University of Nevada
Cooperative Extension

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A Homeowner's Guide to Integrated Pest Management (IPM)

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A partnership of Nevada counties; University of Nevada, Reno; and U.S. Department of Agriculture

Cover photo by Wendy Hanson Mazet, University of Nevada Cooperative Extension.

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Introduction

Integrated Pest Management – what's that?

Integrated Pest Management, also known as IPM, is a sustainable approach to managing pests that combines cultural, physical, biological and chemical methods in a way that minimizes economic, health and environmental risks.

Effective IPM programs identify pests, their life cycles and their interactions with the environment. Considering all available pest control methods, a pest management plan is developed using the most economical means and with the least possible hazard to people, property and the environment.

This guide is intended for pests that occur in your landscape. It does not cover termites, bedbugs or other household pests.

What this guide is about

Our goals are to:

- Introduce you to the concept of IPM.
- Help you assess the level of IPM you are already using.
- Help you set IPM-related goals for your property.
- Help you identify barriers to using IPM.
- Help you decide how to implement the IPM goals you set.

IPM IQ Test

Do you? (Check all that apply.)

- ☐ Mow your lawn at least 3 inches high?
- ☐ Use a mulching lawnmower?
- ☐ Check your irrigation system regularly for leaks?
- ☐ Regularly walk your landscape looking for weeds?
- ☐ Hand-pull weeds in your yard or vegetable garden?
- ☐ Clean up your yard or vegetable garden at the end of the season to eliminate pest overwintering sites?
- ☐ Rotate vegetable crops to prevent pest buildup in the soil?
- ☐ Purchase plants for your yard that are adapted to your climate?
- ☐ Monitor your plants for insect pests?
- ☐ Handpick insects off your plants?
- ☐ Monitor your plants for beneficial insects, such as lady beetles?
- ☐ Plant flowers around your home to attract pollinators?
- ☐ Use a fence to keep rabbits out of your garden?
- ☐ Use a mousetrap to eliminate mice in your home or garden?

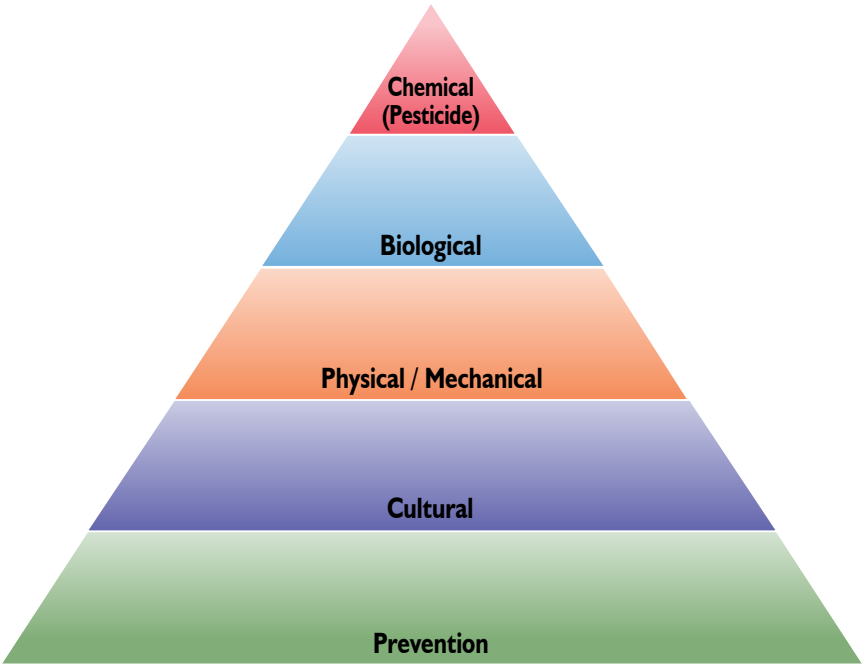
Chances are, you're already practicing IPM in your home and landscape!

Count the number of items you checked on the IPM IQ test to assess your IPM IQ...

- If you checked zero to five items, you are an **IPM Novice**. Don't worry. There's room for improvement! Read the information on the following pages and follow our web links. In no time, you will have the tools you need to get ahead of the pest control game.
- If you checked six to 10 items, you are an **IPM Scholar**. You have been doing your homework and are diligent about keeping your home and landscape pest free. Keep reading to find even more ways to manage pests.
- If you checked more than 10 items, you are an **IPM Pro**. We can tell you've been doing this for a while, and we congratulate you! But there is always more to learn. Read on to deepen your knowledge of IPM, and to more effectively reach your pest management goals while protecting our fragile environment.

How Can IPM Help Me?

