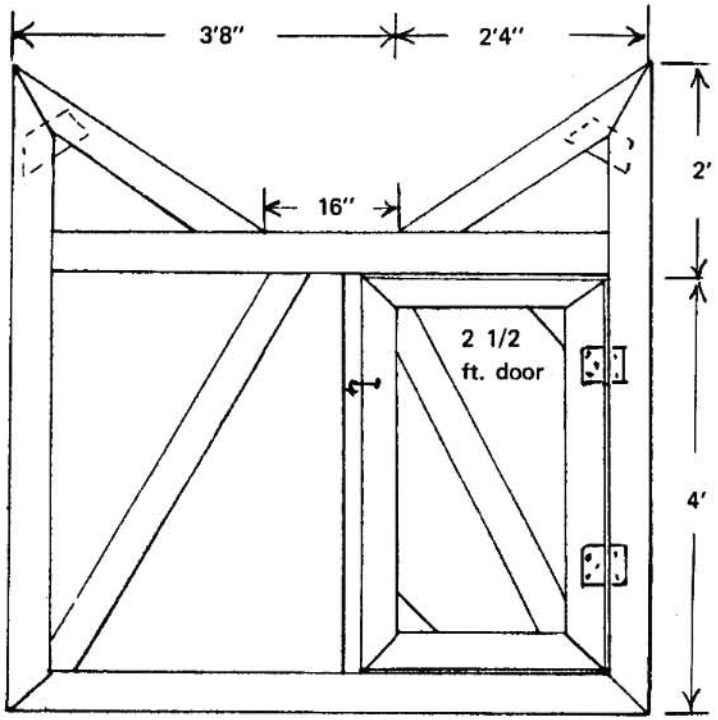
Figure 42. Plans for starling live trap.

Materials needed for trap:
15 1 x 4s 8 ft. long
25 1 x 4s 6 ft. long
4 1 x 1s 8 ft. long
1 1/2 x 16 in. exterior plywood 8 ft. long
2 hinges
2 lbs. staples
40 ft. 6 ft.-wide chicken wire 1-inch mesh

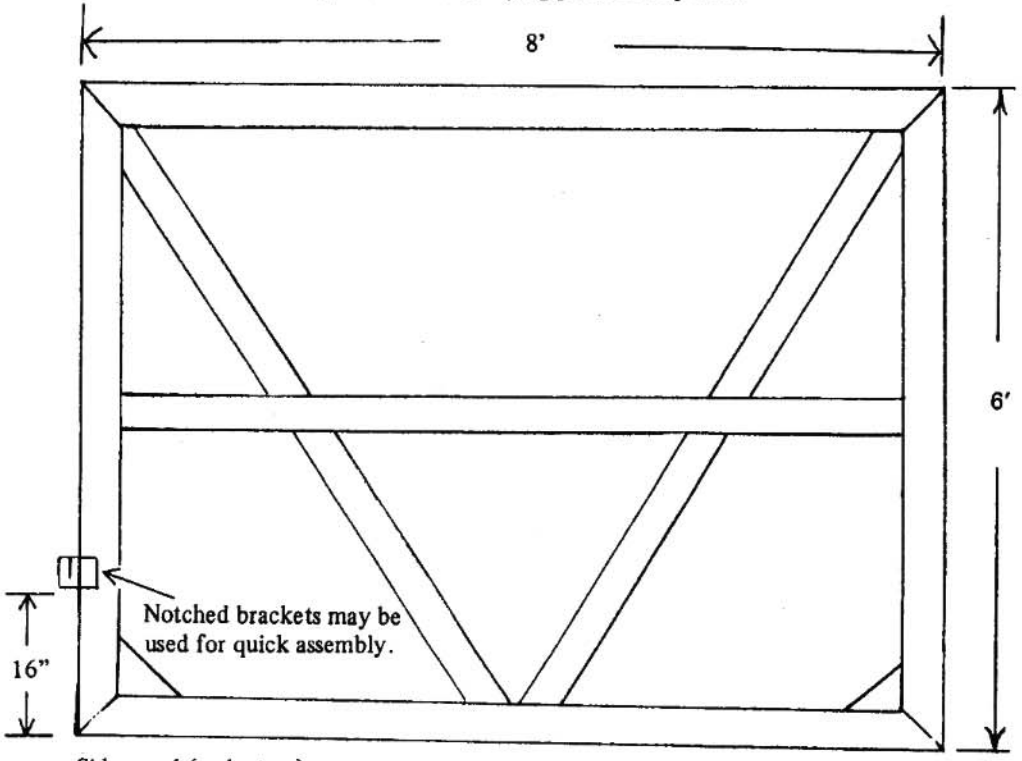
Entrance panel (plywood)
Entrance slots mut be exactly 1 3/4 in. wide.



1/2-inch holes for tying panel to trap roof.



Front panel
Rear panel (omit door)



Side panel (make two)

The only repellents registered for use in roosting areas (1982) are products containing polyisobutylenes manufactured by the Velsicol Chemical Corporation and polybutenes manufactured by the Tanglefoot Company.

After repellents have driven the birds off, seal off the openings by which entrance is gained, such as, holes or broken windows.

Poisoning

The use of poisons for bird control is severely limited and is for use primarily by licensed pest-control operators. Therefore, investigate local, state, and federal laws as to the use of poisons.

The use of some poisons has been prohibited by law and others are for use only to licensed pest-control operators. Therefore, investigate local, state, and federal laws as to the use of poisons.

Use the poisoned bait method with a great deal of care for control of English sparrows or starlings to prevent destruction of other birds and animals. With proper placement of bait, there is little likelihood that other birds, except possibly pigeons, will be harmed. Avoid areas which abound with native, seed-eating birds. Winter is the most desirable season to expose poison bait. Prebaiting sites which are to be used with unpoisoned grain for several days increases the chance of success and saves poisoned bait material. It will also permit observation of birds that feed at the site and thus prevent destruction of desired species.

Placement of poisoned baits on wide girders and rafters in barn lofts, airplane hangers, and other such enclosed areas will usually produce satisfactory results without resorting to placement of poison bait out-of-doors. Fasten shallow pans or feeding trays made of wood or metal to girders or rafters to contain the bait. On sloping roofs of buildings, attach short boards and sprinkle poison bait along the upper edge. Poison baiting can also be effective in unused poultry pens where English sparrows are accustomed to feeding. Starlings, as well as English sparrows, are quick to detect danger and associate their misfortune with the areas in which these occur. For this reason, it is preferable to have a number of spots reserved for poisoning.

