

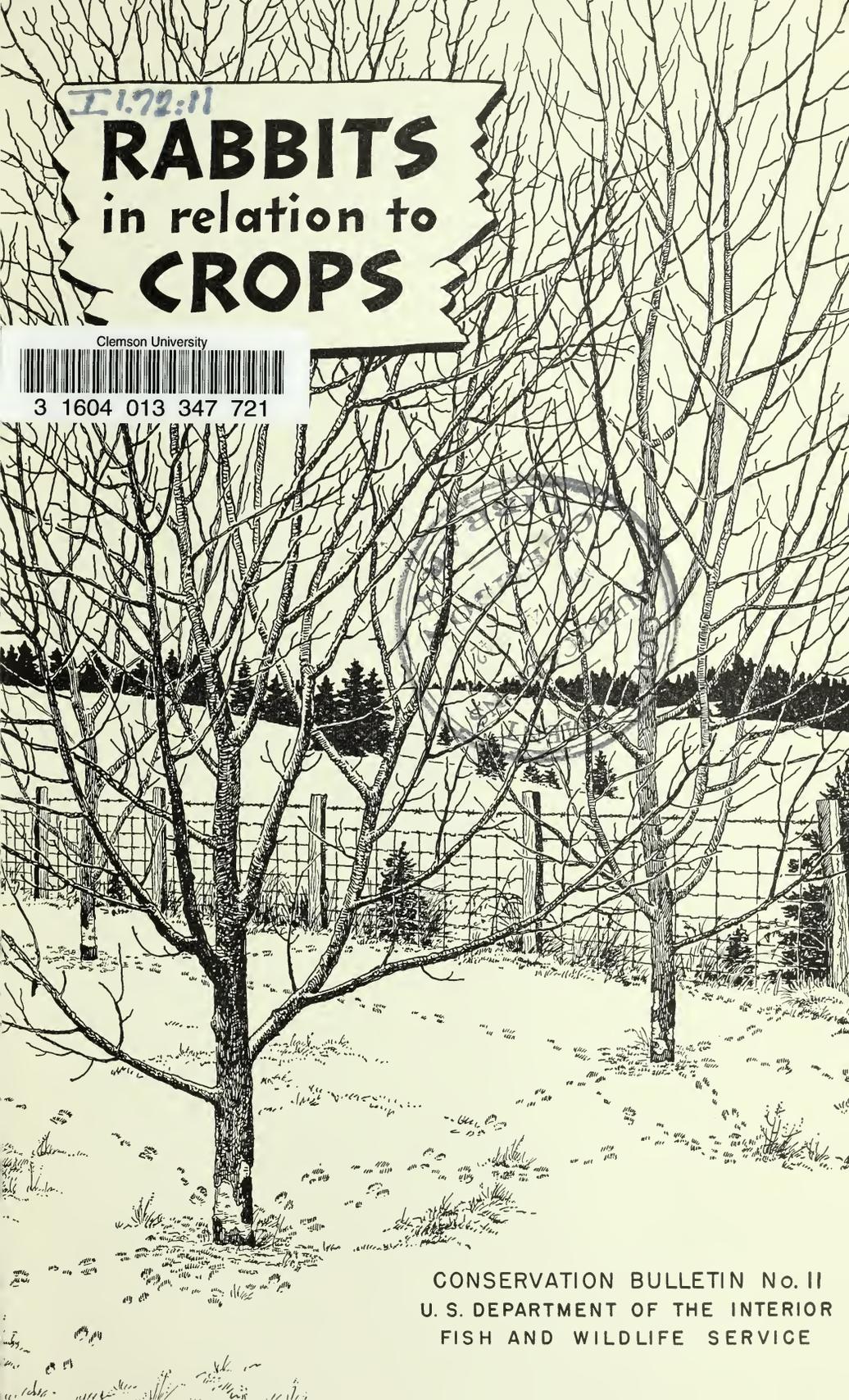
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RABBITS in relation to CROPS

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UNITED STATES DEPARTMENT OF THE INTERIOR

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Conservation Bulletin 11

RABBITS IN RELATION TO CROPS

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RABBITS are hunted for sport and food in most parts of the United States and in some localities are the only game animals available. In many sections, however, they become objectionable because of their injury to orchards and farm crops, and, despite their good qualities, it then becomes necessary to take control measures. Abnormal increases in the number of rabbits are checked usually by hunting and trapping, or naturally, by diseases and predatory animals. When other repressive measures are necessary, poisoning may be resorted to, or crops may be protected by the erection of suitable fences. For the protection of trees, the trunks may be covered with washes that are distasteful or poisonous to the rabbits or with mechanical contrivances that prevent their gnawing the bark. The different methods of control are here discussed.

RABBITS IN RELATION TO CROPS

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INTRODUCTION

AMONG the serious pests in orchards and tree plantations are the several native species of rabbits. These animals do considerable damage to garden truck and other farm crops also, especially on lands recently opened to cultivation. North American rabbits belong to two general classes easily distinguished by their size and habits.

The larger forms¹ include the snowshoe hares and jack rabbits and are found throughout nearly all of Alaska and Canada and in all States west of the Mississippi River except Arkansas and Louisiana. East of the Mississippi snowshoe hares are found in the northern parts of Minnesota, Wisconsin, and Michigan, most of New York, and New England, and southward in the Appalachian Mountains, parts of Pennsylvania, Maryland, and Virginia. Jack rabbits are not found east of the Mississippi except where introduced.

