Category C: Forest Pest Control

Forest Pest Control Learning Objectives

THIS CATEGORY IS AVAILABLE ONLY TO NON-PRIVATE APPLIICATORS BY TAKING A SEPARATE CATEGORY EXAM.

After studying this section, you should be able to:

- ✓ **Define the major forest use objectives.**
- ✓ **Describe the different types of forest insect pests based on the type of feeding damage they inflict.**
- ✓ **List the most common forest diseases.**
- ✓ **Apply Integrated Weed Management (IWM) on forests.**
- ✓ **Identify the different control methods available for IWM.**
- ✓ **Describe the most common vertebrate pests that impact forests in Nevada and control strategies for each.**

Category C, Forest Pest Control

Category C, Forest Pest Control, covers insects, plant pathogens, weeds and vertebrate pests that cause damage on or interfere with land use on forest sites. Nevada's forests provide valuable forage and habitat for wildlife and, to a lesser extent, livestock. Recreational activities are also important land uses. Applicators must consider various land use practices and resources associated with these lands when developing pest management strategies.

The primary pests on these sites are weeds and insects. Plant pathogens and burrowing rodents are less frequent but can become pest problems. Pesticides are useful tools but must not interfere with other land management strategies. To accomplish effective pest control, applicators should take into account all land uses, consider all control methods available and apply pesticides according to label instructions.

Category C, Forest Pest Control, is the category that covers pests of forest trees, both evergreen and deciduous.

Forest Uses:

- **Watershed protection**
- **Wildlife habitat**
- **Timber management**
- **Recreation**
- **Forage for livestock**
- **Tree nurseries**
- **Suburban and urban forest**

Only 6percent of the approximately 8.3 million acres of unreserved forest land in Nevada is classified as timberland; the other 94 percent is classified as unproductive forest land.

Pinyon/juniper forest-type group makes up 80 percent of Nevada's forests.

Types of Forests in Nevada

The information presented in this section is from the USDA Forest Service Rocky Mountain Research Station website at https://www.fs.usda.gov/rmrs/interior-west-forest-inventory-analysis-nevada. This information is based on a 2015 forest survey.

Nevada's forests cover 10.6 million acres, or about 16 percent, of the land in the state. The forests cover a wide variety of environments and forest types that are valued for scenic beauty, wood and non-timber forest products, wildlife habitat and ecosystems services.

The Bureau of Land Management (BLM) manages 6.6 million acres, or 63 percent, of the state's forested lands. 6.1 million acres of this land is unreserved; 0.5 million acres consists of reserved areas, such as wilderness areas. Of the 6.1 million acres of forest unreserved, only 73,000 acres is classified as productive timberland.

The USDA Forest Service manages about 3.2 million acres of forested land in Nevada. 2.2 million acres of this land is classified as unreserved, with the remaining 1.0 million acres classified as reserved areas, such as wilderness areas. Of the 2.2 million acres of unreserved in Nevada, only 144,000 acres are classified as productive timberland.

Private owners, such as Native American tribes, individuals, families and corporations, manage 411,000 acres of forest land in Nevada. There are other public agencies that manage very small portions of Nevada Forested land, including Department of Defense, Department of Energy, U. S. Fish and Wildlife Services, the National Park Service and the state of Nevada.

Only 6 percent of the approximately 8.3 million acres of unreserved forest land is classified as timberland; the other 94 percent is classified as unproductive forest land.

Nevada's forests span a wide range of environments, from pinyon/juniper woodlands to timber forests in the high mountain ranges.

Pinyon/juniper forest-type group makes up 80 percent of Nevada's forests. The most common species are Utah juniper or singleleaf pinyon, but curlleaf mountain mahogany, western juniper, white fir, ponderosa pine, quaking aspen, subalpine fir, whitebark pine and Great Basin bristlecone pine are also found in different areas around the state.

In the Sierra Nevada, the forest land is heavily populated by Jeffrey pine, with California red fir, lodgepole pine, white fir and quaking aspen also common.

Other Forest Related Resources in Nevada

The following is information from the Nevada Division of Forestry website at http://forestry.nv.gov/natural-resource-management/state-conservation-nurseries.

The Nevada Division of Forestry has two state nurseries that offer plants for sale: the Las Vegas State Tree Nursery, located at Floyd P. Lamb City Park at Tule Springs, which offers plants adapted to the Mojave Desert, and the Washoe State Tree Nursery, located in Washoe Valley between Carson City and Reno, which offers plant materials adapted to the Great Basin Desert and the Sierra Nevada Region.

