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MOUNTAIN BEAVERS

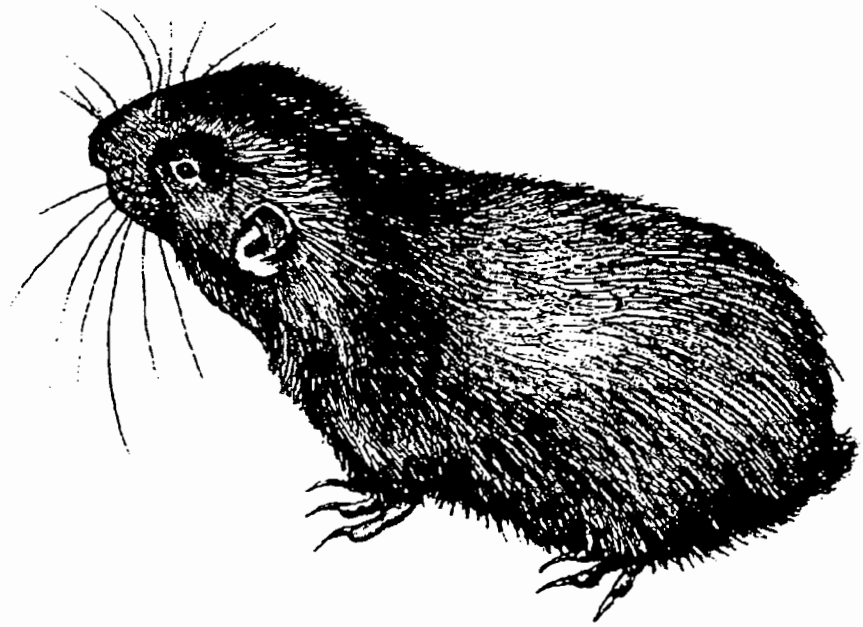

Fig. 1. Mountain beaver, *Aplodontia rufa*

Damage Prevention and Control Methods

Exclusion

Use plastic mesh seedling protectors on small tree seedlings. Wire mesh cages are somewhat effective, but large diameter cages are expensive and allow animals to enter them.

Exclusion from large areas with buried fencing is impractical for most sites.

Cultural Methods/Habitat Modification

Plant large tree seedlings that will tolerate minor damage.

Burn or remove slash to reduce cover.

Tractor scarification of sites will destroy burrow systems.

Remove underground nests to reduce reinvasion.

Frightening

Not applicable.

Repellents

36% Big Game Repellent Powder has been registered for mountain beaver in Washington and Oregon.

Toxicants

A pelleted strychnine alkaloid bait was registered in Oregon but may be discontinued.

Fumigants

None are registered.

Trapping

No. 110 Conibear® traps placed in main burrows are effective but may take nontarget animals using burrows, including predators.

Welded-wire, double-door live traps are effective and selective, but are primarily useful for research studies and removal of animals in urban/residential situations.

Shooting

Not applicable.

Identification

The mountain beaver (*Aplodontia rufa*, Fig. 1) is a medium-sized rodent in the family Aplodontiadae. There are no other species in the family. Average adults weigh 2.3 pounds (1,050 g) and range from 1.8 to 3.5 pounds (800 to 1,600 g). Average overall length is 13.5 inches (34 cm), including a rudimentary tail about 1 inch (2.5 cm) long. The body is stout and compact. The head is relatively large and wide and blends into a large neck with no depression where it joins the shoulders. The eyes and ears are relatively small and the cheeks have long silver "whiskers." The hind feet are about 2 inches (5 cm) long and slightly longer than the front feet (Fig. 2). Mountain beavers often balance on their hind feet while feeding. The front feet are developed for grasping and climbing.