IPM is the use of multiple strategies to control a pest. Often, our first impulse is to apply a pesticide at the first sign of a problem. IPM helps develop a pest control plan that can prevent or limit further pest problems in the future. IPM control strategies are commonly shown as a pyramid. The major emphasis is on the base of the pyramid, preventing pest problems, and the use of chemical controls is limited to situations where they are really needed. IPM is not a no-pesticides approach to pest management. IPM control plans look at all the available methods to control pests. Specific IPM principles will be discussed on Page 22. First, let's talk about pests.



What Are Pests?

Pests are organisms that damage or interfere with crops, ornamental landscape plants, homes, structures or wildlands. Landscape pests can be divided into four groups: weeds, insects, plant diseases and wildlife. Below is a list of websites that will help identify pests and provide further information.

Photo by Terry Spivey, USDA Forest Service, Bugwood.org.

This deer becomes a pest when it jumps the fence and begins consuming crops or plantings in landscape settings.

http://manageNVpests.info Managed by University of Nevada Cooperative Extension, this site contains information on IPM, including photo galleries of noxious and nuisance weeds, pest insects, beneficial insects and exotic insects.

http://agri.nv.gov/Plant-Industry/ Nevada Department of Agriculture plant industry site, with links to the entomology, noxious weeds and plant pathology departments. For wildlife problems, the link is *http://agri.nv.gov/Resource_Protection/*.

http://ipm.ucanr.edu University of California statewide IPM programs website with home, landscape and agricultural pests. It has a weed gallery, exotic and invasive pest information, and beneficial insects gallery.

http://icwdm.org/handbook/index.asp Prevention and control of wildlife damage handbook. This site was funded by the National IPM Network and USDA - CSREES.

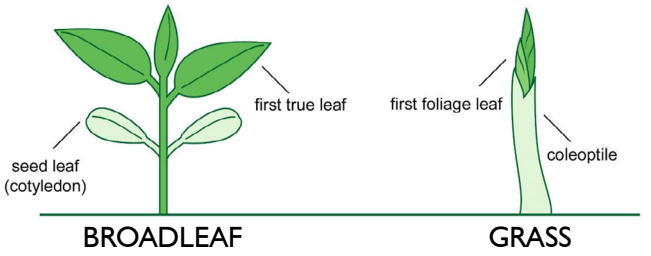
http://www.nevadapesticideeducation.info This site is managed by University of Nevada Cooperative Extension to educate certified pesticide applicators in pesticide safety.

Weeds

The term "weed" refers to a plant growing where it is not wanted. Among weeds, there are some important distinctions. **Noxious weeds** are weeds designated by the state as requiring control. **Nuisance weeds** are weeds that have not been designated as noxious, but occur commonly in our area. Weeds are plants that are:

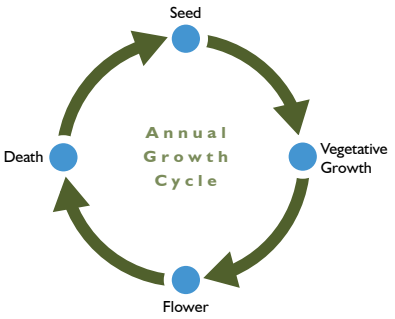
- Competitive: They grow well in spite of interference from other plants.
- Persistent: They will return year after year. They reproduce vigorously and spread seeds effectively.
- Harmful: They may be harmful to native plants, livestock and wildlife, and to the environment in general.

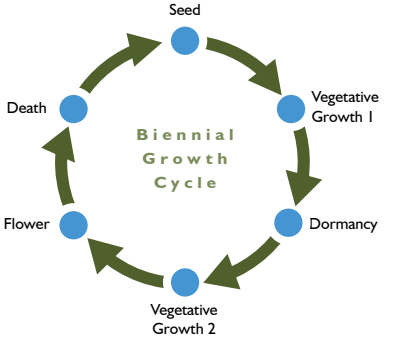
Weeds can be subdivided in several ways. A common way to subdivide weeds is by class: grass versus broadleaf. The first leaves produced by broadleaf weeds are in pairs (two seed leaves). The first leaf produced by grasses are single (one seed leaf). Broadleaf weeds commonly have a coarse taproot and net-like leaf veins. Grasses have fibrous roots and parallel leaf veins. Understanding the class of the weed becomes important when you choose to use a chemical control. Some herbicides (pesticides that kill plants) are grass-selective, and some are broadleaf-selective. There are also nonselective herbicides that will kill all plants. Both broadleaf and grass weeds are most easily controlled at the seedling stage.