Both NDF nurseries provide custom growing services to state and federal agencies, municipalities, tribes, conservation groups, contractors and individuals for restoration and conservation projects across Nevada and neighboring states.

Rural tree sales are offered for sale in Elko twice a year, generally in May and October.

The Nevada Division of Forestry also has the Nevada Seedbank program, which provides seed, equipment and other materials to rehabilitate wildland fire and fire suppression related damages. It also assists private landowners and public agencies with conservation treatments on their land to reduce soil erosion, increase plant diversity, improve wildlife habitat and reduce the threat of wildland fire.

Nevada Division of Forestry has several forest related resources available; visit their website at http://forestry.nv.gov/natural-resource-management/state-conservation-nurseries

Forest Insect Pests

Native and exotic pest species present unique threats to forests in Nevada. Most pest species are only occasionally important in forests. The damage resulting from chronic outbreaks is often dependent on the management history and environmental conditions when the outbreak occurred. Insect species that attack abundantly planted younger trees in already established areas are usually of less concern than those attacking the more valuable and less numerous mature trees.

Forest insect pests are usually grouped by how they feed and the location on the tree where they feed. Pest control is targeted accordingly.

Defoliators: These are chewing insects that attack and remove foliage from trees. Defoliation of evergreens is much more serious than defoliation of hardwoods. Evergreens often die from a single year of attack, whereas some hardwood trees can withstand one or two defoliations in a single year or repeated defoliation over two or three consecutive years. Outbreaks of

Defoliators are chewing insects that attack foliage.

Douglas-fir tussock moth caterpillar. William M. Ciesla, Forest Health Management International, Bugwood.org.

Douglas-fir tussock moth. William M. Ciesla, Forest Health Management International, Bugwood.org.

Western tent caterpillars. Whitney Cranshaw, CSU, Bugwood.org.

Gypsy or Spongy Moth caterpillar. USDA Forest Service- Region 8 - Southern, Bugwood.org.

defoliators usually develop slowly and are often recognized by land managers late or near the peak of the outbreak.

Native defoliators include Douglas-fir tussock moth (occurring in eastern Nevada, Pioche area), various sawflies, tent caterpillars, chafers and various leaf beetles.

Douglas-fir tussock moth: Feeds on Douglas-fir, all true firs, spruce and occasionally on other pines. Caterpillar larvae feed in the spring and early summer, starting with buds and old needles and moving on to new foliage as it grows. Mature caterpillar larvae are 1 inch long and brown with prominent ivory spots. Adult moths are mottled rust-brown and have a wingspan of slightly less than 1 inch. Female moths lay eggs on needles in late summer. Larvae hatch and overwinter in sheltered sites. This moth is a native insect but is capable of significant defoliation, sometimes causing top kill and mortality of trees.

Tent caterpillar: Feeds on aspen, birch, oak, some maples and other deciduous tree species. This is a native insect that can cause significant damage of both urban and native forests. This pest overwinters as an egg. Eggs hatch in the spring and tend to migrate high in the tree, feeding on foliage. There are several different species of tent caterpillar, but all form the distinctive "tent" of webbing that protects them from predators. The adult moths are variable in color from dark reddish-brown to tan, yellow or gray. Pruning out the infested branches is a viable control method for small infestations in urban forests, but not viable for forest scale infestations. Many insect predators and parasites feed on tent caterpillars, along with birds.

In North America, the primary introduced defoliator of forests is the **gypsy moth (aka spongy moth)**. This moth was intentionally brought into the U.S. It then escaped and became a major pest of deciduous trees in the eastern U.S. In recent years, established populations have been found in Oregon and California. Individual male gypsy moths have been trapped in many western states, including Nevada.

There are two varieties: European gypsy moth and Asian gypsy moth. They both have a voracious appetite and will attack more than 300 species of trees and shrubs. They both overwinter as eggs, which are laid in sheltered areas, such as underneath the bark of trees, eaves of homes and other structures or outdoor objects. Eggs hatch in the spring. Caterpillars are striking, with five pairs of blue dots followed by six pairs of red dots along their backs. The body of the caterpillar is dark colored with light brown hairs. The older caterpillars are 1.5 to 2 inches long. In early summer, the caterpillars pupate, with the moths emerging 10-14 days later. Female moths

have a tan-colored body and white- to cream-colored wings. Females have a 2-inch wingspan. European gypsy moth females cannot fly; Asian gypsy moth females are capable of flight. Male gypsy moths are smaller than females, with a 1.5-inch wingspan. The males are darker colored and have feathery antennae. Both have distinctive markings on the wing: an inverted V shape that points to a dot on the wings. The gypsy moth has one generation per year.

