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Controlling Deer Damage in Missouri

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White-tailed deer (*Odocoileus virginianus*) are found in a variety of habitats throughout Missouri. They are beautiful and fascinating animals that provide many aesthetic and recreational benefits.

Deer populations have increased over the past several years because of appropriate harvest regulations and favorable habitat changes. In 1944 the deer season reopened in Missouri after an extended closure. That year, 7,557 hunters took 583 deer during a two-day, bucks-only season in 20 southern Missouri counties. In recent years deer populations have increased dramatically throughout most of the state. More than 400,000 gun and bow hunters harvest more than 200,000 deer annually during statewide seasons.

The white-tailed deer is of great economic importance to Missouri citizens. Deer hunters annually spend in excess of \$100 million on equipment, food, lodging, transportation and other related expenses. The dollars generated from the sale of deer licenses support conservation efforts for deer and other species.

Unfortunately, deer can have a negative impact as well. The cost of damage resulting from deer-automobile collisions is one example. Deer also have the potential to cause damage to field crops, forages, vegetable gardens, landscape plantings, Christmas trees, fruit trees and forest regeneration. The level of damage is often associated with the size of the local deer population and in certain instances with the severity of the winter weather.

The Missouri Department of Conservation (MDC) manages the state's deer population for a variety of interest groups. Their deer management objective is to stabilize the population at a level that will provide maximum recreational opportunities while minimizing conflicts between deer and people.

Most landowners enjoy having deer on their property, despite real or potential damage. This fact, coupled with the economic and aesthetic values of deer, suggests that a combination of herd control through hunting and a reasonable effort at damage control will serve everyone's needs. It is important to remember that success in deer damage control is measured by the reduction of damage to tolerable levels, not the elimination of damage.

The natural predators of deer, such as wolves and mountain lions, are no longer present in Missouri, therefore population management through hunting is necessary to maintain acceptable population levels. However, even with generous bag limits and expanded hunting seasons, deer herds continue to grow in some areas. A lack of adequate hunting pressure contributes to this problem. Although hunting is the most practical and economical way to regulate deer, other control methods, such as repellents, fencing and vegetation management, may be necessary.

Integrated damage management

When deer cause significant damage, they may be considered a nuisance. The best way to control deer damage is through integrated pest management (IPM), which is the process of integrating and applying practical prevention and management techniques to keep pest damage - and the cost of damage control - as low as possible. An IPM approach to deer damage would include careful monitoring and one or more of the following strategies, depending on the nature of the problem: population management, fencing, repellents and vegetation management (Figure 1). Although nonlethal means can help minimize damage caused by deer in a specific area, the lack of population control is likely to result in problems associated with an increasing population. Controlling deer damage requires a comprehensive program.

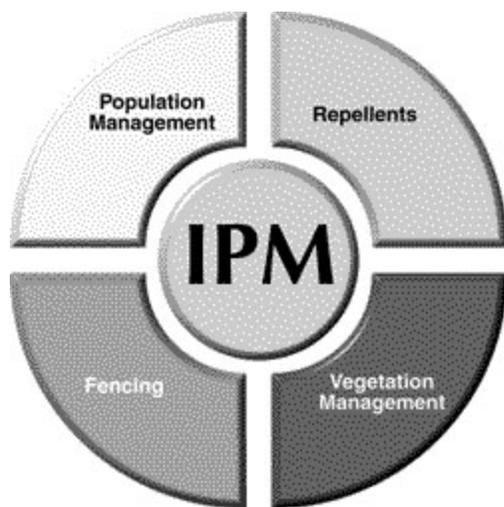


Figure 1

An integrated approach to preventing deer damage includes careful monitoring and a combination of strategies.

The combination of control options one should consider in a deer damage management program depends on accurate assessment of the problem and the desired outcome. Answering the following questions will help you evaluate the factors specific to your situation and plan a deer damage management program, potentially saving time, expense and frustration.

How much money am I losing as a result of deer damage?

It is important to calculate your annual losses resulting from deer damage. Regardless of whether the damage is to landscape plantings or crops, this question must be answered to analyze the costs and benefits of the various control measures.

What are the types of deer damage?

There are primarily two types of deer damage.

- **Browsing**
To recognize deer browsing, look for torn leaves or stalks with ragged ends. Deer have no upper incisors and must jerk or tear plants when feeding. Woodchucks, rabbits and other small rodents usually leave cleanly cut plant stalks.
- **Antler rubbing**
Another form of damage occurs when male deer (bucks) rub their antlers on trees. This type of damage is characterized by vertical scrapes and shredded bark on the saplings, exposing underlying wood.

What is the annual pattern of deer damage?

Patterns of deer damage change from year to year depending on weather, availability of food, deer density and other factors. Many fruit growers have planted young trees, successfully used repellents for two to three years, and then lost their entire investment as a result of deer grazing after a single severe summer or winter. It is best to plan a deer damage control program that is based on the most severe instance of damage in the past five years.

What is the seasonal pattern of deer damage?

Seasonal patterns of damage must also be evaluated over a period of years. Deer have definite food preferences that vary seasonally. In general, summer damage is less extensive than winter damage, because other sources of preferred foods are often available. Fruit growers, foresters, nursery operators and Christmas tree growers commonly lose dormant buds and annual growth to deer during the winter when other food is not available. In these cases, fencing, which can be costly, may be the only realistic option. However, farmers who suffer damage to field and row crops during the summer probably can use other alternatives or lower cost fencing designs to minimize damage.

What are the characteristics of the local deer population?

Growers should investigate deer hunting and population-density data for their region, as well as travel routes and high-use areas, such as stream corridors, woodlots or areas with low hunting pressure. Much of this information is available from your agent with the Missouri Department of Conservation.

What about the site?

The size and characteristics of the area to be protected, as well as the overall farm management plan, are critical to selecting appropriate deer control measures. If planting sites are to be replaced or expanded, control measures should take this into account. Controlling damage on a short-term site-by-site basis can be costly and inefficient.

The size of the site is important. Large areas usually have lower per-acre, per-year control costs but higher deer pressure because alternative food sources are far away. If fencing is used, it is important to provide travel corridors for deer.

Interspersed areas of forest, fields and brush around the site will give deer better access because they do not have to stray far from cover. There is less deer damage potential on sites surrounded by open or developed land.

What are the effects of deer browsing on yields of corn and soybeans?

Damage by deer to agricultural crops such as corn and soybeans can be a problem in certain regions of Missouri. The level of damage depends on many of the factors mentioned above. For instance, whether browsing occurs only on a few plants in small portions of a field or on large numbers of plants across a field often depends on field size, the site characteristics of the area around the field, the availability of other preferred foods in the area and the characteristics of the local deer population.

Research has been conducted in the Midwest on the effects of deer damage on corn yields. Studies have simulated damage during five stages of corn growth: sixth leaf, twelfth leaf, silking-tasseling, blister-milk and mature. Results indicate that deer damage to corn plants peaks during the silking-tasseling stage of growth. Cornfields are more susceptible to deer damage during this growth stage because deer-use is potentially high and the plants are physiologically more susceptible to physical damage. Landowners may be able to reduce the costs of controlling deer damage by delaying implementation of certain control measures (such as scare devices or repellents) until the silking-tasseling stage.

