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Forest Service

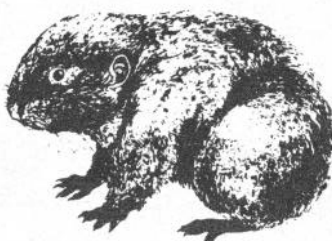
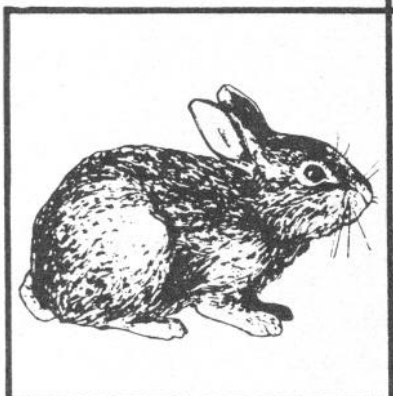
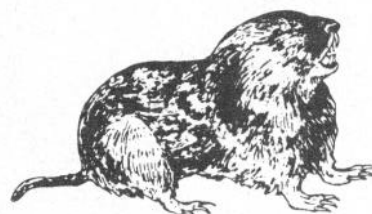
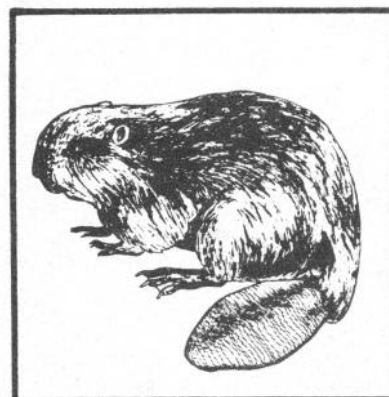
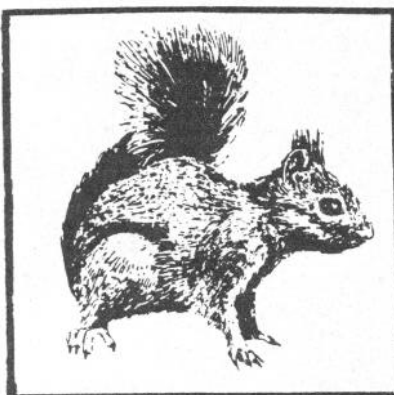
Pacific Northwest
Research Station

General Technical
Report

PNW-GTR-332
September 1994



Animal Damage Management Handbook



Pesticide Precautionary Statement

Pesticides used improperly can be injurious to humans, animals, and plants. Follow the directions and heed all precautions on the labels.

Store pesticides in original containers under lock and key-out of reach of children and animals-and away from food and feed.

Apply pesticides so that they do not endanger humans, livestock, crops, beneficial insects, fish, and wildlife. Do not apply pesticides when there is danger of drift, when honey bees or other pollinating insects are visiting plants, or in ways that may contaminate water or leave illegal residues.

Avoid prolonged inhalation of pesticide sprays or dusts; wear protective clothing and equipment if specified on the container.

If your hands become contaminated with a pesticide, do not eat or drink until you have washed. In case a pesticide is swallowed or gets in the eyes, follow the first-aid treatment given on the label, and get prompt medical attention. If a pesticide is spilled on your skin or clothing, remove clothing immediately and wash skin thoroughly.

Do not clean spray equipment or dump excess spray material near ponds, streams, or wells. Because it is difficult to remove all traces of herbicides from equipment, do not use the same equipment for insecticides or fungicides that you use for herbicides.

Dispose of empty pesticide containers promptly. Have them buried at a sanitary land-fill dump, or crush and bury them in a level, isolated place.

NOTE: Some States have restrictions on the use of certain pesticides. Check your State and local regulations. Also, because registrations of pesticides are under constant review by the Federal Environmental Protection Agency, consult your county agricultural agent or State extension specialist to be sure the intended use is still registered.



Technical Editor

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Animal Damage Management Handbook

Hugh C. Black, Technical Editor

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Abstract

Black, Hugh C., tech. ed. 1994. Animal damage management handbook. Gen. Tech. Rep. PNW-GTR-332. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 236 p.

This handbook treats animal damage management (ADM) in the West in relation to forest, range, and recreation resources; predator management is not addressed. It provides a comprehensive reference of safe, effective, and practical methods for managing animal damage on National Forest System lands. Supporting information is included in references after each chapter and in the appendices.

Keywords: Animal damage management, integrated forest protection, wildlife problem species, damage identification.

CAUTION

Before any control actions are undertaken, be sure to determine the effects they will have on Threatened, Endangered, and/or Sensitive species. For example, the use of poison baits for control of pocket gophers in occupied Grizzly Bear habitat is restricted under a Section 7 consultation with the U.S. Fish and Wildlife Service.

Several genera listed in this handbook (*Sorex*, *Eutamias*, *Thomomys*, *Microtus*, *Neotoma*, and *Sylvilagus bachmani*) have species listed as federal candidates for review under the Endangered Species Act and may be considered a Sensitive species by the USDA Forest Service.

Foreword

This handbook is adapted from Forest Service Handbook (FSH) 2609.22, Animal Damage Control Handbook, Region 6 (Pacific Northwest Region), Amendment No. 6, September 1988. (FSH 2609.22 was published in 1966, and later revised and updated several times. It was revised and adapted for use in the Pacific Southwest and Pacific Northwest Regions in 1976 and for use in the Northern Region in 1988.)

This publication responds to the need for a comprehensive reference for safe, effective, and practical methods for managing animal damage on National Forest System lands in the West. Emphasis is placed on prevention of damage, preferably by indirect means, rather than on direct control of wildlife or livestock causing damage. Any technique described here, when adapted to fit local and regional situations, should help to improve animal damage management (ADM) on National Forest System lands and on other forest and range lands.

This handbook does not provide guidelines specific to a National Forest System Region or Forest and, thus, may lack the indepth treatment desired by some readers. It is hoped, however, that the user will find the tools necessary to form a good approach to specific animal damage problems.

These procedures are guidelines, not prescriptive directions. Successful ADM requires ingenuity and resourcefulness on the part of the biologist or other resource specialist, who must assess the need for ADM, use available resources, and adapt procedures appropriate to site-specific problems. These guidelines also are consistent with the Forest Service's emphasis on resource coordination; that is, the effort to have wildlife biologists work in close consultation with foresters and other resource specialists to develop approaches to ADM that will successfully limit animal damage and minimize adverse impacts on desired wildlife and their habitats.

Animal damage management is a dynamic process that is constantly being improved and expanded by new techniques and refinements of the old. For these reasons, we encourage users to keep up with the state of the art through the literature and by other means. We also encourage users to become involved, to share their ideas with others, as successful practices used in their area may be adapted and used elsewhere.

Robert D. Nelson
Director of Wildlife, Fish, and Rare Plants

Preface

This handbook focuses on animal damage management (ADM) in relation to forest, range, and recreation resources; predator management is not addressed. Methods for limiting animal damage to seedlings, saplings, and mature trees traditionally have emphasized direct control (baiting, trapping, snaring, and special hunts) of wildlife problem species and use of physical barriers (plastic-mesh tubing and fencing). But these practices are limited in effectiveness, costly, and becoming increasingly restricted by regulations and the public's concerns regarding their use. The potential impact of direct controls on threatened and endangered species and other nontarget species and on animal welfare is also of growing concern. In recent years, the value of indirect methods (based primarily on the modification of silvicultural practices) for avoiding or minimizing animal damage has become increasingly important. Integrating direct and indirect methods, in coordination with silvicultural systems, offers the best approach for managing animal damage. Because silvicultural and range management practices profoundly influence the susceptibility of developing stands to animal damage, an understanding of these practices is critical to sound, cost-effective ADM on forest and range lands.

Management of animal damage on National Forest System (NFS) lands is a significant issue for forest resource managers and may become more so in the future. Resource managers must assess the long-term effects of animal damage, the need for management, the degree of protection needed, if any, and the efficacy and risks associated with specific management practices. Greater emphasis on ecosystem management will require consideration of a broader range of biological and environmental factors in preparing an integrated program of ADM (see chapter 1). Animal damage management also is increasingly affected by the social, political, legal, and ethical environment in the United States (see chapter 1). Societal values must be incorporated in decisionmaking processes for ADM.

"New forestry," which involves new approaches to forest regeneration and stand and landscape management, including practices that increase habitat suitability for problem species and other wildlife, also will have a major impact on ADM. Populations of and damage by mountain beaver and pocket gophers, for example, may increase in shelterwood stands and other stands harvested under new forestry practices. Greater reliance on natural regeneration also may renew concerns over the impact of seed-eating mammals and birds. New forestry is likely to improve habitat conditions and

increase the potential for damage caused by most of the wildlife species treated in this handbook. New resource management objectives with greater emphasis on threatened, endangered, and sensitive species and noncommodity resources, however, may reduce the economic costs assigned to animal damage because of reduced or delayed timber yields.

Extensive references are given in each chapter of this handbook, especially in chapter 5, and provide suggested reading for each wildlife species covered. In addition to these sources of information, users should be alert to problem analyses of key species, such as "Porcupine Control: A Problem Analysis" (see chapter 5) and "Pocket Gophers and Reforestation in the Pacific Northwest: A Problem Analysis" (see chapter 5). Annotated bibliographies on wildlife problem species also are valuable sources of information on ADM. Teipner and others (see chapter 5) published a state-of-the-knowledge report on pocket gopher biology, ecology, damage, and control. The authors reviewed gopher species throughout the United States, and a bibliography containing more than 1,000 literature citations is included (see chapter 5). "Assessment and Management of Animal Damage in Pacific Northwest Forests: An Annotated Bibliography" (see chapter 1) is a comprehensive reference guide to published information on ADM in the Pacific Northwest and other regions. It includes citations and abstracts from more than 900 papers and is indexed by subject and author.

Supporting information can be found in the references after each chapter and in the glossary of technical terms. In appendix 3 are reprints of four key papers on "Vexar" seedling protectors that estimate cost-effectiveness of animal damage control and give animal damage prediction models and an overview of ADM in the Pacific Northwest. The appendices also include a sample contract for building a deer fence and information on gopher-baiting probes and the forest-land burrow builder.

Possibly the most comprehensive reference on ADM is "Prevention and Control of Wildlife Damage" (see chapter 4). This valuable compendium provides indepth treatment on everything from "armadillos to woodpeckers" and "beavers to weasels." It contains detailed sections on supplies and materials and pesticides, including a listing of all pesticides registered for control of terrestrial vertebrate pests. In addition, it contains the following sections: "Identifying Wildlife Damage," "Procedures for Evaluating Predation on Livestock and Wildlife," and "Wildlife Diseases and Man." It should be on the bookshelf in all Districts and Forests.

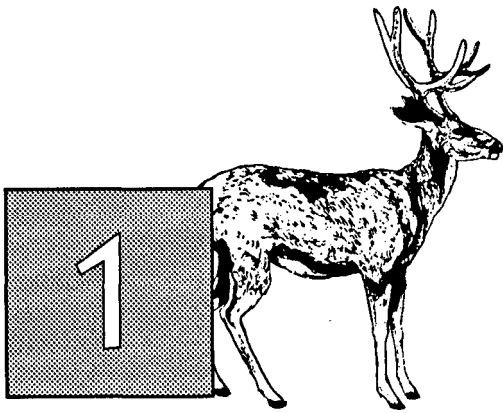
Wildlife biologists, silviculturists, and pesticide-use specialists (District, Forest, Region) can provide technical assistance in ADM. Expert assistance is also available from the USDA Animal and Plant Health Inspection Service; see memorandum of understanding between APHIS-ADC and the USDA Forest Service in appendix 2). Extension wildlife specialists with the Cooperative Extension Service, U.S. Department of Agriculture, also can provide technical support in ADM. Biologists with the Fish and Wildlife Service, U.S. Department of the Interior, and those with state wildlife agencies also may be consulted regarding ADM, particularly if sensitive, threatened, or endangered species may be involved.

Although we may expect an increased tolerance of animal damage in the future, resource managers are responsible for using the best knowledge available to solve these problems.

Hugh C. Black
Technical Editor

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Chapter 1:

Animal Responses to Habitat Changes

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Introduction

To maintain animal use of forest resources within acceptable levels, resource managers must have a basic understanding of the physiological requirements, general behavior, and responses of animals to habitat changes. (See McComb and Hansen [1992] for a comprehensive overview of forest wildlife ecology.) Responses of animals to specific habitat changes are not always well understood. Different animal species often respond differently to similar habitat treatment. Because the system is dynamic, animal damage management must be site specific. No single method of control is universal.

All animals need food, water, shelter, and space. Significant changes in the distribution, relative abundance, or type of food, water, and shelter can influence animal behavior and cause a change in population density or use of an area by a particular species. Some species will find an increase in the type of habitat they prefer and will benefit. Other species will find the habitat they prefer decreased and will be adversely affected. Changes in numbers and distribution of animals and intensities of plant use can be expected when land-management activities alter habitats.

Forest trees and their seeds constitute a portion of the natural diet of many forms of wildlife. For example, feeding on conifers by big game is directly related to animal preference for particular tree species and to the availability of other preferred foods at the time. Indirect control by means of habitat manipulation (based primarily on the modification of silvicultural practices) can be an effective way of limiting animal damage, particularly when combined with other means of animal damage management (ADM). By making the habitat less suitable for wildlife problem species, the impact on plantations and older stands often can be reduced or managed more easily by other means.

One of the best and most comprehensive sources of up-to-date information on the influence of silvicultural practices on animal damage is Black (1992). This book provides a state-of-the-art assessment of ADM as practiced in the forests of the Pacific Northwest. It is a compilation of published information and reports based on operational experience. The book's central focus is the potential of silvicultural practices to minimize animal damage, but it necessarily includes information on the use of chemical repellents, mechanical barriers, and direct control measures to minimize the impact of animal damage.

Work with a Forest silviculturist and other specialists to establish an integrated approach to (ADM) that is applicable to the specific site in question.

Silvicultural Practices

It is beyond the scope of this book to discuss silvicultural practices in detail, but a brief overview of basic silvicultural practices is provided.

Silvicultural systems are divided into two principal categories: even-age and uneven-age management.¹ Within each system are several regeneration methods. Even-age management includes clearcut, seedtree, and shelterwood regeneration methods. Uneven-age management uses single tree or group selection and coppice methods of regeneration.

¹Definitions of terminology are given in the "Glossary" at the end of this book.

Clearcutting removes the canopy and the existing vegetation, thereby allowing succession to begin. Early successional plants occupy the site and change the habitat from one suitable for animal species associated with mature forest stands to one that species associated with new plantations will use. Variations in unit size and rotation length are the principal determinants of the type and extent of wildlife habitat produced. Rodents, hares, rabbits, and other herbivores attracted to the high-quality successional vegetation frequently damage young conifers.

In areas where pocket gophers occur, for example, use of the shelterwood regeneration method, in place of clearcutting, has created less favorable habitats for gophers and reduced damage to the developing stands (Emmingham and others 1992).²

Uneven-age management produces a smaller area of disturbance than even-age management. Forest stand structure remains relatively similar to the preharvest condition. Thus, mature forest wildlife species are favored and damage from such species as deer, elk, or gophers would be expected to be less prevalent.

Small group selection (1/4- to 1/2-acre groups of trees) produces significant amounts of edge, which may promote increases in deer or elk populations. Shade-tolerant species, such as western hemlock and grand fir, are favored by group selection in the Douglas-fir region. Both tree species are less desirable forage to browsing animals than Douglas-fir.

Coppice silviculture is not common in the United States, but it may be used with sprouting hardwood species such as California black oak, tanoak, and madrone. This method could alleviate the need for planting (where management objectives favor maintenance of hardwoods) while producing wildlife forage. Because only a few sprouts per clump are needed for the future stand, browsing should not be a problem.

When animals search for food their movements are closely related to the availability and distribution of cover. Small forest openings are usually fully used by big game. Large openings receive their greatest use near the "edge." Use of the inner portions of large openings differs with the amount of escape cover within the opening or that develops over time.

Big-game carrying capacity increases rapidly as the diversity and volume of low-growing vegetation increases after clearcutting or wildfire. This trend may continue for 10 to 20 years after logging, or until tree canopies close and begin to shade out the understory. Delays in reforestation may extend this period of high forage production. As tree canopies close, the amount, diversity, and nutritional quality of understory vegetation decrease and habitat quality declines (for early successional species). Changes in big-game habitat carrying capacity may be roughly proportional to the changes in habitat resulting from forest management.

Timber management often improves the quality of big-game habitat, particularly on winter ranges. As the quality of browse of the harvested area is reduced by successional trends, new areas can be harvested. To maintain productive big-game habitat, protection from animal damage may be necessary for newly planted young conifers.

²Scientific names of all species are given in appendix 1

The type and quality of wildlife habitat created by timber management is determined mainly by the systems of timber harvest and fuel management that are used. Clear-cutting, and to a lesser extent group-selection cutting, sets back plant succession and usually results in the temporary production of large quantities of forage. Shelter-wood cutting produces similar but smaller increases in big-game carrying capacity than does clearcutting or group-selection cutting.

Fuel Management

Fuel management and planting-site-preparation practices can directly affect use by wildlife and livestock of treated areas.

Unburned Fuels

Rabbits, hares, and many species of rodents are secretive and depend on easily accessible cover for protection from predators. Entire home ranges may exist in small areas where food and cover are abundant. This is particularly true in areas with accumulated down and dead material. Under these conditions, population density often is limited only by the space requirements of individual animals.

Established populations of rabbits, hares, and rodents may expand, if favorable habitat is provided by unburned fuels. These animals will use any available food, including tree seeds and seedlings. Unburned fuels may provide some protection for young trees by restricting movement of big game and cattle and by reducing exposure of trees. Most of the low, herbaceous, and shrubby vegetation responds quickly to the increased light and moisture produced by canopy removal. This improved food source attracts big game and may, in turn, reduce browsing pressure on both natural regeneration and planted trees.

Burned Fuels

Broadcast burning of logging slash and other fuels creates changes in the availability of food and cover, which directly affect the composition, distribution, and abundance of small-mammal populations. Burning also may directly kill some small mammals. In the Douglas-fir region of Oregon, prescribed burning temporarily reduced populations of small mammals (Hooven and Black 1976) and, in Washington, populations of mountain beaver, particularly after an intense burn (Motobu 1978). Animals also may be affected by minor changes in the microclimate, such as soil-surface temperature, water penetration, and air movement. In Douglas-fir clearcuttings in Oregon, before and after logging, Gashwiler (1959) found that deer mice increase after fuel burning, but chipmunks, hares, and redbacked voles decrease.

Steen (1966) reports significant differences in the development of vegetation on burned sites compared with unburned sites near Oakridge, Oregon. Plant composition and the rates of development were affected. Predicting the magnitude of change in habitat after burning is difficult, however. Pengelly's (1961) study of broadcast burning in northern Idaho led him to conclude that "...fire is a rough and largely unpredictable tool due to the following variables: time and intensity of burn, homogeneity of burn, kind and availability of fuel and seed source, and growing conditions during the first season after the fire."

Hot burns tend to favor herbaceous plants and some shrubs, such as red-stem ceanothus in the Pacific Northwest. Cooler burns tend to favor shrubs present in the understory at the time of harvest. When increased light and nutrients are available, these shrubs undergo rapid growth.

Planting immediately after fuel removal has been one of the best ways of minimizing damage from rabbits, hares, and pocket gophers. Planting larger stock also has reduced rabbit and hare damage problems in many areas.

Fuel Piling	On many areas, especially those with flat or gentle slopes, fuel often is piled with bulldozers before burning. Treatment leaving 20 to 30 tons of fuel per acre generally is the recommendation in the Pacific Northwest. This favors regeneration of conifers and shrubs. Intensive treatments that pile (or remove) all the slash cause plant succession to revert to an early successional stage. In these stages, grasses and herbs usually predominate. Intensive site preparation seems to stimulate pocket gopher and vole activity.
Wildfire	Responses by animal populations to habitat changes after wildfire are similar to those after broadcast burning of slash. During the revegetation period, wildlife species diversity may be greatest in the successional stage with the greatest diversity of plants. The degree to which deer and elk and some other animals use a natural burn is influenced (among other factors) by the size and intensity of the burn, abundance of food, and the proximity of cover.
Animal Use	The basic principles that relate to animal-forage preference may be grouped into five categories. These are palatability; associated forage species; climate, soil, and topography; forage preference; and impacts of use (Heady 1964). Understanding the nature of these factors will help land managers recognize and possibly control some of the complex and interrelated influences governing animal use. A brief summary follows of important elements associated with each of these categories.
Palatability	Palatability has been defined as a plant characteristic stimulating a selective feeding response. Some factors found to affect palatability are chemical composition; portion of leaves, stems, and fruits eaten; plant-growth stage; past grazing use; climate; topography; soil moisture; and soil fertility. Other characteristics possibly related to palatability, such as texture, odor, and external plant form, have received little attention by biologists.
Associated Forage Species	Availability of choice affects preference. Some plant species growing in one community have been found to have different preference factors than the same species growing with other combinations of plants. Thus, certain plant species, such as conifers, may be used heavily when sparsely distributed through an area of preferred forage species.
Climate, Soil, and Topography	These factors have been mentioned as affecting palatability, but they probably have a more important effect by influencing animal behavior. Changes in temperature, rainfall, soil texture, steepness of slope, and moisture content of foliage often change animal preferences.
Forage Preference	Preferences differ among animal species for plants, parts of plants, or plants at certain growth stages. Animal preference has been related to individual animal conditions such as fatness, pregnancy, lactation, and hunger. Senses, such as sight, taste, smell, and touch, coupled with instinct and experience also influence preference. Preferences of individual animals also may differ season to season, day to day, or even within a day.

Impacts of Use

Heavy use of forest lands by browsing animals may increase damage to planted seedlings or natural tree regeneration. The interaction of animals with their habitat has been demonstrated in the Olympic National Forest in Washington where small study plots were fenced to exclude deer and elk. The exclusion of browsing animals allowed low shrubs to develop rapidly. This, in turn, provided excellent cover for rabbits and rodents. Under these conditions, destruction of Douglas-fir seedlings inside the big-game exclosure by rabbits, mice, and mountain beavers exceeded losses on the outside. Trees were 30 percent taller, on average, outside the exclosures where big-game browsing had reduced small-mammal cover and vegetative competition. Deer exclosures in the Allegheny National Forest in Pennsylvania also have demonstrated the deleterious effects of deer browsing on hardwood regeneration (Tilghman 1989). In other areas, damage to seedlings may not occur even though big game may browse native shrubs sufficiently to change shrub forms and sizes. This has been reported by the Umatilla National Forest in Oregon

Moore and Reid (1951) observed that pocket gophers adversely affect plant composition in several ways: favored foods are gradually removed and replaced by those of lower palatability, soil excavated from runways suppresses plants on which it is deposited, soil mounds are occupied quickly by annuals that usually are less desirable than the original perennial vegetation, and unused runways provide refuge for other herbivorous rodents such as deer mice and meadow mice. Gophers also prevent natural improvement of mountain meadows that are in poor condition, but do not limit improvement of meadows in fair or better condition.

Uncontrolled grazing by big game or livestock greatly influences soil compaction and range condition (Graham and others 1992). With time, plant communities may be completely altered. The more obvious effects are changes in plant composition, density, vigor, soil structure, and the rate of soil erosion. All wildlife species are responsive to both subtle and dramatic modifications of their habitat. Thus, the type of land use practiced influences their distribution, density, and diversity.

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Chapter 2:

Damage Identification and Prediction

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Introduction

Wildlife-caused tree injury, primarily associated with feeding activity, is the result of removal of some portion of a tree, such as foliage, bark, or roots, that can result in growth suppression or destruction of the tree. Every injury does not cause economic loss, and trees may sustain repeated feeding injuries with little or no long-term effect. Excessive feeding by wildlife on seeds, seedlings, or saplings, however, can prevent or delay successful reforestation, or it may degrade or destroy valuable crop trees in maturing stands. Animal damage, in simplest terms, is the result of any kind of animal activity that interferes with management goals or objectives. (In the past, the emphasis was on animal activity that causes economic losses by reducing or delaying forest yield.) Assessing the significance of animal damage, however, depends on the resource management objectives for a particular area.

Correct identification of damage is necessary before sound prescriptions can be made for managing damage. First, determine whether the damage is caused by environmental factors, disease, mammals, birds, insects, or a combination of these agents. If the evidence indicates that an animal is causing the damage, the species must be determined.

Identification of animal damage often requires a thorough search for evidence. The feeding characteristics of some animals are so similar that identification is almost impossible without evidence such as droppings, hair, tracks, trails, or the presence of burrows in the area. For example, ants may girdle stems of seedlings just above the root collar to nurture aphid colonies, grasshopper feeding on needles can be confused with bird clipping, bird perching sometimes breaks terminal leaders, and terminal shoots may be damaged by snow or ice. This damage can be confused with mammal damage unless investigations are thorough. In some instances, it may be necessary to trap animals, build exclosures, or install cages to identify the damage-causing agent. Requisites for proper identification of animal damage include an inquisitive and open mind, a desire to do a thorough job, a knowledge of animals and their habits, and an ability to interpret field observations.

An excellent field guide on this topic for the Pacific Northwest is Lawrence and others (1961); a dichotomous key to wildlife injuries to trees, adapted from this guide, is included at the end of this chapter. Another useful guide applicable to this same region is Harestad and others (1986). A related publication by Byrd (1981) describes and depicts, with excellent color photographs, observable signs and activities of selected wildlife species, including the identification of wildlife feeding injuries.

Training is necessary to ensure accurate identification of animal damage. The Animal Damage Control Program of the USDA Animal and Plant Health Inspection Service (APHIS-ADC) has qualified biologists who can provide this training. Extension wildlife specialists, USDA Cooperative Extension Service, also may assist with this training.

Types of Damage Caused by Wildlife

A wide variety of damage by wildlife occurs on forests, rangelands, and associated areas. Damage can be grouped into categories by the location where it occurs: forest lands, rangelands, and buildings and grounds.

Damage to Trees

Excellent summaries of wildlife damage to forests in the United States and Canada, with extensive bibliographies, are available (Borrecco and Black 1990, Crouch 1977). Animals may damage trees in many ways. They clip and browse foliage and leaders, gnaw and girdle stems and tree boles, inflict trampling injuries, and completely remove tree seedlings. Keys have been developed to identify damage (table 1). Missing trees are a major problem, however. Missing trees near gopher activity logically can be attributed to gophers; however, when elk and deer pull trees, they often leave no evidence. Unless there are staked rows of trees in the area, this type of damage may be missed completely.

To identify damage to trees and shrubs, the characteristic differences between browsing and clipping need to be recognized.

Browsing-Browsing refers to the feeding habits of ungulates, including deer, elk, and livestock. Browsing on woody vegetation during the dormant season leaves a ragged, splintered break (fig. 1), because these animals lack upper incisors.

Clipping-Clipping refers to the feeding habits of rodents and rabbits, which produce a smooth, oblique cut on woody shoots (fig. 1). These animals possess prominent chisel-like incisors and must tilt their heads to the side to clip a stem.

Table 1-Comparative widths of incisor teeth of some common gnawing mammals^a

Common name	Average width of incisor
	<i>Inch</i>
Beaver	0.24
Porcupine	.14
Black-tailed jackrabbit	.10
Snowshoe hare	.09
Cottontail rabbit	.09
Pocket gopher	.06
Western gray squirrel	.06
Dusky-footed woodrat	.06
Meadow vole	.04
Red squirrel	.04
Red-backed vole	.03
Deer mouse	.02

^a Based on measurements of 6 or more adult specimens of each species from the museum of Natural History, Oregon State University, Corvallis.

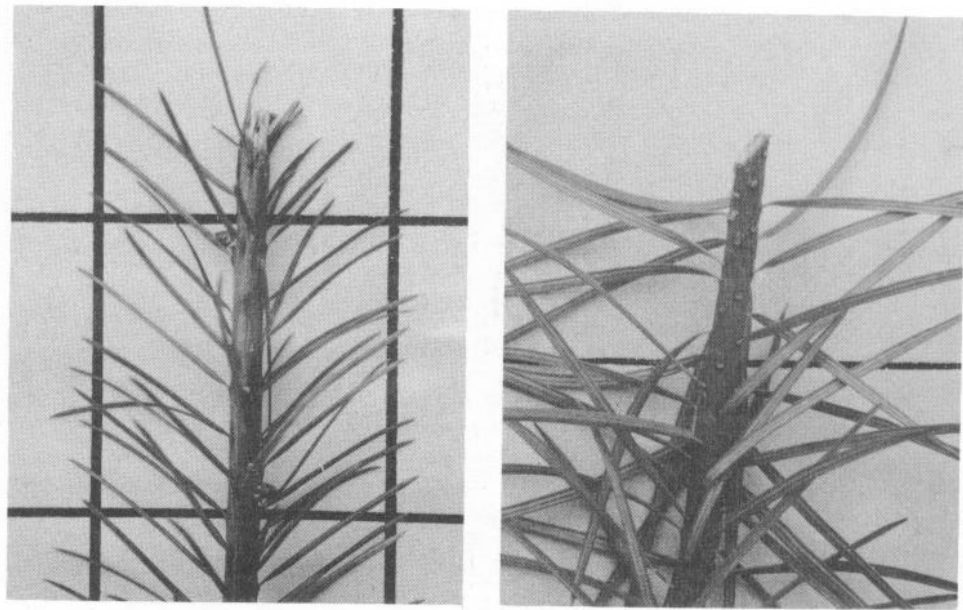


Figure 1—Comparison of twigs browsed by deer (left) and clipped by rabbits (right).

The white-tailed deer skull (fig. 2) lacks upper incisors, which results in the ragged appearance of woody stems browsed by ungulates during the dormant season. The snowshoe hare (fig. 2) has opposed incisors, which permit smooth clipping of stems.

Damage to Rangelands

Grasslands and meadows are subject to three general types of animal damage: plant destruction, soil compaction, and erosion.