Ealy detection and rapid elimination of infestations in Nevada have prevented large infestations of gypsy moth from developing. States with infestations have found the following control measures useful:

- Mass trapping with pheromone-baited traps.
- Release of sterile male gypsy moths.
- Mating disruption with a registered synthetic version of the pheromone disparlure.
- Diflubenzuron (Dimilin®), an insect growth regulator.
- Bacillus thuringiensis kurstaki (Btk), a microbe that is a natural disease agent of caterpillars. Several registered Btk products are available for use.

A caterpillar pest causing damage in forest and landscape trees in Nevada is the **white satin moth**. The caterpillar of white satin moth causes damage by feeding on poplar, cottonwood, aspen and willow, and sometimes oak and crabapple trees. The caterpillar will skeletonize leaves by feeding on the leaf tissue between leaf veins. Extensive infestations can cause defoliation and branch dieback. Severe infestations can cause tree death.

Adult moths are about 1 inch in length and may have a wingspan of up to 2 inches. They have a silvery-white body and satin-like wings. Caterpillars vary in color from pale to medium grayish brown to black. Full sized caterpillars are 1.75 inches long. They have a very distinctive pattern on markings on their back. A row of yellowish or milky white circular shapes runs down the length of its back, with rows of reddish-brown circles in pairs on either side of the yellowish or milky white circular shapes. Additionally, tufts of reddish-brown hairs stick straight out of its sides and back.

The life cycle of the white satin moth is unusual. It overwinters as a caterpillar, emerging to feed in the spring. Early summer, it spins a cocoon and the moth emerges shortly afterwards. The moths lay egg masses until late summer, and young caterpillars feed in late summer to early fall. For this reason, the full-sized caterpillars actually show up in the early spring, while the newly hatched caterpillars show up during late summer/early fall.

Scout regularly for these pests. Keep landscape trees healthy by managing water and pruning properly. Biological controls include birds, parasitic wasps, lacewings, predatory mites and some beetle species. A microbial insecticide,

Gypsy moth female (white) and male (gray). USDA APHIS PPQ, Bugwood.org.

White satin moth caterpillar. Gyorgy Csoka, Hungary Forest Research Institute, Bugwood.org.

White satin moth. Perry Hampson, Bugwood.org.

Control of defoliators can be difficult. Outbreaks may cover wide expanses of up to 1 million acres or more and may be recurrent and progressive.

Cambium and phloem feeders are insects that feed on the water- and food-conducting tissues in trees.

Emerald Ash Borer with paperclip for scale. Kenneth R. Law, USDA APHIS PPQ, Bugwood.org.

Bacillus thuringiensis kurstaki (Btk), can be effective on the caterpillar stage of the white satin moth. This material must be ingested by the caterpillars as they feed on the leaves. Repeated application may be required as the application may wash off. Chemical controls include several foliar-applied insecticides. Some of these insecticides are toxic to beneficial insects and pollinators, so applications should not be made when the trees are blooming. These are foliar applications, not systemics insecticides, so large trees may be difficult to completely treat. Systemic insecticides are not effective. New insecticide formulations are being developed all the time; consult with your pesticide dealer for the latest formulations that may be effective for white satin moth control. For more information go to https://forestry.nv.gov/uploads/missions/20210302_AMT_2019_White_Satin_Moth_Fact_Sheet.pdf.

Control of defoliators can be difficult. Outbreaks may cover wide expanses of up to 1 million acres or more and may be recurrent and progressive. It is against this group of insects that most chemicals are applied in forest areas. Leaf-feeding insects can be easily controlled in the forest habitat with aerially applied chemicals. Many can also be controlled with various biological materials, including bacteria and viruses.