Scaring Devices

Gas exploders which produce a loud noise at automatically timed intervals have been used for the past few years around airports and to reduce depredation in orchards and fields. The location of the exploders has to be changed at intervals of every day or two to be at maximum effectiveness. Some states and local areas have restricted the use of gas exploders by permit only as a result of noise pollution problems. Other scaring devices, such as, noise-producing pans and scarecrows, have rather limited success and only temporary value. Suspend noise-producing pans so as to enable free movement by wind. Move scarecrows at frequent intervals.

PICTORIAL KEY TO SOME COMMON PEST BIRDS OF PUBLIC HEALTH IMPORTANCE

Margaret A. Parsons--Chester J. Stojanovich

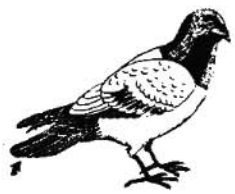
U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
PUBLIC HEALTH SERVICE
Communicable Disease Center
Atlanta, Georgia 30333
1964

bill short

bill long

male and female. body plump, tail fan-like

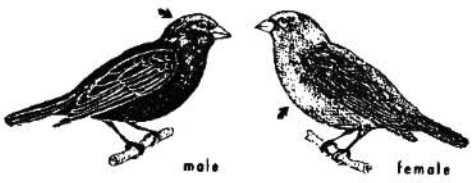
body trim. tail not fan-like



COMMON PIGEON

male. body black, head brown
female. overall dull grey color

male. black throat, grey crown
female. whitish throat, dull eye stripe

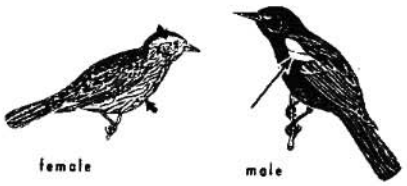


COMMON COWBIRD

HOUSE SPARROW

male. wing with red 'epaulettes'
female. breast heavily striped, light eye stripe

wing without 'epaulettes'
breast not heavily striped



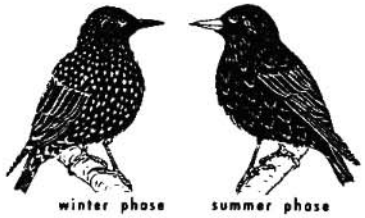
RED-WINGED BLACKBIRD

males. plain bronze or
dull purple back, tail long
females: less iridescent, smaller size

winter. bill dark, body heavily speckled with light dots
spring. bill yellow, color purple and green

male and female.
very large size, coal
black color, tail flat

GRACKLES



STARLING

CROWS

Bats

Bats are important insect feeders, but their importance as pest species is because of rabies infection potential and because of the obnoxious effects of their gregarious roosting. These roosts in homes and other structures are odorous and annoying by the noise and presence of the bats and by the disease hazard presented.

Bats are found almost everywhere, and they can become a nuisance that demands control. Some bats migrate seasonally, following a steady food supply; others remain in protected roosts and hibernate in cold weather.

Many bats roost in caves, hollow trees, and other natural shelters; others are attracted to spaces in attics, hollow walls, and unused areas inside and outside buildings. The scratching, squeaking noises made by bats can be quite annoying. Their droppings have a highly objectionable and persistent odor that attracts new bat colonies after the original ones are broken up.

Bat Facts

- They are not birds–they are the only flying mammals. Their wings are formed by the leathery membrane that joins the elongated bones of the front legs and "fingers."
- Bats benefit us because they feed on insects; do not destroy them needlessly.
- Bats do not become entangled in human hair. Their natural radar equipment enables them to avoid obstacles in flight and to catch their food on the wing.
- Bats normally do not attack people or animals, although sick bats have been known to do so. Vampire bats that feed on blood instead of insects do not occur in Washington. They range further south in Mexico and Central South America.

How Are They Harmful?

Bats may carry parasites such as bedbugs. They may also carry the bat bug (*Cimex*), which closely resembles the common bedbug.

Bats are susceptible to rabies, as are all warm-blooded animals. A decade ago a rabid bat was a rarity, but the incidence of bat-transmitted rabies has steadily increased. Certain kinds of bats may carry rabies without showing symptoms of the disease themselves. Because this disease, always fatal to humans, is apparently widespread, contact with any bat should be avoided.

Do not pick up or handle a bat that is fluttering on the ground or that is actually attacking people or animals–it may be rabid. Bat bites or scratches, no matter how slight, should be treated by a physician *immediately*. If possible, capture the bat without touching it or without damaging the head, so that the health authorities can examine the brain for possible rabies. If the bat is not captured for observation, it is even more imperative that a physician be consulted regarding the possible need for rabies preventive treatment.

Adapted from *Study Guide for Agricultural Pest Control Advisors on Vertebrate Pests,* University of California, Division of Agricultural Sciences. 1973.

How to Control Bats

Bat-Proof Buildings

The only way to permanently control bats is to keep them out. They enter buildings through any opening–the smaller species need only a 3/8-inch space. Large openings can be closed with sheet metal, wood, or 1/4-inch hardware cloth or screen. Narrow cracks can be sealed with caulking compound.

If you are completely bat-proofing a building, make sure all the bats are outside before plugging the last openings. Normally, all bats leave at about the same time. If there are several openings leave one of them unplugged for several days; then close it in the evening after all bats have left the roost.

Repellents

To discourage bats from roosting in attics, scatter 3 to 5 pounds of moth flakes, naphthalene, or paradichlorobenzine over the floor, or hang the flakes in mesh bags from the rafters. Floodlights in the attic or directed upon outside entrances for several nights will sometimes cause bats to leave a building.

Chemical Control

There are no chemicals registered for bat control that can be used in Washington.

Fumigation

Bats can be killed by fumigation if the roosting area is sealed tightly. Space fumigation is highly dangerous and should be attempted only by trained pest control operators.