Damage to plants—Plant damage occurs in two ways and is caused by both livestock and wildlife. The first is a gradual reduction in plant density and vigor over many years. Livestock, deer, and elk are destructive when the numbers of animals or intensity of use is permitted to increase beyond the carrying capacity of the range. This damage often is difficult to detect because it develops slowly. Changes in range condition can be documented by establishing Parker three-step range transects and by making regular usage checks for several years (USDA Forest Service Manual [FSM] 2210, USDA Forest Service Handbook [FSH] 2209.21). Identification of the species causing damage can be made by direct observation of animals and by animal sign in the area.

The second type of plant damage is the removal or covering of vegetation as a result of feeding and burrow-building activities by certain small mammals. This damage may take place over a very short period. Animals primarily responsible include pocket gophers, moles, meadow mice, and ground squirrels. These animals have small home ranges and can be identified as to group by their burrow-building and food-gathering activities.

Mound building (pocket gophers and moles)—Signs of pocket gopher and mole activity are sometimes confused because both are burrowing animals and spend most of their time underground. Aboveground signs of these animals are distinguishable, however.

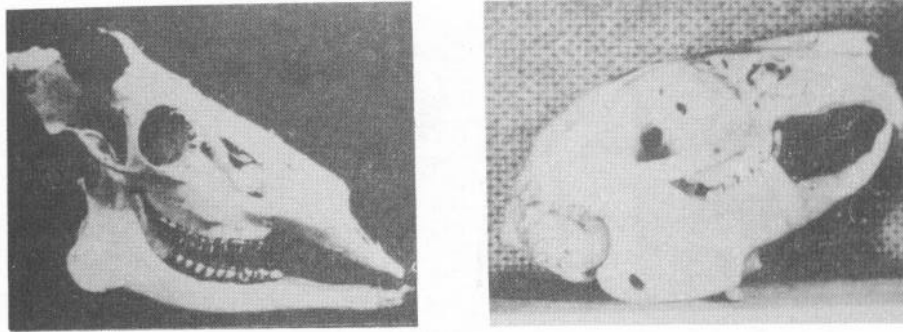


Figure 2—Skull (left) of a white-tailed deer, a browsing animal (an ungulate), compared with the skull of a snowshoe hare (an animal that feeds by clipping or barking).

Pocket gophers—Burrows seldom form a visible ridge on the ground surface. Material excavated from burrows is pushed into fan-shaped mounds or, when under snow, packed in snow tunnels (figs. 3 and 4). When the snow melts, the packed soil remains in cylinders (snow casts). Mounds consist of finely divided soil particles. The burrow entrance usually is near the edge of the mound and is closed by an earthen plug that often leaves a visible depression.

Moles—Much of the burrowing done by moles is close to the surface and often raises a visible ridge (fig. 5). Excavated materials usually are piled in roughly circular mounds, rarely in casts. Mounds often look lumpy (fig. 6). The opening to the burrow usually is near the center of the mound and often lacks a distinct plug.

Meadow voles—Meadow voles require dense cover and seldom are found in sparse cover or openings. Signs of meadow vole activity in grasslands and meadows include vole runway systems that form an intricate network through dense vegetation. When populations are high, these runway complexes are often only inches apart and frequently intersect. Runways can be found by separating matted vegetation or lifting surface litter. Numerous burrow openings are connected by trails. Fresh grass clippings and droppings occur in trails. Burrow openings remain open.

Areas where voles have destroyed perennial vegetation often are invaded by annuals such as cheatgrass and tarweed. Vole depredations frequently can be recognized at a distance by the color patterns of invading or clipped vegetation, which give the area a mottled appearance.

Shrubs or tree seedlings growing in areas of high vole populations often are girdled below the root collar and killed. This damage is easily detected by scraping away the loose duff and soil at the ground line. Girdling also may be found on stems and on branches. Identification of vole species may require capturing them with snaptraps or live-traps.

Ground squirrels—Columbian, Uinta, and other ground squirrels commonly damage grass or meadow areas. Identification is easiest during spring and early summer when they are actively feeding. Specimens can be collected for positive identification by shooting or trapping, if allowed by local regulations.

The presence of open burrows, with little vegetation growing near the entrances, is a good indicator of active dens. Ground squirrels are diurnal and easily seen.



Figure 3--Pocket gopher mound, showing typical fan-shaped appearance, and earthen plug in lower right center.

Figure 4-Pocket gopher snow casts, showing typical tubular cylinders of packed soil and occasional overlaying of the casts.

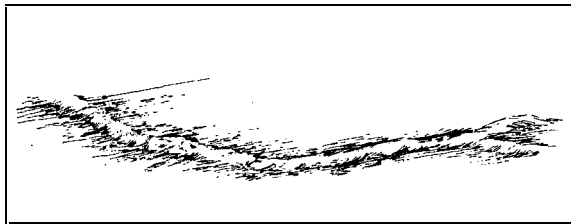
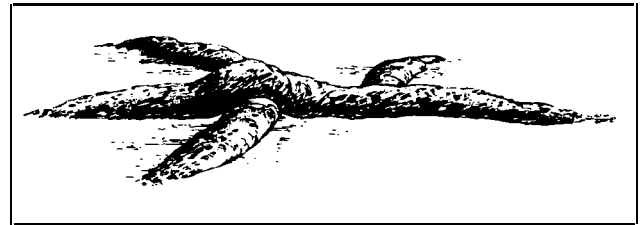
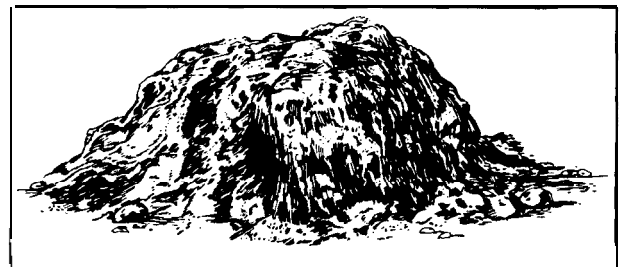


Figure 5-Mole tunnel showing typical shallow ridge formed when feeding occurs near the soil surface.

Figure 6-Mole mound, showing lumpy volcanolike appearance.



Rabbits and hares-Signs of rabbits feeding on grasses or forbs are difficult to distinguish from those of rodents, but fecal droppings are distinctive. As with rodents, identification of rabbit and hare damage must rely on indirect signs that indicate the presence or abundance of animals in an area. Pellet group counts are a useful means of determining presence of rabbits and hares.

Soil Compaction

Soil compaction can occur when excessive numbers of big game or domestic livestock use areas of heavy, clay soils saturated with moisture, or as a result of harvest methods.

Areas damaged by compaction look dimpled and animal hoof prints are discernible, if the trampling is recent. When compaction is severe and prolonged, plant density is reduced, perennial plants are replaced by annuals, water infiltration is inhibited, and overland water flow is increased. The area thus is subject to greater wind and water erosion. Areas along waterways and around meadows are particularly susceptible to damage by compaction. Sites used by animals in the early spring that have shallow soils or poor drainage also may be heavily damaged.

Soil Erosion

Soil erosion may be initiated by burrowing animals, including pocket gophers, moles, ground squirrels, badgers, and meadow voles. In some instances, burrows are oriented downslope and serve as small conduits for water from melting snow or heavy rains. This type of damage is observed in the spring when snow is melting. Later in the summer, drying, settling, wind action, and animal use obliterate much of the evidence related to the initial cause of the damage. (Field signs of voles, ground squirrels, gophers, and moles are described in the previous section.)

Damage to Buildings and Grounds

Various birds and mammals may occupy buildings, adjacent grounds, campgrounds, and other areas of human activity where they may be a nuisance or hazard to human health. Animal use of Forest Service buildings and the grounds around them often leads to excessive maintenance costs. Frequently, little actual damage is done, but the nuisance problems may warrant removing or discouraging these animals (see chapter 5).

Birds-Cavity nesters, such as sparrows, starlings, and swallows, often use open air vents, spaces around utility openings, and other spaces for nest-construction sites.

Rodents-Gnawing occurs wherever rodents are present.

Porcupine-Porcupines are the largest gnawing animals found around buildings. They have a definite liking for glue in plywood. Such items as work gloves, saddles and other leather goods, and tool handles are especially attractive. Droppings 1 inch long are characteristic of porcupines.

Woodrats-Sometimes referred to as pack rats, these native species characteristically build large, bulky stick-nests or houses in the crowns of trees and in sheltered sites at ground level. The dusky-footed woodrat is a semiarboreal species, whereas the bushy-tailed woodrat is less arboreal and usually found near abandoned buildings and rocky outcroppings (Lawrence and others 1961). Both species may cause problems in buildings by fouling stored materials and food supplies. (The dusky-footed woodrat may also cause minor damage to young conifer stands.) Droppings about one-third of an inch long are characteristic of woodrat presence.

Mice-Deer mice are abundant on forest lands and frequently move into buildings, particularly during cold weather. Small holes 1/2 inch or less in diameter allow mice to enter. Droppings about one-eighth of an inch long, chewed paper, and seed hulls are signs of mouse activity.

Tree squirrels-Tree squirrels, such as red squirrels, occasionally move into buildings or cone-storage facilities. Their presence can be determined by their daytime activity, food-storage habits, and midden piles of pine cone parts that have been discarded as the squirrel removes the seeds from cones during feeding.

Prediction of Animal Damage

In recent years, attempts have been made to predict the occurrence of animal damage in plantations. This reduces treatment costs, because controls are begun only when necessary. Most such efforts have attempted to relate habitat characteristics to animal population dynamics, then use localized experience to predict probable damage to plantations for similar conditions. Results occasionally have been useful, particularly when predictions were based on the combined inputs of interdisciplinary teams composed of foresters, range conservationists, and wildlife biologists. Animal damage prediction models are being used and refined in Pacific Northwest forests (see appendix 3).

McComb (1992) reviews the types of models appropriate for animal damage management and provides a useful list of references on modeling. He outlines the basic steps for developing an "expert" model that relates existing habitat conditions to the habitat preferences of the wildlife problem species. Once these relations are developed and analyzed, appropriate action plans can be formulated for situations identified as being at high risk from animal damage. Sophisticated ADM models can be used to predict the occurrence of animal damage over time.

Districts and Forests should develop ADM models applicable to local conditions; they are a promising new way to avoid unnecessary treatments. Where animal damage is expected or predicted, the cost-effectiveness of controlling the damage should be estimated (see appendix 3).

Key to Wildlife Injuries to Trees

This dichotomous key to wildlife injuries to trees is adapted from Lawrence and others (1961).

INJURIES TO SEEDLINGS AND SAPLINGS..... A

INJURIES TO MATURE TREES B

A. INJURIES TO SEEDLINGS AND SAPLINGS

	Key
1A. ROOT CLIPPING	2
1B. STEM BARKING OR STEM BROKEN	3
1C. FOLIAGE CLIPPING AND BROWSING	10
2. Roots gnawed or clipped at root collar...injured seedling may be tipped over or partially pulled underground	POCKET GOPHER
3. Barking on upper stem of saplings or large seedlings	4
3. Barking basal on saplings or seedlings.	6
4. Bark abraded and shredded on upper stem; small lateral branches broken by antler polishing	BIG GAME
4. Bark not abraded...lateral branches intact...bark stripped or gnawed from bole or upper branches	5
5. Barking by gnawing...primarily on pines or hemlocks . .	PORCUPINE
5. Barking by means other than gnawing...bark stripped from terminal and lateral shoots...branch tips browsed	BIG GAME
6. Bark stripped from base of saplings...vertical grooves present on exposed sapwood	7
6. Bark not stripped but gnawed from base of saplings or seedlings...lacks vertical grooves, but many tooth marks on exposed sapwood	8
6. Bark stripped or stem broken by trampling; no grooves or gnawing apparent	BIGGAME
7a. Strips of discarded bark at base of tree...vertical grooves on exposed sapwood	BEAR
7b. Strips of discarded bark absent...irregular vertical claw marks and scattered horizontal or diagonal tooth marks on exposed sapwood...numerous burrow entrances in area	MOUNTAIN BEAVER
8. Individual tooth marks less than 1/16 inch wide...gnawed surface of sapwood fuzzy and roughened...grassy areas with numerous surface runways	MEADOW VOLE
8. Tooth marks distinct, 1/16 inch wide or wider...surface of exposed sapwood not fuzzy	9
9. Tooth marks 1/16 inch wide...sapwood deeply gnawed...above ground damage visible immediately after snow melt...soil mounds, soil casts, and burrow openings	POCKET GOPHER

9. Tooth marks 1/8 inch wide or wider; sapwood deeply gnawed;
1/2- to 1-inch oblong droppings and quills; pieces of outer bark
around base of tree PORCUPINE
10. Bud and needle clipping on terminal or
lateral shoots GROUSE, GROSBEAKS
10. No bud or needle clipping, but with cutting or browsing on terminal
or lateral shoots 11
11. Clipping or cutting injuries 13
11. No clipping or cutting; browsing injuries only 12
12. Game trails, droppings and tracks BIG GAME
12. Browsing-like injury with bud or needle clipping
clustered droppings on stumps, logs and rocks GROUSE
13. Individual tooth marks distinct...clipped stems usually larger than
1/4 inch in diameter 14
13. Individual tooth marks indistinct...clipped stems 1/4 inch or less in
diameter...if on newly germinated seedlings, field signs of rodents are
needed to distinguish from bird or insect injury 15
- 14a. Dams, ponds, and lodges present...cutting areas with distinct trails
leading to water..freshly peeled sticks; signs of active beaver
pond...wood chips present near stumps BEAVER
- 14b. On larger seedlings and saplings, cutting of branches
leaves short stubs on main stem...piles of fresh leafy cuttings
at entrances of numerous burrows MOUNTAIN BEAVER
- 15a. Clipped stems and cotyledons of newly germinated
seedlings, in addition to seed eating DEER MOUSE
- 15b. Clipped newly germinated seedlings...in ponderosa pine region
and mixed conifer region...numerous burrow openings are
signs of ground squirrels
. CHIPMUNKS, GROUND SQUIRRELS
- 15c. Barked stems of larger seedlings, also clipped lateral and
terminal shoots of small seedlings...surface runways in grassy
areas MEADOW VOLE
- 15d. Flattened ovoid droppings
. SNOWSHOE HARE OR COTTONTAIL
- 15e. Clipped seedlings with an oblique cut characteristic of
rodents, but it usually can be distinguished from clipping by
other animals because of the multiple cuts, which leaves a
serrated cut-end. Numerous burrow entrances in area ...
limited to coastal Douglas-fir region . . . MOUNTAIN BEAVER
- 15f. Clipped, small coniferous seedlings PORCUPINE

B. INJURIES TO MATURE TREES	
16A. TREE CUTTING	17
16B. BOLE BARKING	18
16C. BRANCH AND TWIG CUTTING	24
17. Conical top on stumps, with prominent toothmarks	BEAVER
18. Basal injuries	19
18. Crown injuries	21
19. Long, prominent, vertical grooves on exposed sapwood...large strips of discarded bark at base of tree	BEAR
19. Vertical grooves and strips of discarded bark lacking...horizontal or diagonal tooth marks.	20
20a. Gnawing, with distinct horizontal or diagonal toothmarks; tooth marks 1/8 inch wide or wider	PORCUPINE
20b. Gnawing, with tooth marks 1/16 inch wide...Barking occurs in irregular patterns on lower 7 feet of tree	POCKET GOPHER
20c. Gnawing indistinct...occasional vertical claw marks where bark has been gnawed from bole...numerous burrow entrances in area...limited to coastal Douglas-fir region	MOUNTAIN BEAVER
21. Long, prominent, vertical grooves on exposed sapwood of upper bole...large strips of discarded bark at base of tree	BEAR
21. Vertical grooves and strips of discarded bark lacking...prominent horizontal or diagonal tooth marks or gnawing on sapwood	22
22. Prominent horizontal or diagonal toothmarks on exposed sapwood of upper bole and major branches...oblong droppings up to 1 inch long under tree	PORCUPINE
22. Prominent tooth marks lacking	23
23. Short strips of discarded bark (1/2 inch wide by 2 to 3 inches long) under injured tree...fine gnawing visible on exposed sapwood	TREE SQUIRREL
23. Short strips of bark absent...large, bulky, stick nests, either in crowns of trees or on ground in vicinity of injured trees...barking occurs in dense stands of young conifers	DUSKY-FOOTED WOODRAT
24. Cutting confined to branch tips and twigs...peeled or debudded shoots litter ground under tree	TREE SQUIRREL
24. Cutting of moderate-sized branches...no peeled twigs	PORCUPINE

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Chapter 3:

Surveys

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Introduction

Two principal types of surveys are used to assess animal impacts on forest and range resources. The first measures the extent of the physical use of trees and other plants and is called an “animal-use survey.” The second measures animal numbers and is called an “animal population survey.” When possible, animal damage surveys should be included as part of other surveys, such as stocking or range surveys. (Techniques for measuring use of forage plants are described in FSM 2210 and 2620.)

Animal-Use Surveys

Surveys are made on areas scheduled for reforestation, on areas where animal use is delaying or preventing establishment of tree plantations, and on other areas where animal damage is a real or potential problem. These surveys are used to:

- Locate animal use or damage areas.
- Identify animals causing a damage problem.
- Measure animal use.
- Provide data needed for control or prevention of damage.
- Predict in advance of reforestation where animal use or damage is likely to occur.
- Evaluate the impact of animal use on reforested areas.
- Survey predator dependence on rodents, especially raptors that may be impacted by secondary poisoning.

Survey procedures are designed to furnish District Rangers and other resource managers with reliable information to determine where and when animal damage management is needed.

Stocking Surveys

Stocking survey procedures described in Regional reforestation handbooks are designed to evaluate reforestation efforts. These procedures include methods for measuring tree stocking in relation to the influence of weather, vegetation, animals, insects, and diseases. Some forms for reforestation stocking surveys also are designed to allow collection of information on the effects of animal damage. Marking trees with stakes in rows or plots is the best way to determine whether trees are missing and aid in the identification of damage agents.

Examination of staked seedlings provides only an index to survival and growth of seedlings on a unit, however, unless all the seedlings on samplings plots or the entire unit are staked. Staking a small number of trees does not provide precise information on stocking, spacing, distribution of trees, or damage. But it is a useful means of measuring the effects of specific injuries by animals or other factors on growth and survival of seedlings over time.

Examples of potential animal damage areas are south slopes, winter ranges, habitat types particularly favorable to activity by the damaging animal(s), and plantings on established brushfields or grassy areas.

Animal Population Surveys

Two general types of population surveys are counts by direct observation of animals, and indirect estimates of populations by counting pellets, mounds, tracks, or other indicators of animal presence. Variations in terrain, aspect, slope, cover, and animal distribution, abundance, and habits require that techniques be selected to best fit local conditions.

Estimating total populations from sampling surveys is extremely difficult. Population recruitment, mortality, trap shyness, mobility, sex, and age composition are only a few of the many variables that must be identified and interpreted in making accurate estimates of population size. This type of estimation requires good sampling design and ample time to collect data.

Survey procedures must be adequate for obtaining the data needed, but they should be as simple and efficient as possible. Emphasis is placed on measuring one or more of the following parameters:

- Species of animals inhabiting an area.
- Population trends.
- Relative abundance of animals in an area.
- Patterns of animal distribution.
- Effectiveness of control programs.
- Sex and age composition of animal populations.

Direct Population Estimates

Direct population estimates are used most frequently to determine population trends, measure catch per unit of effort, and estimate population size. Big-game populations, for example, often are estimated by trend counts, which survey a given area or route to develop a population index. Trend counts yield an index to estimate population size based on periodic counts, occurrence of damage, or catch per unit of effort. Use care when interpreting trend counts, because weather and other factors frequently influence the number of animals seen.

Trapline Transects

This is an inexpensive method of obtaining useful data on small-mammal populations. Check with local wildlife officials to determine whether restrictions apply.

Kill-trapping-Traplines may be run at any time of the year when animals are active. The periods of inactivity, including hibernation and aestivation, need to be determined locally.

Comparisons of population levels before and after baiting are most reliable when sampling techniques are standardized. Attention to the following details will help achieve uniformity:

- Use the same type and size of traps.
- Maintain consistent spacing between traps.
- Use the same type of bait.
- Tend traps at the same time of day and in the same manner each day.
- Conduct trapping under similar weather conditions, if possible.

Equipment needed--

- Museum special snaptraps, 25 for each trapline. Allow several extra traps for replacement. Ordinary mousetraps may be used, but they are too small to catch chipmunks.
- Bait consisting of equal amounts of peanut butter and whole rolled oats.
- Compass to orient trapline and relocate traps.

- Plastic flagging to mark trap locations.
- Painted stakes to identify trap stations, when permanent locations are needed.
- Forms for recording results (the same form may be used for both snaptrap and live-trap surveys; figs. 7 and 8).

Procedures

- Set traps in a straight line at intervals of either 1/2 or 1 chain (66 feet). One-half chain spacing should be used if mammals having small home ranges, such as voles and shrews, are of primary interest. One-chain spacing should be used for chipmunks and ground squirrels.
- Secure traps to a stake or heavy object by wire or chain. This will prevent poorly caught animals from dragging traps away, or predators from moving the traps.
- Allow a minimum of 5 chains between traplines, when more than one line is needed. In small areas, it may be necessary to locate stations in one direction, offset the line by 5 chains, and continue the line back and forth, as needed, to complete the trapline.

As the size of the area increases, it is impractical to locate trapline transects with the same intensity as for smaller areas; therefore, the following sampling intensity is recommended:

0-100 acres	1 transect/50 acres
100-1,000 acres	1 transect/100 acres
1,000-3,000 acres	1 transect/200 acres
3,000-6,000 acres	1 transect/500 acres

- Mark trap locations either by fastening plastic flagging to vegetation or other objects, or by driving painted stakes at each trap station. The latter method will permit accurate trap placement when retrapping.
- Record compass direction of each trapline on a data sheet.
- Sample representative habitat by placing traps next to logs, stumps, shrubs, or grass clumps within 5 feet of each trap station. Prepare a flat spot, 8 inches in diameter, for each trap to ensure that traps rest firmly on the ground and are not tilted. Traps set during rainy weather should be protected from direct rain impact, to prevent bait from washing from the trigger. Protection may be obtained by setting traps under logs, bark, or similar cover; leave enough space above the trap to allow it to spring shut. For voles, set the trap axis perpendicular to the runway, so that the vole trips the trigger when using the runway.
- Bait and set each trap by pressing a pinch of bait firmly onto the trigger. Expose traps on 3 successive nights; check them each day at about the same time as originally set, remove dead animals and record capture location, species, and other pertinent data. Rebait and set traps after each examination. Trapping may be discontinued after the first or second night, if the catch of seed-eating mammals exceeds five per trapline. This would indicate a population high enough to consume most of the untreated seed, if direct seeding were planned.

Small-Mammal Snaptrap Survey

Observer: J Jones

Forest: Idaho Panhandle

District: Avery

Date: 10/1/77

Location: T 26 N; R19E; Sec. 4; NE1/4; Big Burn

Line No.: 1

Size of Area: 67 acres Percent Slope: 10-30 Aspect: NE Elevation: 2800'

Weather First Day: Clear calm, High temp 80+ - Low temp approx 45 deg. F

Weather Second Day: Clear 10-20 mph wind - approx, temp high 70, low 40 deg F

Weather Third Day: Partly cloudy, no rain, light breeze, high 70, low 40

Ground Cover: Mainly burned logs, some spots of unburned grass and low shrubs

Area History: Area logged 1978. Wildfire through area on 9/27/68

Trapping Results									
Sta. No.	First Day			Second Day			Third Day		
	Trap Cond	Bait Cond	Species Caught	Trap Cond	Bait Cond	Species Caught	Trap Cond	Bait Cond	Species Caught
P				D	N	P			
P			P	N			C		
P			P	N	N	P			
P			P	N	N	P			
	D		P	N	N	P			
	D		P	N			C		
P			P	N	N	P			
P				D	N	P			
	C		G	S	S	G			
G			P	N	S	P			
P			P	N	N	P			
P			P	N	N	P			
G							D		
P			P	N	N	P			
	D		P	N	N	P			
P			P	N	N	P			
	GS		P	N	N	P			
P				D	N	P			
G			P	N			D		
	C		P	N	N	P			
	C		P	N	N	P			
P			P	N	N	P			
P				C			GS		
P			P	N	N	P			
	D		G	S	N	P			
Sp. <u>D</u> No. <u>4</u>			SP <u>D</u> No. <u>3</u>			Sp. <u>D</u> No. <u>2</u>			<u>9</u>
sp. <u>c</u> No. <u>3</u>			sp. <u>c</u> No. <u>1</u>			Sp. <u>C</u> No. <u>2</u>			<u>6</u>
Sp. <u>GS</u> No. <u>1</u>			No. _____			Sp. <u>GS</u> No. <u>1</u>			<u>2</u>
s p . - No. _____			s p . - No. _____			Sp. _____ No. _____			
s p . - No. _____			s p . - No. _____			Sp. _____ No. _____			
Total									
Catch			No. <u>8</u>			No. <u>5</u>			<u>17</u>

RI-FS-2650-1 (3/87)

Figure 7-Sample small-mammal sample survey form (front).

Instructions

Observer, Forest, District, Date: self-explanatory.

Location: Give legal or local description.

Line number: To identify lines when more than one is used.

Size of area, slope, aspect, elevation: Self-explanatory.

Weather: List approximate high and low temperatures, wind conditions, precipitation, and cloud cover conditions during each trapping day.

Ground cover: List dominant vegetation type and density if vegetation is present in the area. If a recent burn, list as such.

Area history: List management practices or abrupt natural changes that have taken place on the area.

Station number: Be sure to read stations in the same sequence each time, to facilitate comparisons among trapping days and trapping periods.

Trap condition: the following code is used-

N = not sprung; S = sprung; M = trap missing

Bait condition: the following code is used-

P = bait present; G = bait gone

Species caught: the following code is used-

D = deer mouse; C = chipmunk; M = meadow vole; S = shrew;

GS = golden-mantled ground squirrel; and O = other (list by species).

If a species is recaptured (live-trapping), place an "R" in the species caught column.

Total catch by species and number for each day.

Total combined catch for each day.

Grand total: species and combined catch for the 3-day period.

Map: Use the space below to show the trapline pattern in relation to the sample area.

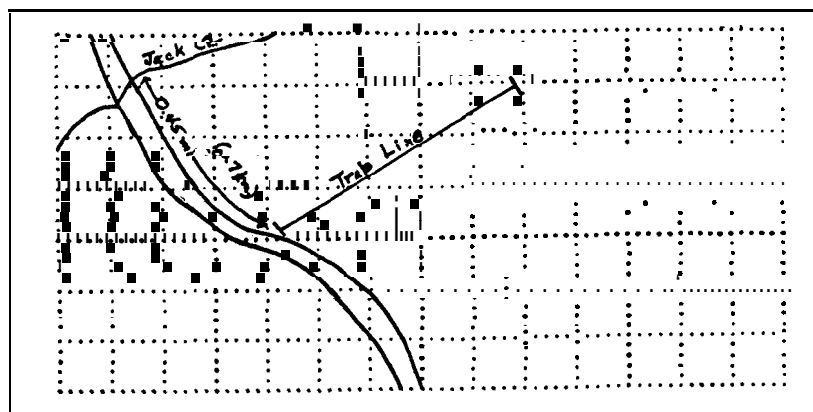


Figure 8-Sample small-mammal census form (back).

- Because snaptraps remove animals from the population, retrapping in the same area may yield misleading data. This source of error can be overcome by either relocating subsequent traplines 5 or more chains away from the original line or waiting 1 year to resample the area.
- Summarize data by expressing the catch as numbers of animals caught per 100 trapnights, so that the results of all surveys can be compared, regardless of the number of traps used. One trapnight is defined as one trap set for 1 night. With two standard traplines, totaling 50 traps, the first night of trapping is equal to 50 trapnights. Three nights of trapping would equal **150** trapnights. The formula for expressing catch per 100 trapnights is:

$$\left[\frac{\text{total catch of small mammals}}{(\text{no. of traps}) \times (\text{no. of trapnights})} \right] \times 100 = \text{small mammals caught per 100 trapnights}$$

If two traplines, with a total of 50 traps, were run for 3 nights, and 15 small mammals were caught, trapping success would be calculated as follows:

$$\left[\frac{15}{(50)(3)} \right] \times 100 = 10 = 10 \text{ small mammals caught per 100 trapnights.}$$

Many environmental variables influence trapping success. For example, 75 traps placed for 1 night in heavy rain might yield different results than 25 traps set for 3 nights in clear weather, even though the number of trapnights is the same. Lengthening the trapping period tends to minimize daily variations and provides more reliable data.

interpreting results-Many environmental conditions affect the rate and composition of small-mammal catches. Some recognized factors of importance are time of year, weather, and site disturbance.

- Small-mammal populations generally are lowest in the spring because of over-winter mortality. Beginning in the spring, numbers increase owing to the addition of young animals to the population. Populations are highest in fall. Dispersal of animals, primarily young, into unoccupied habitat is greatest during late summer and fall. This is an important consideration when scheduling trapline transects, because such habitat may be quickly occupied by dispersing juveniles.
- Deer mice are active during all kinds of weather, although abrupt weather changes may alter their activity patterns. Sudden cold snaps, snows, or heavy rains after mild weather will inhibit deer mouse (and chipmunk) activity. Nocturnal mice show a reluctance to roam freely on bright nights, which results in generally lower catches under full-moon conditions than on dark nights.
- Most mice and shrews are nocturnal; chipmunks and ground squirrels are diurnal and actively forage during the day. Leaving traps set for a minimum of 24 hours therefore is necessary to get a representative sample of species in the area.

Live trapping-Capturing, marking, and releasing small mammals is a desirable variation of the trapline transect (trapping) techniques described above. The major advantages of live-trapping are:

- Animals are not removed from a population. This prevents other animals from reoccupying an area after removal of trapped animals.