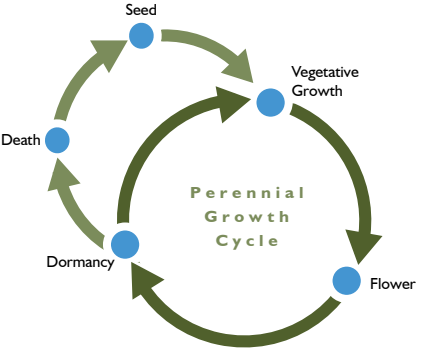
Life cycle. Weeds can also be characterized by their life cycle. All plants grow through stages as shown in the diagrams below.

Annual plants complete all plant growth stages in one growing season. **Biennial plants** complete all plant growth stages in two growing seasons. The first year includes seedling and vegetative stages; the second year includes vegetative, flower and seed development, and then death.





Perennial plants complete all life stages in one growing season (except death). They survive more than two growing seasons and have a seedling stage only during the first growing season.



Why should you care?

Most weeds are easiest to control at the seedling stage. Herbicides are most effective when applied to actively growing plants. Growth stage affects herbicide performance.

Annuals and other weeds establishing from seed. Control of annual weeds is most effective when seeds are germinating and when plants are very young. Preemergence herbicides can be used to kill germinating seeds. Plants that survive are easy to hand-pull when they are young. In unplanted areas, the first crop of weeds may be allowed to germinate, and the young plants are killed with herbicides or tillage. Annual weeds are most resistant to control after flowering, and you risk allowing seed to be produced and distributed, further adding to the seedbank. The seedbank is the viable seed present in the soil from previous weed infestations.

Photo by Nate Weber, Crop Production Services.

Photo by Melody Hefner, University of Nevada Cooperative Extension.

Control of annual weeds (left) is most effective when seeds are germinating and when plants are very young. Biennial weeds are most susceptible to herbicides at the rosette stage of development (right), during the first year and early second-year growth.

Biennial weeds. In addition to preventing seed germination and hand-pulling young plants, biennials can be controlled at the rosette stage of development, by either hand-pulling or herbicide application. After production of flowering stems, susceptibility to herbicide drops. Control efforts should focus on prevention of flowering, to avoid adding to the seedbank.

Perennial weeds. Control of perennial weeds involves prevention of seed production, but also control of growth from vegetative reproductive structures. Many perennial weeds are difficult to control by hand-pulling or tilling. Chemical control is most effective when these weeds are both actively growing and moving carbohydrates to the roots for storage. An effective time to control perennial growth is just before the early flower bud stage, when root reserves have been depleted and carbohydrates from the leaves are beginning to move downward to the roots. Applied herbicides will move with carbohydrates to the roots until the flowers open. Another good time is during the fall, when plants are moving carbohydrates to the roots for storage over winter. Perennial weeds are least susceptible to herbicides at emergence of new shoots or during seed development.

An effective time to control perennial growth is just before the early flower bud stage (above) or during the fall, when plants are moving carbohydrates to the roots for storage over winter (right).

Photos by Melody Hefner, University of Nevada Cooperative Extension.

It is beyond the scope of this publication to identify all noxious and nuisance weeds in the state of Nevada.

Here is a list of resources to help you identify weeds:

Nevada Department of Agriculture noxious weed list *http://agri.nv.gov/Plant/Noxious_Weeds/Noxious_Weed_List/*

University of Nevada Cooperative Extension Nevada Noxious Weed Field Guide *http://www.unce.unr.edu/publications/files/nr/2010/sp1001.pdf*

University of Nevada Cooperative Extension Integrated Pest Management Common Nuisance Weed photo gallery *http://www.unce.unr.edu/programs/sites/ipm/gallery/*

University of Nevada Cooperative Extension publications on weeds *http://www.unce.unr.edu/publications/search/*, click on "key words" and enter "weeds."

University of California Statewide Integrated Pest Management Program Weed Photo Gallery *http://ipm.ucanr.edu/PMG/weeds_intro.html*

Photo by Melody Hefner, University of Nevada Cooperative Extension.

These are dandelions infesting a pasture.

Common Pest Insects and Mites

Less than 5 percent of all insect species are pests. For identification and control purposes, it is important to recognize the differences between insects and mites. Insects have three body parts (head, thorax and abdomen), three pairs of legs and one pair of antennae. Insects also commonly have one or two pairs of wings in the adult stage. Mites are similar to spiders. They have two body parts (head and abdomen) and four pairs of legs; they do not have wings or antennae.

Aphids: *There are many species of aphid (right), all of which have sucking mouth parts. They may reproduce sexually or asexually, with multiple life cycles in a growing season. In addition to damaging plants, aphids can be vectors of disease.*

Photo by Eugene E. Nelson, Bugwood.org.

Photos by Whitney Cranshaw, Colorado State University, Bugwood.org.