ANIMAL DAMAGE CONTROL ON FOREST LANDS

During stand development, conifer seeds, seedlings, saplings, and older trees are subject t various kinds of damage by many animals. In simplest terms, damage by animals is the result o any animal activity that reduces or delays total forest yield (15). In a practical sense, such losse frequently are hard to quantify or define, because net effects of animal damage mostly accru over long periods. Conversely, animals may cause substantial losses of seeds and young seedling or extensive feeding injury without significant impact on a developing stand. Thus, anima damage problems must be identified and assessed carefully before control measures are applied

Protection is aimed mainly at plantations established by seeding or planting, because damage o greatest impact occurs on such stands. But protective measures also may be applicable to natura regeneration, because tree squirrels clip cones, and birds and mammals feed on naturall disseminated seeds and foliage of young seedlings after germination (25, 34). Control of anima damage also may be required in young-growth and mature stands, because serious damag (typically bark removal) is caused to older trees by tree squirrels, wood rats, porcupines, an bears. This type of damage mainly affects timber quality, rather than gross productivity o stocking levels. Regional emphasis, therefore, is on the protection of regeneration during earl phases of stand development when animal-caused stocking failures or growth retardation is mos likely and effects may extend over the longest period.

Surveys of animal damage show that animals rank highest in economic impact, ahead of fire competing vegetation, and other causes of loss, as an impediment to reforestation. Federal an state agencies, and private companies reported that animal damage occurred on about 10 to 2(percent of plantations. Reseeding or replanting was required on about one quarter of al reforested areas, and animals were responsible for roughly one out of five reforestation failure (15). Dimoc and Black (15) estimated that damage by animals is costing the timber industr several million dollars each year in Oregon and Washington. (4) Brodie et al. (1979) estimate tha $60 million are lost annually in Oregon and Washington reducing the net capitalized value of timbe productivity by 1.8 billion.

Methods of controlling animal damage to forest-tree seeds, seedlings, and older trees, primarily with chemicals, are reviewed in this section. For each kind of damage, there is a description of the nature and importance of the damage, animals causing damage, and use of repellents, rodenticides, or other means to control damage. Those practices to control animal damage with chemicals that have proved most practical, and that are approved and available for use now are emphasized. In this review, Rochelle's treatment of this topic in 1973 is followed closely (45).

Originally prepared for presentation at the annual *Forest Pesticides in the Pacific Northwest* shortcourse. Major con tributors have been J. A. Rochelle, Weyerhauser Company; P. R. Canutt and H. C. Black, U.S. Forest Service; an J. Evans, U.S. Fish and Wildlife Service.

Nature of Animal Damage

Kind, degree, and amount of damage must be evaluated in ranking animals in order of their destructiveness to regeneration and to older stands in the Pacific Northwest. Actual damage is frequently severe locally, moderate over considerable areas, and completely lacking in other areas (10). Thus, it should not be surprising that assessments of animal damage on public and private forest lands–of the relative importance of each kind of damage and of the animals chiefly responsible–vary considerably, reflecting a diversity of problems by locality and land ownership, as well as different approaches to appraising damage.

The most comprehensive survey of animal damage on forest plantations in the region is the Cooperative Animal Damage Survey (CADS), which was begun in 1963 to study the kind, amount, distribution, and significance of damage by mammals and birds to Douglas-fir and ponderosa pine plantations in Oregon and Washington (3) Black et al. 1979. As determined by annual examinations, animals damaged seedlings on all plantations sampled in 1968. Browsing and clipping of stems and foliage were the principal causes of seedling injury. Cutting of roots and budding, barking, trampling, and pulling of seedlings also occurred. Browsing by deer was the most common source of animal damage on all plots. Animals that injured seedlings, ranked by frequency of damage, were big game, hares and rabbits, grouse, mountain beaver, pocket gophers, domestic stock, and porcupines (3) Black et al. 1979.

The CADS findings showed that significant damage to planted seedlings mostly occurred in one of two ways: seedlings were killed, usually as a result of clipping of stems or roots or by pulling, or growth of seedlings was suppressed markedly because of e tensive and repeated browsing or clipping injuries–this source of damage was of predominant importance (3) Black et al. 1979.

Based on a questionnaire survey in 1969 of animal damage on national forests in Oregon and Washington, Crouch (12) reported that foliage browsing was the most common type of injury, followed by barking, root clipping, foliage clipping, and trampling. Problem animals, rated by frequency of citation, were deer, procupines, pocket gophers, hares and rabbits, elk, livestock, small rodents, mountain beavers, and bears.

Weyerhaeuser Company, in rating losses caused by forest wildlife on their lands in the Pacific Northwest, assigned 44 percent of damage to deer and elk, 35 percent to rodents, 13 percent to bears, and 8 percent to procupines and livestock (37).

In a review in 1969 of animal damage caused by five groups of small mammals in Oregon and Washington, Canutt (7) ranked in order of importance porcupines, pocket gophers, hares and rabbits, mountain beavers, and dusky-footed woodrats. In 1975 and again in 1980, Evans (personal communications) reported that pocket gophers, mountain beavers, and deer were the top three problem species in western forests followed by hares and rabbits, porcupines, elk, and black bear.

Damage to Forest-Tree Seeds

Seed-eating small mammals and birds constitute serious threats to forest regeneration. Nearly all of the Douglas-fir seed produced during years of light to medium seed crops have been estimated as lost to rodents and birds (31). In western Oregon, Gashwiler (25) found that ground-feeding birds and small mammals caused 63 percent of the loss of natural seedfall of Douglas-fir, although birds and mammals destroyed only 15 percent of western hemlock seeds and no western redcedar seeds from seedfall to start of germination.

In the Douglas-fir region of Oregon and Washington, the deer mouse long has been identified as the principal rodent responsible for seed destruction (36). In cage tests, individual deer mice consumed more than 200 Douglas-fir seeds per night (24). As few as two deer mice per acre (densities may exceed 10 per acre) have been estimated to consume in three months the amount of Douglas-fir seed that normally is seeded per acre.

In recent studies of the fate of Douglas-fir seeds in western Oregon, Hooven and Black found that 70 percent of untreated Douglas-fir seeds were eaten, principally by deer mice, within 4 weeks of aerial seeding in December (4). Attrition of seeds continued until about 93 percent of tagged, untreated seeds had been destroyed by the end of germination in May. Fifty-two percent of tagged, endrin-treated seeds were eaten by animals or found missing during the same period in 1966-67. In 1968, pregermination losses of tagged, endrin-treated seeds on the same area averaged 39 percent.