Adults are grayish brown or reddish brown. The underfur on the back and sides is charcoal with brown tips; guard hair is dark brown or black with

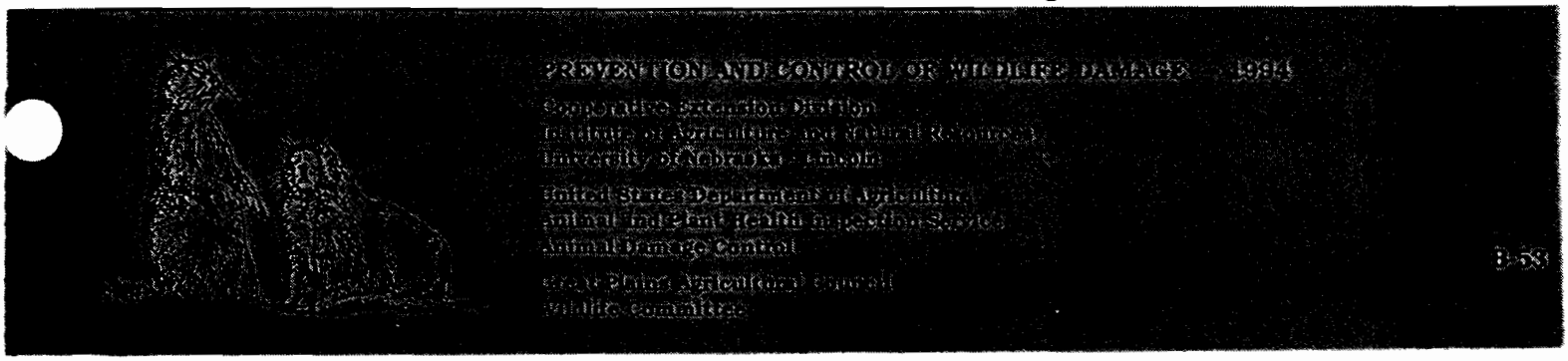

Fig. 2. Mountain beaver feet are developed for burrowing and climbing.

silver tips. Ventrally, the underfur is gray with few guard hairs. A whitish spot of bare skin is present at the base of the ears. The feet are lightly furred on top and bare on the soles. Young animals are generally darker than adults. Males have a baculum (a bone about 1 inch [2.5 cm] long in the penis). Mature females generally have a patch of dark-colored underfur around each of the six nipples.

Range

Mountain beavers are found in the Pacific coastal region from southern British Columbia to northern California (Fig. 3). They range westward from the Cascade Mountains and southward into the Sierras. Numbers are higher and populations are more continuous in the coastal Olympic Mountains and in the coast range of Washington and Oregon than elsewhere. In the southern limit of its range, populations are more scattered but sometimes locally abundant.

Habitat

Mountain beaver habitat is characteristically dominated by coastal Douglas-fir (*Pseudotsuga menziesii*) and western hemlock (*Tsuga heterophylla*). Within this zone, mountain beavers often favor moist ravines and wooded or brushy hillsides or flats that are not subjected to continuous flooding. Although frequently found near small streams, they are not limited to those sites except in more arid regions. Active burrows may carry water runoff after heavy rains, but mountain beavers will vacate burrow systems that become flooded. Mountain beavers do not require free water; they obtain adequate moisture from the vegetation they eat.

Mountain beavers occupy mature forests usually in openings or in thinned stands where there is substantial vegetation in the understory. They usually leave stands where the canopy has closed and ground vegetation has become sparse. Preferred habitats in forested sites are often dominated by red alder (*Alnus rubra*), which the animals promote by preferentially feeding on conifers and other vegetation. These sites are often dominated by an understory of sword fern (*Polystichum munitum*), a preferred food of mountain beavers. Stands of bracken fern (*Pteridium aquilinum*) are also favored by mountain beavers. Preferred shrub habitats include salmonberry (*Rubus spectabilis*), huckleberry (*Vaccinium parvifolium*), salal (*Gaultheria shallon*), and Oregon grape (*Berberis nervosa*). Small trees often found cut by mountain beavers include vine maple (*Acer circinatum*) and cascara (*Rhamnus purshiana*). These species are often intermingled with 30 or more other plant species including forbs, grasses, and sedges.