Elm leaf beetles: *Both adults (above right) and larvae damage leaves. Early hatch larvae (above left) are small and black; late instar larvae (above center) are yellow with black stripes.*

Eriophyid mites: *Not visible with the naked eye, these mites cause discoloration and leaf curl (right). Damage appears similar to herbicide damage. The mites feed within plant tissues, making them difficult to control.*

Photo by Whitney Cranshaw, Colorado State University, Bugwood.org.

Photo by David Cappaert, Bugwood.org.

Photo by Steven Katovich, USDA Forest Service, Bugwood.org.

Leafminers: *Larvae (above left) feed on the insides of leaves, causing discoloration (above right) and subsequent leaf drop during heavy infestations. There are many species; most are host-specific.*

Photo by Whitney Cranshaw, Colorado State University, Bugwood.org.

Photo by University of Georgia Plant Pathology, Bugwood.org.

Leafhoppers: *There are many species, and they are usually host-specific. These insects are very small and difficult to see with the naked eye. A 10x hand lens may help (near left). Damage shows as stippling on the undersides of leaves (far left).*

Thrips: *Feeding damage by adults and larvae (right) can cause discoloration and stunting of leaves and flowers. Some thrips species are also vectors of plant disease. Thrips have several generations per year.*

Photo by Whitney Cranshaw, Colorado State University, Bugwood.org.

Photo by Whitney Cranshaw, Colorado State University, Bugwood.org.

Harvester ants: *These ants (left) live in large colonies. They will clear all vegetation surrounding their nest and along their foraging paths. They eat plants, seeds and insects. They cause damage to crops, pastures and lawns. They have a stinging bite.*

Root weevils: *There are several species and most are host-specific. Larvae (near right) damage plant roots and crowns. Adults (far right) cause minor damage to leaves.*

Photo by David Gent, USDA Agricultural Research Service, Bugwood.org.

Photo by Whitney Cranshaw, Colorado State University, Bugwood.org.

Photo by Jerald E. Dewey, USDA Forest Service, Bugwood.org.

Sequoia pitch moth: *(Adult above) Larval feeding causes trees to produce abundant pitch masses (right). Avoid injuring trees to prevent these pests from laying their eggs.*

Photo by Susan K. Hagle, USDA Forest Service, Bugwood.org.

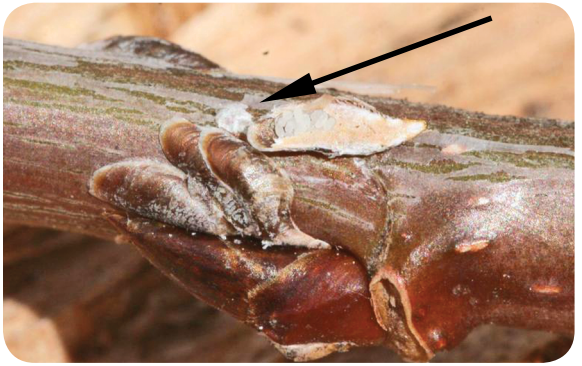


Photo by Whitney Cranshaw, Colorado State University, Bugwood.org.

Scale: *There are many species of scale insects. Small and armored, they are difficult to control except at the crawler stage. Oystershell scale (left) is a common scale pest of many landscape plants. The scale insect at the top of the photo (arrow) has been overturned to show eggs.*

Photos by John A Weidhass, Virginia Polytechnic Institute and State University, Bugwood.org.

Spider mites: *These web producers, generally found on the undersides of leaves (far left), are a common landscape pest. Damage starts as speckling on leaves (near left); leaves turn yellow and drop as the infestation increases.*

Photos by David Shetlar, The Ohio State University, Bugwood.org.

Billbugs: *The larvae (far left) of these insects (adult, near left) feed on the roots and crowns of turfgrass. The stems of affected plants are easily detached at the soil surface.*

Photo by Alton N. Sparks Jr., University of Georgia, Bugwood.org.

White grubs: *Another common lawn pest, these root feeders also damage landscape plants (left). Entire portions of lawns turn brown and are easily peeled back from the soil. They are the larval stage of over 60 species of beetles.*

Common Plant Diseases

Plant diseases are caused by pathogens, microscopic organisms such as fungi, viruses or bacteria.

Signs versus symptoms. Signs are actual pests or parts of pests, including mycelium, spores, bacterial streaming and nematodes. Symptoms are the plant's response to the pest and include wilt, leaf necrosis (death), chlorosis (yellowing or bronzing), galls, deformations and dieback. People often see symptoms before signs.