The smaller forms,² generally called cottontail rabbits, occur in every State, but are absent from the greater part of Maine, the northern parts of New Hampshire, Vermont, New York, Michigan, Wisconsin, and Minnesota, and the western parts of Washington and Oregon. In recent years they have extended their range northward in the New England States, New York, and parts of the West and have invaded and occupied much of the Province of Ontario.

In habits the cottontails differ materially from the larger rabbits. They live in copses and thickets more than in open fields. The young

¹ Genus *Lepus*.

² Genus *Sylvilagus*.

NOTE.—This bulletin supersedes Farmers' Bulletin 702, Rabbits in Relation to Trees and Farm Crops, by D. E. Lantz, issued in 1916 by the U. S. Department of Agriculture—a contribution of the Bureau of Biological Survey, which was consolidated in 1940 with the Bureau of Fisheries to form the Fish and Wildlife Service, U. S. Department of the Interior.

are born blind, naked, and helpless, while those of the larger rabbits, or hares, have the eyes open, and are active and fully furred when born.

Both the large and the small rabbits, however, feed exclusively on vegetation and are at times harmful to crops and especially to trees. Because of their size, and their great abundance in parts of their range, jack rabbits are by far the most destructive. Epizootics (diseases that attack many animals at the same time) are an effectual natural check, and after an attack occurs jack rabbits are usually so reduced in numbers that they are not troublesome again for several years.

Rabbits are valuable for food and afford excellent sport for gunners. In many States, especially in the East, they are protected as game, though in fruit-growing and truck-farming districts farmers regard them with disfavor. The interests of sportsmen and farmers do not seriously differ, however, for when rabbits are closely hunted, losses from their depredations are usually reduced to a minimum. Still there is danger that in years favorable for their increase the animals may inflict serious injury to trees during severe winters.

HABITS

COTTONTAIL RABBITS

Cottontail rabbits breed several times each year during the warmer months, the litters averaging five or six young. The nest is usually placed in a hollow or depression of the ground, often in open fields or meadows. It is composed of dead grass and is warmly lined with fur that the female pulls from her own body. The male rabbit takes no part in caring for the young, and the female weans them as soon as they are able to leave the nest. These animals breed so rapidly that, in spite of many natural enemies and of the fact that they are hunted for human food, they often become numerous enough to inflict serious losses (fig. 1) on farmers and fruit growers in many parts of the United States.

Cottontail rabbits eat all sorts of herbage—leaves, stems, flowers, and seeds of herbaceous plants and grasses—and leaves, buds, bark, and fruits of woody plants or trees. They usually prefer the most succulent foods, as young shoots, tender garden vegetables, clover, alfalfa, and fallen ripe fruits, but they exhibit also remarkable choice in their selection of certain varieties of cultivated plants and in their neglect of others of the same species. C. V. Piper reports that in Oregon rabbits ate Arabian alfalfa down to the ground, while they did little or no damage to other varieties grown in surrounding plats. C. A. Mooers, of the Tennessee Agricultural Experiment Station, reports similar observations in regard to their taste for soybeans, stat-

ing that they greatly relish the Mammoth Yellow variety and that it is practically the only one that suffers from their depredations. When favorite foods are absent, as during summer droughts, or when deep snows cut off ordinary supplies, rabbits resort to whatever is available and attack the bark of growing trees or shrubs.

BLACK-TAILED JACK RABBITS

There are nine varieties of black-tailed, or gray-sided, jack rabbits in the United States, distributed in the Western States south of North

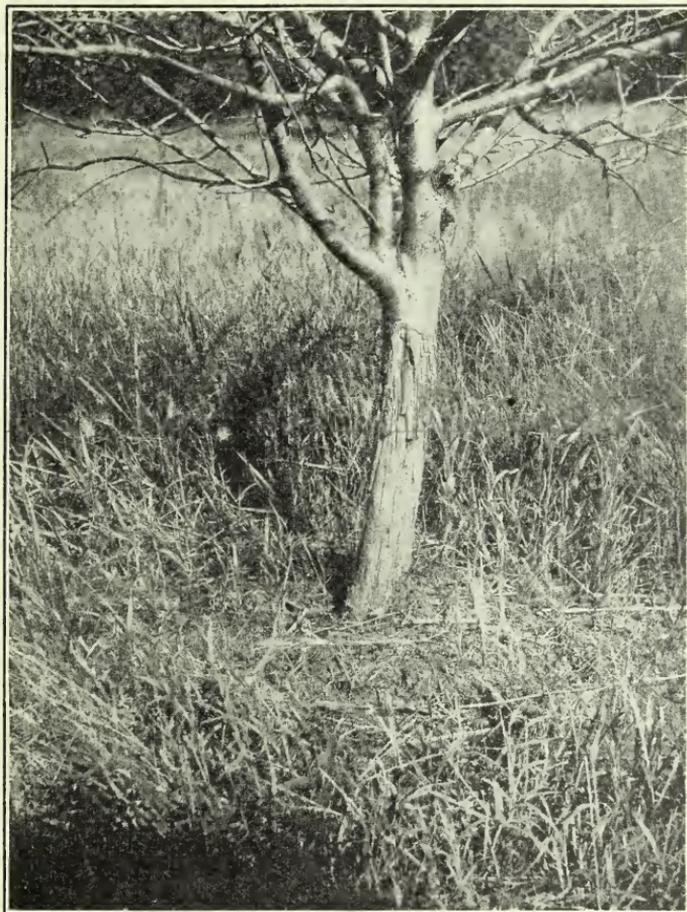


Figure 1.—Apple tree killed by rabbits.