Damage to soybeans by deer has been reported throughout much of Missouri, however, the effects on soybean yield are quite variable. Research conducted in the southeastern United States has simulated the impacts of deer damage by artificially defoliating soybeans at various stages of growth. In many fields, much of the damage caused by deer occurs before the fourth week of plant growth. Results indicate that soybeans can withstand a certain amount of browsing without loss of yield. However, in areas under extreme deer pressure, significant yield reductions can occur. More research is being conducted to assess soybean losses from deer and to evaluate potential solutions, including the use of various agronomic practices that may help deter browsing. Both single-field solutions and communitywide approaches (i.e., population reduction) are being investigated for reducing deer damage to soybeans.

What about controlling other wildlife?

Some deer control programs can be altered to control other pests. With slight modifications, electric fences can impede raccoons, woodchucks and rabbits.

Deer pressure and control options

Deer damage control programs are most effective when planned well before crops are planted. It is important to become aware of the general relationship between deer pressure (not the same as deer numbers), deer damage and the application of cost-effective control options.

Under very low deer pressure, damage levels may not warrant implementing a control program. Behavioral deterrents, such as repellents, usually are effective against low to moderate deer pressure. Deer repellents disrupt, rather than eliminate, deer feeding, and some damage will still occur. As deer pressure increases and economic losses become intolerable, more costly deterrents such as permanent electric or net-wire fencing designs may need to be implemented. In general, it is best to consider fencing as a cost of doing business in areas with heavy deer pressure. This is especially true with new orchards and fields of high-value crops.

The key to an effective IPM program is monitoring on a regular basis to see if the program is working. It is difficult to change seasonal deer feeding habits after they have begun. Therefore, it is important to anticipate when problems will occur. If experience and observation indicate where and when you will most likely have a major problem, then apply the appropriate controls before the damage begins.

Methods for reducing deer damage

Population management

Deer populations in Missouri are capable of doubling within a few years if they are not controlled. With diminished populations of natural predators, hunting provides the most efficient and, in many situations, the only type of population control. Although other types of population control, such as infertility treatments, are being researched, it is unlikely that they will become economically or biologically effective in free-roaming deer populations.

A typical deer herd in Missouri may contain three or four female deer (does) for every buck. In many herds the ratio of does to bucks is higher. One buck is capable of breeding with many does, so eliminating bucks has little effect on the growth rate of the herd. The following example (below) shows how the population of a deer herd can double in one year (without hunting or other mortality) and the effect of hunting on the rate of population increase.

Undisturbed population

Year 1

Deer population in the fall:

27 does + 9 bucks = 36 deer

90 percent (24.3) of the does produce an average of 1.3 fawns by the following fall:

$24.3 \times 1.3 = 32$ new fawns

Year 2

36 original deer + 32 new fawns = 68 deer in the herd the following fall

This herd has almost doubled in 1 year.

Hunted population

Year 1

Deer population in the fall:

27 does + 9 bucks = 36 deer

50 percent of the 27 does are killed by hunting, leaving approximately 14 does.

90 percent of the remaining does (12.6) produce an average of 1.3 fawns each by the following fall:

$12.6 \times 1.3 = 16$ new fawns

Six of the 9 bucks are killed by hunting, leaving 3 bucks.

Year 2

Fourteen remaining does plus the 16 new fawns plus 3 remaining bucks totals 33 deer, which is a slight reduction in population.

Deer herds in Missouri are hunted to maintain populations that are compatible with human preferences. This concept is

often referred to as the cultural carrying capacity. This contrasts with biological carrying capacity, which is the largest deer population that the available habitat can support. Most growers suffering damage want to reduce deer populations, but the goal must be more specific. For example, do you want to eliminate all of the deer, or do you only want to reduce the population so that damage is at an acceptable level? Do you want to reduce damage but also produce trophy-quality bucks? Each of these options requires population management.

Many landowners hunt deer on their property but fail to reduce populations to a level that significantly decreases crop damage. In many cases, attempts to reduce populations through hunting are ineffective because neighboring landowners may not hunt or allow access for hunting. Still other landowners have concerns about their liability in case of a hunting accident. Although there are many reasons for failure, population dynamics show that the sex of the deer killed is more critical to effective management than the number. In many areas of the state, approximately 20 to 25 percent of the does must be harvested to stabilize the population, and a greater percentage must be killed to reduce it.

Developing a hunting program

One of the most effective and practical ways to control deer populations is to harvest deer during established hunting seasons. The regular firearm season in Missouri lasts for nearly two weeks during mid-November. The three-month archery season provides a greater length of time to enjoy the hunt. To be most effective, hunting must be organized, targeted toward certain animals and intense enough to affect deer populations.

The Missouri Department of Conservation has divided the state into 59 deer management units. This allows for regional management of the deer herd and is based on habitat type, deer population and hunter pressure. Deer population goals, based on landowner and hunter attitudes, have been established for each unit. An annual deer harvest quota is then established for each deer management unit.

Antlerless deer are rationed in most units by issuing any-deer and bonus permits. An allowable take of female deer (does) is calculated and the proper number of any-deer and, in some units, bonus permits are issued to accomplish the desired harvest goal. Although the Missouri Department of Conservation provides the legal framework for harvest, landowners and the public hold the key to regulating local deer herds because landowners control hunter access through programs shaped by public attitudes toward hunting. The Missouri Department of Conservation recognizes the importance of landowner decisions in granting or refusing hunter access but also realizes that excessively conservative hunting programs will aggravate existing deer population problems.

Landowners have the opportunity to combine deer population control and hunting recreation. People who want to control deer damage must allow a maximum harvest of does. Hunting exclusively for bucks contributes little to population reduction. One buck can breed many does in a single season. Harvest pressure must be on does if herd control is to be achieved.

Recruiting effective hunters

- Invite hunters who are safe, dependable and capable. Remember, their efforts will determine the success or failure of the hunting program.
- Require hunters to apply for any-deer and bonus antlerless-only permits. Landowners have the opportunity to apply for any-deer permits or for bonus antlerless-only permits so that an adequate harvest of does is maintained. For more information on the application process and availability of deer permits, contact your local agent with the Missouri Department of Conservation or the Permits Section, Missouri Department of Conservation, P.O. Box 180, Jefferson City, Mo. 65102, 573-751-4115.
- Specify that any hunter with a bonus permit harvest a doe before bagging a buck. Give hunters the option of bagging a large buck if it wanders by, but let them know that they should pass up ordinary antlered deer in favor of does. When possible, an adult doe should be selected from a group of does and fawns. Most hunters will readily accept the opportunity under such conditions.
- Consider leasing your land to a local hunting club and develop a contract with clearly defined responsibilities and actions. Although landowners often use leases only when hunters pay for leasing rights, leases are appropriate if no fee is charged.