Other small mammals, if abundant, may consume or destroy large quantities of tree seeds. Hooven and I found that the Oregon vole, western red-backed vole, and Pacific jumping mouse eat Douglas-fir seeds readily in cage tests. Shrews also eat Douglas-fir seeds (32, 36), and in controlled feeding experiments, single shrews consumed more than 200 Douglas-fir seeds per night (32). In similar tests with ponderosa pine seeds, ground squirrels and chipmunks each consumed more than 200 seeds per day (47). Both species also consume or store Douglas-fir seeds. Ground squirrels and chipmunks are important seed consumers in the pine region.

Damage to Seedlings, Saplings, and Older Trees

In addition to seed destruction, animals cause injuries to trees by browsing and clipping (foliage, stem, or root), budding, pulling, trampling and barking (gnawing and stripping). A useful reference, the *Guide to Wildlife Feeding Injuries to Conifers in the Pacific Northwest* (34), defines most of these terms, lists the animals that cause injuries, and describes and illustrates the type of injuries caused by each group of animals. Information on life history and field signs of these animals also is included.

Clipping

Injury by clipping is caused by rodents (pocket gophers and mountain beavers) and lagomorphs (hares and rabbits) feeding, and is identified generally by the smooth oblique cut on woody shoots. Clipping seedlings and saplings mainly cause injury to stems, terminal or lateral shoots, or roots. Small seedlings are especially vulnerable and may be killed or suppressed by stem or root clipping.

In the Douglas-fir region, clipping of seedlings and saplings is caused mainly by snowshoe hares, brush rabbits, and mountain beavers. Snowshoe hares are distributed widely on forest lands throughout the region and may cause heavy losses to plantations. Brush rabbits occur mainly in western Oregon. Both cause serious damage to regeneration in some localities. Mountain beavers, currently (1980) the number one problem animal west of Cascade Crest, were causing damage on over 275,000 acres of forest land and the acreage was expected to increase with increased rehabilitation of coastal brushfields (Northwest Forest-Animal Damage Committee 1977).

In the pine region, pocket gophers are rated as the principal problem animal (Barnes 1973) causing damage on over 300,000 acres of forest land (Northwest Forest Pocket Gopher Committee Working Group. 1976). Many plantations have been destroyed by pocket gophers in central Oregon (7). These rodents clip foliage or roots of seedlings (16, 27, 29). Feeding on conifers occurs mostly under snow in winter. Porcupines occasionally clip seedlings and small saplings (7, 19). In a recent survey, porcupines were rated among the least destructive animals to regeneration in the pine region (5).

Browsing

Foliage, buds, and terminal and lateral shoots of seedlings and saplings are injured by browsing of deer, elk, and domestic livestock. It is the most common type of animal damage occurring throughout the region. Browsing injuries are distinguishable from clipping in most instances by rough cuts on stems especially when examinations are made soon after injury. Browsing by deer was the most common damage by animals on all plantations in the CADS survey. Browsing greatly exceeded all other types of animal-caused damage on CADS plots (3) Black et al. 1979, and on national forests in Oregon and Washington (12).

Swanson (48) rated browsing as the most common type of injury caused by elk. He reported that about 30 percent of the Douglas-fir seedlings sampled in a plantation in southwestern Oregon were injured or killed by elk browsing or pulling soon after planting.

Browsing occurs throughout the year, but it is heaviest during the dormant season and during the period of rapid growth in spring. In eastern Oregon and Washington, most deer browsing occurs in fall and winter, but deer browsing takes place during both dormant and growing seasons in the Douglas-fir region (12). In coastal forests, most deer browsing occurs during the early growing season on new growth but also occurs in winter on dormant seedlings (Campbell and Evans 1977).

Browsing affects height growth of trees and also may cause direct mortality. Repeated injury severely checks height growth and may produce a low, shrublike tree with multiple leaders (34). Suppression of growth is the principal effect of browsing, and it is an important kind of animal damage in the Pacific Northwest. Important damage to stands occurs, however, only when enough trees are browsed to bring stocking rates or distribution below established standards, or when growth of the

stand is suppressed significantly (11). Campbell and Evans (1975 & 1978) estimate that up to 40 percent of the Douglas-fir in a plantation can be browsed without significant growth loss compared to plantations without damage.

Budding

Removal of buds and needles by grouse generally is classed as budding (34). Douglas-fir foliage is a preferred food of grouse, and budding is restricted mainly to the Douglas-fir region. Heavy and repeated defoliation has been reported on Douglas-fir plantations on Vancouver Island (22). In the CADS survey, budding by grouse (chiefly sooty grouse) ranked after browsing and clipping in order of occurrence on Douglas-fir plantations. This type of injury mainly occurred in southwestern Washington. No budding was recorded on pine plots (3).

Barking

There are two principal types of barking injuries–gnawing and stripping (34); gnawing is the more important type of barking injury to seedlings, saplings, and older trees. Bark stripping is caused mainly by black bears and wood rats, although tree squirrels (pine squirrel, red squirrel, and western gray squirrel) also may strip bark from the upper stem and branches of Douglas-fir and other conifers. In this region, damage by black bears occurs primarily in spring and summer, and is confined mainly to young-growth Douglas-fir. Basal barking may be complete (girdling) or partial. Girdling kills the trees, but partial barking causes reduced growth or increased chance of infection by decay fungi. Bear damage is a serious problem in some localities in western Washington (40) and Northwest Oregon. Dusky-footed wood rats also may cause severe barking damage to Douglas-fir reproduction. Bark stripping usually occurs on upper bole and branches, and causes top killing, if bark removal is extensive (28).

Gnawing injuries are caused by microtine rodents (voles), lagomorphs, pocket gophers, and porcupines. Barking injuries of this type are caused mostly by pocket gophers and porcupines and are most important in the pine region. Pocket gophers gnaw the bark, stems, and roots of seedlings and saplings. This feeding usually occurs under snow in winter. Lodgepole pines have been barked to a height of 5 feet by gophers under snow (36). Barking of seedlings and saplings in the pine region also is caused by porcupines, hares, and rabbits. Porcupines seem to prefer pole-size ponderosa pine, although girdling of seedlings, saplings, and mature trees frequently occurs (14). Barking results in girdling or scarring which often kills seedlings and saplings, or suppresses growth of saplings and older trees. Barking also deforms stems, increases exposure of the tree to infection by insects or disease, and kills tops of older trees. Porcupine damage is locally common in the Douglas-fir region (Evans and Matthews 1972); here, porcupines seem to prefer western hemlock over Douglas-fir (Evans 1977).