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Dakota and Montana and west of Iowa, western Missouri, and eastern Texas. The group is characterized by long legs, long ears tipped with black, gray sides, a white or buff belly, and a tail that is black above and grayish white or buff beneath. The weight is 4 to 6 pounds.

Black-tailed jack rabbits do not burrow but make "forms" under bushes or within the dense growths of vegetation where they hide and

rest. The young are born in these forms, fully furred and with eyes open, and within a few days can shift for themselves. One to six young comprise a litter and one to three litters a year are produced.

The natural foods of these hares consist of range grasses, bark and twigs of shrubs and small trees, and bark from the trunk of larger trees. The animals also feed on domestic grasses and grains and on fruit or shelter trees until these are 3 or 4 years old.

Populations of these jack rabbits exhibit cycles during which they build up to a saturation point and then are drastically reduced by disease. A cycle is completed about every 7 years, though it may vary from 5 to 10 years. During peak years it is often necessary for farmers to employ repressive measures to protect grain and grass crops and orchard or other trees from rabbit depredation. On farms in Prairie States, where an effort has been made to establish shelterbelts, the young trees require constant protection.

Black-tailed jack rabbits are swift of foot and offer good sport through coursing with dogs. They are keen of sight and hearing and often run from a hunter long before he is within shooting range. Or with ears flattened close to the back, they may cower close to the ground, where they are difficult to see, and remain thus until almost stepped on by the hunter. These habits present problems when hunting is the kind of control that is undertaken.

WHITE-TAILED JACK RABBITS

White-tailed jack rabbits are of more northerly distribution than the blacktails, but are nowhere so abundant. The ranges of the two overlap in South Dakota, Nebraska, Colorado, Wyoming, Idaho, Utah, Nevada, northeastern California, eastern Oregon, and eastern Washington. These hares are similar, but the whitetails are somewhat the larger, weighing 6 to 8 pounds or more. Their tails are almost wholly white, and in the more northern parts of their range they don a white winter pelage.

Whitetails inhabit the open prairies with blacktails, but range higher on the mountain slopes, reaching an elevation of 12,000 feet in Colorado. They detect hunters more quickly than do blacktails, hence are more difficult to shoot, and also they are less gregarious and consequently more difficult to control.

These hares have forms similar to those of the blacktails, where they rest and where their young, averaging four to a litter, are born.

Their food differs from that of the black-tailed jack rabbits in that they prefer fresh green foods to dry grains. They browse on the bark and twigs of small seedlings, and may be highly destructive to young trees, particularly on shelterbelt plantations.

SNOWSHOE HARES

Snowshoe, or varying, hares are intermediate in size between the cottontails and the white-tailed jack rabbits, and average 3 to 5 pounds in weight. Their legs are longer than those of cottontails but shorter than those of jack rabbits, and their large, broad hind feet are heavily furred between the toes, making travel easy on top of the snow.

Their range in the United States is mostly north of that of the cottontails or at higher altitudes. Some varieties inhabit the Cascades, Olympics, and Sierras, and also the Rocky Mountains as far south as New Mexico. One inhabits the northern part of Wisconsin, the Upper Peninsula of Michigan, and Minnesota, and another ranges in the Appalachian Mountains south of West Virginia.

The name "varying hare" was suggested by seasonal changes in color, from brownish in summer to white in winter. This is true of all varieties except the Washington hare, which remains brown all the year. It lives in the cool, dense forests and underbrush in the rainy belt of western Washington, where there is not much snow.

Like the jack rabbits, these hares have forms in the grasses and underbrush, where they hide and rest during the day and where the young are born, usually three or four to the litter. Snowshoe hares are subject to periodic cycles of great abundance followed by almost complete disappearances. Their varying abundance influences the numbers of their predatory enemies.

For food rather than mature grains they prefer green grasses, shrubs, and small seedlings of both conifers and hardwoods.

PROTECTION OF RABBITS

There is a closed season on cottontail rabbits in many States and Provinces, although some States and Alaska and some Canadian Provinces do not protect rabbits of any kind. In some States rabbits may be taken with dog, trap, or snare at any time, and the closed season for shooting is evidently solely for the purpose of keeping gunners out of fields and woods during periods immediately preceding the open season on quail.

In a number of States that have a closed season on rabbits, the laws permit farmers and fruit growers to destroy the animals to protect crops or trees. Such provision might well be incorporated in laws of all States. In States that protect rabbits, it is well for the farmer to be acquainted with the game laws and in case of doubt to confer with local and State game wardens before undertaking control measures.