Cambium and Phloem Feeders: This group is the most destructive group of forest pests. These insects feed on the water- and food-conducting tissue of trees. Most are secondary pests that attack stressed and dying trees, although a few, especially bark beetles and some flatheaded borers, may attack and kill healthy trees. Death of trees usually results from the girdling of the cambial tissue, but the introduction of disease may also kill trees (e.g. Dutch elm disease). Other insect pests in this group include pitch moths and round-headed woodborers.

Emerald Ash Borer (EAB) is an exotic beetle that attacks ash trees. Adult beetles are metallic green and about ½ inch long. The larvae feed on the inner bark of ash trees, disrupting the tree's ability to transport water and nutrients. Adults leave a D-shaped exit hole in the bark when they emerge in spring. Adults remain active until the end of summer.

Emerald ash borer is thought to have arrived in the United States on solid wood packing material carried in cargo ships or airplanes originating in its native Asia. As of October 2018, it is now found in 35 states, and the Canadian provinces of Ontario, Quebec, New Brunswick, Nova Scotia and Manitoba. Part of the spread of the EAB is through moving firewood.

Prevention measures include a ban on moving firewood from areas with an infestation. Monitor for this pest. New infestations are difficult to detect, as damage to the tree may not be apparent for up to three years. Symptoms of an infestation can include branch dieback in the upper crown, excessive

suckers or water sprouts forming on the tree trunk, and vertical bark splits. Woodpeckers like EAB larva, so heavy woodpecker damage on ash trees may be a sign of infestation. There are several different types of chemical controls that may be effective, including systemic insecticides applied as a soil drench, soil injections, or truck injections. New formulations are being tested for effectiveness against EAB; consult with your pesticide dealer for the latest formulations. Read, understand and follow label directions. For more information and to track the spread of EAB, go to the EAB Information Network at http://www.emeraldashborer.info/.

Chemical sprays applied to individual trees prior to infestation or while infestation is not advanced can afford protection to highly valued trees, especially in the urban environments. The chemical should be applied as high as possible on the trunk and coverage should include the lowest branches if possible. Trap trees and selective thinning or salvaging of infested trees can be used on larger infestations in forested areas. The latter method is the primary method of controlling bark beetle infestations. Bark beetle populations can also be effectively monitored with the use of pheromones for the specific type of beetle. Pheromones can also be used to enhance the effect of trap trees.

Shoot and Root Feeders: These insects are the most important insect pests in the nursery and Christmas tree industries. They seldom kill trees (except small seedlings) but can cause deformity in tree growth that is important both to the lumber and Christmas tree industries. Severe damage can cause a reduction in growth.

Insects that are common pests in this group include tip moths, pine sheath and needle miners, white grubs and a variety of weevils. Control of these pests is difficult. Few, if any, effective controls exist for root-feeding insects. Timing of chemical application to coincide with the vulnerable life stages of the shoot-feeding insects is very critical. Mechanical control (removing tips) on small areas may be effective but is expensive and time-consuming. Cultural controls, such as site selection and delayed planting, can help control some of these pests. One newly introduced shoot feeder is the Nantucket pine tip moth. It was first found in the Las Vegas area on pines from California. This insect has the potential of becoming a very serious pest of pines. It commonly prefers smaller trees and can cause severe tip damage if not controlled.

Sap Suckers: This group includes mites, aphids, scales, mealy bugs, spittlebugs and plant bugs. These pests extract food from the plants through sucking mouthparts. This often results in the infested tree having a dry appearance. Trees often drip honeydew from the insects. If infestations

Part of the spread of the EAB is through moving firewood.

Prevention measures include a ban on moving firewood from areas with an infestation.

Shoot- and root-feeding insects are serious pests in the nursery and Christmas tree industries.

Sap-sucking pests include mites, aphids, scales, mealy bugs, spittle bugs and plant bugs.

continue, defoliation can occur. With evergreens, this is usually seen as loss of the two- to four-year old needles. The trees start taking on a sparse appearance. Deciduous trees generally lose their leaves, and if the infestation continues, the new leaves will be much smaller than normal. Death of all trees usually results only from continuous infestations. Outbreaks of many of these pests are often directly correlated with human activities in the infested area. Biological control agents offer some control, but more detailed studies are required to develop improved methods in this area.

For more information on these pests in an urban forest setting, consult Identification of Common Landscape Pests and Beneficial Organisms in Nevada at https://naes.agnt.unr.edu/PMS/Pubs/2006-4051.pdf.