Hunting strategies

- Concentrate hunting during the opening weekend of the season. Deer are most vulnerable on opening day of the season. They quickly become aware of hunter activity and alter their behavior accordingly.
- Hunt from stands to improve visibility and lessen chances for detection by deer. Hunters should be assigned hunting stands and asked not to move unnecessarily. For safety, make sure that the hunting perimeters of the stands do not overlap and that hunters know the location of all the stands.
- Maintain hunting pressure after opening weekend and throughout the season. Certain stands are more productive than others, and when a deer is harvested at one of these, another hunter should be encouraged to refill the stand. On some farms, as many as four or five deer may be taken in this manner from a single stand. Deer will become more difficult to bag as the season progresses. Deer may move frequently at night, restricting daytime activities to heavy cover.
- Work with neighbors to encourage them to allow deer hunting. Deer damage often affects several farms in a community. To be most effective, neighboring farms should adopt similar programs.

Shooting permits

The Missouri Department of Conservation may issue shooting permits (Authorizations to Destroy Deer Causing Crop Damage) to landowners in cases of extreme losses where there are no other reasonable alternatives for controlling deer damage. Shooting permits are often controversial, especially among neighbors and hunters who would prefer to harvest the deer themselves. Their effectiveness in controlling deer depredation remains questionable, offering at best only short-term relief.

Altering deer habitat — Vegetation management

Habitat for any wildlife species consists of food, cover, water and space found within the home range of the species. The home range of a deer is about 1 square mile for does and up to 4 square miles for bucks. Most landscapes in Missouri provide each of the habitat components within the home range of deer.

Deer prefer to stay near the edge of woodlands and brush areas that provide good cover. Farm crops and landscape trees and shrubs provide high-protein nutritious food sources, as do native sources of browse, such as tree sprouts and seedlings. Growers and homeowners usually experience the greatest amount of damage near these edges. Consider the following solutions:

- Leave as much open area as possible between field edges and planted material. Clear underbrush from field edges to a width of about 60 feet to reduce cover for deer. Mow this area several times a year. However, growers must consider that destroying deer habitat means destroying habitat of other wildlife as well.
- Plant landscape trees and shrubs that are not highly preferred by deer.
- Use repellents and fencing near field edges.
- Implement a forest management plan for your woodland that includes adequate harvesting to promote an abundant source of young, succulent browse plants, which are preferred deer foods.

Scare devices

Gas exploders (and possibly strobe light sirens) set to detonate at regular intervals are the most common scare devices for reducing deer damage (Figure 2). They are effective for only 1 to 2 weeks and should be used only for temporary control.

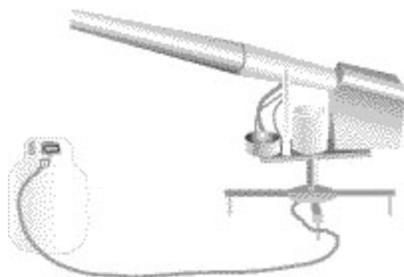


Figure 2

Propane gas exploders provide effective but temporary control of deer damage.

To maximize the effectiveness of exploders, move them every few days and stagger the firing sequence. Otherwise, deer quickly become accustomed to the regular pattern. Noise levels can be increased by raising them off the ground. These

devices can be purchased for about \$200 from commercial sources.

Using dogs, either on a long run or in an enclosed space, can keep deer out of specific areas, although caring for and feeding a dog can be time-consuming. One method of using dogs relies on an "invisible fence" to keep dogs within the area to be protected. The dog wears a receiver collar that administers an electric shock if the dog gets too close to a perimeter wire attached to a transmitter. Maintaining an adequate number of dogs as a deer deterrent can become expensive when the costs of purchasing the dogs, invisible fencing, collar batteries, and food and health expenses are considered but may be less expensive than some other alternatives.

Repellents

Repellents can help reduce deer damage but are best suited for protecting orchards, gardens and ornamental plants. The utility of repellents is limited on row crops, forages and other large-acreage crops because of their high cost, limitations on their use and their variable effectiveness. Repellents are most valuable when integrated into a damage-abatement program that includes several repellents, fencing, scare devices and herd management.

There are two kinds of repellents - contact repellents and area repellents. Apply contact repellents directly to plants; their taste repels deer. They are most effective on dormant trees and shrubs. Contact repellents may reduce the palatability of forage crops and should not be used on parts destined for human consumption.

Area repellents deter deer by odor and should be applied near plants you want to protect. Border applications of area repellents protect large acreages at relatively low cost. Because such repellents are not applied directly to plants, they can be used to protect crops grown for human consumption.

Growers who use repellents should understand some basic principles:

- Repellents do not eliminate browsing, they only reduce it; therefore, repellent success should be measured by the reduction, not elimination, of damage. Even if minimal damage is intolerable, 8-foot fencing is the best option.
- Rainfall will wash off many repellents, so they will need to be reapplied. Some repellents will weather better than others.
- Repellents reduce antler rubbing only to the extent that they help keep deer out of an area.
- The availability of other, more palatable deer food dictates the effectiveness of repellents. When food is scarce, deer may ignore both taste and odor repellents.
- If you use repellents, do not overlook new preparations, products, or creative ways to use old ones. New products are constantly appearing on the market.
- Growers who are facing a long-term problem should compare the costs of repellents and fencing over time.
- Repellents that work in one area may not work elsewhere, even for similar crops and conditions.

Application of commercial repellents

Application methods for commercial repellents range from machine sprayers to manual backpack sprayers. Remember, as labor intensifies, costs rise.

Apply contact repellents on dry days when temperatures are above freezing. Young trees should be completely treated. The cost of treating older trees can be reduced by limiting repellent application to the terminal growth within reach of deer (6 feet above the deepest snow). New growth that appears after treatment is unprotected.

Repellent applications are divided into two general classes based on the time of the damage:

- Winter or dormant season
- Summer or growing season.

Apply repellents before anticipated periods of deer browsing. The objective is to make planted material unattractive to deer so that they feed elsewhere. Once a feeding pattern has been established, repellents are usually less effective. It is important to note that if no alternative food source is available or if deer pressure is too high, even the best planned repellent program may fail.

As a preventive measure, the first repellent application of a summer control program should take place within two weeks

of budbreak. During the growing season, repellents should be applied as necessary to protect new growth, usually every three to four weeks. For some crops, it may be possible to disrupt deer feeding simply by spraying a wide strip on the border of the planting. For dormant season protection, midfall and early winter applications are recommended. Fall applications may also prevent antler rubbing.

Regardless of the type of application used, every program should be planned in advance and implemented on schedule. Periodic monitoring is essential to determine the necessity and timing of subsequent applications.

Available commercial repellents

The following discussion of repellents may be incomplete, but it indicates the variety of materials available. Repellents are grouped by active ingredient and include a brief description of use, application rates and costs. Product labels provide all necessary information on use and must be followed to the letter, not only as a legal requirement but also to achieve maximum success. The active ingredients are shown in parentheses beneath the trade names. Cost estimates are provided for comparative purposes.

- **Deer Away (37 percent putrescent egg solid)**

This contact repellent smells and tastes like rotten eggs. It has been reported to be 85 to 100 percent effective in field studies. It is registered for use on fruit trees before flowering, ornamental shrubs and Christmas trees. Apply it to all susceptible new growth and leaders. Applications weather well and are effective for two to six months. One gallon of liquid or 1 pound of powder costs about \$16 and covers 400 three-inch saplings or 75 four-foot evergreen shrubs.