MEANS OF REPRESSING RABBITS

NATURAL ENEMIES

Among the agencies that help to keep down the numbers of rabbits, few are more effective than carnivorous birds and mammals. These include large hawks and owls, eagles, coyotes, wildcats, foxes, minks, weasels, dogs, and cats. Eagles, the larger species of hawks, and all the large- and medium-sized owls make rabbits a great part of their food. From the standpoint of the farmer and fruit grower these birds and certain carnivorous mammals may be more beneficial than harmful. On the other hand, poultry growers and sportsmen regard them as enemies to be destroyed whenever possible. In the absence of such natural enemies, rabbits, as well as rats and mice, often become a menace to valuable crops. Indiscriminate slaughter of carnivorous birds and mammals should be suppressed whenever rodent pests are to be controlled. These natural enemies, however, may never be numerous enough by themselves to control rabbits, so hunting, trapping, snaring, and other direct methods may have to be employed.

HUNTING

Hunting has been the most important factor in keeping down the numbers of rabbits in North America. In some parts of the country the animals have been so reduced in numbers by shooting that sportsmen have invoked legislation to prevent their extermination. Shooting is undoubtedly the best method of hunting. Ferreting is often impracticable, since native rabbits do not habitually burrow; furthermore, the use of ferrets is forbidden by law in many States that protect rabbits. Coursing with greyhounds is popular in the West, where the swifter jack rabbits are abundant. Cottontails are often chased with foxhounds, but the beagle is rapidly taking precedence, the gun being used to get the game.

When the country is sufficiently open for the purpose, the organized hunt, in which everyone who owns and can safely handle a gun takes part, is a good means of reducing the numbers of rabbits. Organized hunts are popular in the West, where they are also varied, in the case of jack rabbits, by what is known as the "rabbit drive." A large territory is surrounded by men, and the animals are driven into a corral. While a few cottontails are sometimes included in the catch, these usually find refuge in open burrows or under cover of rocks or brush, so that this method is hardly applicable to them.

Another method of hunting jack rabbits is for crews of good marksmen systematically to search an area and shoot the animals as they are jumped. Repeatedly covering a tract in this manner has greatly reduced the number of black-tailed jack rabbits on and about tree plantations. One man, using a 12-gage shotgun or a .22 rifle with long-rifle cartridges and patrolling an area morning and evening, when

rabbits are most active, can maintain effective control about tree plantations. This method is not so effective against the white-tailed jack rabbits because they are wilder and quickly get out of range. It can be supplemented by the use of a good poisoned bait to destroy animals within the plantation.

Patrolling and shooting are not effective against snowshoe hares because these animals keep out of sight and too few of them jump and run when their hiding place is approached. In the State of Washington one can walk all day over an area where severe damage is being done to small seedlings by snowshoe hares and not see an animal.

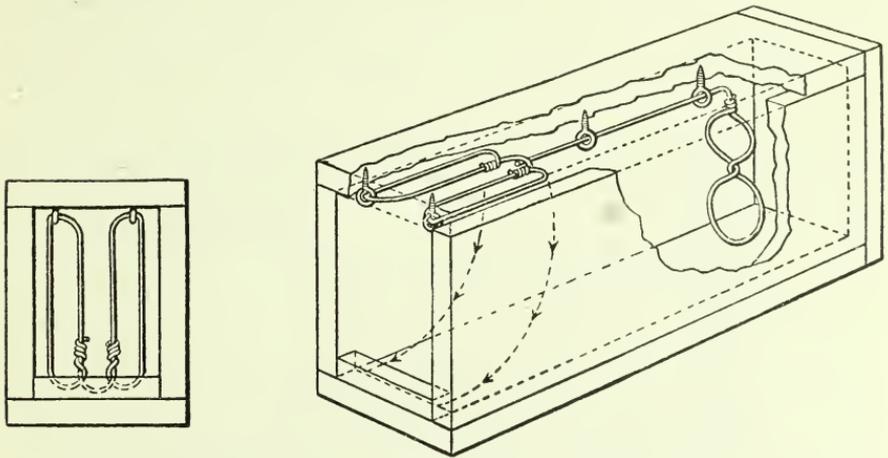


Figure 2.—Details of a Wellhouse rabbit trap.

In Minnesota these hares are not quite so shy but still too few are seen to make hunting successful as a means of control.

TRAPPING AND SNARING

Cottontail rabbits are easily trapped or snared, and while these methods are slow, they are always feasible when the animals infest woodlot, orchard, nursery, field, or garden. Many are caught in old-fashioned box traps set with a figure-4 trigger with cord attached.

An improvement on this familiar trap, widely used in the Middle West, is the Wellhouse³ trap, a box 21 inches long, about 6 inches high, and 4 inches wide (inside measurements) made of 6-inch boards, preferably old ones. The box is closed at the rear and has a wire door in front, which swings inward from the top, a cleat at the bottom preventing its opening outward. The trap is set and the wire door kept open by a wire trigger rod held in place by two staples in the top of the box. The trigger rod is bent downward into a loop or figure 8 near the rear of the trap. As the rabbit enters and goes into the back

³ After Fred Wellhouse, of Topeka, Kans.

part, it presses against the loop and moves the trigger rod backward becoming imprisoned as the wire door is released and falls. Bait may be used but is unnecessary, since cottontails frequently take refuge in dark places from enemies or inclement weather.

The materials needed for making a Wellhouse trap (fig. 2) are: Four boards 1 by 6, 21 inches long, for the top, bottom, and sides; a piece 1 by 6, 8 inches long, for the back; a small cleat for the door stop; 28½ inches of wire for the door; 22 inches of wire for the trigger; 4 small staples for hanging the door and trigger; and nails.