Fig. 3. Approximate range of mountain beavers in North America.

Food Habits

The food habits of mountain beavers are closely tied to the dominant vegetation in their habitat. Sword fern and bracken fern are preferred when available. Douglas-fir, hemlock, western red cedar (*Thuja plicata*), and red alder are all commercial tree species that are cut and eaten by mountain beavers. Other species found in their habitat are either eaten or used for construction of nests. Most feeding occurs above ground within 50 feet (15.2 m) of burrows, although occasionally mountain beavers may travel several hundred feet from burrows. They routinely climb shrubs and trees 8 feet (2.4 m) or higher to cut off branches up to 3/4 inch (1.9 cm) in diameter, where they leave cut stubs of branches on trees. Mountain beavers also girdle the base of tree stems and will feed on stems up to 6 inches (15 cm) in diameter, as well as the root systems of large trees. The bark is found in the stomach contents of animals collected in midwinter. Woody stems are often girdled and cut into about 6-inch (15-cm) lengths. Food and/or nest items are often stacked at burrow entrances (Fig. 4) but are sometimes carried directly to food caches or nests. Plant material is occasionally eaten outside the burrow but is usually eaten at the food cache, in nests, or in the burrow. Mountain beavers practice coprophagy (consumption of feces) and select soft over hard pellets.

Fig. 4. Sword fern and Douglas-fir piled at the entrance of a mountain beaver burrow.

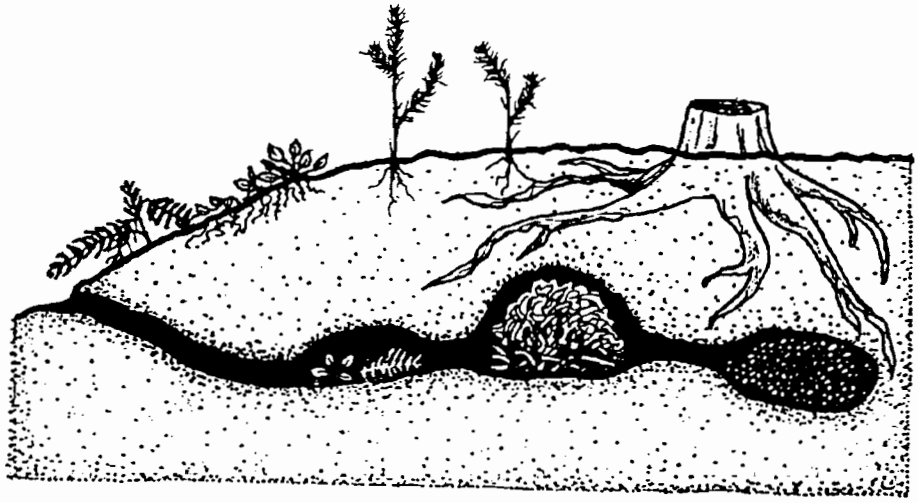

Fig. 5. Cross section of part of a mountain beaver burrow system including food cache, nest, and fecal chamber.

General Biology, Reproduction, and Behavior

Mountain beavers dig extensive individual burrow systems that generally are 1/2 to 6 feet (0.2 to 1.8 m) deep with 10 to 30 exit or entrance holes that are usually left open. The ground surface often caves in where burrows are shallow. There are many exit burrows forming T-shaped junctions with a main burrow. These exits may be horizontal or even vertical. Burrows are often found under old logs and are sometimes on the surface in logging debris. Mountain beavers seldom make obvious trails through vegetation. Most activity is at night and surface travel is usually near their burrows. Sometimes they are seen during daylight in dense surface vegetation several feet from burrow openings. Burrow systems usually cover a 1/4 acre (0.1 ha) or more and may intersect with burrow systems of adjacent individuals. Each system is apparently defended against neighboring mountain beavers. When an animal leaves a system or dies, the system is often quickly reoccupied by another mountain beaver.