For more information on common forest pests infestations in Nevada, consult 2019 Forest Pest Conditions in Nevada at https://forestry.nv.gov/uploads/missions/20190101_AMT_2019_Nevada_Forest_Pest_Conditions_Report.pdf.

Forest Disease Pests

Disease control in the forest environment is generally based upon management decisions designed to reduce loss. Cultural practices that produce the most vigorous stands of forest species also tend to reduce incidence of disease. There are several disease control practices that apply to forest nursery production. Only a limited number of recommended disease management practices involving chemicals apply to the urban environment.

Dwarf mistletoes are host-specific parasitic plants.

Dwarf Mistletoe: Seed-producing parasitic plants commonly called dwarf mistletoe cause one of the most important diseases of western forest conifers. Most of the dwarf mistletoes are host specific; that is, each species of mistletoe has its own host or group of host conifers. They live only as parasites on living conifers from which they absorb water, minerals and organic compounds from the phloem and xylem.

Dwarf mistletoes suppress tree vigor and growth. This results from a gradual reduction of the effective needle surface of the tree and a disturbance of the tree's normal physiological processes. Damage by dwarf mistletoe is recognized in four general categories:

- Reduced incremental growth. This may be 75 percent in some species.
- Increased mortality. This is often very high in young trees.
- Lower timber quality. Increased cull of logs or degradation of lumber.
- Indirect losses. Affected trees are predisposed to attack by opportunistic insects and fungi.

Dwarf mistletoes spread by seeds that are forcibly ejected from a capsule. This ejection system is a very efficient means of seed dispersal; 50 feet to 75 feet of dispersal is common. In addition, seeds have a very sticky surface and remain where they hit. If they land on a susceptible host, a new disease cycle is initiated. Mistletoe plants are perennial and will produce seed for many years. Mammals and birds also move seeds to new areas.

Management of stands infected with dwarf mistletoe is difficult. It is important to remove infested overstory trees, keep stands as even in height as possible, and in some cases clear-cut the stand. In individual high value trees, pruning out infestations is an effective control practice. Replanting no-host species is a viable alternative where mistletoe infestations are severe.

***Cytospora* canker:** This fungal disease of poplars, cottonwoods, willows and some other shade trees is common in Nevada. Pruning out infected branches and destroying them will help control this disease. It is important that trees not be water-stressed by drought or stressed by other factors in the establishment phase, as this increases their susceptibility to infection.

Forest nursery diseases: Disease problems common in the forest nursery environment can be summarized as follows:

- **Root and soil-borne diseases:** *Fusarium* root rot, damping-off, black root rot of pine, *phytophthora* root rot, crown gall and some nematodes are examples of this group. Seed treatment with certain chemicals has given some control. Soil fumigation with various formulations has been relatively effective. Disease incidence is dramatically increased by overwatering or improper drainage.
- **Foliage, stem and branch diseases:** *Phomopsis* canker, white pine blister rust, *Lophodermium* needle cast, *Cercospora* blight of juniper and *Cytospora* canker of poplar are examples of this group. Various protective fungicides have provided control for some of these problems. Cultural practices can reduce disease incidence. Avoid wetting foliage, promote a dry microclimate between nursery stock, isolate or destroy diseased nursery stock, and practice conscientious sanitation.

Forest and Range Weed Pests

Nevada has a smaller amount of forest lands, as compared with rangelands, but weed management is equally important on these sites.

Undesirable native woody and herbaceous vegetation, as well as noxious weeds, which are usually non-native invasive plants, may infest grazing lands and recreational areas. State law defines a noxious weed as any plant that is

Chemical formulations change all the time. Consult your local dealer for recommendations for your particular pest and site.

For the latest noxious weed list, see http://agri.nv.gov/Plant/Noxious_Weeds/Noxious_Weed_List/

Proper identification is critical when managing weeds. Contact the University of Nevada, Reno Extension or the Nevada Department of Agriculture for help with weed identification.

Successful weed management considers all the potential control methods available:

- **Prevention**
- **Cultural**
- **Physical / Mechanical**
- **Biological**
- **Chemical**

detrimental or destructive and difficult to control or eradicate. Landowners and managers are required to control noxious weeds on their lands; therefore, ranchers, farmers and resource managers should be familiar with weeds that are considered noxious. A current listing of state-designated noxious weeds and laws regarding their control may be obtained from the Nevada Department of Agriculture, https://agri.nv.gov/Plant/Noxious_Weeds/Noxious_Weed_List/.