Photographs and a description of a permanent rabbit trap (fig. 3) made of sewer tile and used on farms in Kansas have been furnished by J. M. Walmsley. A 12- by 6-inch T is set with the long end downward and buried so that the 6-inch opening is below the surface of the ground. Two lengths of 6-inch sewer pipe are then connected horizontally with the opening. Soil is placed over the joints to exclude light. The upright tile should be fitted with a tight removable cover—

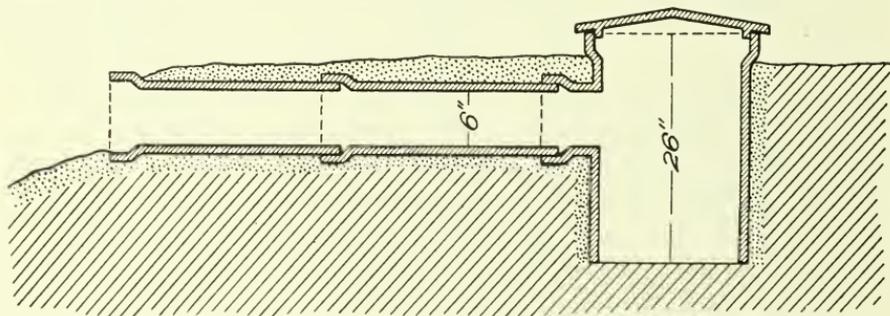


Figure 3.—Cross section of a Walmsley tile trap for rabbits.

an old harrow disk will do. The projecting end of the small tile is surrounded with rocks, brush, or wood, so as to make the hole look inviting to rabbits (fig. 4) and in order that they may appropriate the den as a place of concealment and shelter. A number of these traps in various places, and especially in the vicinity of orchards, have kept many farms comparatively free of rabbits. Rabbits occupy these tile traps, go in or out at will, and may be captured when desired. Whenever a man visits his traps he should be accompanied by a trained dog to locate trapped animals. The cover is lifted from the upright tile and the rabbit captured by hand; if it bolts from the side opening it is caught by the dog. A short pole fitted with a 5-inch wooden disk may be inserted in the side opening to prevent escape.

These traps are especially suitable for open lands and prairies, where rabbits cannot find many natural hiding places. Built on waste land, they may become a permanent part of the farm equipment and will cost nothing for repairs from year to year. Their first cost may be greatly reduced by use of second-grade or even broken tiles. If one

wishes to poison rabbits, the baits may be placed inside these traps without danger to domestic animals or birds. The tile trap furnishes an excellent means of obtaining rabbits for the table or even for market without damaging them by shooting.

Trapping is not a successful method for controlling jack rabbits or snowshoe hares, because too few of the animals will go into a trap or dark enclosure. Snaring is not effective for jack rabbits, but properly done it is satisfactory for Minnesota snowshoe hares.

Construct the snare from a 23-inch piece of No. 2, 12-strand picture cord or cable wire. At one end, make a small loop approximately $\frac{3}{16}$ inch in diameter, either with a single tie as shown in the left diagram of figure 5, or by forming the loop around a twentypenny nail and then twisting the end about the main wire to fasten it, as shown in



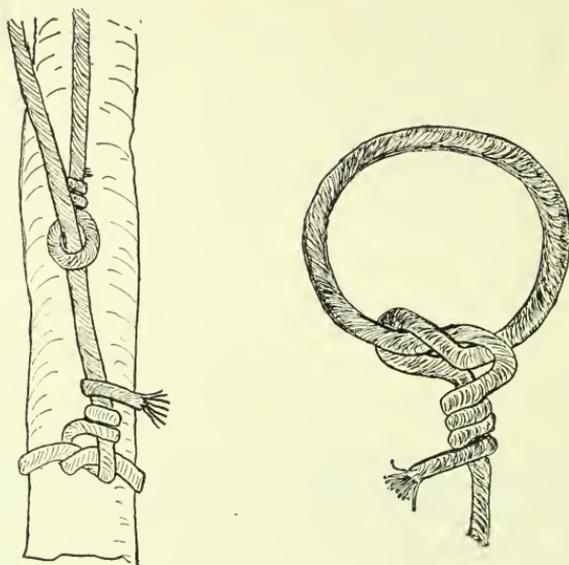
Figure 4.—Tile trap in use.

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the right diagram. Run the other end of the wire through this loop to form a large snare noose (fig. 6).

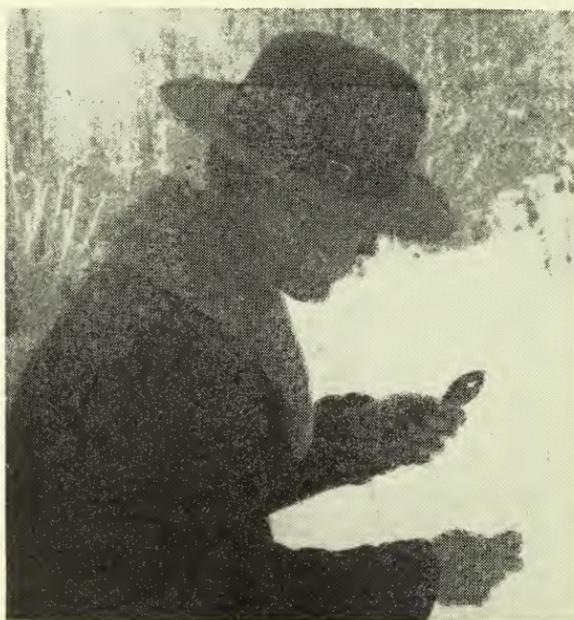
The noose should be in the proper trapping position. Make the ring of the snare about 4 inches in diameter and fasten the free end of the wire to a toggle stick so that the upper side of the ring is about 3 inches from it. The stick must be directly across the trail (fig. 7), or one end of it stuck into the snow at the side of the trail and slanted at the angle that will hold the noose in the right position—the lower side of the ring $1\frac{1}{2}$ inches from the floor of the trail (fig. 8).