Each burrow system contains an underground dome-shaped chamber with a nest, usually about 3 feet (1 m) below ground level (Fig. 5). Nests may vary from 1 to 9 feet (0.3 to 3 m) deep and are entered by one or several entrances. Nest chambers are usually about 2 feet (0.6 m) in diameter and 1 to 2 feet (0.3 to 0.6 m) high. The dome is hardened by packing the soil, apparently with the front feet, causing the ceiling to become a hardened shell. Water entering from above travels along this shell to the edges or floor of the chamber. The floor is often covered with 1 to 2 inches (2 to 5 cm) of coarse sticks to facilitate drainage. On top of the sticks is a variety of dry vegetation that closely surrounds a sleeping mountain beaver. A nest may consist of several cubic feet of dry and nearly dry vegetation. The burrow system also includes smaller chambers or widened burrows used as food caches. A fecal chamber, usually present within a few yards (1 to 3 m) of the nest chamber, is packed with fecal pellets. Fecal deposit chambers may be larger than the nest chamber, representing many years' use of the nest and burrow system.

In the spring and summer, mountain beavers periodically remove molded and partially eaten vegetation from their food caches. Most soil excavation occurs during dry periods from spring to fall. Vegetation is cut year-round, but activity outside burrows and away from the nest is curtailed during subfreezing temperatures. Portions of a burrow may not be used daily, but active burrows in a burrow system are usually used at least weekly.

The habit of stacking cut vegetation at burrow openings has been considered a means to lower its moisture content before taking it into humid food caches or relatively dry nest chambers. Mountain beavers, however, do not always stack cut vegetation and often cut it during periods of continuous rainfall and high humidity. Occasionally there may be 20 or 30 fern fronds or several tree seedlings stacked at burrow openings. The animals usually are quick to carry away small bundles of sword fern that they have placed inside the burrow opening. Some items such as grasses and trailing blackberry vines are cut but are seldom stacked at openings.

Little is known about mountain beaver behavior during the breeding season. Breeding activity occurs mainly from January to March with gestation lasting about 30 days. Young are born blind and hairless, weighing about 3/4 ounce (20 g). They develop incisors at about 30 days and are weaned at about 8 weeks. Young animals are often active in May. Females apparently do not bear young until 2 years of age.

Territorial behavior usually limits mountain beaver population densities to about 4 per acre (10/ha) although densities may be higher in some areas. Densities are generally higher in May and June when young are still active within burrow systems. In winter, average population densities in large reforestation tracts (more than 100 acres [40 ha]) seldom exceed 2 animals per acre (5/ha).

Several predators prey on mountain beavers. Above ground, the main predator, when present, is probably the bobcat (*Felis rufus*). Coyotes (*Canis latrans*) and great horned owls (*Bubo virginianus*) are other major large predators. In burrow systems, mink (*Mustela vison*) and long-tailed weasels (*Mustela frenata*) are the main predators. Weasel predation is probably limited to young or subadult animals less able to defend themselves.

Mountain beavers appear relatively free of diseases and internal parasites. Animals in western Washington were checked as possible carriers of plague but were found negative. A large flea (*Hystrichopsylla schefferi*) unique to mountain beavers is common on the animals but is not known to be a problem for humans. Mites (*Acarina* spp.) often infest the ear and eye region.

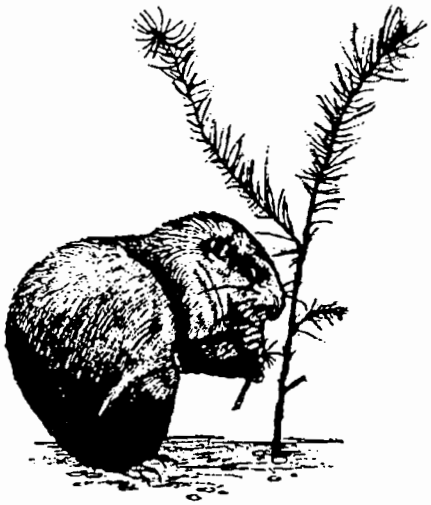

Fig. 6. Mountain beaver in feeding position.