Plants such as leafy spurge, perennial pepperweed (tall whitetop) and Scotch thistle are found in forest and rangelands throughout the state. Saltcedar, also known as tamarisk, is well adapted to alkaline soils commonly found in Nevada and will invade riparian areas. Because of their unpalatability and invasive nature, all noxious weeds have an adverse effect on wildlife and domestic animals.

The objectives of weed management on forest lands are to:

- Improve carrying capacity and productivity of forest lands.
- Reduce competition from weeds, thus improving growth of desirable vegetation and overall health of the forest.
- Improve reforestation success by reducing competition from weeds.
- Reduce the presence of ladder fuels and the potential for wildfire in the forest.
- Improve and protect habitat for wildlife and domestic animals.
- Improve sites subject to erosion through weed removal and re-vegetation.
- Protect riparian areas and improve water quality.
- Enhance and maintain recreational access to forest lands by preventing the spread of invasive weeds.
- Enhance species diversity and the beauty of Nevada's forest lands.

Integrated Weed Management (IWM)

Integrated weed management (IWM) utilizes a number of management strategies, including prevention, cultural, physical, mechanical, biological and chemical control methods. Successful weed management programs do not rely on any one control technique but use a combination of control strategies.

Prevention: Prevention of weed infestations is a major component in effective long-term forest weed management programs. When planting in forests, use certified weed-free seed. Many weed species, including noxious weeds, are transported to uninfested areas in contaminated hay and straw. It is important to restrict the movement of contaminated hay, straw or other

commodities into an area. Each product should be certified weed-free before it is transported to the area as feed, for erosion control or for any other purpose.

Equipment, recreational vehicles, livestock and wildlife are capable of moving weeds. Clean equipment after working or traveling in an infested area to prevent weed spread. Preventing wildlife from spreading weeds may be impossible, but controlled rotational grazing to avoid heavily infested areas during weed seed production can help reduce the spread of noxious weed species by livestock. Keep a close watch, and control new infestations around loading areas, such as corrals and loading ramps, as these are sites where noxious weeds often are introduced when horses or cattle are transported to forest lands. Do not move grazing animals from an infested area to a weed-free site without holding them for seven days and feeding them clean feed. Do not move soil, sand or gravel that is infested with noxious weeds or use it in constructing roads, dams, ramps, etc.

Cultural: In the forest, selecting and planting adapted tree species is wise. Adapted tree species grow best, are competitive and require the least number of inputs per acre. Most have fewer pests associated with them and, as a result, have better vigor. Planting trees close together reduces weeds but increases competition among the trees. High tree densities at planting reduce weed establishment and can be followed up with tree thinning as the trees grow to reduce tree-to-tree competition and to develop larger trees.

Physical and Mechanical: In Nevada, bulldozers with brush blades or chains dragged between two dozers are used to remove brush and prepare a site for planting. Unfortunately, wheeled and tracked vehicles are limited to gentle terrain.

Prescribed burning can sometimes be used for pre-plant brush control but is usually not effective on long-lived perennial noxious weeds and some native shrubs that re-sprout from the roots.

Hand removal of weeds by pulling, digging or hoeing can be effective for selected weed species. Small infestations of annual and biennial weeds, such as musk thistle, Scotch thistle and dyer's woad, may be controlled in this manner. Remove weeds prior to flowering and seed set. The practice is usually not effective on perennial noxious weeds. Hand removal is labor-intensive and requires repeated treatment for several years to be successful.

Biological: Biological control uses living organisms or natural enemies, such as animals, insects, other plants and microorganisms, to interrupt the life cycle of the weed and control it or reduce its competitive advantage.

To prevent new weed infestations:

- **Plant certified weed-free seed.**
- **Restrict movement of contaminated hay, straw and other products.**
- **Clean vehicles and equipment.**
- **Avoid grazing heavily infested areas.**
- **Do not move weed-infested soil, sand or gravel.**
- **Hold and feed grazing animals for seven days with weed-free forage before moving them to a new area.**

Use biological controls as a part of an integrated weed management program. When used alone, insects, pathogens or grazing will not eradicate a weed species.

Chemical formulations change all the time. Consult your local dealer for recommendations for your particular pest and site.

Many chemicals effective on weeds are prohibited from being applied directly to water. Refer to the aquatic pest control section in this manual if you are doing weed control in or near waterways or ponds.