When snow is on the ground, snowshoe hares travel chiefly along main trails, although a fresh fall of snow may cause some deviation. Where possible, set snares along main trails at points where they lead under brush piles, logs, or other obstructions. If an open-trail site is selected, it is well to put a barrier at each side of the set as shown in figure 8.



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Figure 5.—Rabbit snare. At the left is a single tie through which the other end of the wire has been passed and fastened about the limb; at the right is a loop that has been made about a nail and the end twisted about the main wire.



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Figure 6.—Snare, showing operator passing free end of wire through loop.



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Figure 7.—Stick holding snare shown straight across and above trail.

If the area is large and the rabbits abundant, to make snaring effective, operations should be conducted on a scale large enough to cover both the area from which it is desired to remove the rabbits and on a buffer belt around it half a mile wide. Use many snares and cover the area systematically and progressively so that no major trails are missed.

POISONING

Poisoning rabbits has been successful in the West, the most favorable season for this control method being in winter or in summer after a drought has made green food scarce. In some localities crickets or



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Figure 8.—Stick placed at an angle by side of trail and also barrier at each side of snare.

grasshoppers interfere with poisoning in summer by consuming the bait.

Methods of poisoning hares and rabbits vary with species and season. In winter good results may be obtained on cottontails and black-tailed jack rabbits in many localities by use of the following mixture:

Heavy whole oats.....	16 pounds.
Gloss starch.....	1 ounce.
Corn sirup.....	¼ pint.
Strychnine alkaloid.....	1 ounce.
Sodium bicarbonate.....	1 ounce.
Water.....	1 pint.
Glycerine.....	½ ounce.

To prepare, mix the starch with half the water and add the remainder and bring to a boil; mix the strychnine and soda with the sirup and add the hot starch paste, mixing thoroughly; stir in the glycerine; pour this over the oats and mix until the grain is uniformly coated.

Place 1 tablespoonful of the bait at intervals along natural rabbit runs or along artificial ones made with a narrow drag or scraper.

For black-tailed jack rabbits and cottontails in the Southwest, shelled kafir corn or milo maize may be used instead of oats. Kafir corn heads may be treated with the poisoned paste diluted with 3 pints of hot water. They should be dipped into the hot paste and then allowed to drip for a short time and dry. When gathering the heads, cut the stems 12 to 16 inches in length for convenience in dipping and exposing. In cultivated fields where there is no danger of livestock, push the stems into the ground along rabbit paths so that the heads are about 8 inches above the surface. On the range where livestock may be endangered, build a stockproof corral 20 feet square around bushes that offer attractive cover with the bottom wire not closer to the ground than 10 inches, and place several of the poisoned heads about the bushes. These corrals should be along natural runways of the rabbits in draws or on ridges, or in small clumps of brush on the open range.

For black-tailed and white-tailed jack rabbits in the Great Basin and in eastern parts of Oregon and Washington, use green-cured alfalfa leaves as bait material, dipped in a diluted strychnine paste and dried as described. Expose this bait along trails in small handfuls where not accessible to domestic stock.

Another bait that has proved especially effective in the Prairie States from South Dakota to Texas for winter control of black-tailed jack rabbits is prepared as follows:

Powdered strychnine alkaloid.....	1 ounce.
Finely ground table salt.....	2 pounds.
Alfalfa meal.....	2 pounds.

Mix these three together and add just enough water to make the mixture pack well. Cut a 2 by 4 into 5-inch lengths and in one side of each block bore a 2-inch hole, $\frac{3}{4}$ -inch deep and pack it full of the damp bait.

Put these loaded blocks along natural or artificial trails just inside tree plantations, grain fields, or other places frequented by rabbits, but out of reach of livestock. This method may be used throughout the year. The blocks may give slightly better results at one season than another but, being constantly available, they assist materially in rabbit reduction. They should be inspected regularly to keep them in proper condition.

During a long dry period in summer, fresh green alfalfa tips, dusted with powdered strychnine alkaloid in the proportion of 1 ounce of strychnine to 20 pounds of alfalfa, give very good results against jack rabbits in the Great Basin States and in eastern Oregon, but are less effective elsewhere. The strychnine paste described for dried leaves may also be used for poisoning fresh green alfalfa tips.

In dry spells rabbits gather in large numbers about fields of green hay or grain and make trails into them. Expose the poisoned green bait along trails 200 yards or more from the fields, between 3 and 4:30 in the afternoon. If there is sagebrush or other brush at about this distance, expose the bait near the points where the trails emerge from it.

The Minnesota snowshoe hare is fond of the bark of young aspen trees, hence pieces of fresh boughs, 2 to 3 inches in diameter and 4 to 6 feet long, make good bait-station material when snow is on the ground. All small limbs and twigs should be stripped from the boughs to prevent deer from being attracted to them. With a brush, coat these pieces with a strychnine preparation made as follows:

Chloroform-----	1 gallon.
Lanum (anhydrous) -----	1 pound.
Strychnine alkaloid -----	10 ounces.