- Retrapping may be done at any time after initial trapping, thereby taking into account variations in conditions caused by factors such as weather changes and seasonal animal activities.
- Retrapping can be done at original trapping sites. This eliminates error caused when a different population is sampled during retrapping.

Many techniques for kill-trapping and directions for analyzing results have been described in previous section "Trapline transects." This section covers modifications that are necessary to apply live-trapping techniques to the trapline transect survey.

Equipment needed

- Twenty-five live-traps.
- Bait made of whole rolled oats or a mixture of whole rolled oats and peanut butter.
- Raw wool for nest material.
- Cloth or plastic bags about 3-1/2 by 5 by 15 inches are recommended for removing small mammals from Sherman-type traps.

Procedure+

- Shade traps from the sun, so that lethal air temperatures will not build up within them.
- Shelter live-traps from direct rain impact, because they are not watertight. Exposure to rain wets trap interiors and their contents, and often leads to exposure and death of captured animals. Rain protection can be provided by constructing bark shelters, or by placing traps under logs or similar cover. Strips of tarpaper can be used effectively to keep traps dry.
- Place wool or cotton at the back of each trap to provide nesting material. This **may help ensure survival of trapped animals in inclement weather. Be sure that** the material does not interfere with the trigger.
- Animals may be removed from traps and handled safely by placing a cloth or plastic bag over the rear of the trap, opening the trap door, and if necessary, shaking the trap to dislodge the trapped animal. Wear gloves. The animal will usually retreat into the bag, which then should be removed from the trap. Hold the bag closed with one hand and grasp the animal by the nape of its neck with the other hand. Invert the bag so the animal can be marked, examined, and released. This method minimizes the chance of an animal escaping or of a handler being **bitten**.
- All animals should be marked for identification, in the event of recapture. Marking may be done in several ways. Toes of squirrels and chipmunks may be clipped, or ears of mice may be notched. Both of these procedures may be used to identify individual animals by marking a combination of toes or positions on the ears. Numbered monel fingerling tags may be attached to the base of the ear. Check with local wildlife officials to determine whether marking restrictions apply in your area.
- Record marked animals by trapsite (see earlier section, "Stocking surveys") where originally marked and time of recapture.

Indirect Population Estimates

Counting Animal Signs

- Summarize data by calculating the catch per 100 trapnights, enumerating only those animals caught for the first time; disregard all recaptures.

Population trends, relative numbers, or amount of time animals used an area can be estimated by counting pellet groups, mounds, runways, nests, evidence of feeding, and similar signs. Indirect population measurements often are more easily obtained than direct census, but require some type of calibration to relate the item counted to the population density. For example, it is necessary to know the number of deer pellet groups dropped per day when calculating deer-days of use by the pellet-group method. Potential damage to natural seed fall, direct seeding, and spot seeding can be predicted by measuring the rate at which small animals remove food from baited spots.

Three types of surveys useful in gathering population information on forest mammals and birds are pellet group counts, mound counts, and seed-spot surveys.

Pellet-group counts-This section deals with procedures for collecting and interpreting pellet group data for big-game population counts. Other pellet sampling techniques have been developed for censuses of small mammals such as mice (Emlen 1957) and hares (Adams 1959).

The following may apply to the use of pellet transects:

- Pellet-group counts can be used effectively where ground cover density does not preclude accurate counting.
- Pellet-group counts provide a useful means of estimating the amount of big-game use of different forest types.
- Population trends on specific areas can be estimated by comparing annual pellet-group counts for 2 or more years.
- Fewer pellet-group plots are needed for determining population trends than for estimating population density (Moore 1949).
- Pellet-group counts can provide useful information for preparing big-game harvest recommendations. Data from a particular sampling area apply only to that area, however, and should not be extrapolated to other areas.

Plot shape-Circular plots are recommended because they are more easily established by one person than are strip plots, and plot boundaries may be quickly and simply located.

Plot size-A 100-square-foot plot with a radius of 5.6 feet is recommended.

Number of plots-The number of pellet plots needed will be influenced by the density and distribution of pellet groups and the sampling accuracy desired. Sampling accuracy, suitable for most conditions, requires that the sampling error be within 20 percent of the mean 90 percent of the time. Preliminary sampling is necessary to obtain data needed for computing sample size. After preliminary data are analyzed, it will be possible to adjust plot numbers to obtain desired accuracy.

Sample stratification--More efficient sampling may be obtained by separating different vegetational units or cover types and sampling them separately. This will reduce variation in the sample and the number of sample plots needed.

A restricted random sampling procedure should be followed. The technique requires the random selection of transect lines, which have a predetermined plot spacing.

Equipment needed--Variations in topography and cover on sample plots make standard recommendations of equipment impractical. A small broom and dustpan may be suitable for clearing pellet groups from plots that are open and free of large rocks. A small rake, 8 inches wide, and a small shovel work better in heavy vegetation.

A light chain, 5.6 feet long, is suitable for locating plot boundaries. One end should be looped for attachment to a pivot at the plot center. String or rope should not be used because it may stretch.

Materials needed--The only materials needed for plot installations are pointed stakes (1 by 2 inches by 2 feet) for plot hubs and a box of six-penny nails for pivots.

Procedures--Plots are "read" by slowly walking a circular path midway between the center stake and plot boundary. The chain should be tight so that the plot boundary is readily identified. The initial reading will include old as well as recent pellet groups. All groups should be removed from plots or be marked, and estimates should be made of the number of groups less than 1 year old. When plots are re-examined, all new pellet groups will have been deposited since the last examination. If a pellet group falls on a plot boundary, it is tallied if more than half of the pellets lie within the plot. If more than one-half of the pellets are outside the boundary, the group is not counted.

Frequency **of** counts--The type of information needed will determine the frequencies at which plots are read. Monthly counts may be used to construct a use-intensity curve for a given area. Semiannual readings, in spring and fall, are normally sufficient on winter ranges. Summer range transects usually need to be read once a year in a semiarid climate and twice a year in humid climates.

Interpreting results--The number of deer-, elk-, or sheep-days of use per acre can be estimated by dividing the total pellet group count for each species by 13, which approximates the number of defecations per day by these animals. Although defecation rates differ by seasons as animal diets change, they average about 13 per day over a year for deer, elk, and sheep. The estimated rate of cattle defecation is 12 per day. Estimations of game or livestock numbers, per acre, should be related to the amount of damage occurring.

Pocket gopher surveys--Two types of surveys are used to estimate pocket gopher density. Gopher-mound surveys should be conducted when estimating population density to determine whether controls are needed. Open-burrow surveys may be used to evaluate effectiveness of baiting or trapping (see chapter 5, "Pocket Gophers").

Seed-Spot Surveys

Seed-spot surveys can be used as a supplement to the trapline transect to obtain information on the fate of seeds and to determine the damage agent(s). (Trapping may be needed to identify the animals causing the seed loss.) They also provide a way to measure rates of seed destruction or removal. The rate of seed loss, expressed as a percentage of the total seed spots, is easily determined. When seed-spot surveys and trapline transects are used together, they should be spaced at least 5 chains apart to minimize any influence on small-mammal behavior.

Procedures

The following procedures were developed by Moore (1949) for conditions in the Douglas-fir region; the technique applies equally well to the pine region.

Locate 25 seed spots at l-chain intervals in roughly a straight line through the sampling area. Transects should be located to sample representative habitat.

More than one transect may be required to sample large areas; a transect may have to be broken in small areas. Whenever either condition arises, a minimum of 5 chains should be allowed between lines. Spacing requirements should be the same as those described for trapline transects.

Clear a spot about 1 foot in diameter of vegetation and debris to provide a smooth surface that will aid in identifying animals (via tracks) visiting the spot.

Spread about 50 seeds in a line from 3 to 4 inches long on each spot. Cover half of the seeds with a small piece of bark.

Mark the spot with plastic flagging.

Return in the morning after seed placement to record data and interpret results.

Avoid periods of snow or frost.

Materials needed-Conifer seeds and plastic flagging are needed to mark seed-spot locations.

Records-Record results (see fig. 9). Instructions for completing the form are on the back (fig. 10).

Summarizing results-Data are summarized as a percentage of the spots accepted by birds or mammals. For example, if some seeds were eaten at 10 of the 25 spots, this would represent 40 percent seed-spot acceptance.

Interpreting results-The following key is helpful in determining mammal or bird species that have visited a seed spot:

- Seed spot not trampled, seed cover burrowed under: mice, shrews.
Seed mostly hulled or removed: mice.
Seed only partly eaten: shrews.
- Seed spot trampled: birds, chipmunks.
Only exposed seed eaten: birds.
Seed cover pushed aside: chipmunks.

Chipmunks and ground squirrels usually crack open a seed hull to remove the contents, leaving the two halves largely intact. Deer mice typically open one edge of the seed, remove the endosperm, and leave an empty boat-shaped hull with clean-cut edges at the opening. Shrews shred the seed hulls more completely and leave serrated edges.

Seed Spot Survey

Observer: I D. Jones

Forest: I PNF

District: Avery

Date: 12/11/77

Location: _____

Line no.: 1

Size of Area: 3.8 a.c. Percent Slope: 45 Aspect: NW Elevation: 3,000

Weather: Overcast - calm - approx. temp - High 65, Low 45 F.

Ground cover: Recent Burn.

Area History: Clear cut and broadcast burned in Nov. 1968.

Station Number	Seed Spot Survey Results		
	Spot Acceptance		Known or Suspected Animal
	Y e s	No	
1	L		Deer Mouse
2		X	
3		X	
4		X	
5		X	
6	H		Deer Mouse
7		X	
8	M		Birds
9		X	
10		X	
11		X	
12		X	
13		X	
14		X	
15	A		Deer Mouse
16		X	
17			
18		X	
19		X	
20		X	
21		X	
22	A		Deer Mouse and Birds
23		X	
24	H		
25		X	

Total 6 19

~~(total acceptance) x (100)~~ = 24 (%spot acceptance)

Figure 9--Seed spot survey form (front).

Instructions

Observer: Forest, District.

Date: Self-explanatory.

Location: Give legal or local description.

Line number: To identify survey lines when more than one is used.

Size of area, slope, aspect, elevation: Self-explanatory.

Weather: List approximate high and low temperatures, wind conditions, precipitation, and cloud cover conditions.

Ground cover: List dominant vegetation type and density, if vegetation is present on the area. If a recent burn, list as such.

Area history: List management practices or abrupt natural changes that have taken place on the area.

Station number: Be sure to read stations in the same sequence each time, to facilitate comparisons among subsequent surveys.

Seed spot acceptance: If seeds have been removed from the spot, indicate the degree of use with the following legend: L = light; M = medium; H = heavy; A = all.

Known or suspected animal: The following key will aid in identification:

- Seed spot not trampled, seed cover burrowed under: mice, shrews
 - Seed all hulled or carried off: mice
 - Seed only partly eaten: shrews
- Seed spot trampled: birds, chipmunks
 - Only exposed seed eaten: birds
 - Seed cover pushed aside: chipmunks

Map: Use the space below to show the seed spot pattern in relation to the sample area.

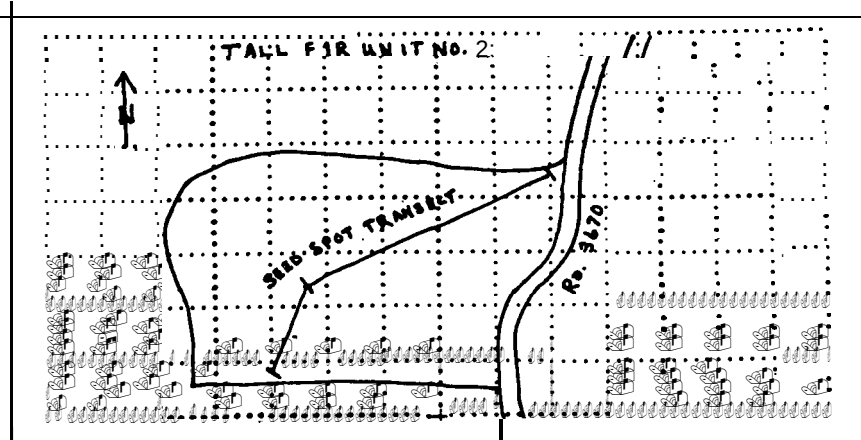
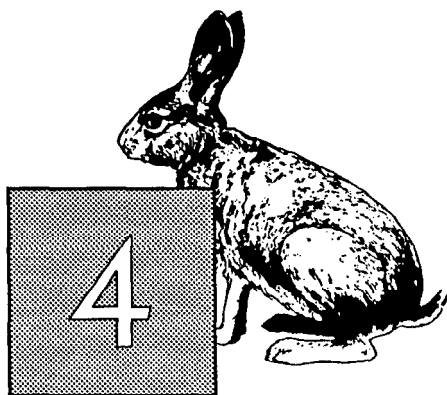


Figure 10-Seed spot survey form (back)

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Chapter 4:

Methods for Managing Damage

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Introduction

Animal damage management methods have been developed for most animals of concern in forest and rangeland management. Many of these techniques are only partially successful, however, and are used because more suitable methods are lacking.

No single method is considered completely effective under all circumstances, because the same species may respond differently to changes in habitat or other conditions. It is also common for more than one species to have caused a specific problem. These possibilities should be kept in mind when planning ADM. Depending on the species involved, extent of damage, potential adverse impacts, and cost of management, any one of several techniques or a combination of techniques may be used, including use of toxicants, repellents, hunting, trapping, habitat manipulation, and mechanical protection.

Updated information on ADM methods may be available from your District, Forest, or Regional wildlife biologist or silvicultural specialist, or from APHIS-ADC.

Chemical Toxicants

Reduction of animal populations by use of chemical toxicants can sometimes be achieved with a minimum of adverse effects.

Safety in the Use of Toxicants

When using toxic materials, utmost care must be exercised in handling, storing, applying, and disposing of these compounds. Pesticides can be injurious to humans, domestic animals, desirable plants, and fish or other wildlife if they are not handled or applied properly. Use all pesticides selectively and carefully. Follow recommended practices for the disposal of surplus pesticides and pesticide containers. Follow all label directions, and follow all directions in FSM 2150.

Animals that eat other animals for food may absorb the toxicant loads of their prey and be killed or affected in other ways (this is called secondary poisoning). Changes in behavior in birds and mammals exposed to chemical toxicants, hatching-failure in birds, and reduced reproduction in mammals may occur. The growth and survival rates of the young produced also may be reduced. For mammals, these changes in reproduction may affect both males and females. For birds, reproductive affects usually occur in females. In cage tests with birds, behavioral effects have persisted for three generations, after either the male or female of the first generation was dosed with a pesticide (Caslick 1980). Land managers should recognize that the full effects of toxicant use are difficult to study, even under laboratory conditions, and very difficult to predict under field conditions. Toxicants selected for field use therefore should be used in minimum effective amounts, and the possible secondary effects should be considered.

For further information on using pesticides safely, and for information on the current registration status of chemical toxicants in your area, contact pesticide-use specialists in Districts, Forests, or Regional Offices, or APHIS-ADC.

Regional Foresters may delegate pesticide-use authority to other line officers, except in designated wilderness, wilderness study areas, or designated or candidate research natural areas (FSM 2151.04a).

Characteristics and Uses of Lethal Agents

Strychnine-Strychnine is derived from the seeds of a plant, *Strychnine nux vomica*, grown in southern Asia. It is stable as a powder and relatively insoluble in water. Its salts have a bitter taste and are not absorbed through normal skin contact.

Ingested strychnine is quickly absorbed, mainly in the intestinal tract. The principal symptoms of strychnine poisoning, which may appear 5 to 30 minutes after ingestion, are the result of increased reflex excitability of the spinal cord. The motor reflexes are modified so that smaller stimuli are effective and the response to slight stimulation is maximal and tetanic and tends to spread to all muscles; but tetanus (continuous muscular contraction) depends on an enormous exaggeration of the "startle" reflexes from a sudden stimulus or fright. This involves the simultaneous contraction of all the muscles, which causes several secondary results such as asphyxia, increased metabolism, disturbance of temperature, rise in blood pressure, increased heart rate, and early postmortem rigor. Convulsive seizures may be interspersed by periods of quiescence. Death usually occurs from the tetanic arrest of respiration in the course of a major convulsion.

Strychnine baits may be consumed in sublethal quantities by target species. Animals consuming sublethal doses of bait may develop an aversion to the bait and usually avoid any remaining bait. Any mammal having access to bait may be killed, if sufficient bait is ingested.

Strychnine is not assimilated into tissues or bone. Predatory birds and mammals have been killed by eating field-killed mice and rabbits that had strychnine-treated grain in their guts.

Strychnine baits are restricted-use pesticides. Contact your local APHIS-ADC representative for instructions on ordering such baits from the Pocatello Supply Depot, USDA APHIS-ADC, 238 E. Dillon, Pocatello, ID 83201.

Zinc phosphide-Zinc phosphide is a finely ground powder with a black or grayish-black metallic appearance. The pure compound is 76 percent zinc and 24 percent phosphorus and has a disagreeable phosphorous odor. The chemical is stable when dry and insoluble in water. When zinc phosphide comes in contact with dilute acids, such as occurs in the stomach, phosphide gas (PH_3) is released and absorbed into the bloodstream. It takes several hours or occasionally several days for terminal symptoms of convulsions, paralysis, coma, and death from asphyxia.

Zinc phosphide-treated baits have a garliclike odor and deteriorate very slowly; if kept dry, lethal qualities are retained for at least 9 months. When exposed to rain, the bait deteriorates rapidly; for example, up to 50 percent of the toxicant can be lost in 24 hours after exposure to heavy rains. Exposure to prolonged rain and moisture can cause the loss of most of the toxicity in 2 or 3 days.

The risk of secondary poisoning of nontarget, predatory mammals and birds generally is low, because poisoned rodents become sickened and usually seek refuge underground before dying. If raptors or predators were to ingest dead or dying rodents poisoned with zinc phosphide, they likely would become sickened and vomit the toxicant. (Rodents are not able to vomit the bait.)

A risk to seed-eating birds and other rodents is present whenever baits are broadcast or placed aboveground. Pheasants, quail, and waterfowl have been killed, occasionally in large numbers, when bait was broadcast on open ground where it could be found readily.

Use extreme care in handling zinc phosphide-treated baits. Zinc phosphide can be absorbed through the bare skin. (Never distribute baits with bare hands.)

Placement of bait in active runways of meadow voles greatly reduces the chance of birds picking up the bait. Bait also can be placed in bait stations.

A 1.82-percent, zinc phosphide-treated grain bait is registered for use to control field (meadow) voles (Environmental Protection Agency [EPA] registration 6704-6). Zinc phosphide baits also are registered for control of pocket gophers, prairie dogs, ground squirrels, woodrats, and commensal rats. Contact your local APHIS-ADC representative for instructions on ordering such baits from their Pocatello, Idaho, supply depot. Order only the amount that will be used within 2 months.

Anticoagulants-Anticoagulants are chemicals that reduce or prevent the clotting of blood and cause damage to the capillaries. Used as a poison, an anticoagulant causes death by internal bleeding. Most anticoagulant baits seldom cause death in a single feeding, although some new anticoagulants may require only a single feeding. Feeding generally occurs over several days. Feeding does not have to occur on consecutive days but should take place within a 10-day interval, with no longer than 48 hours between feedings. It is important that plenty of bait be available at all times.

Continued feeding on slow-acting anticoagulants, which can be accomplished by broadcast baiting, is necessary to cause death. Bait stations (fig. 11) have been used to facilitate multiple feeding on anticoagulant-treated baits in and around buildings, but this is generally an impractical method for controlling small mammals in forest lands. Second-generation anticoagulants, such as chlorophacinone and diphacinone, are fast acting and require only a few feedings to cause death. With reasonable precautions in using anticoagulants, there is little danger to domestic animals or to raptors and predators. Rodents poisoned with anticoagulants become sickened and generally seek refuge underground before dying.

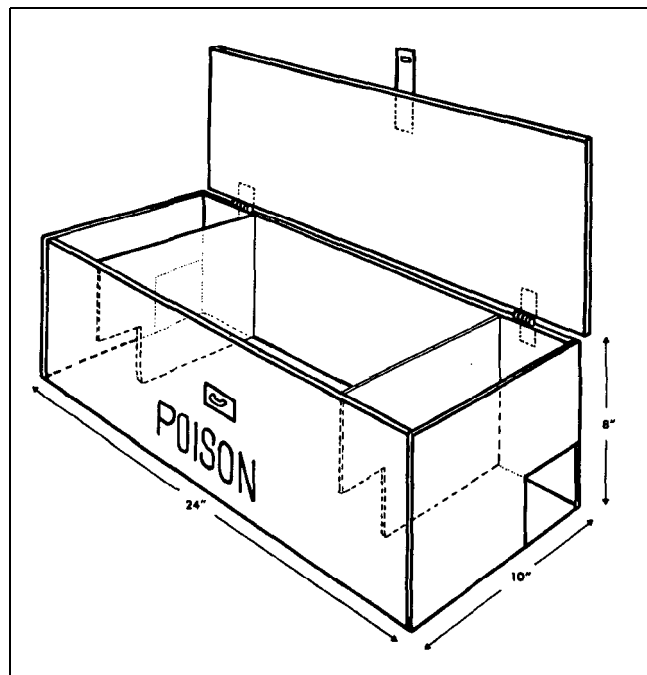


Figure 11-Bait box for use with anticoagulant baits in and around buildings. Baffles reduce spillage and prevent rain, dirt, poultry litter, and so forth, from contaminating the bait.

Several anticoagulants are registered for use in the United States and are marketed under a variety of common and trade names, including Warfarin, prolin, coumafuy, brodifacoum, bromadiolone, chlorophacinone, diphacinone, pindone, and vapone.¹ Most are not registered by the EPA for field use, but some are registered by California and Oregon for use in seed protection. The use of anticoagulants is recommended by APHIS-ADC and approved by the Forest Service for controlling rats and mice in and around buildings.

Fumigants-Fumigants are used to produce a toxic atmosphere within the tunnels of burrowing rodents or moles (and predators). Many factors, such as soil moisture, composition, and porosity, influence the functioning of fumigants. The effectiveness of fumigants is variable, and it usually requires much time and effort to fumigate each individual burrow.

Aluminum phosphide tablets have been used successfully as a fumigant for control of ground squirrels, Norway rats, and (under some conditions) moles. Fumigants have the advantage over other toxicants of eliminating secondary hazards to nontarget species.

Repellents

Some chemicals have repellent qualities that cause avoidance by animals. Species respond differently to various chemicals, with the result that no single chemical is a universal repellent. Big-game repellent (BGR) and thiram (TMTD) are registered repellents (Rochelle and others 1974). BGR is registered for use on conifer seedlings, ornamental shrubs, and fruit trees. Thiram is registered for use on trees, shrubs, ornamentals, nursery stock, and coniferous seed in combination with other active ingredients.

Big-Game Repellent

Big-game repellent is a putrified protein product derived from whole eggs. This product is registered for foliage application to protect conifers from browsing by big game. It is available in both liquid and powder formulations marketed as Deer-Away. The product generally provides protection for about 60 days in most areas, but evaluate this on a trial basis for your local conditions. Best results are obtained in areas with moderate to heavy browsing pressure (20 to 80 percent of terminals browsed). The use of BGR in these areas may reduce use from 60 to 90 percent for 2 to 3 months. In areas with extreme use (more than 80 percent browsed), the repellent may be less effective and browsing damage may not be reduced significantly.

Three to five acres per staff-day can be treated on rough terrain, and from 6 to 8 acres per day on slash-free areas on gentle terrain. The average treatment cost in 1981 (latest available data), for materials and labor to apply BGR to planted seedlings in the field, ranged from \$15 to \$30 per acre.

On May 24, 1993, the Regional Forester, Pacific Northwest Region, suspended the use of BGR in Region 6 pending the results of an EPA review of ethyl acrylate, a compound used in the manufacture of the adhesive contained in the repellent formulation. On July 19, 1993, the EPA completed its review of Deer-Away (BGR product produced by IntAgra, Inc.) and reported that it had no human health concerns about the adhesive (specifically, that it had no concerns regarding the use of ethyl acrylate in manufacture of one of the precursor chemicals in the adhesive) and has retained registration for BGR.

¹The use of trade or firm names in this publication is for reader information and does not imply endorsement by the U.S. Department of Agriculture of any product or service.

Thiram

Thiram (TMTD) has various common and trade names, including Arasan. Thiram is an organic compound, tetramethylthiuram disulfide, which is formulated as a dust, powder, liquid concentrate, or paste. It was developed originally as a fungicide. When used as a foliage spray, it reduces damage by hares and rabbits for up to 60 days but provides inconsistent protection from deer browsing. Thiram is phytotoxic and can cause foliage damage at high concentrations. Some irritation of eyes, nose, and throat have been reported by workers in contact with thiram-treated seedlings.

When a 10-percent suspension is properly applied in the nursery bed at the rate of 1 gallon per 5,000, 2-O conifer seedlings, thiram is nonphytotoxic.

Hunting

Managed hunting is a useful tool that provides recreation and may also help reduce animal damage. Sport hunting is usually the only acceptable method for reducing big-game numbers to levels that will allow plantation establishment or prevent habitat deterioration.

Animals that can be effectively controlled by hunting include deer, elk, bear, and porcupine. Heavy hunting with dogs may locally reduce rabbit populations. Sport hunting also may be a cost-effective means of controlling coyotes.

Deer and Elk

In most states, big game may be controlled over large areas by using an either-sex season, with a specific number of antlerless deer or elk permits issued. If a general either-sex season fails to decrease the population, an early or extended season may be warranted.

General season hunts, especially if restricted to taking males only, usually lack sufficient local intensity to be effective in reducing browsing problems. Controlled hunts in and adjacent to problem areas therefore are more desirable.

Special hunts should not be recommended before the possible results of the hunt are weighed against the high recreational and aesthetic values of the game animals involved. Where the extent of animal damage is unacceptable, special control may be justified. Study state wildlife regulations before attempting to develop recommendations to help solve damage problems caused by big game.

When problems caused by big game are detected, an immediate effort should be made to determine the type and extent of damage and the numbers and species of animals responsible. Careful documentation of problems may aid in securing assistance from state wildlife agencies.

Hunting pressure may be increased in specific areas by providing good road maintenance, adequate signs, maps, and publicity.

Black Bear

To reduce damage to conifers, black bears have been effectively managed in some instances by the regulation of sport hunting. In Oregon and Idaho, for example, special hunts have been scheduled in spring, when bear damage is most prevalent. Sport hunting with the use of hounds is particularly effective where allowed, but taking of bears should be restricted to those areas where significant damage is occurring. In most states, bear hunting is regulated by state wildlife agencies.

Porcupine

Hunting porcupines to reduce damage is most effective after a fresh snowfall in the winter. Trained dogs can greatly increase hunting success. Porcupine control should be done in and adjacent to areas where damage is a problem. Porcupines are inactive during a snowstorm but move around soon after. During the period of activity after a storm, porcupines can be tracked easily and killed. In spring and summer, porcupines can be located by searching meadows and riparian areas in the evening or early morning. Many porcupines can be located in this way, but because porcupines are mobile, it is difficult to determine whether a summer hunting program is effective in reducing subsequent damage.

Trapping

Trapping may serve as a suitable method of controlling animal damage problems in the following situations:

- Removal of ground squirrels remaining after poison baiting.
- Removal of problem beavers.
- Removal of problem bears.
- Control of ground squirrels, pocket gophers, porcupines, and mountain beavers in localized areas.
- Protection of buildings and supplies from wild and commensal rodents (rats and mice).

Consult your Forest wildlife biologist, biologists from the state wildlife agency, or APHIS-ADC for information on trapping techniques specific to your area.

Most animals causing forest or range damage, with the exception of bears, are easily trapped and may be taken with fully exposed traps. The main concern is to select locations frequented by the target animal. Mice and rats prefer to travel under cover of slash or vegetation or along walls in buildings. Ground squirrels and mountain beavers usually stay close to their burrows. Rabbits prefer the protection provided by slash and shrubby vegetation.

If a trap is not set in a natural runway or burrow, an attractant such as bait or scent should be used. Suitable ground squirrel baits include wheat, oats, barley, and apples. A mixture of peanut butter and whole rolled oats is a good bait for small mammals. Nut meats are good baits for woodrats. Fresh cuttings of succulent plants, such as clover, dandelion, or alfalfa, may attract a variety of herbivores.

Current state regulations should be consulted to determine the exact status of an animal in any given area. When game or furbearers are involved, it is necessary to coordinate all proposed trapping with state wildlife agencies. The agency may either take direct responsibility for handling the problem animals or issue special permits allowing their removal.

The Animal Damage Control Program of APHIS-ADC has qualified biologists to consult whenever animal damage control is anticipated. They may either accomplish needed animal control or provide on-the-job training to assist Forest Service personnel in damage control.

Trap Types and Size

Five types of traps are useful for conducting ADM surveys.

Leg-hold trap—A leg-hold trap is a general purpose trap satisfactory for taking small- and medium-sized mammals (fig. 12). The compact structure allows easy placement and concealment. Size 0 traps, with a jaw spread of about 4 inches, are recommended for taking grounds squirrels, woodrats, and Norway rats. Size 1 traps have a 4-1/2-inch jaw spread and can be used for trapping mountain beavers, although Conibear traps are recommended for this purpose. Use no. 2 traps, with a jaw spread of 5-3/4 inches, for trapping porcupines. Use traps with offset jaws to reduce foot injuries and animals pulling out of traps. Traps should be secured to a pin or other solid object with a wire or chain, to prevent an animal from escaping with the trap.

When leg-hold traps are used by Forest Service personnel, traps must be checked at least as frequently as may be required by state regulations. Frequent tending may prevent unnecessary animal suffering and adverse public criticism of control programs.