Intensive grazing can reduce or remove some weedy species in young forests. Unfortunately, grazing is not entirely selective, and trees or other forest plants can be severely damaged. Matching the proper control agent and timing are important. For example, goats will feed on leafy spurge, but cattle will not. Many animals will eat weeds early in the year, but not after they have become coarse and unpalatable. Pathogens or insects are only rarely used because of the possibility that they may infest non-target species, especially economically important crops. Consult Nevada Department of Agriculture for information and permits for insect biocontrols.

Chemical: There are many herbicides registered for use on forest sites, and weed infestations in these areas often require herbicide treatment. For herbicides to be effective they must be applied according to label instructions. Herbicide selection should be based on the site and the weed species. Proper weed identification, environmental conditions and plant growth stage must be considered to get the maximum benefit from herbicides. Products that are effective at controlling one species may have no effect on others.

Serious infestations of Canada thistle, leafy spurge, purple loosestrife and perennial pepperweed will often be found in riparian areas and very near or sometimes in shallow water. Many chemicals effective on these weeds are prohibited from being applied directly to water. Refer to the aquatic pest control section in this manual if you are doing weed control in or near waterways or ponds.

The success of a chemical treatment on weeds in forests is affected by:

- Site specific conditions, including soil class, type of terrain and aspect.
- Applicator skill.
- The chemical applied.
- The species and growth stage of the weeds.
- The type of equipment used.
- Climatic conditions at the site.

Environmental Fate of Herbicides

After an herbicide is applied, one or more things may happen. The herbicide may be taken up by the target plant or be washed off the plant and onto the soil by precipitation or irrigation. The herbicide may volatilize or be broken down by sunlight, a process called photodegradation. When herbicides contact the soil, they may be broken down by microbes or sunlight. Herbicides can be transported through the soil into groundwater. This

process is called leaching. Herbicides may also be carried by runoff from the target site into surface waters.

Application Methods

The size of the weed infestation, terrain and accessibility of the site are all factors when selecting application methods. Aerial applications are appropriate and necessary for some locations, while backpack spray applications are fine for others. Proximity to sensitive sites, such as water or urban and landscaped areas, may require that buffer zones be implemented, especially if using aircraft.

Foliar Applications: Spraying foliage is effective in controlling many forest species and is recommended when controlling hard-to-kill noxious weeds. Aerial and ground equipment is used in spraying. Backpack sprayers apply 3 to 10 gallons per acre, while aerial spraying requires 5 to 10 gallons per acre of mixed product.

Because many forest herbicide applications are conducted on large areas, sometimes by plane or helicopter, drift must be eliminated or controlled. Without adequate drift control, damage can occur to non-target plants in nearby watersheds, the herbicide may contaminate water, and private property may be damaged. Always read and follow the instructions on the label. Doing so reduces risks to the applicator, other people, non-target plants, animals and nearby properties. It is also the law. The General Knowledge: Pesticide Use and the Environment chapter of this manual covers minimizing pesticide drift.

Spot treatments are especially useful in controlling noxious weeds while avoiding drift. When making spot treatments, mix and load at the application site. To avoid water contamination, never mix and load herbicides near waterways, lakes or wells. Use a nurse tank to supply the water rather than filling spray tanks directly from a water source.

Wick applicators or weed wipers are sometimes used to apply herbicides to foliage. This application method reduces the potential for drift and is effective in areas where there are environmental concerns near water or sensitive species.

Many herbicides used on forest sites are foliar applied compounds. Be aware that herbicides used for controlling weed species may also damage or kill desirable vegetation, and many native plants are extremely vulnerable. Some foliar applied products also have soil activity and may prevent germination of desirable species after the weeds have been controlled.

Follow grazing restrictions on the label when grazing animals are present.

If more than one application of herbicide is required to control a weed infestation, it is imperative to use herbicides with different modes of action to reduce the risk of developing herbicide resistance.

Without adequate drift control, damage can occur to non-target plants in nearby watersheds, the herbicide may contaminate water, and private property may be damaged. Always read and follow the instructions on the label.

A major barrier to uptake of foliar applied herbicides is a waxy layer of the leaf surface known as the cuticle. Herbicide labels tell you if a surfactant or adjuvant should be added to the mix to improve plant absorption of the herbicide.