Dissolve the strychnine in the chloroform and then mix with the lanum. Distribute the boughs systematically in the infested area, allowing approximately 1 to each 5 acres. Place them in the snow vertically or at an angle at the side of or across the trails.

BACTERIAL DISEASES

Epizootic diseases often destroy rabbits in large numbers when the animals become excessively abundant in any locality, but thus far all attempts to spread contagious disease among them artificially have failed to give practical results. Tularemia,⁴ an epizootic disease of

⁴ Information concerning tularemia will be furnished by the Fish and Wildlife Service upon request.

rabbits, is transmissible to man through the bites of infected deer flies and ticks and through handling diseased rabbits.

UTILIZATION OF RABBIT CARCASSES

The hunting, trapping, and snaring methods have an added advantage in that rabbits so taken can be utilized for fur and meat, thereby offsetting the cost of control in some cases. In some instances, through utilization of the carcasses, a liability actually has been turned into an economic asset. For the past few years, in most western States where rabbits are a problem, definite benefits to agriculture and range crops have been derived through the establishment of rabbit-skinning plants situated to serve the community and maintained privately as business enterprises. At these plants rabbit carcasses are purchased at prices attractive to farmers, sportsmen, and others and prepared for market. After the animals have been skinned and dressed, the fur and meat are disposed of through local or eastern markets—the fur to dealers and the meat to fox farms, dog-food canning plants, and in limited quantity to cold-water fish hatcheries. During the winter of 1940–41 jack rabbits sold for as high as 13 cents each in Colorado and 26 cents each in North Dakota. Prices vary from year to year, sometimes being as low as 5 cents, because of the small demand for the meat and fur. At such times it has been difficult to keep canning plants supplied with rabbit carcasses. This should be kept in mind and plans made to meet the situation.

Besides the normal benefits derived from crop savings, a definite economic and recreational value is realized by the community—not only from work provided, but also from recreational activity, which is thus possible at minimum cost. In short, an economic pest is made a natural resource of considerable value. Since animal utilization has its geographical, seasonal, and financial limitations, advance consideration must be given to harvesting and marketing.

PROTECTION OF CROPS FROM RABBITS

Complete extermination of rabbits in any part of the United States is neither desirable nor possible. The animals should be reduced in numbers only sufficiently to insure comparative safety to crops. Before active wholesale destruction of the animals is attempted the possibility of crop protection by other means should be carefully considered. In many cases one of these means would probably be more economical.

RABBITPROOF FENCES

When rabbits are abundant and the area to be protected is not too great, a woven wire rabbitproof fence may be profitably used. Fenc-

ing is in general use, not only against the rabbit pests in Australia and Europe but in our own country against both large and small rabbits. As the North American species burrow less than does the European rabbit, the requirements for rabbitproofing a fence here are not so great. Even the cottontails, when driven by hunger, will dig under a fence, but this may be prevented either by use of wire with close barbs in contact with the ground or by plowing a furrow against the lower edge. Against cottontails, a netting of galvanized wire with 1½-inch mesh and 2½ to 3 feet high is a good barrier, and against jack rabbits one 4½ to 5 feet high will suffice. Where snow is infrequent, market gardeners and nurserymen use a 2-foot fence, but in the North they prefer to use a netting 3½ feet wide and to turn 4 to 6 inches of the lower edge flat and cover it with soil. Netting made of No. 20 wire will give good service. Heavier netting slightly increases the cost, but adds to durability. Where lumber is cheap, a picket fence or one made of laths and wire is practicable. When deep snows fall and drifts form, fences offer no protection against rabbits.

PROTECTION OF TREES

REPELLENTS

Many devices for protecting trees from rabbits have been recommended, the majority of which are paints, smears, or repellents supposed to be distasteful. Many are not sufficiently permanent to afford protection for an entire winter, and most of those that are lasting are injurious to trees. Coal tar, pine tar, tarred paper, and oils, under certain conditions, are dangerous to young trees. Carbolic acid and other volatile substances afford only temporary protection, and must be renewed too often to warrant their use. Bitter substances, like commercial aloes and quassia, are useless.

The chief chemical substances that will afford maximum protection to large or small trees are lime-sulfur, copper carbonate, and asphalt emulsion. Apply these, suspended in durable adhesives, as a spray to small seedlings while they are in the nursery beds. Prepare the mixtures in the proper consistency also for painting on the trunks of larger trees (figs. 9 and 10).

The various species of rabbits, especially the white-tailed jack rabbit in the Dakotas and snowshoe hare in Minnesota may be prevented from seriously damaging trees with the following repellent:

- | | |
|-------------------------------------------|-----------|
| 1. Heavy alkyos-type resin..... | 4 pounds. |
| Ethylene dichloride..... | 5 quarts. |
| 2. Asphalt emulsion (any good grade)..... | 4 pounds. |
| Ethylene dichloride..... | 5 quarts. |

Dissolve 1 and 2 separately before mixing. To the mixture add the following in small quantities with constant thorough stirring:

Copper carbonate (50 to 53 percent).....	5 pounds.
Lime-sulfur (powder).....	5 pounds.
Ethylene dichloride.....	2 quarts.