Conibear trap—The Conibear trap is a body-gripping trap that kills animals quickly, thus preventing them from pulling out of the trap (fig. 13). A special wire trigger permits the trap to be used either aboveground or belowground or in water. Successful sets can be made in runways, burrows, holes, or on rafters or poles. The no. 110 trap has a 4-1/2- by 4-1/2-inch jaw spread and is recommended for trapping rats, squirrels, mountain beavers, and similar small animals. The no. 220 trap with a 7- by 7-inch jaw spread is recommended for rabbits and hares. The no. 330 trap with a 10- by 10-inch jaw spread is recommended for trapping porcupines or beavers.

Pocket gopher trap—The pocket gopher trap is a special-purpose trap designed to fit into a burrow (fig. 14). It is 6 inches long with a jaw spread of 2-3/16 inches. Several companies make similar traps. Figure 15 gives instructions for setting a Victor pocket gopher trap.

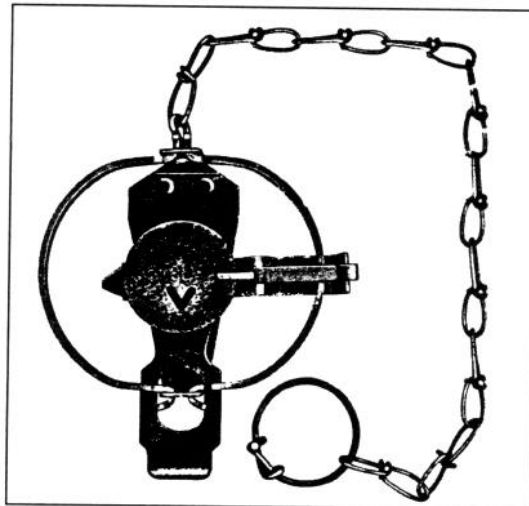


Figure 12—Typical single-spring, leg-hold trap.

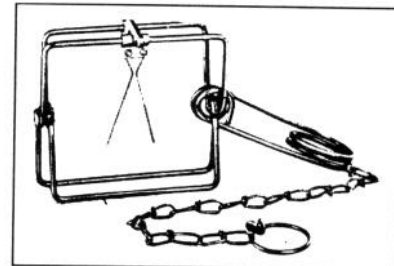


Figure 13—Typical Conibear, quickkill trap.

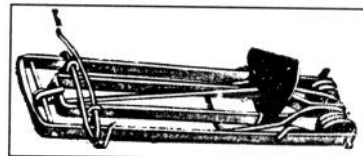


Figure 14—Typical pocket gopher trap used for placement in the burrow systems.

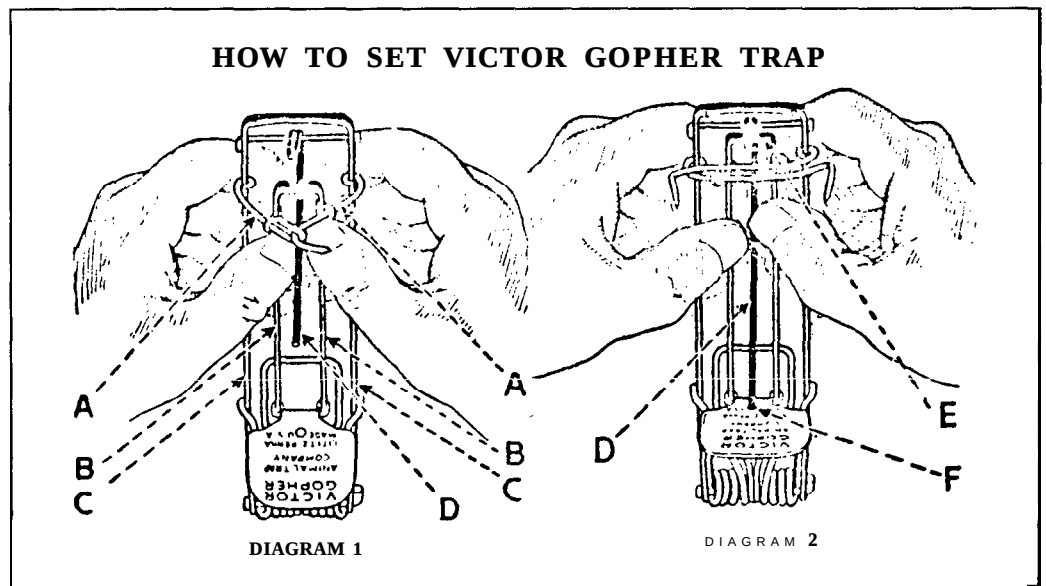


Figure 15-Instructions for setting a Victor pocket gopher trap.

1. Hold the trap in both hands as show in diagram 1.
2. Place thumbs on upper frame (B) back of the jaws (A), with the other fingers underneath the lower frame (C), diagram 1.
3. Lift the trigger (D) with the fingers and press down with the thumbs until the frame members are parallel.
4. Engage hood-end of trigger (D) in diagram 2 over end of upper frame (E); insert long end of trigger in setting hole of pan (F).
5. Place the set trap in a pocket gopher burrow and cover the opening carefully with bark, grass, or other natural materials. The jaws are in position to strike the body of the gopher.

Snaptraps--Simple design and low prices make snaptraps suitable for both surveying and controlling small-mammal populations. Three sizes are available (fig. 16): the small size (mouse trap) is suitable for mice and shrews; the large size (rat trap) is suitable for ground squirrels, woodrats, and Norway rats. The Museum Special is slightly larger than the mouse trap and is recommended for trapping chipmunks and other small mammals of similar size. Traps are usually set on the ground or other flat surface in spots protected from rain and exposure to birds.

Live-traps--Removal of problem animals alive and surveys by mark-recapture methods are best accomplished with live-traps. (Check with local state wildlife officials to determine whether special state regulations apply.) Various sizes are available. The smallest size, 3 by 3 by 10 inches, is suitable for mice, shrews, chipmunks, and golden-mantled ground squirrels. The intermediate size, 5 by 5 by 15 inches, is recommended for rats and squirrels. Larger sizes may be used for snowshoe hares and mountain beavers. The Sherman trap (fig. 17) frequently is used to census small mammals. The two smaller sizes of traps usually are made of sheet metal or aluminum. Larger sizes of live-traps (6 by 6 by 24 inches and 9 by 9 by 30 inches) usually are welded wire. Both types are available in folding and nonfolding models.

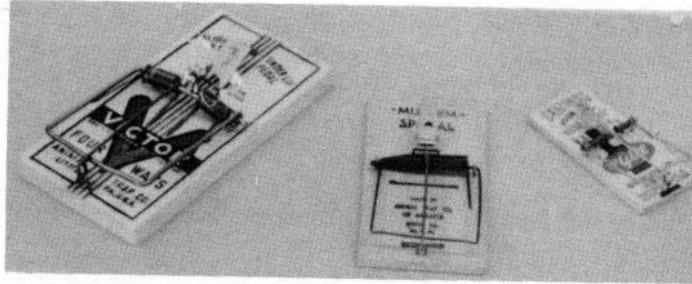


Figure 16—Typical snaptraps for trapping small mammals.

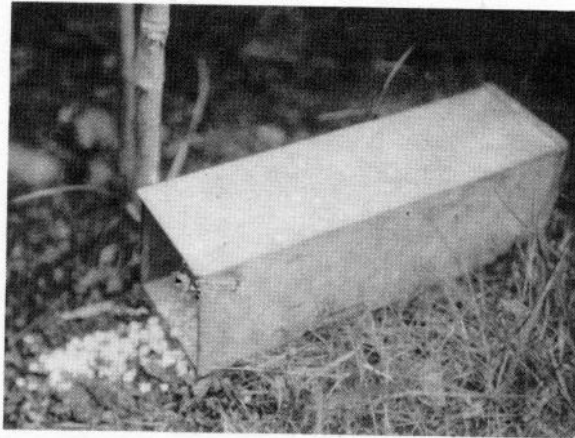


Figure 17—Sherman live-trap for small mammals.

Habitat Manipulation

Habitat manipulation may be used to influence the movements and feeding of wildlife to limit animal damage and for other purposes. Procedures are designed to enrich habitats by selectively favoring preferred herbaceous or shrub species, by seeding or planting preferred species of forbs or grasses, or conversely, by controlling the available forage to make the habitat less favorable to animals. It has been successful in many instances, but results often have not been well documented.

Planning for big-game habitat needs, as a part of forest management, can provide a way to reduce damage to conifer plantations by these animals. Land managers must remember that enhancing habitat temporarily increases carrying capacities of the treated area. Attempts to reduce animal damage by increasing the abundance of preferred grasses, forbs, or shrubs may increase the number of animals in an area and possibly result in increased damage.

Forage Fertilization and Use of Herbicides

Herbicides and fertilizers have been used successfully to alleviate animal damage by modifying animal habitats and increasing seedling survival and growth rates. Under some conditions, however, complete (albeit temporary) removal of herbaceous vegetation and shrubs with herbicides may result in more animal damage to planted seedlings, particularly where animal populations are high or where treated areas are subject to heavy use by transient animals. In some instances, habitat alterations have significantly reduced animal populations, but did not result in reductions of animal damage to seedlings. Use of these methods for ADM has not been sufficiently widespread or well documented for general recommendations to be made.

Supplemental Feeding

In Germany, artificial regeneration has produced forests of parklike stands, where food is the limiting factor for game. Controlling damage while maintaining game populations is a major management goal (Webb 1966).

Establishing game food patches called "*Wildackers*" is a technique practiced in regulated hunting areas of Germany. These *Wildackers* are scattered through the forest, forming chains of feeding areas that encourage animal movement. Food patches are cleared of tree growth, fenced, cultivated, fertilized, and planted to game foods. When supplemental forage is needed, fences are opened for access by deer. It is expected that 3 percent of the forested area in parts of Europe eventually will be devoted to the *Wildackers*.

Attempts have been made to reduce big-game damage to forest reproduction in the Pacific Northwest by seeding and planting foods for big game. Douglas lotus, Dutch white clover, alsike, yellow sweet clover, subclover, red clover, burnet, perennial rye, orchard grass, fall oats, ceanothus, and other species have been sown for this purpose. These plantings generally have been heavily used by deer and elk. Observations indicate that damage to conifers by big game decreases in areas where supplemental browse has been provided (Baron and others 1966) but the practice has not been widely adopted. If grasses are not sufficiently used in grazing, however, high-quality habitat for voles may result in extensive damage to trees by the voles. Grazing by domestic sheep and cattle in clearcuts during spring and summer is being used as a method of preventing excess grass growth in the Pacific Northwest Region of the Forest Service.

During periods of winter stress in the Rocky Mountains, deer and elk use conifer foliage and lichens knocked to the ground by snow and wind or made available by winter logging and thinning operations. Resource managers should consider scheduling thinning operations to attract browsing animals away from damage-susceptible conifer plantations. Management to enhance sprouting of desirable hardwoods in areas adjacent to vulnerable plantations can be used to develop attractive game food. Sprouting can be encouraged by cutting hardwood species that have grown beyond the reach of game. Application of herbicides and prescribed fire also may promote basal sprouting (see earlier section, "Forage Fertilization and Use of Herbicides").

Flowers (1987) tried supplemental feeding of black bears as a possible solution to tree-barking problems in western Washington. (Tree damage by bears occurs shortly after bears emerge from hibernation and when nutritious food is scarce.) He developed a food pellet containing sugar, protein, calcium, and other nutrients attractive to bears. The results of this method for reducing tree damage, however, were inconclusive.

Reducing the attractiveness of habitat for wildlife has been used as a method of reducing animal damage. Broadcast slash burning delays population buildup by brush rabbit and snowshoe hare after logging. Chemical weed and brush control offers many possibilities for controlling animals by reducing available food or cover. A 1974 study showed that complete control of vegetation reduced the abundance of pocket gophers and damage on plantations in southwestern Oregon (Black and Hooven 1974). In Washington, Borrecco (1976) found that the control of vegetation results in a reduction of clipping by snowshoe hares on Douglas-fir seedlings.

Population control through habitat modification should be evaluated carefully, because there is the potential of developing unexpected and possibly unwanted side effects. This type of treatment also can have more impact on the ecosystem than would the temporary population reduction resulting from direct control.

Manipulating Habitat Carrying Capacity

If undesirable browse plants are controlled by herbicide treatments, locally preferred plant species may be released. This may temporarily improve the habitat for some wildlife species, thereby increasing the risk of animal damage. Thinning dense conifer thickets with established understory vegetation, by prolonging the productivity of an area for wildlife, may have the same result.

Silvicultural Practices

Modifications of present timber harvesting, slash disposal, and planting practices may help reduce animal impacts on tree reproduction. Land managers must consider the effects on wildlife and wildlife habitat that may occur after any silvicultural treatment. When modifying silvicultural practices to control animal damage, the side effects of the control measure must be weighed against possible benefits. For example, in certain areas, removing slash to reduce rabbit and rodent cover may increase use by browsing animals.

Animal injuries to forest reproduction are seldom considered, unfortunately, until actual damage to the stand has occurred. The potential impact of animal damage to young trees often can be anticipated well in advance of harvest (see chapter 2). Recognition of potential problem areas during the presale and replanting surveys will allow action to minimize the impact of animal use on reforestation programs. Provision should be made in sale prescriptions for damage control measures (FSM 2472.71).

Animal damage problems should be anticipated during presale surveys when any of the following conditions occur:

- Big-game winter on the site. Areas having south and west slopes, protected valleys and draws, and areas of low elevation often provide suitable wintering grounds for big game. Deer and elk congregate in such areas during severe weather and may use all available browse, including conifers.
- Big-game use is concentrated on areas other than winter ranges. Mixed timber types, river bottoms, old burns, logged sites, game trails, and migration corridors are favored spots.
- Big-game ranges are overpopulated. Excess numbers can occur when hunting is prohibited or harvest is inadequate. Examples are municipal watersheds and areas inaccessible to the public because of distance or because right-of-entry through private property is denied.
- Heavy plant use or numerous tracks, trails, mounds, burrows, or droppings indicate abundant animal activity.
- Use of mechanical tree planters promotes dispersal of pocket gophers and creates conditions favorable for burrowing.
- Trees are planted on sites subjected to severe competition by herbaceous or shrubby vegetation. Thus the trees will be unable to grow rapidly beyond the reach of browsing animals.
- Trees are planted adjacent to older plantations that have a history of animal damage.

When presale surveys indicate that an area has a high probability of animal damage, plans should be made to manage it. Where special silvicultural prescriptions will not provide the desired protection, provisions should be made to provide appropriate physical or chemical protection.

An effort should be made to secure the cooperation and help of the state wildlife agency in alleviating potential problems caused by big game. These efforts, based on accurate and timely data on damage, may lead to special hunts, opening of areas closed to hunting, or issuance of special kill permits.

Timber harvest-Cutting practices that protect existing stocking or control the quality of animal habitat should be considered where animal problems are expected (FSH 2409.26b). Consideration also should be given to the feasibility of leaving corridors for wildlife, moving the unit, or perhaps even deleting the unit.

- Leaving roosting and nesting trees for hawks and owls within or near areas to be reforested may help maintain natural controls on rodent populations (FSM 2470, 5150), although these practices alone may not be sufficient to prevent unacceptable animal damage.

Fuel treatment-The effects of broadcast burning on animal populations and plantation survival must be evaluated carefully. Consider the advantages and disadvantages of burning, as related to the needs and behavior of problem animals.

- Leaving slash from timber harvest and other fuels unburned tends to restrict the movement of deer, elk, and livestock within a plantation. At the same time, unburned fuels provide favorable habitat for maintenance of certain small-mammal populations (see chapter 1).
- Unburned fuels, when used as a barrier to browsing, provide protection to individual conifers.
- Established browse plants remain as buffer food when slash and other fuel is left unburned. This food source will increase rapidly, as shrubs respond to the increased availability of light, moisture, and nutrients (see chapter 1).
- Broadcast burning facilitates access by deer, elk, and livestock to the entire plantation. It also reduces the amount of material, such as light fuel, that can be used to protect individual trees.
- Broadcast burning suppresses existing browse, which increases the vulnerability of planted trees to deer and elk for the first year after burning.
- In some instances, broadcast burning causes direct mortality to lagomorphs and rodents. The reduced protective cover also deters the rapid buildup of rabbit, hare, and most rodent populations during plantation establishment, when small-mammal feeding is most critical (see chapter 1).
- Broadcast burning provides quick release of soil nutrients, which may increase the palatability of recently planted conifers (see chapter 1).

Piling and burning practices should disturb the site as lightly as possible and leave 20 to 30 tons per acre of debris, which can be used to protect tree seedlings. Light disturbance of the site during piling will promote shrubs. Severe disturbance may promote erosion on some soil types and may set a site back to the earliest successional stage, which generally encourages grasses and herbs attractive to rodents and livestock (see chapter 1).

Reforestation practices-The methods followed to reforest denuded areas can greatly influence the intensity of animal damage. If an animal-damage problem is anticipated, reforestation practices can be selected to minimize damage.

Seeding in the late winter or early spring will minimize exposure of seed to seed-eating mammals and birds.

Spring plantings can be made in areas where dormant-season damage is anticipated. This will allow seedlings one growing season to become established, before exposure to severe browsing or clipping damage. Spring-planted seedlings, however, are often more easily pulled out by elk and deer than are seedlings with established root systems.

Planting of less preferred species, where applicable, can help alleviate animal damage. In the Pacific Northwest, Douglas-fir and ponderosa pine are considered preferred browse for deer and elk at certain times of the year. White fir is highly preferred in California. True firs and spruces are among the least preferred conifers. Sitka spruce, for example, is seldom damaged by deer, elk, rabbits, or mountain beaver. Tests of several provenances of ponderosa pine showed that some had natural resistance to pocket gopher damage (Case 1983). In other areas, check with Forest biologists to determine the tree species that local animals are least likely to use.

Animal damage usually is less harmful to large nursery-grown trees than to small trees. Trees with larger stems and more foliage are better able to survive animal-caused injuries than are small seedlings. On suitable sites, the increased cost of planting stock and planting usually is offset by greater seedling survival.

Planting trees under shrub canopies or slash may protect them from damage caused by deer, elk, livestock, and porcupines. The shading also may be beneficial in some areas.

Trees planted along well-used game trails or livestock trails often suffer heavy browsing and trampling damage. To avoid such losses, trees should not be planted within 8 feet of such trails.

On steep slopes, deer and elk generally feed uphill. Thus, trees planted on the uphill side of stumps, logs, and rocks will receive some protection from browsing. Planting close to large pieces of debris may provide protection from trampling.

In some instances, if significant animal damage is anticipated, this loss can be compensated for by increasing the numbers of trees planted. Reduced spacing is often enough to compensate for moderate browsing of big game or the incidental damage by pocket gophers and other rodents that occurs on many sites. It will not, however, compensate for severe damage on sites exposed to repeated damage, where most trees are being damaged or lost.

Mechanical Protection of Seeds, Seedlings, and Trees

Many techniques have been developed to physically protect seeds, seedlings, and trees. Direct protection prevents access, or excludes animals from individual trees or entire plantations. Its application is limited, however, because it usually is the most expensive type of protection available.

Physical protection of plantations usually is not needed on extensive areas but is limited to sites where severe damage has occurred or has been predicted. For example, on plantations with several aspects, only the south slopes may need protection. Protection of only those areas normally free of snow may be sufficient in plantations ranging several hundred feet in elevation. Although the cost of physical protection is comparatively high, such treatment may ensure higher survival, thereby resulting in fewer trees being planted to obtain desired stocking (see the section below, "Individual Tree Protection").

Area Protection

Deer fences-Areas of high damage potential can be fenced to exclude deer. Fencing is one of the most common methods of game-damage control in Germany. In areas where about 10 percent of forest land is fenced at all times, the fences are maintained for about 10 years. As part of the program, deer and elk are provided supplemental feed to compensate for their exclusion from more desirable wildlife feeding areas.

Because fencing excludes deer from prime habitat, it should be used only when it is apparent that reforestation cannot be accomplished by other means. Before fencing, consider all ramifications of this practice.

Fence construction and maintenance costs are high, especially in rough terrain; however, costs per acre decrease rapidly as the size of the enclosed area increases. Also, fewer materials are required per unit area to fence regularly shaped areas.

Excluding wildlife from large National Forest areas is not desirable from a multiple-use standpoint, but it may be necessary temporarily for successful reforestation or necessary to protect seed orchards.

On large areas, it is difficult to avoid fencing in game animals. Enclosed deer and elk are usually difficult and costly to remove, even by shooting or by providing escape gates. Removal of trapped animals must be considered as a cost of protection, as enclosing even a few animals may result in severe damage. To minimize possibilities of fencing in game animals, fences should be constructed before vegetative cover develops.

Deer are persistent in trying to gain access to preferred areas. Thus, fences must be carefully designed, constructed and maintained to exclude deer. Regular maintenance is necessary to prevent animals from penetrating fenced areas. If they gain access but have difficulty leaving, damage may be heavier than if no fence existed.

Fencing one area may increase deer browsing in adjacent areas. Also, deer fencing will not protect trees from rodent or hare damage, and it may increase brush competition.

Electric fences-Electric fences, with the upper wire about 2 feet above the lower, have been used to exclude deer from plantations but are ineffective for elk and moose, which break through the fence on contact.

In addition, electric fences are ineffective in deep snow and may be grounded when in contact with green vegetation. Power failures make them unreliable. Depending on local conditions, high-tensile fences and slanted fences may provide protection. Check with biologists from the state, the Cooperative Extension Service, or the APHIS-ADC for local recommendations.

Woven wire fences-A properly constructed 8-foot-high woven wire fence usually will exclude deer and elk (fig. 18). Woven wire fencing is available in 4-foot widths that can be fastened together with hog rings to produce an 8-foot-high fence. Fencing should not have openings larger than 6 inches. A 7-foot-high woven wire fence may be used, if it is topped with two strands of wire. Fencing may be attached to posts of wood or steel. If there is a possibility of timber blowdown, fences should be built away from the timber edge to avoid excessive maintenance. A travelway adjacent to the fence will facilitate maintenance.

Failure of woven wire fencing usually is a result of poor construction or lack of maintenance. Game animals frequently try to go under a high fence before attempting to jump over it. Deer can work their way under a 4-inch space between the ground and bottom wire, if the wire is slack. Spaces under fences should be filled with stones, logs, or other debris. If the wire between posts cannot be pulled snugly to the ground, it should be fastened to logs or stones that are large enough to hold the wire down. If large logs or stones are not available, two stakes may be crossed over the bottom wire and driven into the ground to close openings. Fences built along contours of steep slopes must be higher than 8 feet or have outrigger attachments to prevent animals from jumping over them.

Woven wire fences must be inspected periodically for damage by animal penetration, snow, frost heaving, fallen trees, slides, and "washouts" under the bottom wire. Restretch loose wire annually.

Cost of woven wire exclosures in the Pacific Northwest ranged from \$2.40 to \$4.85 per foot in 1984 (newer data not available). Maintenance for 5 to 7 years and removal costs will about equal the original installation expenses.

Nylon net fence-Six-inch (diagonally stretched) mesh nylon netting has been used in Oregon to exclude deer from plantations. An 8-foot-high fence is constructed around a plantation by attaching the netting to steel fence posts (fig. 19). The netting can be stretched and easily pegged down to conform to irregularities in the ground surface. Netting should not be stretched tight, because this reduces its resistance to impact.

When first used, nylon-net fencing was attached directly to trees surrounding cutting units, but fence maintenance was high because of falling limbs and trees. Maintenance problems were reduced by moving fences away from standing trees and attaching the netting to fence posts.

Nylon netting has not been in use long enough or in enough situations to permit thorough evaluation of its effectiveness for protecting plantations. Nylon fencing will exclude deer; it conforms to irregular surfaces, and construction and maintenance costs are less than for woven-wire fences, but nylon fences are more susceptible to vandalism. The anticipated life of the material is 5 to 7 years.



Figure 18—Woven wire deer fence.



Figure 19—Eight-foot-high nylon netting attached to steel fence posts to exclude deer from a plantation.

“Beaver baffler” fence-The “beaver baffler” fence (fig. 20) was developed by the Washington Department of Game. The use of this fence to prevent beavers from plugging culverts has been very successful (Fisher 1986, Guenther 1956).

The beaver baffler consists of a narrow lane of woven wire constructed around the head of a culvert or through a dam and extended out into the stream or pond (fig. 21). This lane should be at least 2-1/2 to 3 feet wide and extend 30 to 40 feet above the culvert. Where a beaver dam is continually rebuilt, a fenced lane may be constructed 30 or 40 feet below the dam and extended through the dam out into the pond for 15 to 20 feet. This extension is built in 1 to 3 feet of water and may follow the shoreline, if the lake or pond is deep. Posts must be placed closely enough to hold the wire to the bottom of the pond. If the fence is properly installed, the beaver would have to build a dam completely around the fence to hold water, but such behavior has never been observed. Instead, they concentrate on pushing mud through the fence, crawling over, or digging under the wire at the culvert or dam site.

Early experiments with fenced lanes 1-1/2 feet wide were not always successful, because beavers were able to push the wire together with mud and sticks. A persistent beaver can dig under the fence, but its work is halted when the fenced lane has several cross sections of woven wire located near the beavers accustomed working area. This prevents the beaver from carrying material inside the lane.

Fences are normally built 3 feet high. If it is necessary to build the lane in 3 feet or more of water, higher wire must be used. The cost of new material to install a 30-foot lane of fencing is usually less than the cost of making repeated trips to trap the beaver. Problem areas with heavy snow packs may require a top rail around the fence, to support the wire when buried by deep snow.

Lane fences will save labor, expense, and time wherever they can be used to discourage an occasional unwanted beaver. Streams subject to flooding have not been successfully fenced.

Alarm devices-Electronic noise makers, propane guns, whistles, horns, scarecrows, flashing lights, and various other alarm devices have been used in attempts to protect forest and agricultural crops from animals. Where short-term protection is necessary, alarm devices are sometimes effective. Animals soon become accustomed to these devices, however, and resume use of the area. Alarm devices have not proven effective for continuous protection of forest plantations or nurseries.

Seed Protection

Conical seed protectors-Individual seed spots can be protected from ground squirrels, tree squirrels, chipmunks, and mice by covering them with wire screens. About 750 protective screens can be made from a roll of no. 3 mesh hardware cloth, 100 feet long and 3 feet wide. Using tin snips, the 3-foot rolls should be cut into five strips 7-1/4 inches wide and 100 feet long. The protectors are cut from the narrow strips with the aid of a parallelogram-shaped pattern made of plywood. Pattern dimensions are 7-1/4 inches high by 8 inches wide, the interior angles of 60 and 120 degrees. Large quantities of screen can be stamped out by machine. Screens can be packed flat in boxes or bags for use in the field.

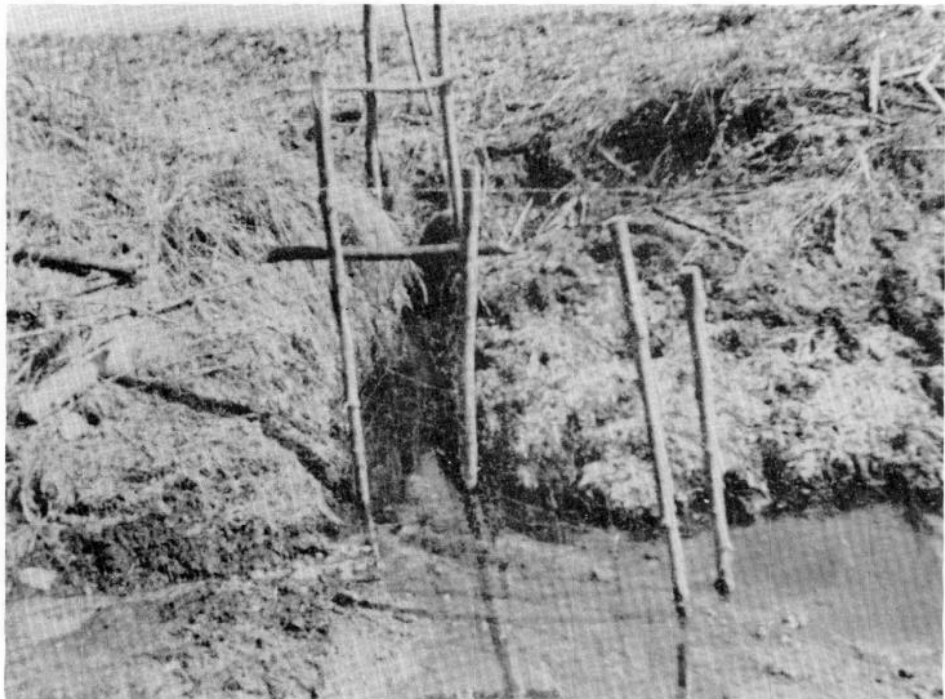


Figure 20—"Beaver baffler" fence, showing placement after a portion of the dam has been removed.

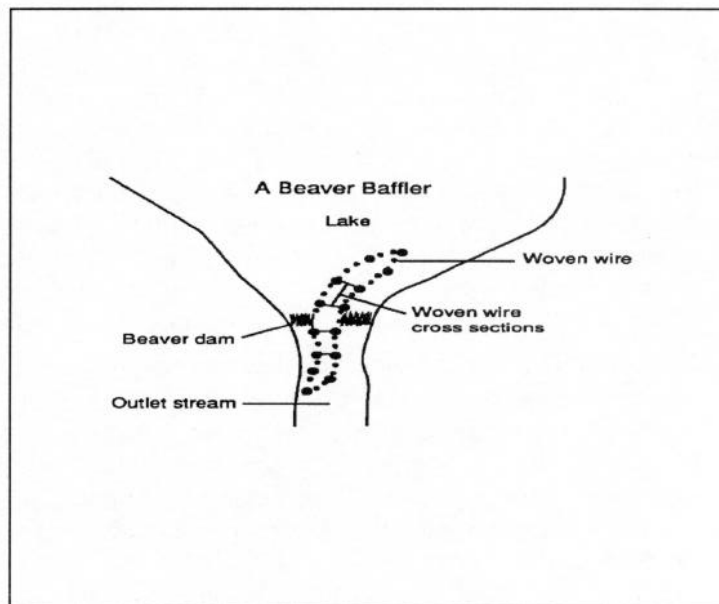


Figure 21—"Beaver baffler" fence, showing fence built through dam and extending up and downstream in 2 to 3 feet of water.