Pulling, Trampling, and Rubbing

Pulling and trampling injuries to small seedlings are caused almost exclusively by big game and livestock (12). Pulling usually occurs before the roots become established after planting. Ordinarily, these types of injuries are only a minor hazard to regeneration. Rubbing (mainly antler polishing) is caused by deer, elk, and livestock, and is probably unimportant, except for local damage to large seedlings planted at minimum density. Each of these types of injury accounted for less than one percent of damage occurrences on Douglas-fir plantations in the CADS survey (3).

Summary

Animal damage to forest trees and their seeds is an increasingly serious problem in the Pacific Northwest. Seeds, seedlings, and older trees are exposed to various kinds of damage during stand development by many animals. Although deer browsing of seedlings and saplings is the most widespread and predominant type of animal damage in the region, other types of damage, such as clipping and barking by pocket gophers and mountain beavers are more important in the PNW. Evans (1976). Thus, estimates of damage emphasize the regional diversity in nature and relative importance of different types of animal damage, as seen by forest managers. Part of the difference in emphasis is caused by inclusion of all age classes from young reproduction to mature stands, and by changes in forest-management practices that tend to shift the spotlight from one group of animals to another, for example from seed eaters to pocket gophers.

There is a strong need for repeated and timely field observations, particularly of plantations, and for accurate identification of animal-damage problems before controls are applied. Campbell and Evans (1977). A forest manager must know not only the kinds of damage confronting him, but also be able to identify those needing control as well as those likely to respond to it.

Chemical-control methods are only one of several approaches to controlling animal damage. Direct reduction of populations with rodenticides should be applied only if other methods are not available, and only for purposes of regulation of population levels to control damage to trees (or tree seeds), not for the destruction of individual animals. What is sought when direct reduction of populations is required really should be *alleviation* of damage, including destruction of animals only when that is a necessary adjunct to alleviation of damage (30).

In most instances, therefore, an effective damage-control program calls for a combination of control methods integrated with forest-management practices that tend to modify habitat conditions so as to avoid or alleviate damage.

Growing ecological awareness and concern for the environment have precipitated critical review of pesticide regulations at national, state, and local levels. Many previously approved pesticides and control practices have been curtailed or banned, especially on federal lands. In a practical sense, we have come "full circle" and, with the exception of certain repellents, the forest industry now is limited largely to use of strychnine for control of some nonpredatory animals.

Pesticides reported and recommended in this paper were approved for use as of August 1984. But, because the registration of pesticides and their uses are under constant review by federal and state agencies, a responsible authority should be consulted as to the current status of a repellent or rodenticide before using it.

Some forest mammals causing damage (including hares and rabbits) may be classified as game animals, or as protected species. Permission must be obtained from state wildlife agencies before initiating direct programs of control to alleviate damage caused by these animals.

In conclusion, using rodenticides for control of forest mammals can present situations that are both ecologically sensitive and hazardous. As Canutt (9) observed, mistakes are costly in terms of loss of non-target species, and possible restrictions on future use of useful pesticides. He concluded that an analysis of past problems (of pesticide uses) invariably traces back to failure of the applicator to follow label instructions, to follow prescribed application techniques, or to use common sense. Canutt (9) considered these the most important aspects of any chemical-control program.

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Appendix

Life History Information Pertinent to Damage Control, and Control Procedures for Selected Species (modified from Canutt, 1972)

Vhite-Footed Deer Mouse *(Peromyscus maniculatus)*

.ife History Information

'referred Habitat. Nearly all habitat types on forest lands in the region are occupied by deer nice. Apparently the need for heavy cover is not as great as in the instance of meadow mice nd shrews. Large numbers of deer mice are often found on burned areas, even though ground over may be sparse.

'eeding Habits. Seeds, berries, and insects provide the major source of food. Coniferous seeds isually are readily accepted, especially seeds of Douglas-fir, western hemlock, and Sitka spruce.

lctivity. Deer mice are active throughout the year. They are primarily nocturnal. The average iome range is about 4 acres.

Reproduction. Litter sizes vary from three to seven, and an average of four litters is born each 'ear. The gestation period is from 22 to 25 days. Young mice may breed when 6 to 8 weeks ıld. The population peak is usually in November.

'ontrol

Jse of endrin as a conifer seed treatment is not permitted on lands of the U.S. Department of the nterior, and only after review and approval in the Pacific Northwest Region of the U.S. Forest Service.

)n private and state lands in Oregon and Washington, endrin can be used to protect tree seed in reas where deer mice are anticipated to be a problem. Endrin is federally registered as a conifer eed protectant at the rate of one-half percent active endrin and two percent active thiram. The ctive ingredients are bound to the seed coats with rhoplex or latex adhesive. Aluminum flakes have to e added to the formulation. Monastral green dye is included in the treatment to identify the seed and rovide bird repellency and must be used in Oregon.

:ndrin powder is a hazardous material to handle and for this reason it is recommended that eed treatment be contracted to competent commercial seed-treatment plants.

:ndrin-treated seed should not be applied in ecologically sensitive areas, such as, live stream ourses, ponds, lakes, intermittent streams used by anadromous fish, campgrounds, viewpoints, or ther areas in which people congregate. Distribution methods that prevent contamination of the bove areas should be followed. For example, rough terrain may make it impossible to protect a :ream when distributing seed from the air. In such instances, buffer strips should be left along :ream banks for hand application of treated seed.

Porcupine *(Erethizon dorsatum)*

Life History Information

Preferred Habitat. Pine forests where there are rock outcrops or old trees and logs suitable for dens are favored areas. Douglas-fir and hemlock forests on the western slopes of the Cascade Range also provide suitable habitats for porcupines.

Feeding Habits. Bark, buds, grasses, and forbs are taken seasonally. Bark feeding usually does not start until late summer after herbaceous vegetation becomes mature and dry. In the Douglas-fir region, bark feeding is most common during winter months.