- **Hinder (ammonium soaps of higher fatty acids)**

Hinder is an area repellent that smells like ammonia and is one of the few registered for use on edible crops. Applications can be made directly to vegetable and field crops, forages, ornamentals and fruit trees. Its effectiveness is usually limited to 2 to 4 weeks but varies because of weather and application technique. Reapplication may be necessary after heavy rains. For fields of less than 30 acres, you can treat the entire field; for larger fields, apply an 8- to 15-foot strip around the perimeter of the field. Apply at temperatures above 32 F. Four gallons of liquid cost about \$60, and when mixed with 100 gallons of water will cover 1 acre. Hinder is suitable for use with most pesticides.

- **Thiram (11 to 42 percent tetramethylthiuram disulfide)**

Thiram is a fungicide that acts as a contact (taste) deer repellent. It is sold under several trade names, including Bonide Rabbit-Deer Repellent, Nott's Chew-Nott, Gustafson 42-S, and Magic Circle Rabbit Repellent. It is most often used on dormant trees and shrubs. A liquid formulation is sprayed or painted on individual trees. Although thiram itself does not weather well, adhesives such as Latex 202-A or Vapor Gard can be added to the mixture to resist weathering. Thiram-based repellents also protect trees against rabbit and mouse damage. Two gallons of 42 percent thiram cost about \$50 and when mixed with 100 gallons of water will cover 1 acre.

- **Miller's Hot Sauce Animal Repellent (2.5 percent capsaicin)**

This contact (taste) repellent is registered for use on ornamental, Christmas and fruit trees. Apply it with a backpack or trigger sprayer to all susceptible new growth, such as leaders and young leaves. Do not apply to fruit-bearing plants after fruit set. Vegetable crops also can be protected if sprayed before the development of edible parts. Weatherability can be improved by adding an antitranspirant such as Wilt-Pruf or Vapor Gard. Hot Sauce and Vapor Gard cost, respectively, about \$80 per gallon and \$30 per gallon. Eight ounces of Hot Sauce and 2 quarts of antitranspirant mixed with 100 gallons of water will cover 1 acre.

- **Ropel (benz diethyl {(2,6 xylylcarbomoyl) methyl} ammonium saccharide (0.065 percent), thymol (0.035 percent)**

Ropel repels deer with its extremely bitter taste. Apply Ropel once each year to new growth. It is not recommended for use on edible crops. Spray at full strength on nursery and Christmas trees, ornamentals and flowers. One gallon costs \$25 and covers about 1 acre of 8- to 10-foot trees.

Noncommercial repellents

All noncommercial are odor-based repellents that are applied to trees, shrubs and vines. When using noncommercial repellents, make sure you are using a registered material for that application. For example, "home remedies" such as mothballs are not registered for this use, and they should not be considered for this purpose. To deter deer in an urban or suburban environment, use scents that are not naturally found in those areas. Three noncommercial repellents are tankage, human hair and bar soap. All are odor-based repellents.

- **Tankage (putrefied meat scraps)**

Tankage is a slaughterhouse byproduct traditionally used as a deer repellent in orchards. It repels by smell, which is readily apparent. To prepare containers for tankage, remove the tops from aluminum cans, puncture the sides in the middle of the cans to allow for drainage and attach the cans to the ends of 4-foot stakes. Drive the stakes into the ground, 1 foot from every tree to be protected or at 6-foot intervals around the perimeter of a block. Place 1 cup of tankage in each can. Cloth bags may be used instead of cans. Containers may need to be replaced periodically as fox or other animals sometimes pull them down. A 50-pound bag costs \$20 and is enough to fill 300 small cloth bags, which will cover 2 acres.

- **Hair bags (human hair)**

Human hair is a repellent that costs very little but has not consistently repelled deer. Place two handfuls of hair in fine-meshed bags (onion bags, nylon stockings). When damage is severe, hang hair bags on the outer branches of trees with no more than 3 feet between bags. For larger areas, hang several bags, 3 feet apart, from fence or cord around the perimeter of the area to be protected. Attach the bags early in spring and replace them monthly through the growing season.

- **Bar soap**

Recent studies and numerous testimonials indicate that ordinary bars of soap applied in the same manner as hair bags can reduce deer damage. Drill a hole in each bar and suspend it with a twist tie or string. Each bar appears to protect a radius of about 1 yard. Any inexpensive tallow-based brand of bar soap will work. Soap-bar applications to newly planted apple trees are estimated to cost approximately \$40 per acre, less expensive than a typical commercial repellent program during the first growing season. However, as trees grow and more than one application of soap bars becomes necessary, commercial repellent sprays become the economical choice, particularly in orchards. In addition to providing an odor-based repellent, soap bars may reduce deer browsing through visual cues. Empty soap-bar wrappers alone have reduced damage in some circumstances.

Fencing

In situations in which deer pressure is moderate to high and the growing stock is very valuable, using fencing to exclude or deter deer from growing areas is a necessity. An 8-foot fence is needed to exclude deer. Many designs of electric and nonelectric fence are available to meet specific needs, whether it be field crops, gardens or tree plantings. They range in cost from pennies per foot to as much as \$6 per linear foot (Table 1).

Consider fencing as a long-term investment. A well-maintained fence should last between 5 and 20 years, depending on the type. Most fences pay for themselves within a few years by reducing losses caused by deer damage.

Table 1

Types of deer fencing and installed cost per linear foot (cost does not include electric fence charger)

Type of fence	Deer pressure	Labor and material cost per foot	Material cost per foot
8-foot woven wire	High	\$5 to \$7	\$2 to \$4
7.5-foot plastic mesh	High	\$1 to \$1.50	\$0.65
Slanted 7-wire	High	\$1.75 to \$2.25	\$1.50 to \$2
Vertical 7-wire	Moderate to high	\$1.50 to 2	\$0.75 to \$1.50
Spider Fence 5-wire	Moderate to high	\$0.70 to \$0.80	\$0.35 to \$0.40
Peanut butter	Low to moderate	\$0.30	\$0.10
2-strand polywire	Low to moderate	\$0.35	\$0.18

Electrified fencing

Electric deer fences are the most common and effective type of fencing used. They are effective because deer, unless chased, prefer to go through or under a fence rather than attempt to jump it. Electric fences are powered by high-

voltage, low-impedance chargers, which provide timed pulses (45 to 65 per minute) of short duration (0.0003 per second). How well a charger will perform depends on its power output measured in joules under load. Deer hair is hollow and an effective insulator, and deer hooves are small and pointed, which lessens the impact of an electric shock. Therefore conventional fence chargers that will deter cattle may lack sufficient output to deter deer. The charger must also be matched to the fence design. A good rule of thumb when selecting a charger is that 1 joule of output from a charger will adequately power 3,000 feet of fence wire. By determining the perimeter of your fenced area and the number of wires that will be charged, you can get a rough idea of your charger needs. All electric fences should be marked with signs.

Chargers can be AC, battery, or solar-powered and should maintain a charge greater than 5,000 volts on several miles of fence. It is best to use AC-powered chargers because they have the lowest cost per joule of output and are most reliable. A power wire can be run to the fence, or aluminum fence wire can be run considerable distances on posts from an AC-powered charger to the remote fence location. The cost of running a well-maintained electric fence with a 4-joule energizer for one year is equivalent to the cost of running a 40-watt light bulb for one year. Battery chargers are adequate but must be maintained properly. Solar chargers have a solar panel that keeps a battery charged, but they are expensive and high-joule units must be custom made.