Individual Tree Protection

In the field, the screen is rolled into a cone and held in this shape by folding the cut-wire ends into the body of the screen. The protector is set by forcing the base about 2 inches into the ground. When set, this protector has a basal diameter of about 4-1/2 inches and a height of 5 inches. This type of screen provides at least 90 percent protection against small mammals during the first season. The screens should be left in place through the growing season to keep rodents from destroying the young seedlings, and then removed. Protectors can be reused several times.

Netting-Netting has been used successfully to protect a variety of agricultural crops from depredating birds. The cost of netting and installation is generally quite expensive (\$500 to \$800 per acre in 1984) and can be justified only to protect high-value crops such as berries, fruits, or tree seeds in nurseries. When used, care must be taken to obtain netting with a small enough mesh to exclude undesirable birds. The netting needs to be installed such that feeding through the net or gaining entrance under the edges is eliminated.

Several companies produce various netting materials suitable for excluding birds from high-value crops. Contact your local Cooperative Extension Service agent or APHIS-ADC for current sources.

Plastic-mesh tubing-Enclosing individual trees with plastic-mesh tubing will protect them from damage by mountain beavers, hares, rabbits, deer, and elk (Campbell and Evans 1975a) and, to a lesser extent, pocket gophers. Where intensive protective measures such as tubing or fencing are necessary for successful reforestation, tubing has an advantage over fencing because it does not exclude wildlife from prime habitat. Tubes should be used only when extra planting of 30 or 40 percent will not yield sufficient stocking, and they should be used only where they are cost effective. Extensive use of plastic tubing to protect plantations is expensive, and costs increase rapidly as terrain becomes steeper and rougher. In addition, cost per unit area for a specific number of tubes is fixed; it does not decrease with additional area as does the cost of fencing. (Larson and others [1979] is an excellent reference for tube installation.) It is very important not only to install the tube correctly, but also to use a tube diameter large enough to allow the tree to develop and grow as normally as possible. Four- to five-inch-diameter tubes should be used for pines. For Douglas-fir and western larch, 3-1/4-inch-diameter tubes are recommended. Diamond twill pattern is recommended as it is the most rigid. Other patterns are more flexible and tend to bend over more. A 3/8-inch mesh opening is recommended.

There will be some growth distortion of tubed trees, due to tube bending or new growth being caught in the mesh opening. The large diameter (recommended above) will help alleviate distortion. Annual maintenance of the tubes should be included in tubing operations. Tubes can be ordered with different breakdown rates. For Rocky Mountain sites, tubes should be ordered that have 30- to 40-month photobreakdown rates. For other areas, local experience and local management guidelines should be followed.

The number of trees to be tubed should be governed by the stocking required in a specific area. The presence and condition of "natural" seedlings as well as those trees seeded or planted always should be considered when assessing stocking adequacy. For additional details see Campbell and Evans (1975; also in appendix 3 of this handbook).

Obstructions-Constructing barriers over and around young trees may effectively protect them from big game and domestic livestock and partially protect them from other wildlife (fig. 22). Materials such as tree limbs and other debris normally are available after logging, site preparation in brush fields, or fires. It may be necessary to cut small, fire-killed trees or shrubs for additional material. Protection costs using this technique differ relative to the availability of materials and the number of trees protected per acre.

Tree guards-Tree squirrels can be discouraged from climbing individual trees, such as in a tree-seed orchard, by placing a 2-foot-wide metal band around the trunk of the tree, about 6 feet above the ground. Because tree squirrels are excellent jumpers, the bands are ineffective if branches of unprotected trees are near enough to permit jumping between trees.

Beavers can be discouraged from cutting individual trees by encircling the lower 3 feet of the tree with 1-inch mesh wire fencing. Allow room for tree growth, and replace as needed.

Bud caps-Bud caps are effective against browsing by big game, particularly in winter and early spring. Caps should be used on stock strong enough to support a cap without bending over. Generally, stems 1 1/4 inch in diameter at the point of installation will support a cap. Bud caps are effective for one growing season and may need to be replaced annually for 3 years before seedlings are free to grow. Areas without protection being browsed at 50- to 70-percent rates should expect to have damage reduced to about 10 percent of terminals browsed.

Many types of bud caps have been tried; the style shown in figure 23 has proven very effective. This cap uses a piece of 8-1/2- by 5-1/2-inch waterproof paper and five staples. One staple is used to hold the top of the cap together. The other staples are used in pairs on each side of the stem just below the bud, to hold the cap firmly in place. The terminal bud should be positioned in about the center of the tube, with 4 inches of the tube above the bud and 4 inches of stem in the tube below the bud. No more than 25 percent of the foliage should be stapled inside a cap. Some Districts in Region 6 have reported heat damage to the leader from using this type of cap. Bud caps made of polypropylene netting are now available; they may reduce or eliminate this heat damage. Bud caps should be tried first on a small scale to determine their usefulness under local conditions. Although bud capping is not widely used for animal damage reduction, it may be useful in some situations.



Figure 22—Hand-piled brush provides effective protection of planted ponderosa pine seedlings.

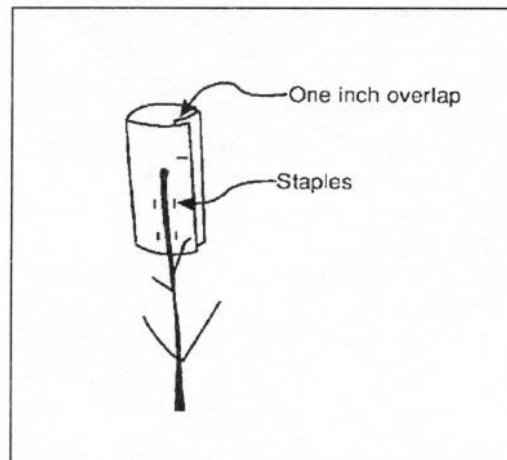
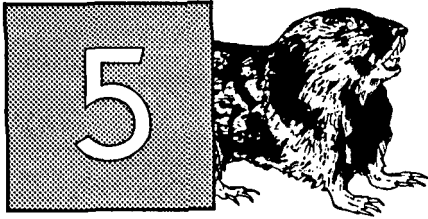


Figure 23—Bud cap, showing placement of staples in relation to the terminal bud.

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Chapter 5

Wildlife Problem Species and Their Management

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Large Mammals

Rocky Mountain Elk, Wapiti (*Cervus elaphus nelsoni*)

Description—A large member of the deer family with a pale yellow rump patch, small tail, and reddish brown body. Elk can weigh up to 1,000 pounds. Males have huge spreading antlers. Cows are much smaller, rarely weighing more than 600 pounds.

Economic significance—The Rocky Mountain elk is one of the most prized game animals. Money spent in its pursuit provides a substantial source of income to local communities that furnish services and supplies.

Overgrazing by elk in localized areas may cause range and watershed problems when populations are allowed to exceed carrying capacity. Rocky Mountain elk also may cause serious problems in forest regeneration, and in some areas, elk depredations cause serious economic losses to ranchers. When forced by hunger, elk will use orchards and haystacks to supplement their diets.

Life history information-

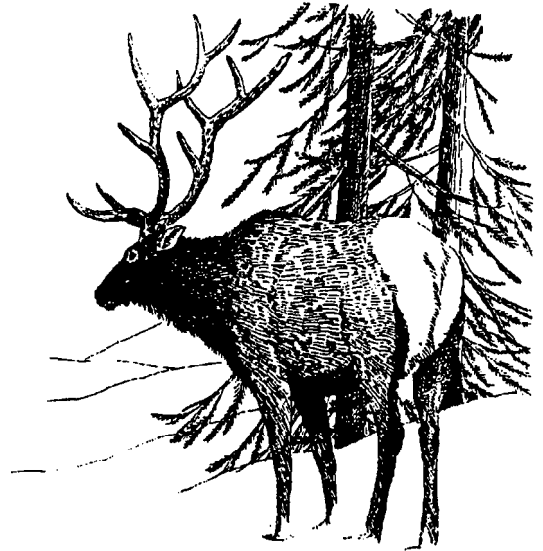
Preferred habitat—Rocky Mountain elk are found in timbered mountainous areas. Favored habitats include meadows and grasslands for feeding and dense timber for cover. Optimum habitat has gentle terrain and free-running water available during summer. Areas disturbed by fire or logging usually support a diversity of vegetation and are attractive to elk. A good distribution of escape cover is needed to make these areas more desirable.

Feeding habit—shrubs, forbs, grasses, and sedges form the basic diet, but significant quantities of forbs and browse are used seasonally. During spring and early summer, succulent grasses, sedges, and forbs make up the major portion of the diet of Rocky Mountain elk. As grasses and sedges mature during late summer and early fall, the diet shifts to shrub species, which stay succulent longer. Wintering can occur on open bunchgrass or shrub ranges, as the highly adaptable elk will use whatever food source is most readily available. The two daily feeding periods are in the morning—from just before to several hours after daylight—and in the early evening. Winter feeding periods are more frequent and erratic.

Activity—Elk normally cover several miles a day as they feed during spring, summer, and fall. In winter, they are more sedentary and feed heavily in one area before moving to another. Migration from summer to winter range usually takes place in late November and December. Some routes are more than 100 miles, but they usually are much shorter.

Elk are gregarious and travel in herds most of the year. Herd size is greatest from late summer through winter. Older bulls are more solitary, are often found alone, and tend to winter at higher elevations.

Elk make well-defined trails. They usually bed on gentle slopes, benches, or ridgetops.



Reproduction--Rocky Mountain elk are polygamous. Their main breeding period is from late August through September. The gestation period is 249 to 262 days, with the calf drop occurring from late May to mid-June. Breeding age of cows normally begins at 2-1/2 years, although 1-1/2 year-old cows may breed. Bulls 1-1/2 years old are capable of breeding and are significant breeders in many heavily hunted populations. Many Rocky Mountain elk herds have high calf production rates, with a 35 to 50-percent annual rate of population increase possible.

Damage problems and their management-

Browsing-Elk, possessing lower incisors only, leave a splintered break on browsed, dormant woody stems (see fig. 1). Spring browsing may cause the bark to slip from the browsed twig, resulting in a stripped stem below the break. Small, newly planted seedlings may be pulled out by elk, especially on wet or loose, sandy soils. Where large numbers of planted seedlings are missing completely and elk are numerous, elk may be responsible. Elk also bark shrubs and small deciduous trees, particularly willow and cottonwoods. Elk may seriously damage plantations by trampling, particularly along trails and in loafing and bedding areas.

Grazing--Grazing use is difficult to differentiate from that of livestock. The best way to identify the impact of elk use on rangelands is by a combination of surveys. A range survey (FSH 2209.21) can be used to evaluate total forage use, and a series of pellet-group-count transects (see chapter 3), which can be read once or twice a year, can be used to separate big-game use from domestic stock use.

Defering the need for damage management--Browsing on conifers is frequently highest immediately after planting in new clearcuttings. When forage plants become well established in a harvest unit, the amount of conifer use declines. A survey, such as the reforestation stocking survey, should be made to gather information to evaluate degree of use by elk. Browsing of 20 percent or less of the terminal shoots is usually not sufficient to warrant control, because a plantation may sustain the effects of such browsing without serious growth loss. Elk prefer to feed near bedding areas, and damage may be concentrated near them. Some plantations can be adequately protected by treating only those areas on gentle to moderate slopes. Overuse by grazing is frequently the result of excessive use by both big game and domestic livestock. The type of control depends on the land-management objectives for the particular area and the ability to implement control practices.

As in most damage situations, the best predictive information can be found by evaluating adjacent areas having similar conditions and history.

Management methods-

Hunting--increased elk damage to plantations or forage areas may be related to habitat deterioration. Downward trends in the condition of big-game habitat must be brought to the attention of the state wildlife agency and the public that does the hunting.

Silvicultural modifications--leave sufficient debris on the site after site preparation to provide seedling protection and forage for elk. When planting on wintering areas, plant as late in the spring as is consistent with other reforestation practices, use large 2-O planting stock, plant seedlings in spots protected by debris or other obstructions, and plant seedlings a minimum of 8 feet from well-used elk trails. On steep hillsides, plant in or above debris piles.

Roosevelt Elk, Wapiti
(*Cervus elaphus roosevelti*)

Habitat manipulation-Consider forage fertilization, supplemental food development, or improvement of forage species composition to lessen impacts on planted trees (see chapter 4).

Area protection-Properly constructed, 8-foot high, woven-wire fences will exclude elk, but this procedure is costly and seldom used other than for very high-value plantations. Resource managers must weigh the advantages and disadvantages involved in fencing portions of National Forest System lands.

Individual tree protection--Tubing or bud caps on individual trees will protect them from elk damage (see chapter 4). For additional details see Campbell and Evans (1975; also reprinted in appendix 3).

Repellents--Big game repellent can be used to provide short-term protection to seedlings (see chapter 4 and section on black-tailed deer).

References--References for Rocky Mountain elk are combined with those for Roosevelt elk and are found at the end of that section (below).

Description--The Roosevelt elk is the largest subspecies of North American elk. Mature bulls weigh 700-1,000 pounds and mature cows 400-700 pounds. The antlers of the Roosevelt elk are generally shorter, less symmetrical, more massive, and have a narrower spread than those of the Rocky Mountain elk. The wintercoat is heavy with dark brown coloring on head, neck, and legs. The sides are a much lighter grayish-brown, and a large rump patch is whitish-yellow in color. The summer coat is more reddish brown.

Economic significance--Roosevelt elk of the Pacific slopes of Washington, Oregon, and northern California are highly valued by both outdoor enthusiasts and those who wish only to observe and photograph the animals. (About 8,000 Roosevelt elk are harvested annually in Washington and Oregon.)

In some areas, feeding damage constitutes an important loss in forest plantations. Plantation damage also may occur when elk trample young trees.

Life history information-

Preferred habitat--Roosevelt elk generally range west of the Cascade Crest in Oregon and Washington. They favor forest ranges that provide a mosaic of young and mature stands interspersed with grassy openings and narrow streamside meadows. During summer, elk in the Olympic Mountains and on the western slopes of the Cascade Range in Oregon and Washington may migrate to high mountain meadows.



Optimum habitat includes about 60 percent cover, gentle southerly or flat exposures, and a free-running water source, all in close proximity.

Feeding habits--shrubs, forbs, grasses, and sedges are all eaten readily at some period of the year. Elk use of Douglas-fir differs with season and availability of other food materials. Succulent new growth on Douglas-fir is frequently eaten, even when there is an abundance of other food. Western hemlock occasionally constitutes a major food in winter. Elk generally feed upslope in steep country. Roosevelt elk seldom feed more than 200 yards from suitable hiding or escape cover.

Activity--Roosevelt elk are most active just before dawn and again in late afternoon. Daytime activity increases during winter, when food is less abundant. Home ranges average about 2 to 4 square miles for nonmigratory populations. Migratory populations follow the receding snow to summer ranges at higher elevations. Most elk return each year to the same wintering area. Roosevelt elk normally feed over a large circular route, moving slowly through each feeding area and then moving on. A typical small band of elk makes a complete circuit of its feeding area in about 2 or 3 weeks.

Reproduction--Roosevelt elk are polygamous. Most breeding takes place between September 15 and October 15. Most yearling bulls are capable of breeding. Pre-season populations have 2 to 10 percent antlered bulls. On good range, females usually breed during the second fall after birth. The gestation period is from 8 to 8-1/2 months, and calves are dropped from mid-May through June. Less than 1 percent of births are twins. Cows in the wild are believed to be capable of bearing young for at least 20 years. Lactating cows are frequently in such poor condition that fewer than half become pregnant. Most cows with calves are still lactating during the breeding season. Studies have shown that 75 to 85 percent of dry cows and all cows in areas with high-quality forage are capable of conceiving.

The mean annual population increase depends on many factors, with quality of forage, herd density, and age structure being most important. Herds are capable of increasing at a rate of 25 to 40 percent per year.

Damage problems and their management-

Identification-Elk, possessing lower incisors only, leave a splintered break on browsed, dormant woody stems. Spring browsing may cause the bark to slip from the browsed twig, resulting in a stripped stem below the break. Small, newly planted seedlings occasionally are pulled up by elk, especially in loose, sandy, or pumice soils. Elk also bark shrubs and small deciduous trees, particularly willows and cottonwoods. Areas damaged by elk often are related to movement patterns. Elk usually travel in small bands, making well-defined trails. They bed most often on gentle slopes, benches, or ridgetops.

Determining the need for damage management--Although use of clearcuttings by Roosevelt elk is heaviest 6 to 8 years after logging, severe damage to coniferous seedlings may occur immediately after planting. Moderate to heavy browsing damage may occur throughout stand establishment and continue until terminal shoots of Douglas-fir and other conifer saplings are out of reach of the elk. Rubbing the antlers on trees may cause serious injuries, but it seldom kills the trees.

A survey should be made to gather information to evaluate degree of use by elk. Browsing of 20 percent or less on the terminal shoots usually is not significant enough to warrant control, because the plantation may sustain the effects of such browsing without serious growth loss. Some plantations can be adequately protected by treating only those areas preferred by elk that are on gentle to moderate slopes.

As in most damage situations, the best predictive information can be found by evaluating adjacent areas with similar conditions and history.

Management methods-

Hunting--Increased elk damage to plantations may be related to habitat deterioration. Downward trends in the condition of big-game habitat should be brought to the attention of the state wildlife agency, so that hunting pressure may be increased.

Silvicultural modifications--**Plant** on elk wintering areas as late in spring as is consistent with other reforestation practices; use large planting stock (24 to 30 inches high), plant seedlings in spots protected by slash or other obstructions, and plant seedlings a minimum of 8 feet from well-used elk trails. On steep hillsides, plant in or above debris piles.

Habitat manipulation--**Consider** forage, fertilization, supplemental food development, or improvement of forage species composition to lessen impact of elk damage to planted trees.

Area protection--Properly constructed, 8-foot high, woven-wire fences will exclude elk. Resource managers must weigh the advantages and disadvantages involved in fencing portions of National Forest System lands, however.

Individual plant protection--**Use** plastic tubing or bud caps on the minimum number of trees desired for the site. Treat only those areas likely to be exposed to heavy elk browsing. For additional details see Campbell and Evans (1975) in appendix 3 of this handbook.

Repellents--Big-game repellent can be used to provide short-term protection (see chapter 4 and section on black-tailed deer in this chapter).

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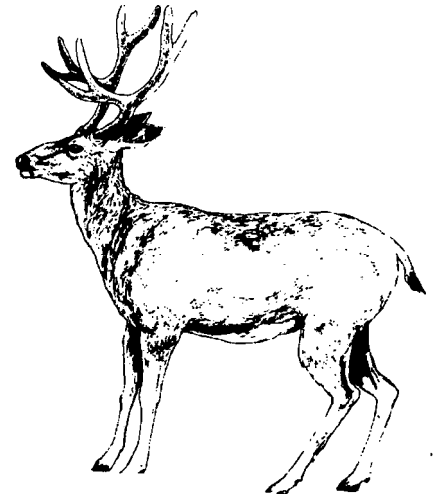
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Mule Deer
(*Odocoileus hemionus*)

Description-Mule deer differ considerably in size; bucks may weigh more than 300 pounds live weight. Pelage is dark gray during fall and winter months, reddish brown in summer. Large ears, white rump, and a short, round tail with a black tip and hairless undersurface are typical mule deer characteristics. Antlers branch in a dichotomous manner.

Economic significance-The mule deer is an important big-game animal, in both total kill and hunter days of effort. For example, during the 1982 hunting season, more than 60,000 mule deer were harvested in northern Idaho and Montana, 21,000 of which were taken from National Forest System lands. Serious reforestation problems can occur in plantations within or adjacent to deer winter range. Most damage occurs from mid-fall through spring.



Life history information-

Preferred habitat-Mule deer use nearly all habitat types that provide suitable food, cover, and water. Preferred topography includes open forests and broken brushlands on steep and rugged terrain.

Foods and feeding-Mule deer are primarily browsers and consume woody forage throughout the year. In fall and early spring, however, grasses make up a significant part of their diet. Forbs are used extensively during late spring and summer.

Activity--Daily movements are from 1 to 2 miles on summer range. On winter range, daily movement is much more restricted, generally about 1/4 mile, if undisturbed.

Most feeding is done in late evening and early morning; however, in winter it takes place throughout the day. Mule deer tend to be gregarious. This is particularly true during winter, when they often form groups of 10 or more.

Reproduction-Mule deer are polygamous. Breeding takes place from late October through early December. The gestation period is 196 to 210 days, with the fawn drop occurring in June. Most deer breed at 16 to 18 months of age. During the first two pregnancies, single fawns are normal; thereafter, twin births are common. The average number of fawns per doe is 1.5. Potential productivity is 50 to 60 percent annual increase, but net productivity seldom exceeds 20 to 40 percent in most herds.

Damage problems and their management-

Barking-Antler polishing by mule deer leaves tree bark in a shredded condition, with long frayed strips of bark hanging at the top and bottom of the barked area. Antler polishing is generally restricted to an area between 1 -1/2 and 3-1/2 feet above the ground. Preferred targets are small, live, open-growth saplings 3/4 to 1-1/2 inches in diameter, generally restricted to an area between 1-1/2 and 3-1/2 feet above the ground.

Browsing-Deer feeding on woody vegetation leave a ragged splintered edge during the dormant season, although early spring browsing may result in the bark slipping, thereby leaving a stripped stem some distance below the break. Browsing of new growth usually leaves a clean, blunt stem-end, where the tender shoots were broken off. Browsing seldom occurs more than 4 feet above the ground, except in deep snow situations (see chapter 2).

Grazing--Deer use of grass and forbs is best differentiated from use by domestic livestock and other ungulates by the use of pellet transects (see chapter 3).

Need for management-Antler polishing occurs sporadically and control is generally impractical. Browsing of less than 20 percent of the terminals is generally not a serious problem on established plantations.

The amount of deer use on rangelands that is required to constitute damage will depend in part on the objectives set for the area. If a combined deer-livestock overuse situation occurs, and if reduction in deer or livestock use is anticipated, pellet transects can help document the amount of deer use.

Management methods-

Hunting-Controlling mule deer damage by hunting is often feasible because the animals occupy open habitat and form groups in late fall. Hunting should not be considered a panacea, however, because in preferred habitats with large deer populations, tree damage may occur even though large herd reductions are made. Roads into the problem areas should be kept open and maintained during the hunting season to promote increased deer harvest.

Silvicultural modifications--Leave 20 to 30 tons per acre of debris on the site after site preparation. When planting on or near deer winter range, plant as late in the spring as is consistent with other reforestation practices. Do not plant trees within 8 feet of well-used deer trails. Practice obstruction planting (see chapter 4).

Habitat manipulation--Consider forage fertilization, supplemental food development, or improvement of forage species composition to lessen impacts on planted trees (see chapter 4).

Area protection--An 8-foot fence will effectively protect most plantations. If plantations are in deer migration routes or are subject to extremely heavy deer pressure, a woven wire fence should be used. Area protection has a number of disadvantages and should not be used if other protective measures will be equally effective (see chapter 4). Managers must determine the feasibility of this based on local conditions and current costs.

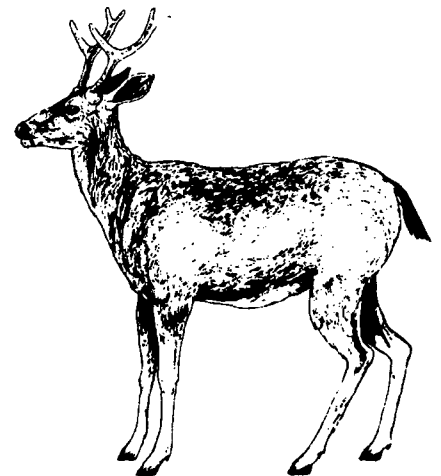
Individual tree protection--Tubing or bud caps on individual trees will protect them from deer damage (see chapter 4). For additional details see Campbell and Evans (1975; also reprinted in appendix 3).

Repellent--Big-game repellent may be applied to seedlings to provide protection (see chapter 4 and black-tailed deer). Thiram can be used as a brush-on during the dormant season.

References--References for mule deer are combined with those for black-tailed deer and are found at the end of that section (below).

Black-Tailed Deer (*Odocoileus hemionus columbianus*)

Description--The black-tailed deer is smaller than the mule deer, its closest relative. Adult black-tailed does average 110 to 130 pounds live weight, with an occasional doe weighing up to 145 pounds. Adult bucks average 120 to 160 pounds, although an occasional buck may exceed 200 pounds live weight. The summer pelage is typically reddish brown, in contrast to the winter coat, which is predominately brown to gray-brown. The tail is broad at the base and narrows gradually to a rounded tip. The outer surface of the tail is dark brown to black, with a white undersurface. The rump patch is not as pronounced as in the typical mule deer. When startled, black-tailed deer often raise their tail as a flag, similar to the behavior of white-tailed deer.



Antlers of black-tailed deer branch in a dichotomous manner, typical of mule deer. Antlers begin growth in April and are dropped from mid-December to March. Antlers of most yearling black-tailed deer and many 2 year olds develop as spikes. Branched antlers are rare for yearlings but are most common for 2 and 3 year olds.

Economic significance-The black-tailed deer is the most important game animal west of the Cascade crest, with about 90,000 harvested annually in Washington and Oregon.

Black-tailed deer usually are able to meet their year-long habitat needs within a limited area, and as a result they exert a steady pressure on forest crops. Conifer plantations often are set back as much as 5 years because of heavy deer feeding.

Life history information-

Preferred habitat-Black-tailed deer range west of the crest of the Cascade Range in Oregon and Washington. They occupy a wide range of habitats and thrive in areas of subclimax vegetation that develop after fire or logging.

Feeding habits--Black-tailed deer are primarily browsing animals, but they also consume a wide variety of herbaceous plants. As grasses and forbs become available, the volume of browse in the diet decreases. Use of conifers differs as a result of abundance, location, time of year, availability of other foods, and deer population density. The feeding pattern on steep slopes is generally uphill. Black-tailed deer seldom venture more than 200 yards from escape cover while feeding.

Activity-Daily movements are usually only a few hundred yards in extent. Many black-tailed deer are nonmigratory and spend most of their lives within an area of 1 to 2 square miles. In the more mountainous portions of their range, black-tailed deer may seasonally move to higher elevations. Migrations seldom exceed 1 mile. Deer moving into the Cascade Range migrate several miles to spend summer at upper elevations and return in fall to winter ranges that are usually below 2,000 feet.

Reproduction-Black-tailed deer are polygamous. Breeding takes place from late October to early December, with the peak occurring in mid-November. They usually breed as yearlings, but the greatest productivity is in the 3-1/2- to 6-1/2-year age group. The gestation period is about 208 days. The average fawn-per-doe ratio in good habitat is about 1.2 and in poor habitat is about 0.8. Black-tailed deer have reproductive rates of 35 to 65 percent per year, with habitat conditions being the principal control on population growth rate.

Damage problems and their management-

Barking-Antler polishing by black-tailed deer leaves the bark in a shredded condition with long frayed strips of bark hanging at the top and bottom of the barked area. Antler polishing is generally restricted to an area between 1-1/2 and 3-1/2 feet above the ground. Preferred targets are small live saplings 3/4 to 1-1/2 inches in diameter.

Browsing-Deer feeding on woody vegetation leave a ragged, splintered stem during the dormant season, although early spring browsing may cause the bark to slip, which leaves a stripped stem some distance below the break. Browsing of new growth usually leaves a clean, blunt end where the tender shoots were broken off. Browsing seldom occurs more than 4 feet above the ground, except in deep snow situations.

Winter and summer browsing damage to Douglas-fir and other conifers is a widespread problem in the Pacific Northwest (Borrecco and Black 1990). Summer browsing is common in many areas; it starts soon after spring bud burst and continues into the summer.

Determining the need for damage management-Antler polishing occurs sporadically and in such a manner that control is generally impractical. Browsing of less than 30 percent of the terminals is generally not a serious problem on established plantations.

Management methods-

Hunting-Sport hunting to regulate black-tailed deer numbers is the most desirable, although not always the most effective, method of controlling browsing damage to plantations. Deer population levels that can be maintained in this way without causing damage to other forest resources must be determined from a knowledge of local habitat conditions and deer use patterns. Obtaining a harvest that will produce a desired population level is primarily the result of coordination with the state wildlife agency and the hunting public. Roads into the problem areas should be kept open and maintained during the hunting season to promote increased deer harvest.

Silvicultural modifications-Leave logged areas unburned to restrict deer access to trees and to preserve existing food. When planting on deer winter range, plant as late in the spring as is consistent with other reforestation requirements. Mix tree species and include those that local experience has indicated are of low preference. Plant stock 24 to 30 inches tall with leader diameters of 3/8 inch or larger. Plant seedlings in spots protected by slash or other obstructions and a minimum of 8 feet from well-used deer trails. Plant on the uphill side of logs, stumps, rocks, and other obstructions when on steep hillsides.

Habitat manipulation-Consider possibilities for reducing browsing pressure on conifers by improving quantity and quality of food in areas away from damage-susceptible plantations.

Area protection-Gameproof fencing is an effective method of controlling deer use in plantations, if it is economically feasible. It restricts other uses on the area, however, and should be used only after other protection alternatives have been evaluated and judged inappropriate.

Individual tree Protection--Plastic-mesh tubing or bud caps on individual trees are effective in protecting trees from deer damage. Tubing should not be used on steep slopes where deep snow cover normally occurs. For additional details see Campbell and Evans (1975; also reprinted in appendix 3).