Fungal diseases. Most plant diseases in Nevada are caused by fungi. Signs to look for are visible spores and mycelium. Generally, these are internal and hard to see. Symptoms are variable and may include necrosis, wilt, leaf chlorosis, dieback, gall and deformation. Three main categories of fungal disease are common in Nevada:

Phytophthora: This is a water mold with over 60 species that can infect many different plant species. It most often causes root, crown and fruit rots; damping-off of seedlings; leaf, twig and fruit blights; and dieback. It affects vegetables, ornamentals, fruit trees, forest trees, shrubs and succulents. Spores can travel in water and wet soil, and are long-lived in soil or plant debris. Cultural controls are important to prevent and control this disease. Reduce standing water and soil moisture. Increase soil drainage, and decrease soil compaction. Stop the spread by limiting soil and plant debris movement. Properly dispose of plant debris. Sanitize equipment, and use sterilized soil/growing media.

Fusarium: This includes many species and many varieties within species. Most often, this fungus causes root/crown rot, wilt, dieback, chlorosis and blight. It can cause one-sided wilt/chlorosis in plants. It is long-lived and widespread in soils, both natural and manmade; it can be a nursery, landscape, forest and agricultural pest. Control is similar to *Phytophthora*. *Fusarium*-resistant cultivars are available.

Powdery mildew: Many different fungal species cause powdery mildew. Genera include *Erysiphe*, *Sphaerotheca* and *Leveillula*. Signs are easily seen and include groups of spores and mycelia. Symptoms include leaf yellowing, bronzing, tissue death, and reduced growth or production. Powdery mildew control must include cultural practices: Reduce standing water/humidity, site plant in a sunny area, increase air circulation and avoid excess fertilizer. Chemical controls include fungicides, sulfur products and horticultural oils.

Photo by Georgia Forestry Commission, Bugwood.org.

***Powdery mildew** on a rose plant. The fungal mycelia covers the leaf surface, giving the typical powdery appearance.*

Bacterial diseases reproduce rapidly and kill plant tissue. The most common sign is bacterial ooze. Symptoms are varied and include wilt, rot, decay, galls, blight and scorch. A common bacterial disease in our area that affects certain fruit trees and roses is **fireblight**.

Photo by P. G. Psallidas, Benaki Institute, Athens, Bugwood.org.

***Fireblight** on a pear tree, forming a characteristic blackish shepherd's crook. Young leaves, shoots and fruit are affected.*

Viral diseases. You cannot see virus particles with the naked eye. They are generally spread by insects or grafting. Symptoms include mosaics, chlorosis, fasciation (stems grow together) and phyllody (abnormal growth in floral structures).

Nematodes. Most nematodes that attack plants are microscopic. Symptoms of nematodes include root galls, seed galls, cysts, wilt and dieback.

Common lawn diseases. These include **fairy ring** (*Basidiomycetes*), **bacterial wilt** (*Xanthomonas*), **brown patch** (*Rhizoctonia*), **dollar spot** (*Sclerotinia*), **snow mold** (*Microdochium nivalis*), **Anthracnose** (*Colletotrichum*), **powdery mildew** (*Blumeria*), ***Pythium* blight**, and **melting out** (caused by multiple fungi).

Signs and symptoms of lawn diseases vary, depending on what function in the grass plant is affected. Spores are visible on diseases such as rusts, smuts, mildews and slime molds. Fruiting bodies are seen with *Rhizoctonia* and Anthracnose. Bacterial diseases and dollar spot show no visible signs. Symptoms of lawn diseases can include leaf yellowing and death, and root rot.

Chemical and mechanical controls of lawn diseases vary, depending on the actual disease, but some common cultural controls can be used. Fertilize properly, ensure proper drainage and aeration, use resistant cultivars, reduce drought stress, mow properly, and limit standing water on grass blades.

Photo by Lester E. Dickens, Bugwood.org.

***Fairy ring**, a fungal lawn disease, forms characteristic rings that increase in size.*

Photo by William M. Brown, Jr., Bugwood.org.

Photo by Barb Corwin, Turfgrass Diagnostics, Bugwood.org.

***Snow mold** (left) and **dollar spot** (right). Snow mold is generally pinkish, while dollar spot forms small-diameter, light-brown circular patches.*

Wildlife Pests

Unfortunately, there is no single solution to managing nuisance wildlife safely and effectively. Your options depend on the species of animal, where you live, and your comfort level with different methods of control.

The first step is to properly identify the species of animal. The following websites provide additional information:

- Internet Center for Wildlife Damage Management *http://icwdm.org/handbook/index.asp*
- Nevada Department of Agriculture, Wildlife *http://agri.nv.gov/Wildlife/*
- Nevada Department of Wildlife, Nevada Wildlife *http://www.ndow.org/Nevada_Wildlife/*
- University of Nevada Cooperative Extension, Pesticide Safety Education Program, Vertebrate Pest Management *http://www.unce.unr.edu/programs/sites/pesticide/files/pdf/VertebratePestsNDOA.pdf*
- U.S. Department of Agriculture (USDA) Animal and Plant Health Inspection Service (APHIS), Wildlife Damage Management *http://www.aphis.usda.gov/aphis/ourfocus/wildlifedamage*

Shooting is generally not an option, as there are regulations regarding discharge of firearms in most urban areas.