Fence maintenance and effectiveness

Many landowners experience problems with deer penetrating fences after the first year because of a lack of maintenance. Fences must be maintained to remain effective. Vegetation must be kept off of the lower fence wires using herbicides or mechanical means to reduce grounding and voltage loss. The voltage must be checked regularly and broken strands quickly repaired. Deer constantly test the fence, and if they find they can penetrate it because the power is off or for some other reason, the fence will lose its effectiveness. A common mistake is not electrifying the fence before leaving the area during construction or afterward. Some people have made the mistake of turning off the power during the off-season while leaving the fence in place. This renders the fence ineffective even after it is re-electrified, because the deer have learned that they can penetrate it. Fences used for temporary protection should be dismantled during the off-season. It is important to understand that most fences are not true physical barriers but behavioral barriers. The electric shock conditions the deer to stay away. Once deer know they can penetrate this fence, its effectiveness is seriously reduced.

Another problem is not providing a 10- to 15-foot cleared buffer outside the fence to allow deer to see the fence. Without such a buffer, deer will run into the fence and break it or go through it. On steep slopes this buffer must be wider.

The following discussion presents some general information on various types of fencing that differ in cost and have different applications.

Temporary electric fencing

Temporary electric fences provide inexpensive protection for many crops on small and large acreages. They are easy to construct, do not require rigid corners, and use readily available materials. The fences are designed to attract attention and administer a strong but harmless electric shock (high voltage, low amperage) when a deer touches the fence with its nose. Deer become conditioned to avoid the fence. These fences are easily installed and removed. The major cost associated with temporary electric fencing is the fence charger. Install fences at the first sign of damage to prevent deer from establishing feeding patterns in your crops. Such fences require weekly inspection and maintenance.

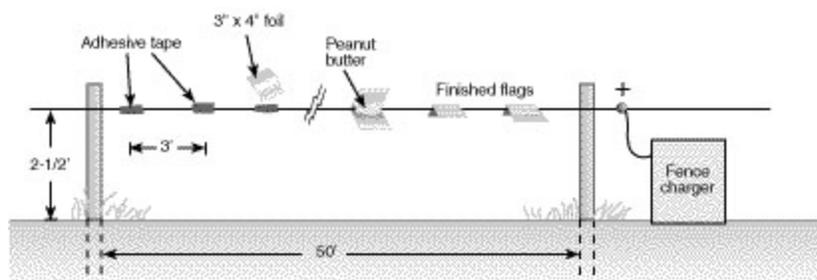


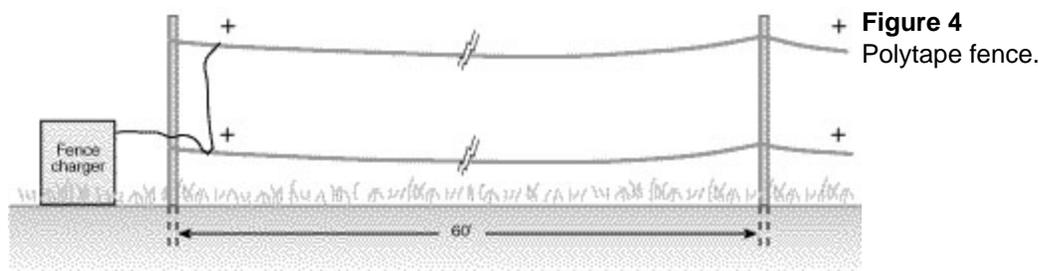
Figure 3
Peanut butter fence.

Peanut butter fence (Figure 3)

The peanut butter fence has been shown to be an effective and inexpensive fence design in a number of field conditions. It is best used for gardens, nurseries, orchards and field crops that are subject to moderate deer pressure.

A single strand of 17-gauge wire is suspended about 30 inches above the ground by 4-foot fiberglass rods at 30- to 60-foot intervals. Wood corner posts provide support. Aluminum foil "flags" (foil squares 4 inches by 4 inches folded over the wire) are attached to the wire at 20- to 50-foot intervals using tape or paper clips to hold them in place. Aluminum flashing can also be used and has the advantage of not being damaged or blown off. Closer spacing may be necessary near existing deer trails and during the first few months the fence is used, when deer behavior is being modified. The underside of the flags is baited with a 1:1 mixture of peanut butter and vegetable oil. The smell attracts the deer, which touch or sniff the flags and receive an electric shock. The flags should be rebaited every 4 to 8 weeks, depending on weather conditions.

For fields larger than 1 acre, it may be more practical to apply the peanut butter mixture directly to the wire. You can make a simple applicator by mounting a free-spinning, 4-inch pulley on a shaft inside a plastic ice cream pail. Fill the pail with the peanut butter mixture that has the consistency of thick paint. Coat the entire wire with peanut butter by drawing it along the pulley. Apply foil flags near runways or areas of high deer pressure. This baiting strategy can also be used with polytape fences. Check the fence weekly for damage by deer and for grounding vegetation.



Polywire and polytape fences (Figure 4)

The effectiveness of the original peanut butter fence has been greatly enhanced by using polywire or polytape, rather than the 17-gauge wire. It has the advantage of being more visible to deer, especially at night. It is also easier to roll up and remove. Polywire has a life expectancy of 5 to 7 years.

Polywire is composed of three, six, or nine strands of metal filament braided with strands of brightly colored polyethylene. A wider polytape is also available and has the advantage of being stronger and more visible, but also more expensive. Although both polywire and polytape come in a wide variety of colors, many users claim that white provides the greatest contrast to most backgrounds and is easier for deer to see, especially at night. Loss of voltage over long distances of polywire/polytape can be a problem. Purchase materials with the least electrical resistance (ohms per 1,000 feet) for these applications.

In its simplest application, an electrified single strand of polywire is suspended about 30 inches above the ground by 4-foot fiberglass rods at 20- to 50-foot intervals and baited in the same way as the original peanut butter fence. This basic design can be enhanced. A second wire can be added to increase effectiveness: one wire placed 18 inches from the ground and the top wire at 36 inches above the ground. This prevents fawns from walking under the fence and also increases the chance that one wire will remain electrified if deer should knock the fence over. Usually only the top wire is baited. In smaller areas, such as home gardens, more wires can be added on taller poles if desired, and closely spaced bottom wires can keep out rabbits and woodchucks. It is important that vegetation be mowed or removed under the fence so it does not short out.

Fiberglass rods usually do not provide enough support for use as corner posts. At corners it is better to use 4-foot metal fence stakes with a bottom plate that provides stability when it is pushed into the ground. A piece of thin-walled 1-inch PVC pipe can be slipped over the metal stake to act as an insulator with the polywire or polytape wrapped around a few times. This allows the stringing of the wire with sufficient tension to hold the flags. A variety of wooden posts with plastic insulators will also work well.

The use of electric fences in and around home sites can cause concern for children and visitors. One option is to put the fence charger on a timer so that it comes on only from dusk to dawn. This method provides adequate protection in areas where deer are not a problem during the daytime hours.