Repellents--Big-game repellent, a putrified protein product derived from whole eggs, is available in both liquid and powder formulations. It is registered for the protection of conifer seedlings (Douglas-fir, noble fir, grand fir, and ponderosa pine) from black-tailed deer and Roosevelt elk in the Pacific Northwest (see chapter 4). These repellents may be applied to seedlings in the nursery bed or by backpack sprayer to newly planted or established seedlings in the field. The recommended use during the growing season is to apply deer repellents to new growth immediately after bud burst.

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White-Tailed Deer (*Odocoileus virginianus*)

Description-The white-tailed deer is smaller than the mule deer and black-tailed deer, although the species differs widely in size throughout ifs range. Pelage is gray-brown during fall and winter, reddish brown in summer. Large fail, white beneath; antlers (males only) branch from main beam.

Economic significance-The white-tailed deer is the most common and widely distributed deer in North America and is the most important big-game animal in the Nation, in both kill and hunter days.

There is direct competition between white-tailed deer and domestic livestock, particularly on deer winter ranges. Much of this range is privately owned and is used by ranchers as spring and fall range. When forage competition becomes keen, the ranchers may be faced with downward adjustments in stocking or supplemental feeding. In either case, they may suffer a financial loss.

Serious reforestation problems can occur in plantations within or next to deer winter range. Most damage occurs from mid-fall through spring. In hardwood forests, browsing on understory vegetation may cause extensive damage to young tree seedlings. The estimated cost of this damage to hardwood forest landowners in Pennsylvania was estimated at \$13 per acre per year if control measures (including fencing, fertilizing and herbiciding) were not used (Tilghman 1984). In Eastern forests, deer have seriously damaged oak and aspen regeneration. They also have inflicted browsing damage on planted white pines.

For some areas, guidelines are available for integrating deer management and timber management (Pruitt and Pruitt 1986). Consult with your National Forest wildlife biologist for updates on this topic.

Life history information-

Preferred habitat-White-tailed deer use various habitat types. Topography does not appear to be a constraint to use; however, preference for mesic sites, such as flood plains, marshes, and stream bottoms, does exist.

Feeding habit-White-tailed deer are primarily browsers and consume woody forage throughout the year. In spring, grasses make up a significant part of the diet. Forbs make up a substantial part of the diet during spring and summer months. The winter diet consists primarily of browse species, with conifers being a locally significant component, where available.

Activity--In northern climates, daily movements are from 1 to 2 miles on summer range. On winter ranges, daily movement is much more restricted, generally about 1/4 mile if undisturbed. Most feeding activity is in late evening and early morning; however, it may take place throughout the day in winter.

White-tailed deer tend to be gregarious during the rut and particularly during the winter.

Reproduction-White-tailed deer are polygamous. Breeding takes place from mid-November through early January. The gestation period is 185 to 200 days. Most female white-tailed deer breed at 18 months of age.

Damage problems and their management-

Barking-Antler polishing by white-tailed deer leaves the bark in a shredded condition, with long-frayed shreds of bark hanging at the top and bottom of the barked area. Antler polishing is generally restricted to an area between 1-1/2 and 3-1/2 feet above the ground. Preferred targets are small, open-grown saplings 3/4 to 1-1/2 inches in diameter.

Browsing-Deer feeding on woody vegetation leaves a ragged splintered edge during the dormant season, although early spring browsing may result in the bark slipping, which leaves a stripped stem some distance below the break. Browsing of new growth usually leaves a clean, blunt stem end where the tender shoots were broken off. Browsing seldom occurs more than 4 feet above the ground, except in deep snow situations (see chapter 2).

Grazing--Deer use of grass and forbs is best differentiated from use by domestic livestock and other ungulates by the use of pellet transects (see chapter 3).

Need for management-Antler polishing occurs sporadically and control is generally impractical. Browsing of less than 20 percent of the terminals is generally not a serious problem on established plantations.

The amount of deer use on rangelands that is required to constitute damage will depend in part on the objectives set for the area. If a combined deer-livestock overuse situation occurs, and if reduction in deer or livestock use is anticipated, pellet transects can help document the amount of deer use.

Management methods-

Hunting--Managing deer damage by sport hunting is often feasible where animals occupy open habitat and form into groups in late fall. Hunting should not be considered a panacea, however, because in preferred habitats with large deer populations, free damage may occur even though large herd reductions are made. Keep roads open to encourage hunting.

Silvicultural modifications-Similar to mule deer (see previous section on mule deer). In addition, fertilization to promote rapid seedling growth or use of fencing to temporarily exclude deer from recently harvested areas has proven very successful in achieving successful reforestation on the Allegheny National Forest in Pennsylvania (Tilghman 1984).

Habitat manipulation--Consider forage fertilization, supplemental food development, or improvement of forage species composition, to lessen impacts on planted trees (see chapter 4). Opening the overstory to discourage deer browsing during the regeneration period has been helpful in trials at the Ottawa National Forest in Michigan.

Area protection-An 8-foot fence will effectively protect most plantations. If plantations are located in deer migration routes or are subject to extremely heavy deer pressure, a woven wire fence should be used. Area protection has a number of disadvantages and should not be used if other protective measures will be equally effective (see chapter 4).

Where nurseries experience high levels of deer damage, a permanently installed woven wire fence will likely prove to be effective. Several designs have been used successfully by orchard owners; an 8-foot-high mesh fence topped with two strands of wire (about 1 and 2 feet above the woven wire) has generally been cost-effective (Caslick and Decker 1979).

A 1985 survey of 55 users of high-tensile electric fencing for controlling deer damage to orchards and field crops in the Northeast indicated that fence performance was excellent, although a majority reported that deer penetration did occur (Ellingwood and others 1985). A study of 12 randomly selected fences showed that most were in poor operating condition and needed better maintenance.

Several fence designs to exclude deer from hardwood regeneration cuts have been tried over the last 30 years at the Allegheny National Forest in Pennsylvania. An 8-foot woven wire fence has proven effective (1980 cost: \$0.81/lineal ft). In their trial of plastic mesh fencing, initial construction costs were less, but increased maintenance costs more than made up for initial savings, when compared with the woven wire fence (Tilghman 1984).

A recent evaluation of an electronic device that emitted auditory and visual stimuli showed no effectiveness in protecting hardwood seedlings in Alabama from deer (Roper and Hill 1985). In this test, the AV-ALARM electronic scare device produced the sound and strobe light.

Individual tree protection-Tubing or bud caps on individual frees will protect them from deer damage (see chapter 4). For additional details see Campbell and Evans (1975; also reprinted in appendix 3).

Repellents--Big-game repellent may be applied to provide protection (see chapter 4). Thiram can be used as a brush-on during the dormant season.

Many compounds have been investigated for their potential use as systemic deer repellents. Because they would be absorbed by the plant, they would have the advantages of not being washed off and protecting new growth. Only the naturally occurring element selenium has shown potential for this use. In studies with penned white-tailed deer at Pennsylvania State University, selenium provided some protection for white ash and black cherry seedlings, but further research is needed with free-ranging deer to evaluate repellency of systemic selenium (Angradi and Tzilkowski 1987). Field tests in Washington, in 1984, failed to confirm adequate repellency of selenium-treated seedlings to black-tailed deer (Black and Lawrence 1992).

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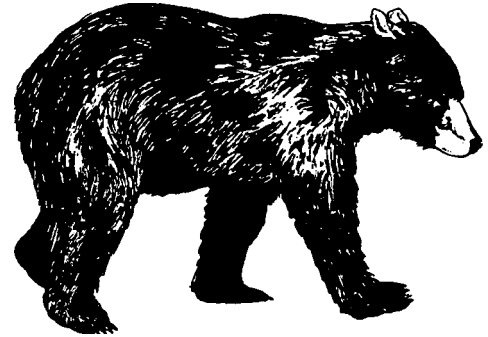
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Black Bear
(*Ursus americanus*)

Description-Black bears may weigh 200 to 500 pounds and reach a height of 2 to 3 feet at the shoulders. Their color ranges from cinnamon or black to a light brown, and usually a small patch of white is on the breast.

Economic significance-Black bears are game animals in most states. Most black bears are shot incidentally by people hunting deer and elk. There also is considerable sport hunting with hounds in local areas where bears are abundant.



Bear pelts are of only minor importance in the U.S. fur market. The largest outlet is in England where the furs are used in making hats. Poaching of bears to obtain body parts, such as gall bladders, for an illicit foreign trade has become a serious problem in all regions, particularly in the Southeast United States.

Bear damage in forests is localized; however, this damage is expected to increase as more plantations reach pole size. Bear damage was found to be three times higher in thinned versus unthinned blocks in Montana (Schmidt 1987). There, the 6- to 8-inch diameter at breast height (d.b.h.) class had 63 percent of the bear damage. Thinned blocks with moderate damage may still yield significantly more board feet per acre than unthinned stands with less damage. Supplemental feeding of bears may result in hazards to humans and is not recommended.

Life history information-

Preferred habitat-Dense forests with scattered mountain meadows and areas of berry-producing shrubs provide ideal habitat. Bears seldom venture far from escape cover.

Feeding habits--Succulent herbs, roots, grasses, nuts, fruits, insects, and animal flesh are readily eaten, with vegetable matter making up the bulk of their diet. In many areas, bears do considerable damage to young conifers during May, June, and July by stripping off bark to feed on the sap and inner tissue. They prefer fast-growing, smooth-barked firs 5 to 15 inches d.b.h. They bite the bark off or peel it downward and then scrape the sapwood with upward movements of their lower incisors.

Activity--The size of the home ranges of bears differs considerably by habitat type. In western Washington, for example, the home range of female black bears is about 1 square mile and about 30 square miles for males (Poelker and Hartwell 1973). In Montana, the home range of female and male black bears is 207 acres and 1,233 acres, respectively (Jonkel and Cowan 1971). Information has been tabulated on translocation distances of live-trapped black bears to determine how far they must be moved to minimize their chances of returning (Rogers 1986).

Reproduction-Black bears are polygamous. Most breeding takes place during June and July, and females usually breed every other year. Breeding begins when the animals are 3-1/2 years old. The gestation period is from 7 to 7-1/2 months. Cubs are born in January or February while the mother is still in the den. Twins are normal; singles and triplets are not uncommon. The average annual population increase is about 5 to 12 percent.

Damage problems and their management-

Identification-Black bears leave large strips of bark around the bases of trees they peel. Long vertical grooves in the sapwood are left by the incisors as the bear strips off the outer layers of sapwood (fig. 24), in contrast to rodents that leave short horizontal or diagonal grooves in barked stems.

Determining the need for damage management-Before a bear removal program or other bear management practice is begun, stand exam information needs to be reviewed closely to determine whether impacted stands are being reduced below acceptable stocking levels or are only being thinned. Frequently, individual bears can be removed to alleviate a serious damage problem.

Management methods-

Hunting and snaring are the most effective management methods now available. The effectiveness of these methods in reducing damage to young trees is not fully known, but population reduction usually will reduce damage to an acceptable level. There are no current data to support supplemental feeding as a method for reducing bear damage to trees. It is not recommended by the U.S. Department of Agriculture, APHIS-ADC.

Hunting-In damage areas, sport hunting for bears should be encouraged, because it is a desirable use of the resource and can help reduce damage (see chapter 4). Local newspaper and radio releases can be helpful in directing hunters to critical areas. Maps showing damaged areas and the road system should be available to inquiring hunters.

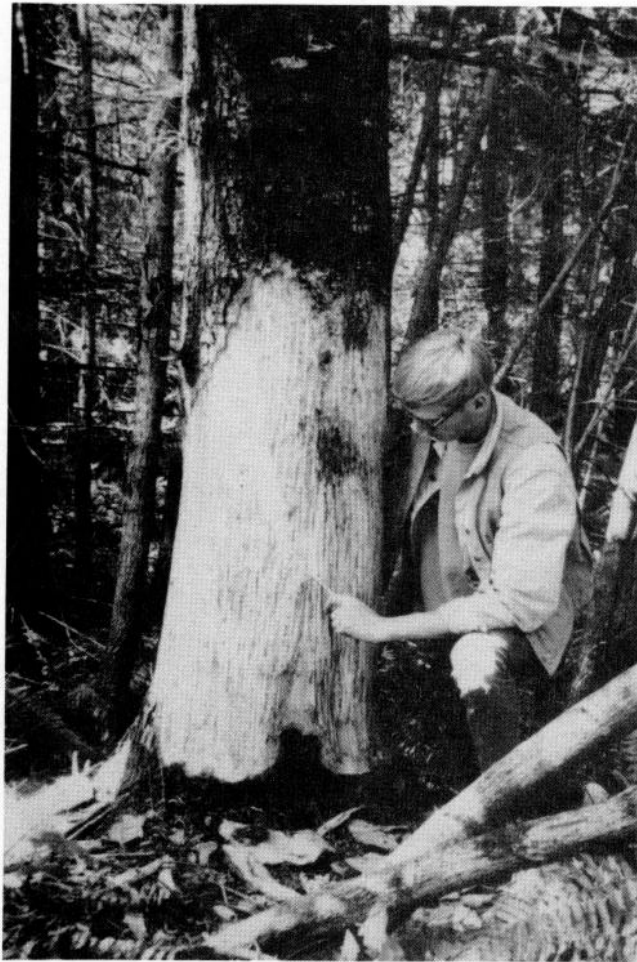


Figure 24—Basal barking on Douglas-fir by a black bear. Long vertical grooves on the exposed sapwood and large strips of bark at the base of damaged trees are identifying characteristics.

Snaring—Taking bears with a steel cable foot-snare is a common practice in many damage areas (see chapter 4). Snaring has the advantage of restricting control to specific problem areas. Consult with APHIS-ADC and the state wildlife agency regarding snaring procedures and pertinent regulations before beginning any bear removal program involving foot snares.

Piling slash against the bases of crop trees at precommercial thinning—

Although the initial trials were inconclusive and the practice is labor intensive, piling slash against croptrees may offer a practical and environmentally acceptable way to alleviate bear damage to young stands.

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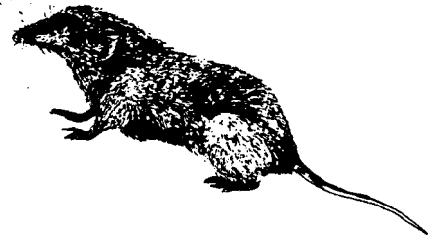
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Small Mammals

Shrews (*Sorex* spp.)

Description-Shrews are mouse-sized insectivores with dark beady eyes. Ears are concealed or nearly concealed by soft, thick fur. Shrews differ from mice, with which they often are confused, by having five toes on each foot. Mice have only four toes on each front foot. Field identification among species is difficult.



Economic significance-Shrews are among the many small forest mammals that eat conifer tree seeds. Shrews destroyed up to 10 percent of white spruce seed over a 6-year period in Alberta (Radvanyi 1970). Shrews also ate lodgepole pine seeds there (Radvanyi 1977). More studies are needed to determine the effects of shrews on reforestation.

Life History Information-

Preferred habitat-Severals species of shrews occur on Forest Service lands. They prefer moist sites with an abundant food source and dense cover and are most abundant in mesic forested regions.

Feeding habits-Shrews feed primarily on the adults and larvae of insects, other small forms of animal life, and carrion when available, although seeds and other plant parts also are eaten. They have both a voracious appetite and a rapid rate of metabolism; they will starve if deprived of food for more than a few hours.

Activity--Shrews are active throughout the year. They spend most of their time under cover and may be active either day or night.

Reproduction--Shrews do not breed until their second year. They usually have two litters of four or five young each per year.

Damage problems and their management-

Identification-Damage by shrews has not been studied extensively. A trapline survey is the best way of determining shrew occurrence.

Determining the need for damage management-Shrews should be considered as potential seed eaters and included with the small rodents when considering the need to protect seed.

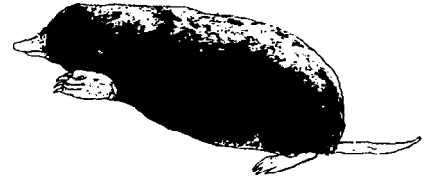
Management methods-None known. Snap traps baited with peanut butter may be used to collect shrews. Pit traps (large cans sunk into the ground until the lip of the can is level with the ground) usually are more effective.

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Moles (*Scapanus* spp)

Description--Moles live most of their lives underground. Their small, pinhead-size eyes are adapted to poor light. Broad front feet, with palms usually facing outward, aid moles in burrowing through the soil. Ear openings are completely covered by thick, soft fur.



Economic significance--Moles often are more of a nuisance than an economic liability.

The most serious problems occur in nursery beds, home yards, gardens, and golf courses where they do extensive burrowing and mound building in their search for earthworms and grubs. They may directly damage tree roots, their burrowing activities may result in root desiccation, or their mounds may cover small seedlings.

Life history-

Preferred habitat--Moist soils, lawns, fields, and forest areas where soil can be easily worked.

Feeding habits--The major items in the diet of moles are earthworms, grubs, beetles, and other insects. Small amounts of plant material, including rootlets, are occasionally consumed.

Activity--Moles are active day and night, year-round. Peak periods of mound building occur in late winter and early spring, and also in the fall, when young disperse and establish new burrow systems.

Reproduction--Breeding occurs in February to March, with young born in March and April. One litter is raised yearly, with two to six young per litter.

Damage problems and their management-

Identification--The mounds and shallow tunnels of moles are readily noticeable whenever they are present. The mole creates a rounded soil mound by shoving excavated dirt up through the center of the mound. See chapter 2 for the key features differentiating mole hills and gopher mounds.

Determining the need for management--Control of problem individuals is the best approach. Preventive management is generally not recommended, as it can be time consuming and expensive, whereas individuals can be removed with minimal effort.

Management methods-

Baiting--No baits are registered for use in the control of moles on National Forest System lands.

Trapping--Trapping is the most reliable method of control. Several types of mole traps are available at hardware stores and nurseries. Most mole traps are designed to be activated by a mole pushing aside an obstruction in a main runway of its burrow system. Trap sites should be selected by locating areas of recent activity, then stamping down short sections of the runway to determine if it is still being actively used. Main tunnels probably will be repaired within a day. The shallow feeding tunnels that branch from the deeper main tunnel frequently are not reused and should not be used for trap locations. Best results are obtained by setting traps only in actively used main tunnels (see fig. 25).

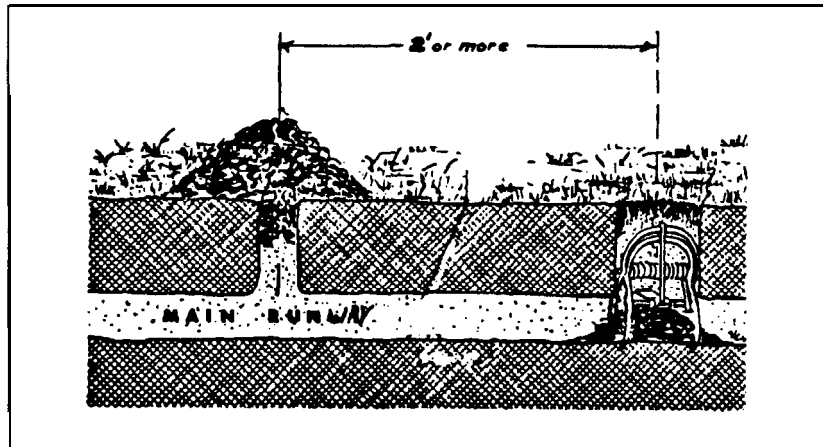


Figure 25--Scissors-jaw trap set in a main mole runway. The position of the jaws and the dirt plug under the trigger are shown.

Fumigants—There are several fumigants registered for use in controlling moles (see chapter 4). In general, the use of fumigants has given undependable results. The variability of soils, soil moisture, burrow depth, and burrow length combine to make the use of fumigants difficult and questionable.

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Rodents in Campgrounds

An excellent reference on the problems that rodents and other kinds of wildlife may create in campgrounds, diseases that may be involved (primarily plague), and practical control measures is Marsh and others (1981). It deals mainly with California species, but has an extensive list of general references. As pointed out in the report, the establishment of campgrounds may result in high densities of rodents through provision of extra water, food, and burrowing sites. When rodent densities are high, the stage may be set for epizootic disease (a disease attacking a large number of animals simultaneously). The integrated management plan proposed includes sanitation, changes in the design of facilities, and other suggestions. Rodent population-reduction methods and ectoparasite control methods also are discussed.

Managers should remain current on wildlife diseases and epizootics specific to their areas. Consult with public health officials and local veterinarians for updated local information. Wild birds are reservoirs for viral encephalitis; rodents and lagomorphs for plague and tularemia (their ticks are carriers for Rocky Mountain spotted fever). Beavers are suspect in spreading human giardiasis; woodchucks and deer spread parasites pathogenic to domestic livestock; waterfowl contaminate bathing beaches with "swimmers' itch," and *Cuterebra* bots (larvae of bot flies) of- pets are normally parasites of rodents and rabbits (Georgi 1983). Lyme disease, carried by deer ticks, is now a concern nationwide.

References-

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Uinta Ground Squirrel (*Spermophilus richardsoni*)

Description--Uinta ground squirrels are medium-sized rodents. The middle of the back is brownish. The tail is black mixed with buffy white above and below; belly hairs are tipped with pale buff.

Economic significance--Uinta ground squirrels are usually of only minor concern in reforestation programs, but they feed on emerging pine seedlings and young trees when other food becomes scarce.

Life history information-

Preferred habitat-Meadows, grasslands, and forest openings are the most suitable habitats.

Feeding habit-spring and early summer foods consist mainly of roots, grasses, legumes, and a wide variety of succulent plants. Some insects also are taken. In late summer, ripening seeds and grains are taken in abundance. Food is not stored.

Activity--These ground squirrels normally enter hibernation in late summer or early fall, as soon as they have accumulated sufficient body fat. Older males enter hibernation between late July and early August. Young animals require much of their food for growth, and some may be found aboveground as late as mid-September. Emergence takes place in February and March, after from 5 to 7 months of hibernation. Ground squirrels are relatively short-ranging animals and may spend their entire life in a very small area.

Reproduction--Breeding takes place shortly after spring emergence from hibernation. Young are born in 24 to 30 days and leave the nest in 2 to 3 weeks. Litters average from five to seven young.

Damage problems and their management-

Identification--Uinta ground squirrels are active during daylight hours. Their burrow entrances and adjacent soil mounds are readily apparent.

Determining the need for damage management--Squirrel control may be needed to protect new grass seedlings, if an old meadow area is heavily populated. Ground squirrels are seldom a problem on forest land, unless it has been deforested for several years and squirrels are common where trees are planted.

Management methods-

Baiting--Aboveground uses of strychnine-treated baits are no longer registered for ground squirrel control on National Forest System lands. Contact pesticide-use specialists in District, Forest, or Regional offices, or APHIS-ADC, for the current status of aboveground uses of strychnine and other toxicants for use in ground squirrel control.

Habitat manipulation--There is a direct relation between ground squirrel numbers and range condition. Poor vegetative conditions usually provide more desirable squirrel habitat because of decreased plant density and a greater variety of plant species available. Improving poor range conditions through management often will reduce the density of ground squirrels.

Trapping--Use no. 0 jump traps, live-traps, or no. 120 Conibear traps (see chapter 4). Trapping of individuals is effective and highly selective. Trapping should be used only for localized problems, because it is time consuming and costly.

Hunting--Where it can be used safely, a .22 caliber rifle is suitable for shooting ground squirrels, and it may be used effectively as a control measure within localized areas.

Fumigants--Fumigants may be effective in reducing ground squirrel populations (see chapter 4).

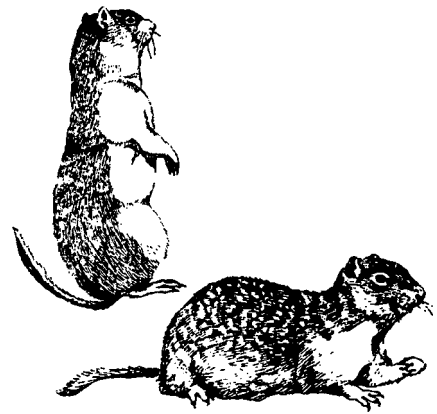
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Belding (Oregon) Ground Squirrel (*Spermophilus belding*) and **Columbian Ground Squirrel** (*Spermophilus columbianus*)

Description-Belding ground squirrels (left in the illustration) are medium-sized and have grayish upper parts mixed with buffy white. A brownish streak may run down the back. The tail is reddish beneath, tipped with black and bordered with buff or white and is small and relatively flat.

The larger Columbian ground squirrel (right) may be distinguished from all other species within its home range by its mottled, gray upperparts and dark rufous feet and legs.



Economic significance-Belding and Columbian ground squirrels are usually of only minor concern in reforestation programs, but they do feed on emerging pine seedlings and young trees when other food is scarce.

Life history information-

Preferred habitat-Belding ground squirrels range east of the Cascade Range in Oregon. Columbian ground squirrels are found in eastern Washington and north-eastern Oregon. Meadows, grasslands, and openings in or along the edges of ponderosa pine, Douglas-fir, and larch stands are the most suitable habitats.

Feeding habits-spring and early summer foods consist mainly of green vegetation, including grasses, legumes, and a wide variety of succulent plants. Some insects also are taken. In late summer, ripening seeds and grains are taken in abundance. Food is not stored.

Activity-These ground squirrels begin hibernation in mid-summer to early fall. Older males enter hibernation between late July and early August. Young animals may be found aboveground as late as mid-September. Emergence takes place in February and March. Ground squirrels are short-ranging animals and may spend their entire lives in small areas.

Reproduction-Breeding takes place shortly after spring emergence. Young are born in 24 to 30 days and leave the nest in 2 to 3 weeks. Litter sizes range from five to seven.

Damage problems and their management-

Identification-These ground squirrels are active during daylight hours. Their burrow entrances and adjacent soil mounds are readily apparent.

Determining the need for damage management-Squirrel control may be needed to protect new grass seedlings if an old meadow area is heavily populated. Ground squirrels are seldom a problem on forest land, unless it has been deforested for several years and squirrels are numerous where trees are planted.

Management methods-

Baiting-Aboveground uses of strychnine-treated baits are no longer registered for ground squirrel control on National Forest System lands. Contact pesticide-use specialists in District, Forest, or Regional offices, or APHIS-ADC, for the current status of aboveground uses of strychnine and other toxicants for use in control of ground squirrels.

Habitat manipulation-There is a direct relation between squirrel numbers and range condition. Poor vegetative conditions usually provide more desirable squirrel habitat, because of decreased plant density and the greater variety of forbs available. Improving poor range conditions through management often will reduce destructive concentrations of ground squirrels.

Trapping-Use no. 0 jump traps, live traps, or no. 120 Conibear traps. Trapping of individuals is an effective and highly selective control method. Trapping should be used only for localized problems because it is time consuming and costly.

Hunting-Where it can be used safely, a .22 caliber rifle is suitable for shooting squirrels, and it can be used effectively as a control measure within localized areas.

Fumigants-Fumigants may be effective in reducing ground squirrel populations in localized areas.

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Golden-Mantled Ground Squirrel (*Spermophilus lateralis*)

Description-The golden-mantled ground squirrel, which looks something like a chipmunk, has a relatively short, straight tail. The head is copper colored, and white stripes bordered with black are on each side of the back. The lack of stripes on the sides of the face and its much larger size distinguishes it from the chipmunks.

Economic significance-Golden-mantled ground squirrels consume large quantities of both coniferous seed and emerging seedlings. They do the most destruction to forest regeneration in some areas of any of the ground squirrels.

These ground squirrels behave much like chipmunks, adapting easily to human presence and becoming quite tame. Their appearance and mannerisms also make them a very attractive part of the natural environment.



Life history information—

Preferred habitat—Forest lands containing rocky areas for nesting provide ideal habitat.

Feeding habits—The golden-mantled ground squirrel is omnivorous, eating green vegetation, roots, bulbs, seeds, grain, nuts, berries, mushrooms, and meat. Diets differ with the seasonal availability of different plants and plant parts. Carrion apparently is eaten whenever available.

Activity—Golden-mantled ground squirrels are active during daylight hours. They rarely climb trees. Nesting is in underground burrows, usually located in rocky areas. Hibernation starts about the middle of September and usually lasts until May. Variations in the hibernating period are caused by location, elevation, weather, age, sex, and physical condition.

Reproduction—Breeding occurs once a year, shortly after emergence from hibernation. Four to six young are born in late June or early July.

Damage problems and their management—

Identification—The golden-mantled ground squirrel often opens pine seeds while on a rock or log used as an exposed feeding perch; the empty hulls are left nearly intact (fig. 26). Clipping of needles and newly emerged seedlings also occurs, but it is difficult to identify which species did the damage.

Determining the need for damage management—The golden-mantled ground squirrel should be considered a potential seed-eater if broadcast seeding is planned. Clipping damage is erratic, but if found to be a persistent problem in an area, a temporary reduction of ground squirrels should be considered.

Management methods—

Baiting—Aboveground uses of strychnine-treated baits are no longer registered for ground squirrel control on National Forest System lands. Contact pesticide-use specialists in District, Forest, or Regional offices, or APHIS-ADC, for the current status of aboveground uses of strychnine and other toxicants for use in ground squirrel control. Anticoagulants are registered for use in controlling golden-mantled ground squirrels in California and are effective (see chapter 4).

Other methods—No definitive studies have been done on the impact of habitat manipulation on golden-mantled ground squirrel populations. Trapping, hunting, fumigation, and habitat manipulation likely would be effective in controlling golden-mantled ground squirrels within localized areas, but no data on the efficacy of these methods are available.