While you can live-trap some nuisance wildlife, relocation is not allowed. The trapped animals must be destroyed, since they may carry disease, and relocation could spread the disease. Many of these diseases are transmissible to humans. Always use caution when dealing with wildlife, and never approach wildlife that are acting strangely.

To be successful at controlling nuisance wildlife, you will need an exclusion plan. For example, it does little good to remove raccoons from the attic if you do not discourage more raccoons from taking up residence. Similarly, you can kill the blacktailed jackrabbit in the yard, but unless you fix the hole in the fence, another blacktailed jackrabbit will crawl through.

Exclusion requires the following:

- Seal off all entry points into the home. This includes attics, chimneys, eaves, sheds, outbuildings and pet doors.
- Refrain from feeding wildlife. You will often attract unwanted animals.
- Remove as many temptations as possible. Bring pets and their food dishes in at night. Eliminate water sources. Limit edible scraps in the compost pile.
- Limit access to the temptations you cannot remove. Better fencing or buried fencing may discourage nuisance wildlife. Secure your garbage cans and wait until the collection day to put out the garbage.

The tables on Pages 20 and 21 list common nuisance wildlife in Nevada. Legal status, hunting and trapping restrictions, exemptions, and other control measures are given for each species. This information is taken directly from Dealing with Nuisance Wildlife, University of Nevada Cooperative Extension FS-11-40 *http://www.unce.unr.edu/publications/files/nr/2011/fs1140.pdf*. This fact sheet also discusses large carnivore control issues, Endangered Species Act, Migratory Bird Treaty Act, Game Animal Status and Furbearing Status issues to consider while developing a wildlife pest control plan.

Mammals

Legal Status	Bats●	Badgers	Beavers	Bobcats	Chipmunks●	Coyotes	Deer	Fox	Ground Squirrels	Blacktailed Jackrabbits	Marmots	Voles (Meadow Mice)	Wood Rat / Packrat	Cottontail Rabbits & White-tailed Jackrabbits	Racoons	Skunks
Game species							✓							✓		
Furbearing species			✓	✓				✓								
Protected, sensitive or threatened species	✓				✓											
Unprotected species		✓			✓	✓			✓	✓	✓	✓	✓		✓	✓
Management Guidelines																
May not be hunted, trapped or harassed at any time.	✓															
Hunting is approved in the established season with an appropriate license.			✓	✓			✓	✓						✓		
Trapping is approved in the established season with an appropriate license.			✓	✓		✓		✓								
Hunting without a license is approved.		✓			✓	✓			✓	✓	✓				✓	✓
Live trap and euthanize. Do not relocate.					✓				✓		✓		✓		✓	✓
Use rodenticide bait according to label instructions and apply in a bait station.									✓		✓	✓	✓			
Eliminate hiding places and cover, such as rock and debris piles and low-growing vegetation.					✓				✓	✓	✓	✓	✓	✓	✓	✓
Exclusion techniques: Eliminate access; install barriers to keep animals out; install barrers when animals are away; use fine-mesh wire to protect trees and other sensitive plants; repair holes in fences and buildings.	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

● *Only five species of bats are protected.*

● *Palmers and Hidden Forest Uinta Chipmunks are protected under state law.*

Birds

Legal Status	California Quail	Crows	Raptors - Owls, Hawks, Turkey Vultures, Eagles	Pigeons (Rock Doves)	Starlings	Waterfowl - Ducks, Geese, Coots	Woodpeckers & Flickers	Swallows	House Sparrows (English Sparrows)
Game bird	✓	✓				✓			
Protected by Migratory Bird Treaty Act (MBTA)		✓	✓			✓	✓	✓	
Not protected by MBTA - introduced feral species				✓	✓				✓
Management Guidelines									
Capture, killing or possession prohibited unless you obtain a special permit issued by U.S. Fish & Wildlife Service and Nevada Department of Wildlife.	✓	✓	✓			✓	✓	✓	
May only be hunted during established season with appropriate license and/or permit.	✓	✓				✓			
May be hunted at any time without a license. Note: Discharge of firearms is prohibited in some areas.				✓					✓
No permits are required to scare or harass birds, but you must do so before nesting or egg laying occurs. May not harm nest or eggs. Remove nests only when eggs or young are not present.			✓			✓	✓	✓	
Exclude by installing a barrier. Remove sources of food and water. Frightening devices may also have limited effectiveness.	✓	✓	✓	✓	✓	✓	✓	✓	✓
Live trapping and euthanasia is approved. Relocation is not effective, as birds will return from more than 50 miles away.				✓	✓				✓
Chemical pesticides may be applied by a state-licensed applicator.				✓	✓				✓

Excerpted from Dealing With Nuisance Wildlife, University of Nevada Cooperative Extension Factsheet FS-11-40 https://www.unce.unr.edu/publications/files/nr/2011/fs1140.pdf.