Activity. Porcupines actively forage from dusk through early morning. In the pine region, daily travel is limited and animals often remain in one area for many days. In the Douglas-fir region, porcupines tend to be more nomadic. Seasonal movement often covers several miles and is probably related to changing food preferences.

Reproduction. A single young is born each year during May or June. Birth takes place after a gestation period of about 7 months. The minimum breeding age is 1 year.

Control

A combination of control techniques may be required to provide effective control.

Restrictions have been placed on the use of strychnine alkaloid for porcupine control on federal lands as a result of Executive Order No. 11643 and its subsequent interpretation by the U.S. Fish and Wildlife Service. Use of strychnine is not permitted, for example, where there is reasonable doubt as to the hazard of secondary poisoning.

Baiting. Strychnine-treated salt blocks may be used only in trees according to federal registration.

Other Control Methods. Porcupines also may be controlled by trapping or by shooting, especially with the aid of over-snow vehicles in winter. Tubes of plastic fabric or expanding aluminum can be used for protection of young seedlings in lieu of direct control.

Pocket Gophers (*Thomomys* sp.)

Life History Information

Preferred Habitat. Grasslands, meadows, clearcuttings, burns, and open conifer forests, with adequate soil depth for burrowing, are the most desirable sites. Gophers are found in a wide diversity of habitats throughout the region.

Feeding Habits. Bulbous roots of forbs and grasses are favorite foods. Aerial parts of grasses and forbs are taken to a lesser extent. The roots and upper parts of small woody species, such as young pine trees and other conifer species, also are eaten readily. Barking and clipping of shrubs and trees above ground occurs, especially under snow in winter.

Activity. Gophers spend most of their time below the ground surface. They do come above ground at night, during cloudy days, and when young are leaving the burrow system to establish new homes. When snow cover persists, burrow systems may be extended into the snow. Each adult has its own burrow system. Main tunnels are 2 to 3 inches in diameter, usually several hundred feet in length, and vary from a few inches to several feet below the surface. Feeding tunnels normally are 2 to 8 inches below the surface and are most extensive in areas where vegetation is sparse.

Reproduction. Most species in Oregon and Washington normally have only one litter each year. Breeding begins in early spring, and four to eight young are born after a gestation period of 18 to 19 days. The female rears the young, which become solitary as soon as they are weaned.

Control

Gophers may be controlled by habitat manipulation and by direct removal. However, use of rodenticides for control of pocket gophers is restricted and the effectiveness of habitat alteration has not been fully demonstrated.

Strychnine-treated grain is federally registered for use on all commercial forest lands for control of pocket gophers. Restrictions have been placed on its use on federal lands as a result of Executive Order No. 11643 and its subsequent interpretation by the U.S. Fish and Wildlife Service. Use of strychnine is not permitted, for example, where there is reasonable doubt as to the hazard of secondary poisoning. State and federal laws regulate its use on private and state lands in Oregon and Washington.

Habitat manipulation is a method in which the vegetation is managed to make living conditions less suitable for gophers. This is usually done by spraying an area with selective herbicides to reduce the availability of gopher foods. Much work still remains before this method can be recommended as a control measure.

Direct removal techniques include hand baiting, machine baiting, and trapping. Choice of method should be based on site characteristics, season, and available manpower. These are discussed under each method.

Gopher control by means of baiting is a difficult job that usually requires one or more annual follow-up treatments. The number of additional years of baiting and time intervals between baiting will vary from area to area. Initial control success, type of habitat, and potential for invasion from untreated areas will be factors controlling variability.

Control effectiveness can be checked readily by marking and opening holes in a number of burrow systems on the treated area. If the systems are still occupied, the opened holes usually will be closed within 48 hours. Mortality checks should not be made until bait has been exposed for about 2 weeks.

Hand Baiting. Any site regularly occupied by pocket gophers may be hand baited, but there are several conditions that influence control effectiveness. These conditions are as follows:

- Active mound building must be taking place to allow best selection of spots to bait. Fresh mounds can be identified by their unweathered appearance and loose structure. Recent mounds often will be darker than surrounding soil, because of their greater moisture content.

- Soil moisture should be sufficient to prevent burrow crumbling when probing or excavating tunnels for baiting. Moisture content becomes less critical in soils that are well-structured, fine-textured, or heavily sodded.

- Guidance of experienced baiters is necessary to insure correct bait placement.

The following diagrams illustrate the location of lateral and main runways in relation to earth mounds, mound plugs and main runway plugs. Knowledge of these burrow characteristics is necessary for efficient and accurate bait placement.

Main runways may be located and baited by probing or excavating with a heavy garden trowel.