Fig. 7. Mountain beaver–girdled conifer tree.

Damage and Damage Identification

Mountain beavers have damaged an estimated 300,000 acres (120,000 ha) of commercial coniferous tree species in western Washington and Oregon. Much of the affected land has the potential to produce timber values of over $10,000 an acre. The damage period extends to about 20 years after planting. The major losses occur from cutting tree seedlings during the first year after planting (Fig. 6). Secondary damage occurs during the next 5 years to surviving tree seedlings, followed by stem girdling and root damage for the next 10 to 20 years. Increased need for weed and brush control and occasional replanting costs add to the economic losses caused by mountain beavers.

Damage to conifer seedlings is identified by angular rough cuts on stems 1/4 to 3/4 inches (0.6 to 1.9 cm) in diameter. Mountain beavers climb larger trees and cut stems near the tips. Limbs are often cut a few inches from the stem. Small trees are usually cut near ground level while others may be cut several feet up the stem. Seedling damage occurs primarily in winter and early spring, but often continues throughout the year.

Most stem-girdling damage is at the base of 3- to 6-inch (7- to 15-cm) diameter stems (Fig. 7). Girdling damage can be distinguished from that caused by bears or porcupines in that mountain beavers do not leave pieces of bark scattered on the ground and they cut the bark smoothly along the edges. Girdling damage to older stems is more difficult to distinguish, but it can be verified by examining burrows near tree trunks where fresh girdling can be seen on the roots.

Root girdling may occur at any age, but small roots are usually cut instead of girdled. Trees with stems over 6 inches (15 cm) in diameter may die due to extreme root girdling. Root girdling may allow tree root pathogens to become established in individual trees and spread to other trees. It occurs in winter and spring, and may occur in other seasons.

Mountain beaver damage in 10- to 15-year or older stands appears to be increasing and is of great concern because the crop trees are often selected at this time for precommercial thinning. Stem and root girdling may affect over 50% of the trees in a stand. Managers cannot achieve proper spacing in these damaged stands, and damage may continue on trees left as crop trees.

Damage to coniferous species is considered detrimental to forest production and can have long-term effects on habitats. This damage to commercial crops and other vegetation, however, does provide diversity of cover for other wildlife. In one area on the Olympic Peninsula in Washington, the excessive damage to conifers by mountain beavers caused a manager to change the area designation from reforestation land to wildlife habitat.

Legal Status

Mountain beavers are generally considered unprotected nongame species. Individuals wanting to control mountain beavers should consult their state fish and game agency to determine current regulations. A subspecies in California is considered endangered. Information on registered pesticides is available from the state's Department of Agriculture.

Damage Prevention and Control Methods

Exclusion

Small diameter plastic mesh seedling protectors (Fig. 8) will protect most conifer seedlings. Most are effective until the seedlings grow taller than the tube height. The relatively small (1-to 3-inch [2.5- to 7.6-cm]) diameter tubes

Fig. 8. Plastic mesh seedling protector.

do not protect much competing vegetation and also allow lateral branches to grow through the mesh. The advantage of plastic mesh protectors over some other control methods is that they provide protection from a variety of animals including deer (*Odocoileus* spp.), hares (*Lepus* spp.), elk (*Cervus* spp.), and voles (*Microtus* spp.). The cost of installation can be high, but can be reduced if done at the time of planting. Tree seedlings that become established and reach 30 inches (76 cm) or more in height are less susceptible to damage.

Plastic mesh seedling protectors photodegrade and deteriorate after several years. Although they expand with stem growth, they probably provide little protection from girdling of large diameter stems by mountain beavers.