Herbicide formulations change all the time. To find out if a product is registered for forest weed control, go to http://npirspublic.ceris.purdue.edu/state/state_menu.aspx?state=NV

Basal Application: Trunks of trees and brush can be treated to selectively control woody species. The bottom 15 to 18 inches of the trunk must be soaked to be effective. Application in spring gives the best top kill, while summer and fall treatments control sprouts. Winter treatments require greater concentrations of product to be effective. In all cases, it usually takes 1 to 2 years to completely kill a woody plant. Low-volume and thinline basal bark treatments use herbicide products in increasingly greater concentrations to control small woody plants less than 6 inches in diameter.

Cut-surface or Cut-stump and Other Applications: Trunks that are frilled or hacked at intervals around the trunk and stumps can be treated with herbicides to kill woody species and prevent resprouting. Cut-stump treatments are commonly used to control brushy or woody species, such as saltcedar (tamarisk). Seasonality affects how well a chemical works with this treatment method. Many products work best during the spring, when the movement of sap is upward. Others are effective when the sap is moving down into the roots during the fall. Some work best during the growing season, from June through November. Many products are labeled for direct injection. Conifer stands are commonly thinned using injection methods.

Soil Active Herbicides: Several herbicides are active when applied to the soil, where they form a barrier to sprouting weeds or are absorbed by the roots of weeds. Rainfall, snowmelt and irrigation move them into the soil. They may break down more quickly during warm, moist conditions because of increased microbial activity. They may be leached from the soil with excessive precipitation. Some formulations have both a preemergence and post-emergence effect and are used in conifer forests to control annuals and some perennial weeds. Because these chemicals are commonly water-soluble and can easily contaminate water, including groundwater, they must be applied at the proper rate and according to label directions.

Soil-active or preemergence herbicides are the most common pesticide contaminants found in Nevada's groundwater. Some pesticide labels advise the applicator to not apply or to reduce applications of these products in sites that are vulnerable to groundwater contamination. Risky sites include those with sandy or gravelly soils and areas where groundwater levels are near the surface (areas with shallow groundwater).

Applicators must consider the proximity of desirable non-target vegetation. Some soil-active herbicides will damage or kill existing vegetation, and some have no effect on it at all. Product labeling describes precautions related to protecting non-target trees and other vegetation. Serious violations, resulting in enforcement actions, have occurred after applicators have damaged or killed adjacent non-target vegetation with pre

-emergence herbicides.

Forest and Range Vertebrate Pests

Animals play an important role in forest ecosystems. Several species of rodent, including pocket gophers and ground squirrels, occur naturally in forest sites. Other native species, such as deer and rabbits, also inhabit these areas. Harm to forests is rare, but adjacent agricultural lands or urban landscapes may sustain significant damage due to burrowing and feeding activities.

While uncommon, animal damage may occur during reseeding, land rehabilitation or reforestation activities. Forest nurseries may also sustain damage by gophers, squirrels, deer or rabbits. Baits or traps are most commonly used on burrowing rodents, such as gophers. Using wire cylinders to protect individual plants from deer and rabbits is labor intensive but effective. Chemical repellents can be useful in some situations but must be reapplied when washed off by precipitation.

Using toxic baits to control deer and rabbits is strictly prohibited. Deer and some rabbit species are game animals and are protected under state fish and game laws.

For more information on vertebrate pests, consult the General Knowledge: General Pest Problems chapter of this manual.

Conclusion

Nevada's forests provide valuable forage and habitat for wildlife. Recreational activities are also important land uses. Applicators must consider various land-use practices and resources associated with these lands when developing pest management strategies.

The primary pests on these sites are weeds and insects. Plant pathogens and burrowing rodents are less frequent but can become pest problems. Pesticides are useful tools but must not interfere with other land management strategies. To accomplish effective pest control, applicators should consider all land uses, consider all control methods available and apply pesticides according to label instructions.

Originally published in 1987 as Category 2 Pest Control on Forest and Rangelands, Nevada Pesticide Applicator's Certification Workbook, SP-87-07, by W. Johnson, J. Knight, C. Moses, J. Carpenter, and R. Wilson.
Updated in 2018 by M. Hefner, University of Nevada Cooperative Extension, and B. Allen and C. Moses, Nevada Department of Agriculture.
Updated in 2023 by M. Hefner, University of Nevada, Reno Extension and B. Allen and R. Saliga, Nevada Department of Agriculture.

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