IPM Principles

Now that we have discussed common pests of the landscape, let's discuss the four IPM principles.

IPM Principle #1: Identify the Pest

One of the primary principles of IPM is to identify the pest. This will help you come up with an effective management strategy. Some pests or pest signs are easy to identify. Seeing a mouse or mouse droppings makes it pretty easy to identify the pest. Other signs can be misleading. For example, what looks like a plant disease in your landscape may, in fact, be caused by environmental factors, such as water stress or herbicide damage. Additionally, many pests may produce similar damage. Using an insecticide on a plant disease will not control your pest problem and may damage your plant. Once you have identified the pest, learn all you can about its life cycle. Some pests are more susceptible to control during certain stages of their lives.

IPM Principle #2: Tolerate a Certain Level of Pests

IPM also strives to have people work toward "management" rather than "eradication." Obviously, the goal is to completely eradicate mice or cockroaches in your home. In your landscape, you may want to practice a little more restraint. There is an intricate, complex food chain at work in our gardens. Most insect pests have natural enemies, other insects that prey on them, commonly referred to as beneficial insects. Beneficial insects need prey or hosts. If you eradicate all the pests, you eliminate an important food source for beneficial insects. The beneficial insects will move to another site or die. These natural predators can also be harmed by insecticides. When you eliminate beneficial insects from your site, you inherit their job! Keep beneficial insects in your landscape, using them as a willing workforce in pest control.

IPM Principle #3: Monitor at Regular Intervals

It is important to monitor for pests at regular intervals. Don't wait until a pest problem is out of control. Check your garden regularly for signs of pests. If you have had pest problems in the past, good recordkeeping may help with your pest management plan. Note the pest, the time of year, the host plant or location in your garden, what you did, how it worked, and when you think you should monitor for the pest again.

When monitoring for pests in the garden or landscape, don't forget to also monitor for beneficial insects and note their numbers.

IPM Principle #4: Establish Action Thresholds

An action threshold is the number of pests that indicates the need for control. Action thresholds vary from pest to pest, site to site, and person to person. For agricultural crop pests, the threshold is economic. This is the pest population level that produces damage equal to the cost of controlling the pest. Urban landscapes and homes have a different set of thresholds. Some people are absolutely unwilling to tolerate even one mouse, cockroach or spider in their home. This is termed an emotional threshold. Sometimes the appearance of a pest or the damage it causes triggers an aesthetic threshold. Homeowners may not like the way the pest makes their landscape look. Health and safety thresholds can also trigger a pest control program. For example, black widow spiders at a day care facility can trigger a health and safety action threshold.

IPM Principle #4: Establish Action Thresholds (continued)

It is important to set action thresholds for your own property. The following photos of landscape problems are provided to help you consider how and when you would set an action threshold and initiate a pest control plan.

Photo by Wendy Hanson Mazet, University of Nevada Cooperative Extension.

Has the weed infestation in this landscape reached an action threshold? (Red circles indicate weed seedlings.)

Has the weed infestation in this hardscape reached an action threshold?

Photo by Sean Gephart, Nevada Department of Agriculture.

IPM Principle #4: Establish Action Thresholds (continued)

Has the weed infestation in the lawn below reached an action threshold?

Photo by Wendy Hanson Mazet, University of Nevada Cooperative Extension.

Photo by Sean Gephart, Nevada Department of Agriculture.

Has an action threshold been reached in the lawn to the left?

Photo by Sean Gephart, Nevada Department of Agriculture.

The weed shown to the left is puncturevine, a noxious weed. What is the action threshold for this weed?

Steps to Developing a Pest Control Plan

1. Identify the pest.
2. Identify its life cycle. Pests are most susceptible to control during a particular stage of their life cycle.
3. Determine the size of the infestation. Have you reached an action threshold?
4. Monitor for beneficial insects or natural enemies. Do you have beneficial insects already preying on your pest?
5. Develop a pest control plan using a variety of strategies.
6. Track your results and modify your plan for the best possible results.

Monitor for pests and beneficial insects.

Photo by Heidi Kratsch, University of Nevada Cooperative Extension.