If the mixture is not smooth, let it stand 1 or 2 days until it is homogeneous on stirring. The mixture should be thoroughly agi-



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Figure 9.—Chinese elm seedling damaged by white-tailed jack rabbits. Limbs and twigs cut off and bark girdled.

tated and then passed through a 16-mesh screen. It will then be of a consistency suitable for spraying on trees with a compression-type sprayer or for applying with a brush as a paint.

Some power-sprayer outfits can be readily adjusted to apply the repellent to seedlings still in nursery beds. Spraying should be done under 45 to 50 pounds air pressure. The operator should proceed first in one direction, spraying one side of the seedlings, and then in the opposite direction in the same row so as to have both

sides of the young plants well covered. The trunks are more easily coated if bent slightly away from the operator, another person going ahead and using a rod for the purpose. Although the spray gun may be manipulated by hand, it is not difficult to mount all the equipment on a truck or trailer. To permit spraying at the proper angle, a rod is attached to bend the seedlings and the guns are held on an adjustable bar attached to the rear of the vehicle.



B60405

Figure 10.—Chinese elm adjacent to one shown in figure 9 treated with a lime-sulfur spray.

For use on small holdings, a portable, compression-type sprayer, which is strapped to the back, may be used. Several such sprayers of 1 to 3 gallon capacity are on the market.

The spray is greenish black and when sufficiently applied makes the seedlings quite dark colored (fig. 11). About 2 to 8 pints should be used for each 1,000 seedlings, which may be 4 to 12 inches in height and vary in foliage (fig. 12).

Another paint or spray that may be used as a repellent for rabbits, particularly cottontails, is made as follows:

	<i>For warm climate</i>	<i>For cold climate</i>
Asphalt emulsion.....	3 pounds	3 pounds.
Water.....	2 quarts	
25 percent wood alcohol in water.....		2 quarts.
Make a smooth paste and add:		
Copper carbonate.....	2 pounds	2 pounds.



B60402

Figure 11.—Green ash sprayed with repellent to a dark color. No rabbit damage, and plant is leafing out through paint without ill effects from the spray

This formula is for use in applying with a brush. To make a spray add 6 quarts of water for either cold or warm climate and apply as described above.

Another recommended paint or spray is:

Asphalt emulsion.....	2 pounds.
Water.....	2½ quarts.

Make a smooth paste with these two ingredients and add the following slowly with rapid stirring:

Diatomaceous earth.....	4 ounces.
Lime-sulfur.....	1½ pounds.

This has the consistency of paint and may be thinned for spraying by adding 2 quarts of water to each quart of the mixture. Apply as described above. When there are only a few seedlings or trees to be treated and a power sprayer is not necessary, one of the hand sprayers on the market may be used, if provided with a nozzle of the proper-sized aperture.

MECHANICAL CONTRIVANCES

Among the best mechanical contrivances for protecting young trees from rabbits are cylinders of woven wire netting. Poultry net-



Figure 12.—Seedling of Chinese elm in foreground, showing severe damage, was not treated with a repellent. The remainder in the row were sprayed. (Photo courtesy Soil Conservation Service.)

ting of 1-inch mesh, made of No. 20 galvanized wire, will answer every requirement. Rolls 18 inches wide are used for cottontails, and the material is cut into 1-foot lengths. One of the sections is rolled into cylindrical shape about each trunk and fastened at several places by bending and twisting the projecting ends of wire. No other fastening is needed, but stakes or spreaders may be used to prevent rabbits from pressing the wire against the bark and doing injury

through the meshes. These guards should be left on the trunks, and will last as long as the trees require protection. They may vary in size to suit the requirements of any particular locality or kind of tree and may be adapted to protection from the larger rabbits by using wider rolls and to protection from both meadow mice and rabbits by using wire of finer mesh and by pressing the lower edges into the ground.

Veneer and other forms of wooden protectors are popular and have several advantages when used for cottontail rabbits. Left permanently upon the trees, however, they furnish retreats for insect pests. For this reason they should be removed each spring. While the labor of removal and replacing is considerable, they have the advantage when pressed well into the soil of protection against both mice and rabbits and are much superior to building paper or newspaper wrappings. Instances are known where rabbits tore wrappings of building paper from apple trees and in a single night injured hundreds. Gunny sack and other cloth wrappings well tied on are effective protectors.

OTHER MEANS

Few of these methods for the protection of individual trees in orchards or elsewhere are applicable to young woodlands or forest plantations where trees grow close together. In these cases the only remedy is the destruction of the rabbits or their exclusion by wire nettings.

Clean cultivation has advantages in preventing rabbit depredations, since it reduces the number of places of refuge for the animals; but rabbits go long distances in search of food, especially in winter, and clean cultivation is not practicable on the western plains, where dense windbreaks are essential to successful orcharding.

Feeding rabbits in winter to prevent their attacks on orchards has sometimes been practiced, on the theory that it is cheaper to feed than to fight them. One plan is to leave the winter prunings of apple trees scattered about the orchard. Another is to furnish corn, cabbage, or turnips in sufficient quantity to provide food for the rabbits during cold weather. If practiced, however, these methods must be used with caution, for, if the supply of other more acceptable food is not maintained, the rabbits that have been drawn into the area by the presence of this food may join with the normal population and cause more severe damage to the trees and crops than normal numbers would have done.