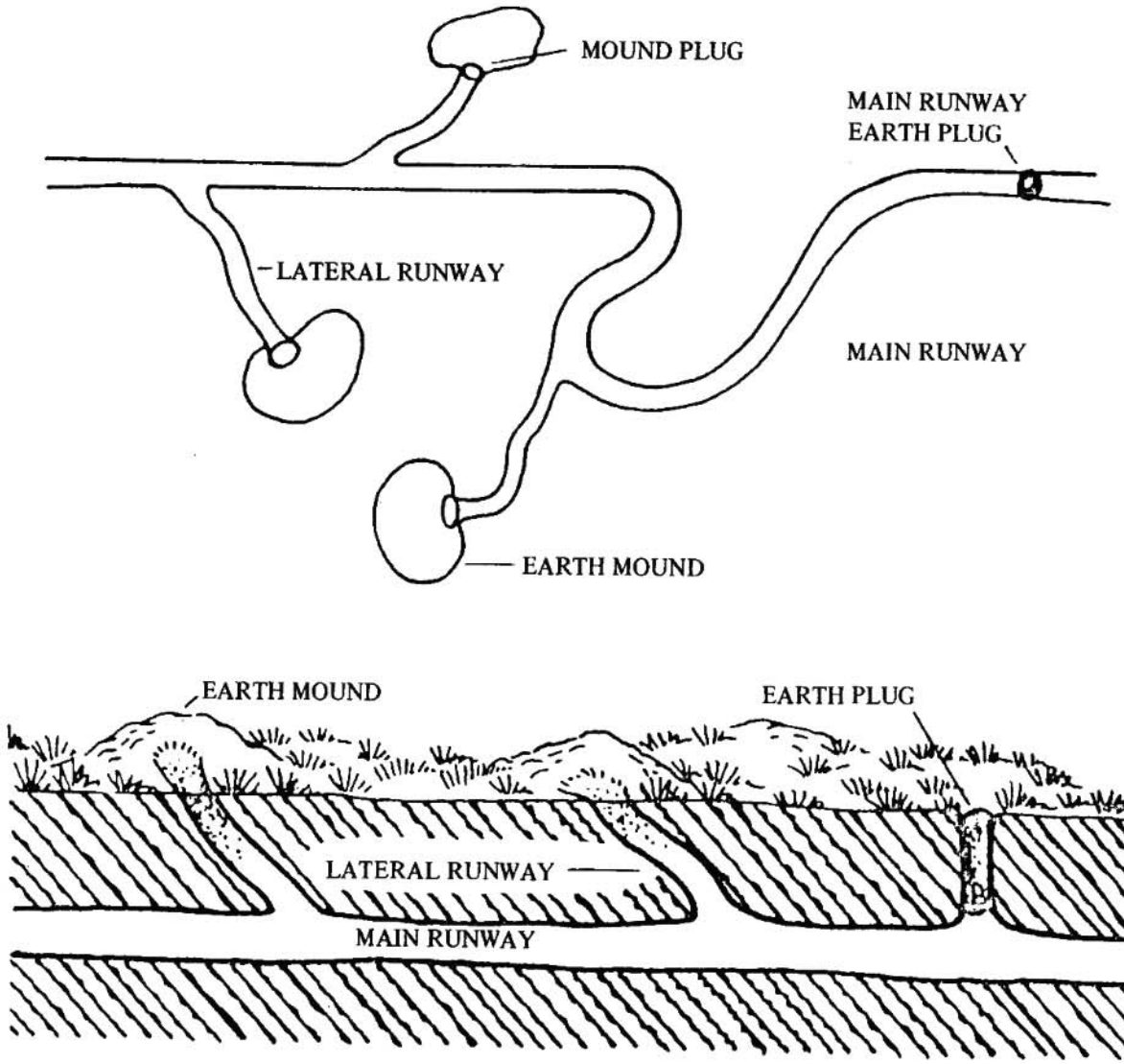

Figure 43. *Above,* **pocket gopher burrow showing characteristic location of lateral and main runway.** *Below,* **cross-section of burrow.**

- The number of available baiters must be sufficient to permit complete coverage of the area requiring protection. This often becomes a problem on large areas of several hundred acres or more in size.

Probing. This is the most commonly followed method of hand baiting. It is the fastest hand-baiting technique but requires considerable knowledge of gopher habits to be done effectively.

Ideally, a probe should be of metal. It should have a small end of 1/4" to 3/8" diameter for exploration and a larger end of 3/4" diameter for opening the bait-drop hole. Both ends should be sharpened for easier soil penetration. A short handle welded at a right angle to the large end is also helpful when probing in hard soil or heavy sod.

Expertness in using the probe is gained largely through experience and self-training. The first step is to select a spot on which to check for the presence of a burrow. The probe then should be forced gradually into the ground at that location. If the choice is correct, a sudden release of pressure will be felt when the point enters the burrow.

Initial attempts at probing should be verified by digging out the lateral and part of the main runway. In this way, errors can be discovered quickly and corrected.

The following sequence should be followed when baiting with a probe:

1. Select an area with recent mound-building activity.

2. Locate the main runway by probing-out a lateral runway to its junction with the main runway. Laterals usually will join a main run within two feet or less. One or two test probes down each arm of the main runway to form a rough "T" will verify the location of the runway.

   Main runways also may be located by the presence of small convex earth plugs. The plugs are made when gophers close their burrows upon returning from surface excursions. A probe should be made directly into the earth plug, as the main runway is often immediately below.

3. Enlarge a probe hole in the main runway to accept the bait—being careful to avoid making a deep hole in the bottom of the burrow.

4. Drop a level teaspoonful of strychnine-treated oats into the burrow.

5. Carefully cover all probe holes with clods, rocks, or other suitable material to prevent light from entering the burrow system.

6. Bait two to five spots in what appears to be the active working area of a single gopher.

7. Mark treated areas by scuffing the tops of several earth mounds. This will prevent confusion if several people are working in the same area.

Excavating. Opening main runways with a garden trowel is a positive method for locating the best baiting spot. The only disadvantage is that it is relatively slow.

Excavating is an excellent way to study the nature and arrangement of the burrow systems of gophers and in this respect serves as a useful tool for training inexperienced baiters to use a probe. One or two days of burrow excavation before advancing to a probe will help insure good control results.

Baiting should be done in the following way:

1. Select an area with recent mound-building activity.

2. Open an earth plug at a lateral or main runway to its junction with the main runway. Avoid disturbing the main burrow, if possible.

3. Place a teaspoonful of strychnine-treated oats into the main burrow, several inches from the opening.

4. Carefully close the opening with a clod or rock to exclude all light. Do not allow an excessive amount of soil to fall into the burrow.

5. Bait two spots in what appears to be the active working area of a single gopher.

Machine Baiting. The forest-land burrow builder provides an effective means for controlling pocket gophers within limits determined by slope, surface and subsurface obstructions, soil texture, and soil moisture.

The machine is pulled through the soil creating an artificial burrow, and at the same time depositing small amounts of strychnine-treated oat bait. Gophers locate the new burrows and eat the deposited bait within a few days. Maximum control is usually achieved within 7 to 10 days after treatment.

Individual Tree Protection. "Vexar" plastic seedling protectors offer excellent protection of roots and stems of several conifer species (Anthony et al. 1978) and are being used operationally on several national forests in western United States to minimize pocket gopher-reforestation conflicts.

Snowshoe Hares *(Lepus americanus)*

Life History Information

Preferred Habitats. Snowshoe hares occupy most commercial forest lands in the region provided there is an abundance of brush, bracken fern, and other good protective cover.

Feeding Habits. Foliage of a wide variety of grasses, forbs, shrubs, and trees are eaten readily. Hares prefer a woody diet of foliage, stems, and bark of shrubs and trees throughout most of the year, although herbaceous vegetation is the predominant food in summer. Damage to conifer tree seedlings, however, occurs mainly from late fall through early spring.