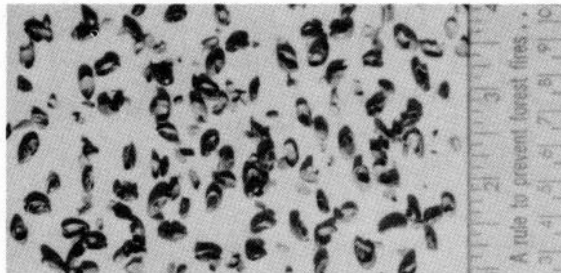


Figure 26—Ponderosa pine seeds opened by golden-mantled ground squirrels.

References-

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Black-Tailed Prairie Dog (*Cynomys ludovicianus*)

Description-These squirrellike rodents have short legs and tails. Hair color is sandy brown to cinnamon, with lighter hair on the belly. Tail tips are black. Weights are up to 3 pounds. These rodents get their name from their barklike calls.

Economic significance-prairie dogs cause extensive losses on National Grasslands by destroying high percentages of annual forage production. They may cause an unwanted change in plant composition of pastures by removing favored grasses. Their burrowing activities may create problems for mechanical cultivation and harvesting and vehicle operation, and pose hazards for horses and other livestock. Irrigated fields may be drained by burrowing activity. These animals may serve as a reservoir for bubonic plague.

Life history information-

Preferred habitat-prairie dogs prefer open areas of low vegetation (grasses or shrubs) and may be especially numerous near water sources in arid areas.

Feeding habits--Prairie dogs eat the seeds, succulent leaves, stems, and roots of grasses, sedges, and forbs. Grasshoppers and a variety of other insects are eaten during summer.

Activity--These animals are active year-round.

Reproduction--One litter of four to eight young is produced each year.

Damage problems and their management-prairie dogs clip vegetation for food and apparently to maintain open areas around their burrows. This may result in a change in forage species composition. Managers should note, however, that these changes may be beneficial to other wildlife species. Isolated or small colonies generally can be tolerated. When colonies cover several acres or more, particularly where they adjoin managed private lands, controls may be necessary. Before controls are planned, check the legal status of this animal in your area by consulting with local state wildlife officials or APHIS-ADC personnel. Because the black-footed ferret is listed as an endangered species and may occur within prairie dog range, special attention must be given to its possible occurrence.

Management methods-

Baiting-Aboveground uses of strychnine are currently prohibited in most situations. Contact pesticide-use specialists (District, Forest, or Region) or APHIS-ADC for the current registration status of chemical toxicants for use in prairie dog control.

Habitat manipulation-Plow and leave lands fallow for 2 years, then plant tall grain crops. Rest-rotation and light grazing can delay prairie dog reinvasion. Restoration of degraded rangelands now occupied by high populations of prairie dogs offers the optimum long-term solution to managing prairie dog "problems."

Trapping-For small areas, up to 5 acres, trapping with leg-hold traps, live-traps, or no. 120 Conibear traps may be effective; trapping on larger areas seldom is practical.

Hunting-Persistent shooting may reduce localized populations of prairie dogs by up to 75 percent. Managed sport shooting is a potentially effective method of managing prairie dog populations over wide areas.

Fumigation-Gas cartridges can be used for prairie dog control in some states. Check with APHIS-ADC for restrictions, recommendations, and ordering information.

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Chipmunks (*Eutamias* spp.)

Description-The chipmunk probably is the most popular and well known squirrel species. It can be identified easily by facial stripes, which distinguish it from all other mammals over most of its range. Side and back stripes end at its reddish-colored rump.



Economic significance-Coniferous tree seeds are a favorite food of chipmunks. These seeds are eagerly sought after and stored for winter use. Studies have shown that chipmunks can consume more than 200 ponderosa pine seeds in one day of feeding. When these animals are abundant, they have a deleterious effect on both natural and artificial seeding. Most seed stored by chipmunks is in deep caches and, even if uneaten, few seeds will grow.

Life history information-

Preferred habitat-Chipmunks occupy nearly all forest and range lands.

Feeding habit-Principal foods are flowering plant and tree seeds, grasses, berries, roots, and insects. Large quantities of seeds are stored in deep underground burrows to provide food during winter.

Activity-Chipmunks are terrestrial but climb readily when alarmed or when searching for food. Activities are confined to daylight hours. Nests are usually underground, near the base of a stump or beside a rock or log. These animals are most active during spring, summer, and fall. They hibernate in winter but wake occasionally to eat from stored food and to make short excursions from their dens.

Reproduction-Breeding occurs once a year, usually in March or April. The gestation period is 28 to 30 days, and litters range from four to six.

Damage problems and their management-

Identification-Trapline surveys and general observations give a good indication of chipmunk occurrence (fig. 27).

Determining the need for damage management-Chipmunks should be considered with deer mice when determining rodent control or repellency needs for seed protection. Clipping of emergent seedlings occurs but has not been shown to be a serious problem.

Management methods-Control may be needed when populations are high in reforestation project areas scheduled for seeding. Control is most effective in spring and early fall. Spring control primarily protects emerging seedlings. Early fall control will help protect the seed during the period when it is normally collected and stored by chipmunks.

Baiting-Anticoagulants (chlorophacinone, diphacinone, Pival, and Warfarin) are registered only in California for control of chipmunks (and golden-mantled ground squirrels).

Trapping-Trapping with Sherman-type live-traps or leg-hold traps is an effective means of controlling chipmunks within a localized area.

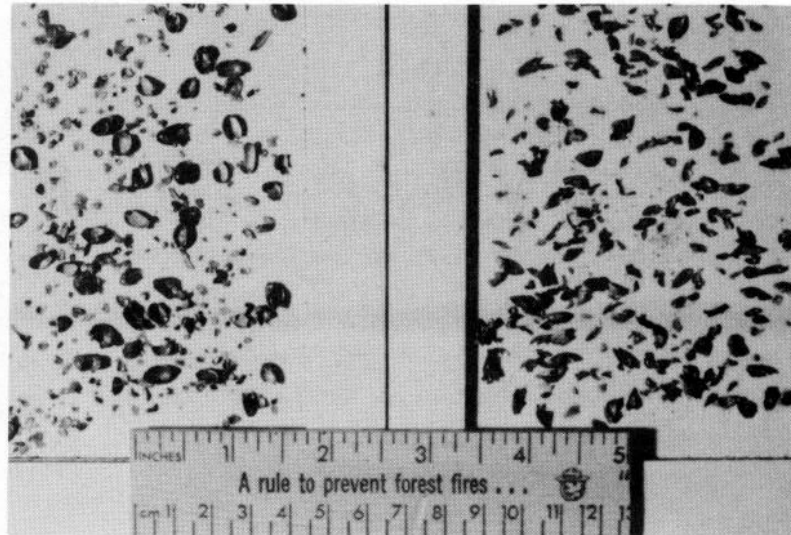


Figure 27—Seed-coat fragments after feeding by chipmunks; ponderosa pine seed on left and Douglas-fir seed on right.

Other methods—No definitive studies have been made of the impact of habitat manipulation on chipmunk populations. No data are available regarding the use of shooting or fumigation to control chipmunk populations.

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Tree Squirrels: Douglas Squirrel or Chickaree
(*Tamiasciurus douglasii*),
Western Gray Squirrel
(*Sciurus griseus*), and
Red Squirrel
(*Tamiasciurus hudsonicus*)

Description-Douglas squirrels and red squirrels are also known as “pine squirrels.” The Douglas squirrel (pictured) is slightly smaller than the red squirrel; head and body length of the Douglas squirrel is 6 to 7 inches. The vocal Douglas squirrel is a dark, reddish-olive color, with a yellowish or rusty belly. Distinct black lines along each side, which develop during the summer, help distinguish it from the western gray squirrel. The western gray squirrel is silvery gray in color with white underparts and has a very bushy tail edged with white.



The bushy-tailed red squirrel is widespread throughout most of the pine, spruce, and mixed hardwood forests of North America. It usually is heard before it is seen, because of its noisy, ratchetlike call. Its color is uniformly yellowish or reddish with seasonal variations, including a paler back color during winter and a black line running down each side in summer. It is the smallest tree squirrel in its range; head and body length is 7 to 8 inches.

The western gray squirrel is found along both sides of the Cascade Range in western Washington and western Oregon, in the Coast Range, and along the Sierra Nevada in California. This species commonly inhabits oak groves of the interior valleys. It is much larger (about 22 inches long, including tail) than the Douglas squirrel or red squirrel. It may cause minor, localized damage to mast crops in mixed coniferous-deciduous forests. Bark stripping in the upper boles of conifers is a much greater problem, however.

Economic significance-squirrels may be serious nuisances in seed orchards, seed production areas, cone storage facilities, trees with artificially pollinated cones, or conifer stands designated for cone collection because tree squirrels cut immature cones. However, cone cutting and caching also provides a source of seed that may be readily collected by humans. Squirrels also may place considerable stress on ponderosa pine through defoliation (Soderquist 1987). They eat conifer buds and inner bark from shoots; they also may clip terminal and upper lateral shoots and may strip bark from the upper boles of trees to feed on exposed sapwood.

Life history information-

Preferred habitat-Tree squirrels occupy all coniferous forest types throughout their ranges. The western gray squirrel also commonly inhabits oak groves of the interior valleys.

Feeding habits-seeds, berries, nuts, buds, mushrooms, and insects are eaten when available. Large quantities of food are stored, and single caches may contain up to 10 bushels of cones. When feeding on cones, tree squirrels habitually return to a favorite log or low limb, eventually creating a large “midden” pile of discarded cone scales.

Activity—Squirrels are diurnal (active during daylight hours). They are agile climbers, but also spend much time on the ground. Nests are usually in hollow trees, logs, or old woodpecker holes. One squirrel may have several nests. Home range is normally from 1/2 to 1 acre. Squirrels do not hibernate, but are inactive during cold or wet weather.

Reproduction—One or two litters may occur. Females breed during their second year, in March and April. The gestation period is about 40 days, and litters range from three to six. The young are weaned in about 5 weeks.

Damage problems and their management—

Identification—The occurrence of green, unopened cones scattered on the ground under mature trees and an accumulation of cone scales in a midden pile indicate the occurrence of these tree squirrels, if their chattering has not already caught your attention. The tips of branches are often cut and peeled during winter (fig. 28). Occasionally, only the buds are eaten from the twigs.

All three species of squirrels strip bark from the boles of conifers to feed on the exposed sapwood. (Bark stripping by the western gray squirrel often forms a barberpole pattern in the upper crown of conifers, which is an identifying characteristic for this species.) The sapwood and short strips of discarded bark that accumulate on the ground under the injured tree, characteristically, lack tooth marks. These bark strips readily distinguish squirrel work from similar crown-girdling injuries by the porcupine and woodrat (Sullivan 1992).

Determining the need for damage management—Management is generally needed only on an individual basis to protect seed trees or to keep squirrels out of buildings.

Management methods—Tree squirrels often are classified as game animals and can be taken only as provided by hunting regulations or under authority of a depredation permit. When local problems arise, the following protective measures should be followed.



Figure 28—Field sign of tree squirrels showing (A) opened Douglas-fir cone, with scales cut and removed, and (B) branch tips of pine cut and peeled during winter.

Individual free protection--Bands of sheet metal flashing will prevent squirrels from climbing trees. The bands should be at least 2 feet wide and should be placed 6 feet above the ground. Branches of protected trees should not be adjacent to unprotected trees.

Trapping--Individual squirrels can be readily trapped with a live-trap, size 0 jump trap, or a Conibear size 110 trap, using walnut meats for bait. Trapping requires skill, experience and considerable time for baiting, setting, and checking traps. Trapping is practical only where a few squirrels are to be removed.

Baiting--No poison baits are registered for control of tree squirrels.

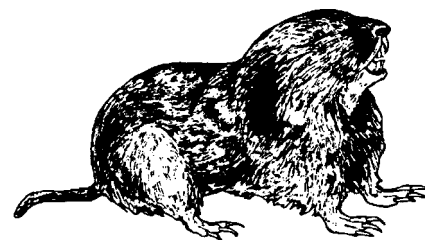
Hunting--Where legal and safe, using a .22 rifle or shotgun is a practical method of population reduction.

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Pocket Gophers
(*Thomomys* spp.)

Description-There are three genera of pocket gophers in the United States. The distinguishing characteristics of all pocket gophers are the external cheek pouches that open on either side of the mouth, and lips that close behind large yellow incisors. Consistent with a burrowing mode of life, they have long, curved front claws. Size is extremely variable in pocket gophers with combined head and body length ranging from 5 to 9 inches. The size of pocket gophers seems related to the vegetative community, locality, altitude, and latitude of their habitat; males generally are heavier than females.



Only two age-class distinctions can be made in the field: juveniles (less than 1 year old) and adults (1 or more years old). Juveniles are noticeably smaller and have smaller reproductive organs.

Similar species-Ground squirrels are sometimes called gophers in local expression, but pocket gophers are most often confused with moles. The following tabulation shows the differences distinguishing pocket gophers from moles.

Pocket gophers	Moles
Large yellow incisors	No incisors
Blunt snout, small eyes and ears	Long snout, no apparent eyes or ears
Cylindrical, winter "casts," aboveground	Tunnels form low surface ridges
Fan-shaped mounds, dirt "plugs" near edge	Circular mound plug near center

Life history-An evaluation of pocket gopher damage requires a clear understanding of resource management goals and objectives and how gophers may affect those objectives. If their activities are interfering with management objectives, damage evaluation must begin with a knowledge of the animal; how to identify it and its characteristics and behaviors, and how its populations increase and decrease.

Reproduction-Usually, only one litter is produced per year in the northern part of their range, but two litters per year are common in southern parts of their range. Breeding usually occurs in early spring but may occur at any time in the southern parts of their range. After a gestation period of about 18 days, a litter of four to eight young is born in the burrow system of the female and reared by her for about 40 days. The juveniles then disperse and establish their own burrow systems. Burrowing through snow facilitates pocket gopher dispersal.

Population Cycles-Pocket gopher populations are dynamic and exhibit random fluctuations. Gopher numbers continue to increase until an imbalance occurs between the population level and the capacity of the habitat to support it. During the annual cycle, pocket gopher populations generally peak at a high level between August and October and then begin to decline until spring, when the population is increased by the young. The population is comprised of up to 75 percent juveniles. The range of fluctuation that populations undergo can be dramatic. Densities have been recorded as high as 62 per acre.

Natural limiting factors that regulate pocket gopher populations include predation, weather, food and cover, and to some extent, gopher territoriality.

The major predators of gophers include weasels, coyote, bobcat, badger, great horned owl, barn owl, hawks, and snakes. Dispersing juveniles have the greatest vulnerability to predators because they spend more time traveling aboveground. Predation, however, serves more to slow the rate of increase than to prevent the population from peaking.

The greatest influence of weather on gopher populations occurs in winter and late spring and relates to the amount of snowfall received. An extremely deep snowpack with a high water content results in high mortality of both adults and newborn young, particularly when the snow melts rapidly and saturates the ground with water, which floods the burrows. Too little snowfall results in even higher gopher mortality, because most forest and range soils percolate ground water rapidly and the soil freezes solid without the insulating effects of deep snow. Pocket gophers may freeze in their burrows under these conditions.

Gophers are herbivorous and highly adaptable in their feeding habits. The relative abundance and quality of forage and the amount and type of habitat available directly correlates with the density of pocket gophers in a particular area. The territorial size of individual gophers depends on habitat conditions, and because these territories are aggressively protected, only a limited density within a given area will occur.

The maximum life span of pocket gophers is about 5 years; few gophers live beyond 2 years, however. Juveniles (less than 1 year old) have the highest mortality rate in pocket gopher populations, and winter mortality of all age groups takes the greatest toll.

Habitat characteristics-

Want community types-Pocket gophers are remarkably adaptable and occupy a wide range of plant communities from sea level to over 10,000 feet in elevation. The communities most preferred by gophers are those supporting an understory of relatively lush stands of fleshy-rooted forbs or rhizomatous sedges and, to a lesser extent, grasses. Rangelands, meadows, clearcut areas, burn areas, and open coniferous forests are the most desirable sites, if adequate soil depth for burrowing is present. Plant community types can be stratified to determine the risk of pocket gopher damage (Volland 1974). Some of the factors enhancing the selection of a site by pocket gophers are the palatability of the vegetation, the associated plant species or the combination of plant species occurring in the area, the climate and topography of the area, and the seral stage of the plant community; for example, whether it is a herbaceous community or a shrub community.

Grass seeding on disturbed sites in Idaho (Green and others 1987) significantly delayed natural succession, thereby resulting in high pocket gopher populations

Soil conditions--Because pocket gophers live underground in burrows, soil characteristics also help determine pocket gopher habitat preference. Burrow systems usually are located in friable, light-textured soils with good drainage, poor water-holding capacity, and high porosity. Clay soils, soils with a depth of less than 6 inches, soils with a shallow water table, and soils that are continuously wet are unfavorable for pocket gopher burrowing. Pocket gophers tend to use soils with a moisture range up to 50 percent.

Pocket gopher burrow systems provide shelter and access to forage. Each adult has its own burrow system covering an area of about 0.02 to 0.1 acre. The systems consist of runways 4 to 48 inches below the ground surface. Side tunnels from the main runways are used as exits and for deposition of soil, debris, excess food, and feces. Larger chambers are used for nest sites and food storage. Tunnels are from 2 to 3 inches in diameter. Feeding tunnels are shallow, normally 2 to 8 inches below the surface, and are most extensive in areas where vegetation is sparse.

Food caches are maintained near nest chambers, and shallow underground food caches also are located 3 to 4 inches below the ground in lateral chambers loosely plugged-off from the main burrow system. Large amounts of plant materials may be stored.

The burrow system is a closely regulated microenvironment, and a gopher will generally plug any openings in the system within 48 hours--often within 24 hours or less.

By building, maintaining, and living in burrow systems, pocket gophers leave three types of physical signs on the surface of the ground that are visible in the snow-free period: mounds, winter soil casts, and tunnel entrances that gophers have plugged with soil (known as soil plugs).

The typical horseshoe-shaped mounds pushed up by gophers are the result of soil excavated as they extend and repair their burrow systems. Mound building is most common in late summer and fall when juveniles are establishing burrow complexes and older animals are enlarging burrow systems.

In winter in the northern parts of their range, gophers extend their burrow systems into the snow, apparently to facilitate their search for food. Later, excess soil is pushed into these snow burrows to create the ribbonlike "winter casts" that become evident as the snow melts. These winter casts can indicate where damage might occur, if suitable conditions are present.

Soil plugs are more difficult to detect. They are small circles of disturbed soil at the ground surface or a small circular depression toward the edge of a mound. These usually are formed where gophers have emerged to forage and plugged the hole upon reentry. Vegetation may be clipped around soil plugs. In spring, soil plugs and winter casts may be the only soil indicators of current pocket gopher activity.

Feeding habits-pocket gophers are herbivorous mammals and use all portions of plants in their diet. Roots, stems, leaves, and bark (chewed from woody species) provide forage for gophers. Because of their burrowing habits, roots are readily available, but pocket gophers also make openings from their tunnels and forage for food and nest material aboveground. In some instances, they have been observed pulling entire plants down through the soil into their burrows. Barking and clipping of shrubs and trees occurs aboveground, especially under snow in winter.

Forbs are the most preferred food plants of pocket gophers. Grasses are also used and may constitute a major component of the gopher's diet in winter. The outer bark and roots of woody species are used by gophers in winter, when other fresh vegetation is sparse, and in summer and fall when other vegetation is drying up and roots are being collected for food caches.

The habit of storing food in underground caches may account for the harvest of considerably more vegetation than is actually eaten. Roots constitute the major portion of the forage collected for food caches.

Damage problems and their evaluation-

Forest lands-pocket gopher damage to forest crops was first reported in the early 1900s, but it did not become a serious reforestation problem until the 1950s. This increased importance is the result of intensified management and of recognition that gophers are responsible for some damage previously attributed to porcupines, mice, squirrels, livestock, and unknown causes.

Increases in pocket gopher problems and subsequent damage are directly related to the opening up of timber stands through harvest, insect and disease losses, or wild-fires that result in a flush of seral vegetation (forbs and grasses). Gophers, normally, are widely but sparsely distributed in timber stands, and are primarily concentrated at sites where preferred ground vegetation provides ample forage; for example, river banks, spring areas, meadows, and other breaks in the forest canopy. Dense brush areas often produce low food volumes, which limit gopher populations on those sites.

In the Nez Perce National Forest, Idaho, severe site disturbance in 1986 resulted in increased pocket gopher activity: the number of mounds ranged from 300 per acre on minimally disturbed, broadcast-burned sites to more than 6,000 per acre on severely disturbed areas where slash had been piled by bulldozer (Boyd 1987). The practice of grass seeding on disturbed sites significantly delayed natural succession, thereby resulting in higher gopher populations and increased seedling mortality.

Substantial gopher populations can become established in 2 to 3 years when a low residual population is present on or near a cutover area. The current reforestation policy is to plant or seed as soon as possible after harvest treatment. This allows tree seedlings to develop into larger, less susceptible sizes, as the gopher population is expanding. If small, slow-growing conifers are planted where gopher populations are high, the trees are subject to severe damage and mortality in the first 3 to 5 years after planting. A second advantage of rapid reforestation is the reduced competition for available soil moisture by the seedlings, often resulting in higher seedling survival rates.

Heavy pocket gopher infestations in regeneration areas have commonly resulted in seedling losses of 20 to 30 percent and, occasionally, up to 70 percent in 1 year. Losses of seedlings due to pocket gopher damage in regeneration areas usually continue over a period of years, so that what may appear as acceptable yearly gopher-caused seedling mortality is actually, in a cumulative respect, excessive.

Damage identification--The two most common types of tree damage by gophers are root pruning and a combination of stem barking and clipping. Stems of small seedlings (basal diameters of 1/2 inch or less) often are cut into two or more sections. Seedlings frequently are clipped at or near ground level and the roots or stems are taken. Gophers may pull entire seedlings into their burrow systems, which leaves no evidence of damage other than missing seedlings. If seedlings are missing, suspect gopher or elk damage. Root pruning and barking of small seedlings occur year-round but are most frequent in winter.

Root pruning on larger seedlings and saplings also occurs year-round. The seasonal frequency has not been determined, primarily because damage generally does not become evident until long after the trees have been injured. Some trees also incur damage over a period of several years. Characteristic indicators of root-pruned trees include shortened needles, premature needle drop, shortened internodes, and overall poor development.

Clipping and barking on larger trees occur primarily underground or aboveground under snow cover. This damage is more prevalent in areas where heavy snowpacks persist or food quantity is short. Girdling is often complete and leaves white stems easily seen in spring.

Other types of tree damage caused by gophers include root exposure by burrowing and burying of seedlings by winter casts or mounds. Root exposure occurs most often in conjunction with root gnawing and barking. It is usually of minor importance in comparison with other types of damage. Damage from winter casts or mounds deposited on small planted or natural seedlings is a common occurrence in areas of high gopher density and may injure or kill seedlings.

Rangelands--Damage by pocket gophers to rangelands differs with livestock use and condition of the range. In the past, much time, effort, and money were spent for pocket gopher control on rangelands in poor condition. Pocket gopher control is seldom economically feasible on poorly managed rangelands or those in fair or better condition.

Soil erosion--Pocket gopher activity can accelerate soil erosion in some areas depending on slope, soil type, and the action of water. Tunnel collapse and water running through burrows may intensify already existing erosion potentials.

Dams and dikes--Pocket gopher activity can affect dams and dikes by weakening their structural design or decreasing their water-holding capacity.

Damage surveys--There are three methods of surveying pocket gopher activity and relative abundance. The purpose of the survey determines which method is used. The first, the reconnaissance survey, evaluates the presence or absence and relative numbers of pocket gophers. This method is used to determine the extent of pocket gopher damage potential and usually is initiated when a timber management proposal entails some form of regeneration harvesting as an alternative. The second type, the gopher-mound survey, determines the level of gopher activity in an area and provides an indication of gopher abundance. Its main purpose is to determine the location and extent of gopher control needs. The last method, the open-burrow survey, evaluates the effectiveness of baiting or trapping as a control technique.

Reconnaissance survey--This survey is usually a part of another examination, such as a timber sale reconnaissance. The primary purpose is to determine if an active gopher population exists in the area, and if so, the extent and relative size of the population,

Information on gophers is collected at each plot, when a timber-sale planning or other survey is being conducted. The presence of recent mounds (mounds formed during the year) or winter casts are primary indicators of gopher presence.

If a joint silviculture examination and gopher reconnaissance survey reveals moderate gopher activity on 50 percent of a planned timber sale area and if the silvicultural prescription developed for the area calls for a regeneration harvesting method, the reforestation portion of the prescription should consider the following issues: the type of regeneration that will occur; the ease with which it will be obtained; the amount that could be lost to gophers; and the effect of timber harvesting on the population of gophers present at the site. These data and the information obtained during the gopher reconnaissance will allow the consideration of silvicultural alternatives and alert the land manager to assess possible treatment or control alternatives, before the project's implementation.

Gopher-mound survey--An indication of the pocket gopher population level and extent of control needs can be obtained with a gopher-mound survey. This survey is particularly useful when management alternatives are being considered, and it should be conducted whenever gophers are a potential problem. It often is conducted as part of another survey, such as a stocking survey.

The gopher-mound survey determines the percentage of an area that has current gopher activity by using the presence of recent mounds (mounds formed during the year) to determine the approximate size and distribution of the population. The percentage of plots with sign is used as an index to population density and as a basis for determining control needs.

Standard plot size should be 1/100 of an acre or 11.8-foot radius. Plot sizes differ if they are part of another survey being conducted simultaneously.

Minimum sampling intensity should not be less than that of the associated survey, or 5 percent of the area. The number of plots and their distribution should be sufficient to determine the location of gopher population centers, the approximate number of mounds per acre, and the range in numbers over the area. (Counting the number of mounds may not provide better information than simply determining the presence or absence of fresh gopher activity on the sampling plots.) These data will provide the bases for determining control needs, based on staff experience with local conditions.

The extent of the area affected and the number of mounds indicate the relative feeding pressure by pocket gophers. Although food habits differ by site and availability, the more gopher activity, the greater the potential for damage to conifer seedlings.

Wherever pocket gophers occur, some damage and mortality of planted seedlings can be expected. Temporary population reductions of pocket gophers in plantations are probably needed if some or all of the following conditions occur:

- Percentage of active gopher plots exceeds 25 percent of 1/100-acre plots on new plantations (0-2 years old) or 40 percent of 1/100-acre plots on established plantations (3-5 years old).
- Current stocking level of seedlings is low or marginal, and additional environmentally caused mortality can be expected.
- Trees are growing slowly and are less than 0.2 inch in caliper about 1 inch above ground level.
- Number of active pocket gopher systems exceeds two per acre.
- Food supply of gophers will be significantly altered by herbicide or other treatment, which will cause these animals to seek alternative food sources.

The gopher-mound survey and the above criteria should not be relied on as sole determinants for implementing a control project. There also is need to evaluate actual losses occurring in a plantation. The same densities of pocket gophers in different habitats with different seedling sizes, survival rates, and other variables will result in different impacts.

It is essential that local experience and conditions be considered in making the final determination of the need for temporary population reductions.

Open-burrow survey-The objective of this survey is to determine the reduction in gopher activity that occurs after an operational control program.

Sampling points are established in an area before treatment. These should be at least 100 feet apart and include recent (less than 1 week old) gopher activity.

A minimum of 40 sampling plots (or fewer on units of less than 10 acres) should be used per treatment area. The plots need to be flagged and numbered to facilitate resurveying. An active burrow system is opened on each plot having recent sign. Twenty-four to 48 hours later, the area is revisited and notation is made on whether the opened burrows were plugged or remained open. A survey after 48 hours is preferred by some experienced biologists. Repeat the survey 7 to 14 days after a control treatment. If the direct control operation was successful, there should be significantly fewer plugged burrows found during the second survey.

Biologists believe that a reduction in activity of at least 80 percent is needed to accomplish a significant reduction in damage. Areas with less than an 80-percent reduction in activity should be considered for retreatment; baiting techniques and other operational conditions should be analyzed to ensure that control activities are optimum.

Methods of damage management-The history and current status of pocket gopher damage to conifers in western forests are well documented (Borrecco and Black 1990, Crouch 1986). At the present time, direct control of damaging gophers, primarily by baiting or trapping, is the most widely used approach to alleviating pocket gopher damage. In the future, integrating indirect or ecological control to reduce the habitat suitability for gophers with direct control practices may prove to be more effective and less costly.

Indirect control by habitat manipulation-Indirect control to limit damage to seedlings by pocket gophers is accomplished by reducing habitat suitability, providing alternate (buffer) forage, or by silvicultural modifications, including planting additional seedlings.

Herbicide applications-Treating an area with selective herbicides can be done to reduce the availability of gopher foods. Vegetation management with herbicides, principally to control perennial grasses and forbs, can result in reduced gopher numbers and may improve conifer survival by decreasing competition for moisture by other vegetation. Herbicide treatment to control gophers requires a broader area of coverage than does site preparation, and it is recommended that the planting of conifer seedlings be delayed for one winter between herbicide treatments and reforestation, to allow time for a sufficient reduction in the gopher population. It also prevents the gopher population (at the pretreatment level) from being sustained by a primary food source of planted seedlings.

Numerous herbicides are available for such use. The type of herbicide, the timing of application, and the method and rate of application depend on the chemicals considered, their selective toxicity, and label requirements. Identification of the plants or plant types being used as a food source will help indicate the herbicide needed. Herbicides need to control the food source and, with the large number of approved chemicals and the continual changes in these chemicals, recommendations should be obtained from specialists at either the National Forest or the Regional Office.

The response of pocket gophers to herbicide treatments will differ with the type of herbicide application, because the impact of the herbicide on gopher foods depends primarily on the composition and density of the pretreatment vegetation. Because of their highly selective toxicity, some herbicides may cause little change, as gophers may switch to less desirable vegetation for food.