Wire mesh cages 1 to 3 feet (0.3 to 1 m) in diameter will protect individual trees but are expensive and may be climbed over and burrowed under. These cages also allow competing vegetation to be protected and often cause poor tree growth. The wire used in these cages may injure tree growth if cages are tipped or come into contact with the tree stem.

Cultural Methods

Plant large tree seedlings to improve survival of the trees in sites occupied by mountain beavers. Larger stems are less subject to being clipped at ground level. Although large seedlings may be seriously damaged, enough foliage often remains after damage to provide for regrowth and survival after later damage. Damage-resistant trees should be about 2 feet (0.6 m) tall and have 1/2-inch (1.3-cm) or larger diameter stems at the base. Trees should be planted away from burrow openings so that mountain beavers will find them less convenient to cut.

Prescribed slash burning before planting may reduce mountain beaver populations by reducing available forage and increasing predation. Extremely hot fires may cause some mortality, but most mountain beavers will remain protected in their burrows. Reduction in available forage after fire may cause mountain beavers to travel farther from burrows and subject them to higher levels of predation. Legal restrictions or other practices that inhibit prescribed burning may favor mountain beaver populations.

Mountain beaver burrow systems may be destroyed by tractor scarification on level or moderate slopes when done to remove logging debris for replanting or to convert brush fields to plantations. This method requires the use of toothed land clearing blades to rip soil and destroy burrows. It seldom removes the deeper nest chambers but can make the area unattractive to mountain beavers. Avoid piling soil and wood debris, both of which will attract mountain beavers. Wood debris piles should be burned when possible and soil leveled.

Removal of nest chambers after population reduction will reduce reinvasion of the burrow systems by 50% or more. Practical methods for locating and removing nest chambers need further study.

Localized control of plants such as sword fern, bracken fern, or salal may reduce the attractiveness of an area to mountain beavers, but more study is necessary before methods can be recommended. Use caution when applying herbicides to avoid causing increased feeding pressure on conifers by suddenly removing the availability of other forage plants. In such situations, tree seedlings may require protection with plastic mesh seedling protectors.

Fig. 9. Application of powdered repellent to conifer seedling.

Repellents

Coniferous seedlings subject to mountain beaver damage may be treated with repellents, but they require special application procedures to assure the plant stem is treated near the base (Fig. 9). The effectiveness of a repellent can be enhanced by conditioning the mountain beavers to the repellent. Treat cull seedlings with the same repellent and place them in active burrows. This practice has caused mountain beavers to avoid both treated and untreated planted seedlings for up to a year after planting. The only repellent that has been registered for mountain beavers in Washington and Oregon is 36% Big Game Repellent Powder (BGR-P), originally registered only for big game. Thiram (tetramethylthiuram disulfide) is another repellent registered for hares, rabbits (*Sylvilagus* spp.), and big game that has been effective against mountain beavers. Repellents may be of most value where they cause a long-term avoidance. The placement of repellent-treated cull tree seedlings in burrows at time of planting and treating significantly improves repellent efficacy.

Toxicants

A pelleted 0.31% strychnine bait (Boomer-Rid®) has been registered in Oregon for control of mountain beavers. Recent field tests in Washington and Oregon, however, showed marginal efficacy in late winter with Boomer-Rid®. Pelleted bait is placed by hand inside main burrows, using about five baits each in 10 burrow openings in each system. The registered label allows 1/2 to 1 1/2 pounds of bait per acre (0.6 to 1.7 kg/ha). The bait formulation contains waterproofing binders that tolerate wet burrow conditions.

Experimental zinc phosphide-treated apple bait was poorly accepted by mountain beavers and was potentially hazardous to bait handlers. The treated bait was readily eaten by blacktailed deer (*Odocoileus hemionus columbianus*) and could present a hazard.

Baiting is severely restricted in areas frequented by endangered species such as northern spotted owls (*Strix occidentalis caurina*), and bald eagles (*Haliaeetus leucocephalus*).