Permanent and semipermanent electric fencing

High-tensile fencing can provide year-round protection from deer damage. Many designs are available to fit specific needs. All require strict adherence to construction guidelines concerning rigid corner assemblies and fence configurations. Frequent inspection and maintenance are necessary. High-tensile fences have a 20- to 30-year life expectancy.

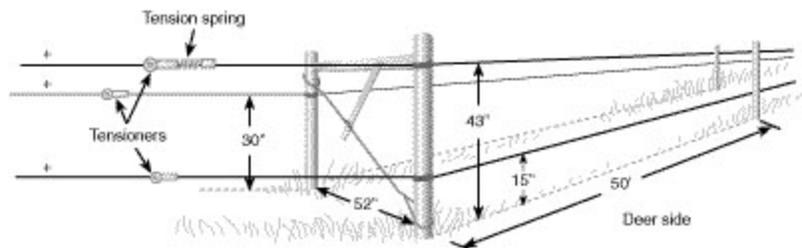


Figure 5
Offset or double fence.

Offset or double fence (Figure 5)

This fence is most appropriate for gardens, truck farms or nurseries that experience moderate deer pressure over an area of 40 acres or less. Deer are repelled by the shock and the fence's three-dimensional design. Wires can be added if deer pressure increases. Cost, excluding labor, is about 35 cents per linear foot.

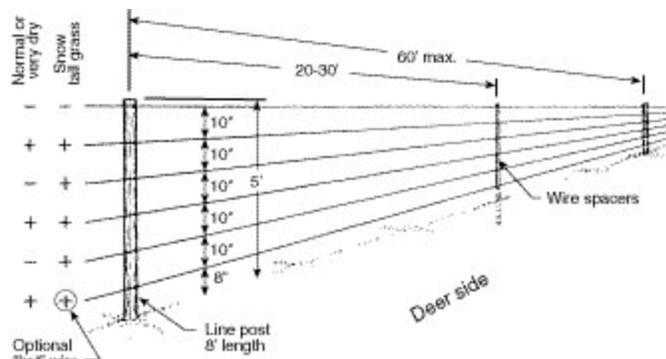
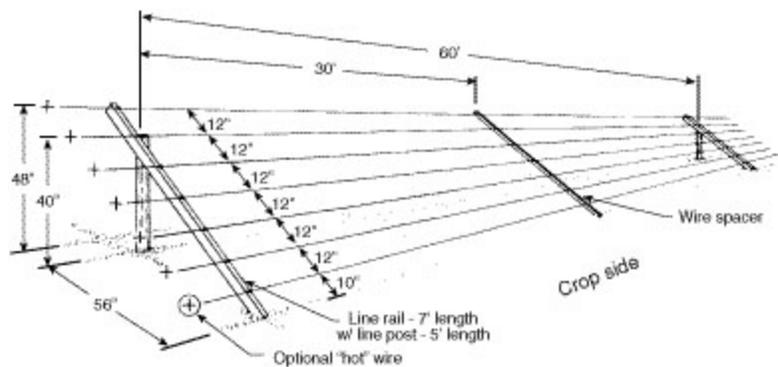


Figure 6
Vertical electric deer fence.

Vertical electric deer fencing (Figure 6)

This is a permanent fence for protecting large truck gardens, orchards and other fields from moderate to high deer pressures. It provides highly effective protection for areas up to 20 to 25 acres. A wide variety of fence materials and specific designs are available, including variation in the number of wires (5, 7, 9 or more) and fence height (5 to 10 feet). Posts are usually driven into the ground and high-tensile wire (12 gauge) is applied and maintained under high tension, hence the need for good support. The fence is powered by a high-voltage, low-impedance, New Zealand-style charger. Because of the prescribed wire spacing, deer try to go through the fence and are effectively shocked. Vertical fences use less ground space than three-dimensional fences, but are probably less effective at keeping deer from jumping over. It is recommended that you employ a local fence contractor. Cost, excluding labor, ranges from \$0.75 to \$1.50 per linear foot.

Figure 7
Slanted seven-wire deer fence.



Slanted seven-wire fence (Figure 7)

This fence differs from the vertical fence in its post alignment and wire barrier, which are constructed at a 30-degree angle to the ground. Its three-dimensional design (5 feet high by 8 feet wide) and electric shock present a formidable barrier. It is primarily used where high deer pressures threaten moderate-sized to large orchards, nurseries and other high-value crops.

The fence is constructed using 12-gauge wire. The wires are attached to slanted fence battens at 50-foot intervals to attain the three-dimensional effect. One drawback to this fence is that it requires 8 feet of space along its entire length, which increases maintenance cost and removes a larger area from production. Cost, excluding labor, is \$1.50 to \$2 per linear foot.

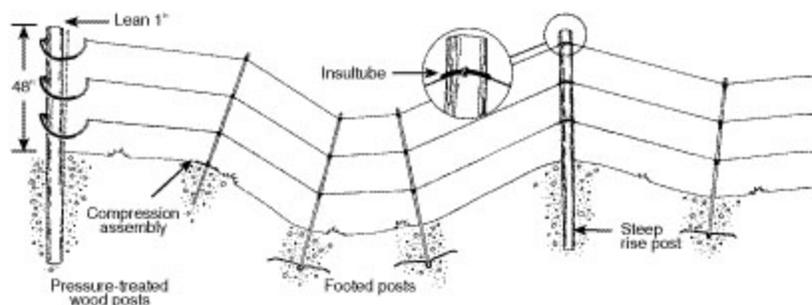


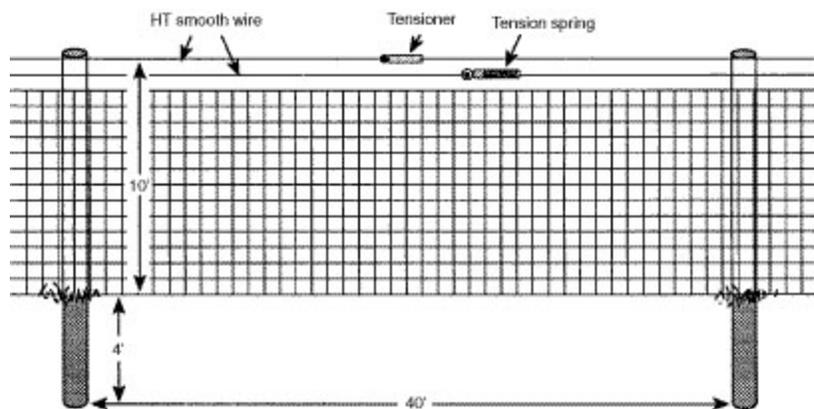
Figure 8
Spider electric fence.

Electric spider fence (Figure 8)

This is a relatively new fencing concept that combines multiwire electric fencing technology with medium cost and good exclusion capability. This five-wire fence is 48 inches tall and uses a 17-gauge wire that is not under high tension. The only driven posts are the corners, and intermediate fiberglass posts are used periodically to maintain wire spacing and height. The minimal wire tension is increased or decreased by wrappings on the Spider G-Spring at the gate opening system. Because there are few driven posts and low tension, the fence is only semipermanent and much cheaper to construct than conventional high-tension systems. Baiting with peanut butter flags, described earlier, is essential to make this fence effective. Properly maintained, this fence has a life expectancy of about 10 to 12 years. Cost, excluding labor, ranges from \$0.35 to \$0.40 per linear foot.