Control

Follow the same measures as outlined for snowshoe hares.

Mountain Beaver *(Aplodontia rufa)*

Life History Information

Preferred Habitat. Distribution is limited mainly to western Oregon and Washington, although the range of the species extends from southern British Columbia to central California. Mountain beaver are found in suitable forested habitats throughout their range; mountain beaver populations thrive on suitable sites on cutover areas. Populations are most abundant near drainages and on areas with moist, deep soils.

Feeding Habits. The mountain beaver is herbivorous and eats a wide variety of herbaceous and woody plants. Sword fern, bracken fern, and salae comprise an important part of its diet throughout the year.

Activity. Most surface activity takes place at night, but movements within the extensive burrow system may occur during the night or day. Mountain beaver do not hibernate. Some burrowing may occur in the snow. Late spring is the season of greatest activity for burrowing and "cleaning out" burrow systems.

The burrow system consists of extensive irregular tunnels, 4 to 8 inches in diameter. These tunnels form a network of passages from a few inches to several feet beneath the ground surface. There are many entrances and unrepaired roof openings.

The nest is a deep and fairly elaborate structure containing numerous layers of packed leaves and other foliage.

Although not sociable, mountain beaver often densely populate areas. One sample area 100 by 500 feet was estimated to have a population of 11 animals. There were 100 burrow entrances in this area.

Reproduction. Breeding takes place once a year in late February or early March. Two or three young are born at the end of a gestation period of 28 to 30 days. Females do not bear young until they are in their second year.

Control

Control of mountain beaver in large areas often has been unsuccessful. Control measures are effective only when the animals are actively feeding and moving about. At the present time, kill-trapping is the only method available for reducing mountain beaver populations. Its relation to reducing damage is not known.

No federally registered rodenticides are available now for use for control of mountain beaver on public or private lands in Oregon and Washington. An EPA ruling on field use of strychnine, subsequent to

Executive Order No. 11643, prevent use of strychnine (shipped in interstate commerce) on fresh baits for control of mountain beaver except under special state registration.

Trapping. Trapping is an effective method of removing mountain beaver from small areas. The conibear trap is recommended. Traps should be set on the ground inside the entrance of an active burrow. Before setting a trap in a burrow, be certain that the opening is not being used for pushing out soil or plant debris. Secure traps with stakes and chains. Set upright and at right angles to the underground runways. There is no need to conceal or cover traps. Visit sets at least twice daily to insure maximum effectiveness of traps. Steel leg-hold traps are not recommended for use against mountain beavers.

Meadow Voles (*Microtus* sp.)

Life History Information

Preferred Habitat. Meadow voles occur in a variety of sites in which sufficient vegetation is produced to provide food and cover. Areas of dense grass provide the most desirable habitat.

Feeding Habits. Vegetation, including grass, herbaceous foliage, twigs, roots, seeds, and bark are acceptable foods.

Activity. Meadow voles are active both day and night throughout the year. Their presence is readily detected by distinct winding runways beneath the vegetation. Each vole generally maintains its own set of runways, but its territory may be occupied by several voles. Individual home ranges vary from a few square feet to areas as large as a tennis court.

Reproduction. Four to 10 young are born after a short gestation period of 3 weeks. Females can breed when only weeks old and many have litters continuously from early spring to late fall. Populations often fluctuate drastically from year to year.

Control

Baiting. Meadow voles usually can be controlled with a 1-percent, zinc phosphide-treated grain bait. Distribute the bait in quantities of one-half teaspoonful directly in runways and burrows. The quantity of bait needed per acre will vary depending upon mouse density and distribution and density of cover.

Two pounds of bait per acre normally will be enough to control high populations in dense cover. Correct bait placement is very important, as the voles seldom venture from the protection of their runways. Baiting is most effective in late fall, but should be initiated as soon as meadow voles are detected on the plantation. Baiting may be needed for several years in problem areas.

Habitat Manipulation. Removing food and cover is an effective method for controlling damage by meadow voles, but it may have adverse effects on other wildlife. This approach to damage control is generally limited to old fields and other areas where heavy equipment can be operated. Habitat manipulation can be accomplished by cutting, cultivating, burning, or spraying grasses with herbicides.

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Activity. Daily movements usually are limited to a small area. The period of greatest activity is from dusk to dawn. Snowshoe hares do not migrate but may shift their feeding activities to different vegetative types during deep snow conditions in winter.

Reproduction. Snowshoe hares normally have three to four young per litter and may have up to four litters a year. Young are born from April through August. The gestation period is from 36 to 40 days. Hares are precocial at birth–the newborn young are well-developed and are soon able to move about.

Control

No federally registered rodenticides are available now for use on fresh baits for control of hares or rabbits on public or private lands in Oregon and Washington. An EPA ruling on field use of strychnine, subsequent to Executive Order No. 11643, prevents use of strychnine (shipped in interstate commerce) on fresh baits for control of hares or rabbits.

Silvicultural Practices. Disposing of slash, brush, and accumulations of logging debris will reduce the attractiveness of the habitat for hares. When a serious, hare damage problem is anticipated, use of large seedlings 2 or more feet in height will reduce feeding damage.

Individual Tree Protection. Plant trees that have been treated with Thiram (TMTO) animal repellent. Repeated applications of Thiram in the field may be required, after each growing season, until trees grow large enough to be out of danger. The repellent can be applied effectively with a back-pack sprayer. The recommended dilution is 1 gallon of 20 percent Thiram to 1 gallon of water.

Tubes of plastic fabric also may be used to protect individual tree seedlings. The tubes can be placed on newly planted or established seedlings and will provide protection of new and old foliage from clipping by hares (Campbell, 1969; Campbell and Evans 1975a).

Brush Rabbit *(Sylvilagus bachmani)*

Life History Information

Preferred Habitat. Dense brush interspersed with openings provides ideal habitat. Distribution is limited to the area west of the Cascades' crest in Oregon. Brush rabbits do not occur in Washington.

Feeding Habits. Buds, twigs, bark, grasses, and a wide variety of succulent forbs are eaten.

Activity. The main period of activity is from dusk to dawn. Movements are confined to very small areas. The young are born nearly hairless and blind at birth and spend a much longer time in the nest than do hares.

Reproduction. Brush rabbits normally have two or three litters per year, with three to six young per litter.

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