Although selective herbicide treatments show a potential to promote the survival and growth of conifer seedlings and make habitats less favorable for pocket gophers, the effectiveness of this method to reduce damage has not been widely studied. On herbicide-treated sites, the seedlings may be better able to sustain minor damage by gophers, and a reduction in gopher numbers usually leads to a reduction in gopher-caused seedling mortality.

A disadvantage of herbicide treatments involves the possible adverse effects on the food and cover plants used by other wildlife species. Abrupt alterations in the vegetative density and composition of an area can have a significant impact. In most cases, the impact on other wildlife is temporary, because the changes in vegetation are normally of short duration. Before herbicide treatments are undertaken, an evaluation of the importance of the treatment site to all wildlife should be completed.

Silvicultural modifications-Habitat alteration by modifying silvicultural practices has great potential for effective, long-lasting control through preventive management. Emmingham and others (1992), for example, found that the use of the shelterwood regeneration method, in place of clearcutting, creates less favorable habitats for gophers and reduces damage to developing stands. In many instances, gopher damage could be avoided or reduced through early recognition of the animal's probable response to habitat changes resulting from silvicultural treatments.

Protecting conifers is difficult on a plantation densely populated with gophers. Recruitment of animals from inside or outside the plantation boundaries tends to maintain the habitat at or near its carrying capacity. Rather than waiting to confront the problem under these conditions, a logical alternative is to anticipate the potential damage and attempt to prevent the population buildup that causes it.

Temporary buffer strips-In this method, an uncut strip of timber, 500 feet wide (or wider), is left between logged units and gopher-populated areas (Barnes 1974). Meadows, open stands, or any area with abundant food supplies adjacent to harvest units should be checked for presence of gophers. Buffer strips represent a temporary measure and essentially delay the invasion of gophers into harvested areas (unoccupied or only sparsely occupied by gophers), thereby reducing the potential for damage to seedlings. This delay can be useful, because in some areas where sufficient natural regeneration can be obtained, even moderate pocket gopher populations will not pose a problem.

In some situations, buffer strips are most effective when used in combination with the direct control methods of baiting or trapping. The need for direct control before harvest is obvious where a reservoir of gophers occurs within a planned harvest unit. Direct control in buffer strips is also necessary, if substantial gopher populations are present in these strips. Where leaving strips of standing timber is not practical; direct control in stands adjacent to gopher-occupied areas or along plantation boundaries will have a buffer-strip effect and should be considered before logging.

Site preparation-Site preparation, in general, is beneficial to tree growth and survival, but the effect of site preparation on seedling survival and growth (and on associated vegetation) must be reviewed in relation to pocket gopher population responses and damage. Site preparation techniques that disturb large amounts of soil should be used as little as possible in areas prone to pocket gopher damage. This practice may result in rapid invasion of pocket gophers from adjacent populated areas, or an increase in breeding success by established gophers. Newly disturbed soil often allows gophers to move rapidly underground. Gophers use disturbed soil along roads and terraces to travel up to 1 mile or more. (On private forest lands in south-central Oregon, intensive, large-scale site preparation with large, tractor-drawn Rototillers, combined with herbicide treatments to control the recovery of herbaceous vegetation, decimated resident pocket gopher populations for a sufficiently long period to enable successful regeneration.)

Highly disturbed soils created by plowing, discing, or machine planting often predispose seedlings to gopher damage by creating a nearly readymade burrow system. Gophers follow these readymade burrows, gathering food as they go.

Limited site preparation is a damage control measure that can be used to deter the distribution of gophers. Site preparation with selective herbicides also may be an extremely useful technique (see above).

Stage-overstory removal--The harvest method selected in a potential area of pocket gopher damage also can be a control measure. The relation of tree crown-cover to herbage production indicates that clearcutting results in the best conditions for pocket gopher invasions, establishment, and population increases. Partial cutting in certain conifer stands minimizes the increase of the understory vegetation due to continual partial shading, retains conifer reproduction in the understory (which is usually past the stage most susceptible to pocket gopher damage), and results in minimal soil disturbance. Depending on the habitat type, such an alteration generally supports fewer gophers than does a comparable clearcut site. On some sites, however, natural regeneration after partial cutting is unsuccessful because of factors other than gophers, but gopher populations build rapidly and may be mistakenly blamed for regeneration failure. Shelterwood cutting and underplanting shelterwood units, for example, reduced pocket gopher damage to pine plantations in eastern Oregon (Emmingham and others 1992).

Stage-overstory removal and the vegetative communities created must be carefully analyzed, as many timbered types do not readily lend themselves to this silvicultural treatment. The treatment also may not be compatible with stand composition requirements.

Early planting--Planting should occur as soon as practicable after harvest. Waiting longer than 1 year to begin reforestation allows an increase in food supplies for gophers, and this often results in higher overall population levels. It usually takes 2 to 3 years after a timber harvest for significant increases in herbaceous vegetation to occur and for pocket gophers to establish a population level detrimental to seedling survival. Planting immediately after harvest will give seedlings a head start.

Size of planting stock--Large planting stock (2-1 or 3-0) is less susceptible to gopher damage than are small-sized seedlings. Seedlings less than 1/2 inch in caliper width are commonly clipped by gophers, especially in winter where feeding takes place under snow. Larger diameter seedlings may be chewed but may not be completely girdled. Also, large-caliper stems are seldom bent or pinned down in the snow by the formation of winter casts. Such activity normally leads to misshapen trees.

Direct population control--Direct control techniques include hand- and machine-baiting, trapping, and use of individual tree protectors. Choice of these methods should be based on site characteristics, season, available labor, economic considerations, and local experience.

Trapping--Several types of traps are available for controlling pocket gophers, although the Macabee kill-trap is probably the most popular. Trapping has been used on forest lands to a limited extent. It is extremely slow and time consuming and is practical only in small areas, in high-value situations such as nurseries or experimental areas, or as a supplement to other forms of damage control. Consequently, there are few forest situations where trapping is feasible. This method is, however, of value as a way to estimate population densities.

Trapping procedures are as follows:

1. Select an area with recent mound-building activity.
2. Open the lateral runway with a trowel.

3. Set a gopher trap and insert it, prongs forward, well back into the burrow (fig. 29). If the lateral runway is very short, the main runway often will be exposed during excavation. In that case, a trap should be set in each arm of the main burrow.
4. Secure traps with a light chain or wire and pin.
5. Leave entrance hole open to attract the gopher.
6. Mark each trap spot with flagging so that it can be relocated easily.
7. When trapping is done in spring, traps should be reset after a catch is made because a burrow system may have more than one occupant at that time.

Baiting--Hazards to nontarget animals have been evaluated (Barnes and others 1985, Evans 1987, Fagerstone and others 1980). Baiting by hand or machine is a much faster operation than trapping and is safe and effective when done properly. But it usually requires one or more annual followup treatments. The number of baitings and their frequency differs from area to area. Initial control success, tree damage, vegetative conditions, and potential for reinvasion are among factors to be considered. Baiting should be done during periods of greatest local mound-building activity; using larger baiting crews for shorter periods often is advisable.

Hand-baiting requires three steps: location of a runway by probing or excavation; placement of the toxic bait in the burrow by hand, spoon, or other appropriate means; and covering the exposed burrow. Hand-baiting by spoon or bait dispenser may be useful for gopher control on small acreages or steep terrain with isolated populations, or to maintain control over low populations to restrict their dispersion into unoccupied or sparsely occupied habitats. This method is particularly useful in treating peripheral populations or spot-treating populations before they build.

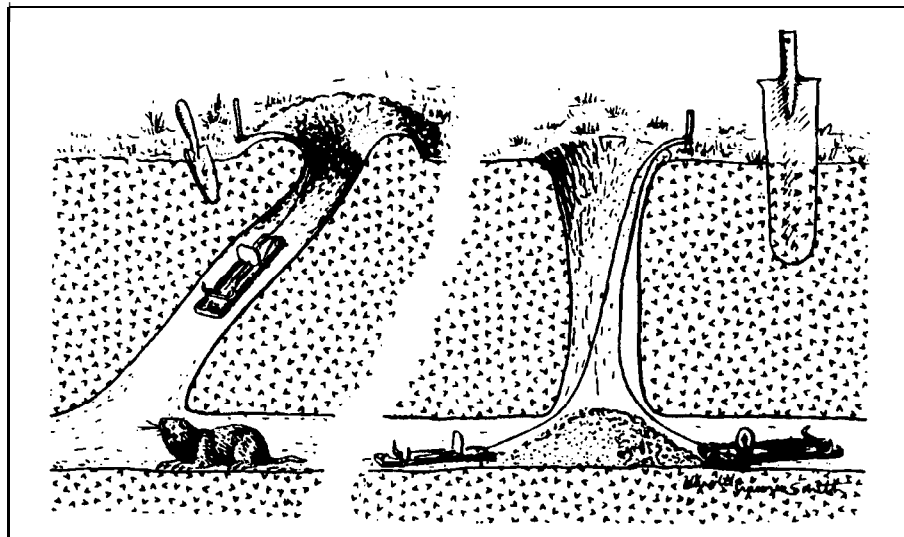


Figure 29 -Trap placement for pocket gophers.

Effectiveness of hand-baiting can be checked readily by an open burrow survey. If the burrow systems are still occupied, they usually will be closed within 48 hours. Activity checks should not be made until bait has been exposed for 2 weeks.

Strychnine-treated oats is currently the bait of choice for pocket gopher control; zinc phosphide also is registered for this purpose. Anticoagulant baits are registered for pocket gopher control in some states. Check with your wildlife biologist, Regional pesticide-use specialist, or APHIS-ADC regarding the status of bait registrations and control recommendations.

Hand baiting—Any site regularly occupied by pocket gophers may be hand-baited, but there are several conditions that influence control effectiveness:

- Active mound building must be taking place, to allow best selection of spots to bait. Fresh mounds can be identified by their unweathered appearance and loose horseshoe shape. Recent mounds often will be darker than surrounding soil because of their higher moisture content.
- Soil moisture and soil type should be such that burrow crumbling does not occur when probing or excavating tunnels for baiting. Moisture content becomes less critical in soils that are well structured, fine textured, or heavily sodded. Granitic soils and sandy soils are extremely difficult to probe; suitable moisture conditions are required during the operation.
- Guidance of experienced baiters is necessary to ensure correct bait placement.
- The number of available baiters must be sufficient to permit complete and careful coverage of the area requiring protection within a reasonable time. This often becomes a problem on large areas.

Probing (with bait dispensers)—Probing is the most commonly followed method of hand-baiting. It is the fastest hand-baiting technique but requires considerable knowledge of gopher habits to be done effectively.

Expertise in using the probe is gained mainly through experience and self-training. The first step is to check a spot near a fresh gopher mound for the presence of a burrow. The probe then is pushed gradually into the ground at that spot. If the choice is correct, a sudden release of pressure will be felt when the probe enters the burrow.

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

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

1. Select an area with recent mound-building activity.
2. Locate the main runway by probing a lateral runway to its junction with the main runway. Laterals usually join a main run within 2 feet or less. One or two test probes down each arm of the main runway to form a rough "T" will verify the location of the runway. Main runways also may be located by the presence of small convex earth plugs. The plugs are made when gophers close their burrows after returning from surface excursions. A probe can be made directly adjacent to the earth plug, as the main runway is often immediately below.
3. Enlarge a probe hole in the main runway to accept the bait, but be careful to avoid making a deep hole in the bottom of the burrow.

4. Drop 1 teaspoonful of strychnine-treated oats into the burrow. Most baiting operations will require from 1/2 to 1 pound of strychnine-treated oats per acre.
5. Carefully cover all probe holes with clods, bark, stones, or other suitable material, to prevent light or dirt from entering the burrow system. Covering the probe holes also will reduce the chance of nontarget wildlife eating the bait. If the holes are left open, gophers may push the bait aboveground while closing the holes, thereby possibly exposing the bait to nontarget species.
6. Bait two spots in what appears to be the active working area of a single gopher.
7. Mark treated areas with plastic flagging. This will prevent confusion and facilitate inspections.

Excavating-Opening main runways with a garden trowel (excavating) is a positive method of locating good baiting spots. The only disadvantage is that it is relatively slow. Excavating is an excellent way to study the arrangement of the burrow systems of gophers and, in this respect, serves as a useful tool for training inexperienced baiters to use a probe. One or two days of burrow excavation before advancing to a probe will help ensure good control results.

The baiting procedure is very similar to that followed in the probing technique, except that the hole is opened to allow bait placements. Follow the steps outlined for hand baiting with a probe.

Machine-baiting procedures-An improvement over hand-baiting is the mechanical bait dispenser-it is faster and just as efficient. This device allows an operator to intersect runways and deposit bait in the same operation. With this device, 1 acre per hour can be treated. The Forestland Burrow Builder provides an effective means of controlling pocket gophers within limits determined by slope, surface and subsurface obstructions, soil texture, and soil moisture. Soil conditions must be suitable for preparing and maintaining a burrow. Excessively dry or coarse-textured soils do not allow this to occur.

The machine creates an artificial burrow and at the same time deposits small amounts of strychnine-treated oat bait. (A Rhoplex-binder added to this bait allows the oats to flow smoothly from the hopper of this machine.) Gophers locate the new burrows and eat the deposited bait within a few days. Maximum control usually is achieved within 7 to 10 days after treatment. The machine can be used to treat 2-1/2 to 6 acres per hour. The crew includes a tractor operator and bait checker.

Machine-baiting has been shown repeatedly to be cost-effective in controlling pocket gopher damage, especially on large plantations. It is currently the most widely followed method of controlling gopher damage, but treatment must be done correctly to assure effectiveness, and even successful baiting provides only temporary relief. This is an important concept, because tree protection may be necessary for several years, depending on the rate of tree growth. Complete population reductions rarely if ever occur, and offspring of survivors may quickly repopulate unoccupied burrow systems. In many areas, rapid invasion from adjacent, uncontrolled populations also can be expected. An abundance of unoccupied systems likely will increase survival of dispersing young, and reduced population densities may temporarily stimulate reproduction and survival.

Use of the burrow builder on forest lands introduces additional factors not encountered with hand-baiting. The artificial burrows may persist for several years, and the possibility that they may facilitate reinvasion should be considered. One of the most critical factors governing the use of the burrow builder is soil moisture. In dry climates, where most gopher-reforestation problems occur, use of the machine often is restricted to short periods in spring and fall. Moisture requirements usually can be met in spring, but the potential for reinvasion will necessitate fall treatment in most cases. Fall moisture is unpredictable, and at higher elevations may first appear in sufficient quantity as snow. The necessity of last-minute scheduling places an added burden on management.

Environmental considerations-Strychnine-treated oat bait is sold by the Pocatello Supply Depot, USDA-APHIS, 238 E. Dillon, Pocatello, ID 83201. Strychnine-treated bait placed belowground is effective only for a limited time, ranging from 1 week to 1-112 months, depending on soil moisture and other factors. Strychnine does not accumulate in the body, and it may be consumed at very low dosages over prolonged periods with little or no ill effects. Ingestion of extremely high doses may cause immediate sickness and death in many animals. Sublethal doses may cause bait aversion. In some cases, animals may excrete low dosages of the poison through normal metabolism.

Small mammals that readily eat the bait, such as ground squirrels, can be killed in treatment areas (Anthony and others 1984). Secondary hazards to predators that feed on gophers appear to be greatly lessened by the tendency of gophers to die underground (Barnes and others 1985). Studies by the EPA and the U.S. Fish and Wildlife Service of strychnine baiting for gopher control found very minor losses to other than the target species when bait was correctly placed. Most of these losses were to burrowing animals intercepting burrows or using food found underground. Secondary poisoning may occur only from ingestion of material stored in the gophers' cheek pouches. In response to a question on whether grizzly bears (an endangered species) would be affected by strychnine baiting for pocket gopher control, the U.S. Fish and Wildlife Service conducted research with radio-collared gophers in the Targhee National Forest in Idaho (Barnes and others 1985). They concluded that carcasses of gophers in baited areas did not pose a hazard. Also, grizzly bears were not likely to consume lethal amounts of baits stored in gopher nests, although baits stored in gopher food caches could present a risk.

Under the Endangered Species Act, the Forest Service must request formal consultation and a biological opinion from the U.S. Fish and Wildlife Service where management activities may affect an endangered species.

A formal consultation regarding the potential impact on grizzly bears of direct control of pocket gophers by strychnine baiting resulted in a biological opinion. The opinion requires that the following steps be taken before baiting for pocket gophers in grizzly bear range:

- Use of strychnine baits is permitted in occupied grizzly habitats, with Regional Forester approval.
- Presently, a review of Forest Service rodent control plans is required by the U.S. Fish and Wildlife Service, where endangered species may be affected.

In grizzly bear range, a proposed treatment area is to be surveyed for grizzly sign or grizzlies before control program is begun. If there is evidence that a grizzly is physically present in the area, a strychnine-baiting program may not be initiated, or if already begun, the program must be discontinued.

Strychnine and other chemicals used in various control operations are often misunderstood; an effective education program for the applicators and concerned publics will be required. This program often needs to begin inside the Forest Service, so that those most directly involved with the program understand and are committed to it.

In all suppression actions, direct or indirect, the program objective is to alleviate reforestation damage. The killing of individual animals is only one of many alternatives. Managers should consider all options, and the benefits and costs of each. Direct suppression through baiting is often the least suitable alternative in the long run.

Individual seedling protectors--Plastic-mesh tubing, such as Vexar, is an effective but costly means of limiting gopher damage. Partially buried seedling protectors (to protect both roots and stems) have reduced damage by 85 to 90 percent over 1 year. In small reforestation areas exposed to heavy pocket gopher damage, seedling protectors can be cost-effective but are very labor intensive. Because of the labor involved, costs for controlling gopher damage with this treatment may increase planting costs by 50 to 150 percent.

In snow country, seedling protectors cannot be used on slopes greater than 25 percent without extensive maintenance, because snow movement frequently causes terminal buds to grow through the plastic mesh, thereby distorting tree growth. Even under optimal conditions, tubing often causes an excessive amount of distortion of tree growth. Information is not available on the rate of breakdown of the tubing underground and potential adverse impact on root growth. Seedling protectors (to provide belowground protection), whether installed during planting or by prepacking seedlings and protectors at the nursery, must be handled with great care to ensure **good seedling survival**. For additional details see **Campbell and Evans (1975; also reprinted in appendix 3)**.

Prediction and prescription matrix-

Ecological considerations-Management of animal damage is most effective when based on sound ecological principles. The response of pocket gophers to timber harvest and reforestation is most influenced by the species of seral vegetation that revegetate harvested sites, the composition and productivity of these plant communities, and the abundance of gophers or the proximity of populated areas before harvest. All these factors may differ with habitat type, silvicultural method, and the system of logging.

The habitat type classifies aggregates of land capable of producing similar plant communities at climax. Each climax plant community reflects the integration of environmental factors on the resultant vegetation. One habitat type may support a variety of disturbance-induced, seral, plant communities. The classification of climax overstory and understory vegetation is possible at any successional stage because this vegetative succession, anywhere within one habitat type, ultimately produces similar communities at climax.

Table 2-Options for controlling pocket gopher damage in relation to plant community classes

Control option	Community class						Class 3
	Class 1 ^a			Class 2 ^a			
	A	B	C	A	B	C	
Indirect:							
Herbicide	?	x	x	XP-F	XF	XF	?F
Silvicultural method-							
Shelterwood	N/A	N/A	N/A	X	X	X	X
Selection	N/A	N/A	N/A	X	X	X	X
Intermediate treatment	N/A	N/A	N/A	X	X	X	X
Size planting stock	x	x	x	x	x	x	X
Buffer strips	N/A	N/A	N/A	X	X	?	X
Site preparation-							
Mechanical ^b	N/A	N/A	N/A	X	X	X	N/A
Hand	N/A	N/A	N/A	N/A	?	X	N/A
Herbicides ^c	x	x	x	x	x	x	N/A
Early planting	x	x	x	x			
Direct:							
Baiting, hand and machine	XP	XP-F	XP-F	XF	XF	XF	XF
Trapping	?	N/A	?	N/A	N/A	N/A	X
Plastic tubes	N/A	X	X	X	X	X	X
Monitor							Primary

N/A = not applicable; P = pretreatment; F = followup.

^aClass 1 and 2 communities are further defined by the range within the classification. Class 1A is the least typical of the type, with the lowest continuous gopher populations. Class 1B is the most typical. Class 1C forms an intergrade between classes 1 and 2, being more commonly like class 1 than 2. Class 2 has a similar classification system (see text for details and examples).

^bDozer stripping

^cLimit application, strip or spot

The variety of seral plants differs in composition, based on the habitat type, because of the variation of environmental interactions and the ability of various plants to cope with a given environment. This composition is predictable. The variation in the makeup of a seral plant community affects the habitat suitability of each community for gophers. A stratification of communities associated with habitat types can be used to assess the risk of gopher damage when allocating or planning for resource uses on a site. This determination will indicate where values and risks are the greatest.

Matrix development-The preference of pocket gophers for certain identifiable habitat types suggests that communities may be grouped into three classes (table 2).

Class 1: Those communities having moderate to high incidence of gophers in natural and disturbed stands.

Class 2: Those having a low incidence but a high potential for gopher occupancy.

Class 3: Those showing little observed gopher activity before and after activity or disturbance at the site.

The understory vegetation provides the principal means of identifying and mapping these communities, irrespective of their successional status. Consequently, expected tree mortality and necessary gopher control measures can be planned before harvesting class 1 communities. Field identification of class 1 sites becomes important in predicting postdisturbance infestation sources,

Class 2 communities usually support impoverished herbaceous understories in the undisturbed condition. Burning or scarification will stimulate grass and forb production up to 10 times pretreatment levels. The burst of food supply makes these communities attractive to scattered, onsite gophers or those populations from adjacent class 1 communities. For this reason, severe gopher damage within class 2 communities usually is localized and must be treated as it occurs. In some areas, potential damage has been reduced by leaving near-natural buffer strips between class 1 and 2 communities; this is a viable alternative.

Class 3 communities are dominated by shrubs that are not preferred gopher food. Seral forbs created by disturbance seldom occur in this class. Once identified, little consideration of gopher damage and control is necessary.

The classification of the habitat type or community as to class must be made at the National Forest or Ranger District level and may be based on evidence or experience. Some examples follow.

Class 1 communities often are open stands where herbaceous material is predominately fleshy-rooted forbs preferred by pocket gophers. In the Pacific Northwest, examples are poorly stocked subalpine fir/elk sedge habitat type, predominated by open-grown lodgepole pine, with clusters of lupine occurring throughout; mixed stands of various conifers and aspen present; large volumes of fleshy-rooted forbs are common in the aspen areas.

Class 2 communities often are dense old growth or densely stocked small saw timber or pole-size stands, with mostly dense sod-forming grasses. In some cases, these may be lightly stocked and composed entirely of bunchgrasses with few forbs or other vegetation present. When disturbed, dormant seed (soil-stored) will flourish, producing abundant moderately to highly desirable forbs, shrubs, or grasses. Some examples in the Pacific Northwest are Douglas-fir/pinegrass that has been harvested by using various silvicultural systems with resultant fireweed, geranium, lupines, and pinegrass producing abundant growth. Often roads and skid trails are present that produce numerous annuals; ponderosa pine/bitterbrush habitat that has been lightly harvested and disturbed often produces abundant forbs, especially lupine, or soil-stored forbs with bulbous early growth characteristics.

Class 3 communities often are dominated by brush species that sprout, sucker, or have root regenerating systems that allow rapid occupation of such areas by brush. Brush communities that are sporadic in their occurrence or support both brush and grass-herbaceous cover normally will be in class 1 or class 2 communities, depending on the specific situation. Some changes in classification may occur because of silvicultural activities that affect the ability of an area to produce pocket gopher food plants.

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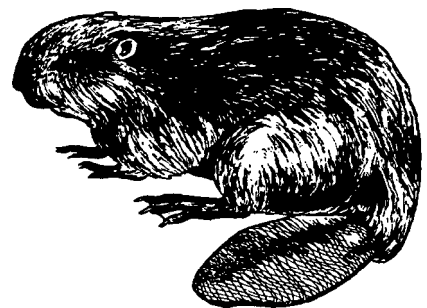
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Beaver
(*Castor canadensis*)

Description-The beaver is the largest rodent in North America, sometimes weighing over 60 pounds. Its large size, flat scaly tail, and webbed hind feet easily distinguish it from other native mammals and from the nutria, which is much smaller and has a round tail. Beaver are golden to dark brown above, somewhat lighter below.



Economic significance-Beavers were eliminated from much of their former range by over-trapping, but with proper management they have become reestablished and are now common in many areas.

Beaver skins provide a minor source of income to some trappers. Most pelts are used in Europe for making fur coats and hats and for trimming cloth garments.

Beavers are noted for their dam-building and tree-felling activities that have both short- and long-term effects on the areas they occupy. Streams are slowed and usually warmed, streamside shade is reduced, vegetative structure is changed, water-borne sediment is deposited in slack water of the ponds, stream courses are sometimes altered, and downstream flows are usually stabilized during the dry season.

Tree-cutting damage is usually of less importance than the damage produced by the plugging of culverts and flooding of roads and timber stands as new ponds are created. Tree cutting by beavers is usually a problem only when trees are removed in campgrounds or scenic areas. Recent estimates of beaver flooding damage to timber include \$45 million in Georgia and \$17 million in Mississippi (Robles 1987).

Life history information-

Preferred habitat-water courses with aspen, willow, cottonwood and associated streambank vegetation are the most suitable sites. Smaller streams with flows from 2 to 12 feet per second are very attractive to beavers.

Feeding habits-Bark, twigs, leaves, roots, and a wide variety of aquatic plants are major food items. Cottonwood, aspen, and willow are the principal tree species eaten. Conifers occasionally are eaten but are not a staple food.

Activity-Dam building and feeding occur primarily at night. Travel usually is restricted to small areas around ponds or water courses. Young beavers dispersing from colonies may travel many miles to find new habitat.

Reproduction-Beavers are polygamous and mate once a year in late January or February. They are capable of breeding when 2 years old. From two to six kits are born in April or May after a 3-month gestation period. The young remain as part of the colony until 2 years of age, when they leave to establish their own homes.

Damage problems and their management-

Identification--Beavers can be identified by the presence of characteristic beaver dams, conical stumps with prominent tooth marks, and large wood chips present around stumps. Peeled sticks also may be present in or near water (fig. 30).

Determining *the need for damage* management-Beavers are valuable when their activities can be tolerated. In considering the need and method of control, it should be remembered that the ponds maintained by beavers generally have a high value for recreation and as fishery and wildlife habitat.

Management methods-

Trapping and shooting-Trapping is the most common method of removing individuals, but shooting may be more effective. In both instances, results may be only temporary, however. To remove problem beavers, get assistance from APHIS-ADC, state wildlife biologists, or licensed private trappers. APHIS-ADC has found that shooting by using a night scope is one of the most efficient, selective, and expedient methods of removing nuisance beavers. Consult with state wildlife officials regarding regulations pertaining to the taking of beaver by means of trapping or shooting.

Fencing--A fenced lane can be constructed that will effectively discourage beavers intent on plugging culverts or building dams in undesirable locations. (See chapter 4 for design of the beaver-baffler fence.)

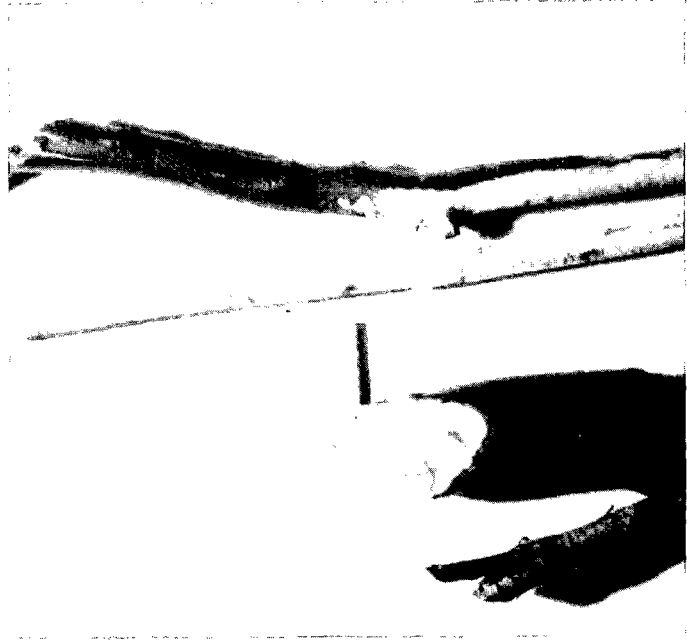


Figure 30-Beaver damage showing typical conical-shaped stump (left), and peeled sticks with uniform horizontal toothmarks (right).

Tree guard-preventing beavers from damaging individual trees in areas such as campgrounds requires intensive protective measures and continuous surveillance. Individual trees can be surrounded by a sheet metal or 2- by 2-inch-wire fence built from the ground to a height of 3 feet. Fencing may be ineffective in deep snow.

Explosives-Explosives have been used to rupture dams and drain water impoundments. Trapping usually precedes dam destruction. In Louisiana, where 117 beaver dams were demolished with water gel explosives, researchers found that deep water dams could be removed more effectively than shallow water dams, and that dams removed in late summer were rebuilt less frequently than those removed in early and midsummer (Dyer and Rowell 1985). Prompt draining of flooded timber land is important, particularly during the growing season.

Plastic tubing-Plastic drainage tubing and wire mesh culverts have been used to control water levels at nuisance beaver sites in New York (Roblee 1983). T-culvert guards have also proven to be effective in recent trials (Roblee 1987).

The San Dimas Technology and Development Center, Pacific Southwest Region (444 E. Bonita Avenue, San Dimas, CA 91173, phone 818/332-6231), has evaluated methods of keeping beavers from building dams at culverts and developed a downspout design showing great promise. Contact them for design details on downspouts, perforated pipes, bafflers, and perforated culvert extensions. They are soliciting field experience with these designs or other new concepts.