Permanent nonelectric deer fences

Figure 9
Wire mesh fence.



- **Wire mesh fencing (Figure 9)**

Woven-wire fences are used for year-round protection of high-value crops subject to high deer pressures. These fences are expensive and difficult to construct, but easy to maintain and highly effective. Although a fence may last for 20 years or more, its initial cost of \$2 to \$4 per linear foot, excluding labor, has resulted in minimal use over the years. It is assembled from two tiers of 4-foot woven wire strung together to form an 8-foot barrier. The fence should be close to the ground so deer will not crawl under. The tiers of wire are tied together at the seam to prevent penetration. Other designs include 6-foot woven wire with strands of high-tensile wire above that to a height of 8 to 10 feet. Little maintenance is required.

- **Plastic mesh fencing**

Nonelectric plastic mesh fencing has some residential and landscape applications. The fencing is lightweight, high-strength, and virtually invisible, so it does not detract from the appearance of the property it protects. The fencing consists of a 7.5-foot black plastic mesh with an expected life of 10 years. This type of fence can be attached to existing trees or hung on pressure treated posts. The light weight of the material minimizes the need for many posts. White streamers 12 inches long are attached 4 feet off the ground every 12 feet to warn deer of the barrier. Galvanized 12-inch stakes can be purchased to secure the fencing to the ground every 12 feet. The cost of the fencing material, excluding posts, is approximately \$0.65 per linear foot.

Tree shelters

The tree shelter (Figure 10) is a transparent, corrugated polypropylene tube that is placed around seedlings at the time of planting. The tube is supported by a 1-inch by 1-inch wooden stake located next to the shelter. An ultraviolet inhibitor is added to the polypropylene to prevent it from breaking down too rapidly when exposed to sunlight. The shelter disintegrates after 7 to 10 years.

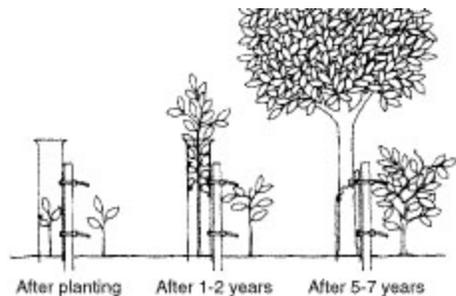


Figure 10

Growth of tree seedlings with, left, and without, right, the protection of tree shelters.

A 4-foot shelter is commonly used and will prevent deer from browsing on tree seedlings. A 5-foot shelter may be needed in areas with excessive browsing or snowfall. The tube has the added benefit of promoting rapid height growth of the seedling by acting like a "minigreenhouse."

The shelter is used mostly in forestry applications to protect hardwood tree seedlings, with 70 to 100 shelters used per acre. Manufacturers now have larger diameter shelters available, which claim to be better suited to pine seedlings. The shelters also make it easy to apply herbicides for weed control. Prices will vary, but for quantities of 100 or more, the 4-foot shelters with stakes average about \$2.85 per shelter. For prevention of deer damage it is important to compare the

cost-effectiveness of using tree shelters, repellents, and temporary fencing.

Suburban deer damage control

Deer damage is no longer a problem only for rural landowners. Population shifts to rural and suburban areas, lack of hunting pressure, firearms discharge restrictions in developing areas, and deer adaptability to suburban habitats, among other factors, have resulted in rapid increases of suburban deer populations in many locales in Missouri. Homeowners often face the dual problem of preventing deer from damaging a vegetable garden while also protecting foundation shrubs and landscaped planting beds.

The options open to homeowners and associations are usually limited to nonlethal combinations of control methods, such as fencing, repellents and landscapes designed with plant species less desirable to deer. Table 2 provides information that may be useful both for choosing plants that are unlikely to be damaged by deer and for identifying plantings that are most likely to require protection. Check with a local horticulturist or your MU Extension center before planting species listed in Table 2 to ensure that they are adapted to your climatic and soil conditions.

Unfortunately, reducing the deer population is the only method that offers a long-term solution. Efforts to reduce deer populations by use of special hunts, sharpshooters and special permits have resulted in serious conflicts between various groups.

The Missouri Department of Conservation continues to conduct research in urban landscapes to improve our understanding of managing deer populations in these environments. Refer to the publication list to find information on the various approaches to successful resolution of deer damage management in suburban areas.

As a final note, landowners and homeowners are encouraged to be tolerant of losses caused by wildlife and to make thoughtful management choices. This includes not only a personal choice to tolerate some damage in return for the significant aesthetic benefits derived from viewing wildlife, but also an understanding of choices made by neighbors and farmers who may perceive a real economic threat from wildlife damage.

Table 2

Resistance of woody ornamental plants to deer damage

Rarely damaged

- Common barberry
- Common boxwood
- Russian olive
- American holly
- Drooping Leucothoe
- Colorado blue spruce
- Japanese Pieris

Seldom severely damaged

- American bittersweet
- Red osier dogwood
- Kousa dogwood
- English hawthorn
- Forsythia
- Honey locust
- Chinese holly
- Inkberry

- Chinese junipers
- Beautybush
- Norway spruce
- White spruce
- Austrian pine
- Mugo pine
- Red pine
- Scots pine
- Japanese flowering cherry
- Corkscrew willow
- Common sassafras
- Common lilac
- Japanese wisteria

Occasionally severely damaged

- White fir
- Paperbark maple
- Red maple
- Silver maple
- Sugar maple
- Common horsechestnut
- Downy serviceberry
- Trumpet creeper
- Japanese flowering quince
- Panicked dogwood
- Smokebush
- Cranberry cotoneaster
- Rockspray cotoneaster
- Japanese cedar
- Border forsythia
- Rose of Sharon
- Common witchhazel
- Smooth hydrangea
- Climbing hydrangea
- Panicked hydrangea
- Japanese holly
- China girl/boy holly
- Eastern red cedar
- European larch
- Goldflame honeysuckle
- Privet
- Saucer magnolia
- Dawn redwood
- Virginia creeper
- Sweet mock orange
- Eastern white pine
- Bush cinquefoil
- Sweet cherry
- Douglas fir
- Firethorn
- Bradford callery pear
- Common pear
- White oak

- Chestnut oak
- Northern red oak
- Deciduous azaleas
- Rhododendron
- Staghorn sumac
- Rugosa rose
- Willows
- Anthony water spirea
- Bridalwreath spirea
- Persian lilac
- Japanese tree lilac
- Late lilac
- Greenspire littleleaf linden
- Basswood
- Eastern hemlock
- Judd viburnum
- Leatherleaf viburnum
- Doublefile viburnum
- Koreanspice viburnum
- Oldfashion wiegelia

Frequently severely damaged

- Norway maple
- Eastern redbud
- Atlantic white cedar
- Celmatis
- Cornelian dogwood
- Winged euonymus
- Wintercreeper
- English ivy
- Apples
- Cherries
- Plums
- Rhododendrons
- Evergreen azaleas
- Hybrid tea rose
- English yew
- Western yew
- Japanese yew
- English/Japanese hybrid yew
- American arborvitae

For further information: Selected suppliers and references

For more information on deer management and damage control options, contact the Missouri Department of Conservation and refer to the Department's Wildlife Damage Management Program. Wildlife Damage Management Biologists and Urban Wildlife Biologists are in various locations in Missouri to help you solve deer damage problems. *Missouri Whitetails: A Management Guide for Landowners and Deer Enthusiasts*, published by the Missouri Department of Conservation, provides information on managing white-tailed deer populations on your property. Your local MU Extension center offers NRAES Bulletin 11, "High-Tensile Wire Fencing." For more information about controlling deer damage in suburban areas, an informative videotape entitled *Suburban Deer Management: Voices, Views, Visions* may be borrowed from the School of Natural Resources, 1-30 Agriculture Building, Columbia, Mo.