Fumigants

Fumigants are generally ineffective because of the open, well-ventilated structure of the mountain beaver burrow systems. Aluminum phosphide that was activated when mountain beavers pulled pellets attached to vegetation into the nest area was only partially effective. The use of carbon monoxide gas cartridges and carbon monoxide gas have been unsuccessful in controlling mountain beavers. No fumigants are registered for mountain beaver control. The use of smoke bombs or similar material is effective in locating the numerous openings in a mountain beaver burrow system.

Trapping

Mountain beavers are routinely kill trapped for damage control on many forest lands scheduled for planting. Trapping is usually done just prior to planting and repeated 1 or 2 years afterward. Trapping is also repeated when damage is found in established plantations. Set kill traps in older stands where stems and roots are being girdled and undermined. Live trapping is seldom done in forest lands except for research purposes, but it is used where there are urban damage problems.

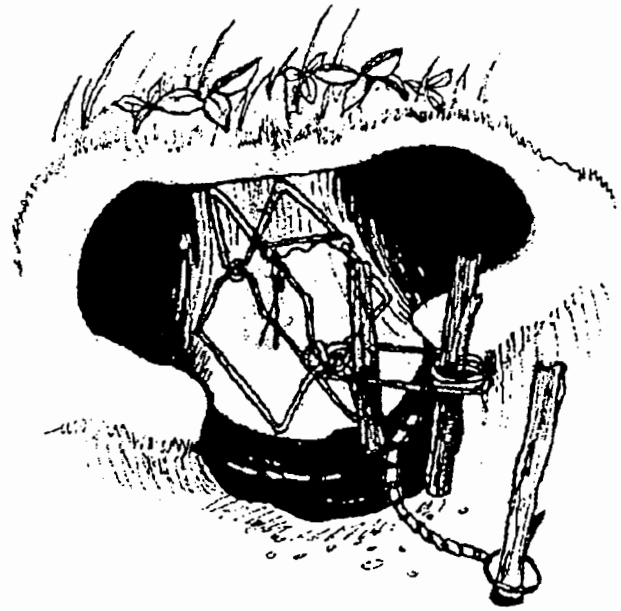

Fig. 10. Method for setting a kill trap in a mountain beaver burrow.

Kill trapping is normally done using unbaited Conibear® No. 110 traps set in main burrows. Anchor traps with three sticks, with either two in the spring (Fig. 10) or with one in the spring and one at the far end of the jaws, in a vertical position with the trigger hanging. The trap should take up most of the space in the burrow, and when properly anchored, is readily entered by the mountain beavers. This trap is sometimes not immediately lethal because of the mountain beaver's thick short neck. Stronger double-spring traps may be more effective, but are more difficult to set in the limited burrow space.

Teams of trappers are normally used when trapping large acreages. Individual trappers should be spaced about 30 to 50 feet (9.1 to 15.2 m) apart, depending on habitat conditions. Extra searching may be required in areas with many small drainages that may have many burrows. Active burrows have fresh soil and vegetation piled at burrow entrances or in burrows. Burrows can often be visually inspected through openings to determine if there is recent use. Set two or three traps in each active burrow system. All trap sites should be marked with flags and mapped so they may be relocated; a crew of trappers should use several colors of flagging so that individuals can relocate their own traplines by color. Trapping in older stands of conifers can be very difficult because traps are not easily relocated when branches hide the flagging. Mapping and flagging travel routes in this type of habitat may be necessary. The trap lines are usually checked after 1 day and again checked and pulled after about 5 days. Traps are usually reset during the first check even where mountain beavers are captured, because the systems may be quickly invaded by other mountain beavers. If trapping is unsuccessful, move traps to burrows with fresh activity. During the breeding season (January to March), male mountain beavers may be more commonly trapped than females because of their greater activity.

During subfreezing temperatures, trapping should be postponed or trapping periods lengthened to include warmer periods when mountain beavers are more active. Trapping during periods of snow is also usually less successful than during snow-free periods because trap sites are difficult to

locate and set, and animals are less active.

Trapping may take nontarget species such as weasels, spotted skunks (*Spilogale putorius*), mink, squirrels (*Tamiasciurus* spp.), rabbits, and hares that use the mountain beaver burrows. Nontarget losses may be reduced by positioning the trap trigger near the side of the trap so that it is less likely to be tripped when small animals pass through.

Live trapping is recommended where domestic animals may enter the burrows. Double-door wire mesh live traps such as Tomahawk traps (6 x 6 x 24 inches [15 x 15 x 61 cm]) should be set nearly level in main burrows. Suitable vegetation should be placed inside and along the outside of the trap. Wrap the trap with black plastic and cover it with soil to protect animals from the weather. Placement should assure that animals enter rather than go around the ends of the trap. Traps must be checked once or twice daily, preferably in early morning and again in the late afternoon, to minimize injury and stress to mountain beavers held in the live traps. Live-captured mountain beavers should be placed in dry burlap sacks and, if necessary, euthanized with carbon dioxide.

Shooting

Shooting is not a practical control method.

Other Methods

Habitat manipulation by increasing or decreasing favored vegetation has been evaluated only indirectly. Where native forbs were seeded to reduce deer damage to Douglas-fir plantations, mountain beaver damage did not significantly decrease or increase. In another area, where red huckleberry was abundant and extensively cut, mountain beaver damage to Douglas-fir was insignificant.

Economics of Damage and Control

Mountain beavers cause considerable economic damage to reforestation. Most of their habitat is in timberland where the potential crop value is high. Well-stocked stands of Douglas-fir are usually commercially thinned once or twice before final harvest, and often produce timber values of thousands of dollars per acre. When mountain beavers prevent reforestation or cause expenditures for protecting reforestation, the value of the crops is reduced or eliminated. A planned Douglas-fir crop rotation period of 40 years on good sites can be severely disrupted if at 15 years the crop is lost to damage by mountain beavers. Since mountain beaver damage occurs on about 300,000 acres (120,000 ha) of commercial forest land, a conservative annual loss estimate of $100 per acre ($250/ha) results in an annual loss of $30 million. Losses to mountain beavers may be $10,000 per acre ($24,700/ha) when damage causes failure of the timber crop.

Economic losses are caused by both direct and indirect damage. Cutting of planted tree seedlings is the most common damage. If it has been several years since planting, the site may need brush control by machine, hand, or herbicide before replanting can be done. Damage to tree seedlings also keeps the trees within a size range that is susceptible to damage by hares, rabbits, deer, and elk. If damage is not controlled, large areas may not be adequately reforested. Trees that escape early damage may be damaged later by girdling and undermining by mountain beavers, causing a loss of many years' growth of commercially valuable species.

The mountain beaver currently has no commercial value. The pelt has no fur value and there is no market for the meat. The animal is of significant zoological and medical interest, however, because of its limited range and unique physiological characteristics. Despite its limited range, however, the overall populations of mountain beavers have probably increased since timber harvesting began in the Pacific Northwest.

The burrowing and vegetation cutting activities of mountain beavers may improve soils and reduce competition by brush species. Sometimes, however, the burrowing activity has caused damage to roads and trails. Forest workers are periodically injured by falling into mountain beaver burrows.

An economic study of Pacific Northwest forest animal damage indicates that damage control expenditures of about $150 per acre ($375/ha) are reasonable on average-site Douglas-fir forest land. On higher quality land the expenditure for damage control can be higher, particularly where mountain beavers cause heavy mortality in reforestation areas.

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I wish to thank numerous employees of USDA-APHIS, the USDA Forest Service, the USDI Bureau of Land Management, the Washington Department of Natural Resources, the Oregon Department of Forestry, and many private forest industry companies for support of studies involving research into mountain beaver damage control. I also wish to thank Kathryn Campbell for the illustrations drawn from photos and descriptions by the author.

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