65211. In addition, refer to the publications in the list below.

Most nurseries, garden centers and farm co-ops sell commercial repellents, tree protectors and fencing materials. Locating other materials such as tankage or human hair requires some ingenuity. Several suppliers of scare devices and fencing are listed below. See the appendix for suppliers of repellents.

Scare devices

- Alexander-Tagg Industries, Inc., 395 Jacksonville Rd., Warminster, Pa. 18974
- Margo Horticultural Supplies Ltd., RR 6, Site 8, Box 2, Calgary, Alberta, Canada T2M 4L5
- Reed-Joseph International Co., P.O. Box 894, Greenville, Miss. 38702
- Smith-Roles, Box 1607, Minot, N.D. 58702

Selected fencing suppliers

- Agri-Sales Associates, Inc., 209 Louise Avenue, Nashville, Tenn 37203, 615-329-1141
- Gallagher Power Fence, P.O. Box 708900, San Antonio, Texas 78270, 800-531-5908
- K Fence Systems, Rt. 1, Box 195, Zumbro Falls, Minn. 55991, 507-753-2943
- Kiwi Fence Systems, Inc., 1145 Roy Furman Highway, Waynesburg, Pa. 15370, 412-627-8158
- Live Wire Products, Inc., 1127 "E" Street, Marysville, Calif. 95901, 800-272-9045
- McBee Agri Supply, Inc., Rt. 1, Box 121, Sturgeon, Mo. 65284, 573-696-2517
- Premier Fence Systems, 2031 300th Street, Washington, Iowa 52353, 800-282-6631
- Waterford Corporation, P.O. Box 1513, Fort Collins, Colo. 80522, 800- 525-4952

Brand names appearing in this publication are for product identification. No endorsement is intended or implied, nor is any criticism of similar products not mentioned.

Additional readings

- Agricultural producers' perceptions of wildlife-caused losses, 1994, A.P. Wywialowski, *Wildlife Society Bulletin* 22(3):370-382.
- *Benefit-Cost Analysis of a Deer-proof Fence for Apple Orchards*. Wildlife Control Circular (volume 17, number 1). New York State College of Agriculture and Life Sciences, Cornell University.
- "Citizen task force on deer management," 1992, M. Hall, *Proceedings of the Eastern Wildlife Damage Control Conference* 5:195.
- *Controlling Deer Damage*, 1992, by F.R. Henderson and C. Lee, Ext. Bull. C-728, Kansas State University Cooperative Extension Service, Animal Damage Control, Manhattan, Kan.
- *Controlling Deer Damage in Wisconsin*, 1986, by S. Craven and S. Hyngstrom, Ext. Bull. G3083, Univ. of Wisconsin - Extension, Madison, Wis.
- *Deer Damage Control in Nebraska*, 1992, by S. Hyngstrom and B. Baxter, Nebraska Cooperative Extension EC 91-1773.
- *Deer Damage Control in New York Agriculture*, 1983, by J.B. McAninch, M.R. Ellingwood and R.J. Winchcombe, New York Department of Agriculture and Markets, State Campus, Albany, N.Y.
- "Deer overabundance," 1997, R. J. Warren, editor, *Wildlife Society Bulletin, Special Issue* 25(2):215-596.
- "Effectiveness of repellents in reducing deer damage in nurseries," 1984, M.R. Conover, *Wildlife Society Bulletin* 12:399-404.
- "Effects of browsing by white-tailed deer on yields of soybeans," 1987, R.L. Garrison and J.C. Lewis, Georgia Cooperative Wildlife Research Unit, *Wildlife Society Bulletin* 15:555-559.
- "Electric fences and commercial repellents for reducing deer damage in cornfields," 1988, S.E. Hyngstrom and S.R. Craven, *Wildlife Society Bulletin* 11:161-164.
- *Electric Fences for Preventing Browse Damage by White-tailed Deer* (FNR 136), 1992, B.K. Miller, G.L. O'Malley and R.K. Meyers, West Lafayette, Ind.: Indiana Cooperative Extension Service, Purdue University.
- *High-Tensile Wire Fencing*, 1981, by A.W. Selders, J.B. McAninch and R.J. Winchcombe, Northeast Regional

Agricultural Engineering Serv. Bull. 11, Cornell University, Ithaca, N.Y.

- *How to Build Fences with U.S.S. MAX-TEN 200*, United States Steel, Pittsburg, Pa.
- *Human Dimensions Evaluation Research to Assist Public Participation Processes*, 1991, D. Decker, Occasional Paper Series number 2, Colorado Division of Wildlife, Denver.
- *An Integrated Approach to Deer Damage Control* (Publication number 809), 1985, West Virginia University Agriculture Extension Committee on Deer Damage, Morgantown: West Virginia University Cooperative Extension Service.
- "Methods used by selected Ohio growers to control deer damage," 1985, J.D. Scott and T.W. Townsend, *Wildlife Society Bulletin* 13:234-240.
- *Missouri Deer Hunting*, 1992, Missouri Department of Conservation.
- *Missouri Whitetails: A Management Guide for Landowners and Deer Enthusiasts*, 1997, Missouri Department of Conservation.
- *Prevention and Control of Wildlife Damage*, 1996, R.M. Timm, editor. Great Plains Agricultural Council, Coop. University of Nebraska-Lincoln.
- Reducing deer damage to yews and apple trees: Testing Big Game Repellent, Ropel, and soap as repellents, 1990, R.K. Swikhart and M.R. Conover, *Wildlife Society Bulletin* 56:154-157.
- *Reducing Deer Damage to Home Gardens and Landscape Plantings*, 1994. Department of Natural Resources, Cornell University, Ithaca, N.Y.
- "Relationships between characteristics of nurseries and deer browsing," 1989, M.R. Conover, *Wildlife Society Bulletin* 17:414-418.
- *Strategies for Reducing Wildlife Damage in Orchards* (Bulletin 855), 1985, R.K. Swikhart and M.R. Conover, New Haven: Connecticut Agricultural Experiment Station.
- *White-tailed Deer Ecology and Management*, 1984. L.K. Halls, editor. Harrisburg, Pa.: Stackpole Books.
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Acknowledgment

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Related MU Extension publications

- G9420, Landowners' Guide to Lease Hunting in Missouri
<http://extension.missouri.edu/p/G9420>
- G9425, Solving Wildlife Damage Problems in Missouri
<http://extension.missouri.edu/p/G9425>

Order publications online at <http://extension.missouri.edu/explore/shop/> or call toll-free 800-292-0969.



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