IPM Control Methods

Okay, you've identified your pest, you've monitored for pest numbers, and you've reached an established action threshold. Now what? IPM recommends combining two or more control methods for the most effective long-term solution.

Prevention

Prevention is the most economical and easiest pest control method. Prevention strategies seek to prevent pest infestations from occurring in the first place, or they minimize the conditions that contribute to pest infestations. Combined with other strategies, prevention can lead to effective long-term control. Some prevention strategies are listed below.

- Select plant varieties that are adapted to and will flourish in Nevada's challenging climate. Healthy, vigorous plants are less susceptible to diseases or other pest problems.
- Choose pest-resistant plant varieties. For example, many roses are susceptible to powdery mildew. Resistant rose varieties have been developed and can be used in areas where powdery mildew is a problem.
- Inspect new plants before planting to make sure diseases, insects, weeds and other pests are not present. Remove weeds from nursery containers before you place the plants in your landscape.
- Choose disease-, weed- and pest-free plants, seed, mulch and soil amendments.
- Select hardscape materials and products that eliminate habitat or food for pests.

- Clean tools and mechanized equipment after each use to prevent spread of pests. Clean vehicles, especially tires, if you've been in a weed-infested area. Properly dispose of all plant debris to prevent the spread of pests.

Cultural Controls

Cultural controls seek to manage your landscape by making it as difficult as possible for pests to be successful.

Here are some useful tips:

Eliminate clutter, including trash, brush, debris or leaf piles, where pests may hide and nest.

Properly dispose of plant debris so it will not become a source for further pest infestation.

- Dispose of diseased or insect-infested materials properly. Double bag and remove this material from your property.
- Dispose of weed plants and plant parts properly. Do not allow weed plant parts or seeds to escape on the property or to any other property.

Eliminate food and water sources for pests.

- Empty containers that collect rain or irrigation water. This eliminates a water source for plant pests and also eliminates potential mosquito breeding sites.
- Regularly empty trash cans and replace liners to reduce insect and rodent pest problems.
- Clean out rain gutters to allow proper drainage.

Eliminate access to the landscape by pests. Fix holes in the fence.

Reduce problems in the landscape.

- Apply mulch to retain water and limit competition from weeds.
- Mow your lawn at least 3 inches high, and water deeply.
- Check the sprinkler system several times in the growing season to make sure it is functioning properly.
- Water and fertilize landscape plants appropriately.
- Group plants with the same water needs to ensure they are not stressed.

Physical or Mechanical Controls

Physical or mechanical controls are methods that reduce pest infestations by disrupting the pests or providing a physical barrier to prevent pests from infesting an area. One of the simplest methods is handpicking insects or hand-pulling weeds. These methods work best in situations where the pests are visible and easily accessible. Physical or mechanical disruption of

Photo by Scott Roberts, Mississippi State University, Bugwood.org.

Photo by James H. Miller, USDA Forest Service, Bugwood.org.

Physical controls can be barriers, such as the fence to the left. Mechanical controls can be as simple as hand-pulling weeds (above).

pests also includes mowing, hoeing, tilling or cultivating. Another method is washing. A strong spray of water may interrupt the life cycle of many insect pests while causing little damage to host plants or the surrounding environment. Physical barriers, such as fences, netting, sticky barriers, plastic mulches, bird spikes, row covers, plant cages, and paper or plastic tree collars, can help prevent or, at least, deter pests. Traps are another physical or mechanical method and include mechanical traps, such as snap traps, sticky traps and light traps.

Biological Controls

Biological controls use living organisms to control pests. Biological controls include predators, parasites, weed feeders and pathogens. Predators include lacewings and ladybird beetles (ladybugs) that eat other insects, and hawks and owls that prey on rodents. Parasites feed on their hosts, eventually killing the host. Certain wasps, flies and nematodes are common parasites of landscape insect pests. Weed feeders include grazing animals, fish and insects. These control agents help reduce the spread but rarely control or eradicate a weed infestation. Pathogens are diseases, viruses, bacteria or fungi that can infect plants, insects and vertebrate animals. A common pathogen used for biological control is *Bacillus thuringiensis*, a bacterium that controls mosquitoes, flies and other insects in their larval stage. It is sold as a pesticide.

These are assassin bug nymphs consuming a blow fly.

Photo by Chazz Hesselein, Alabama Cooperative Extension System, Bugwood.org.

Chemical Controls

Chemical controls include a variety of pesticides. According to the National Pesticide Applicator Certification Core Manual, a pesticide is any substance or mixture of substances intended for preventing, destroying, repelling or mitigating any pest, and any substance or mixture of substances intended for use as a growth regulator, defoliant or desiccant. Pesticides are formulated to kill pests or interrupt their life cycle.

Examples of pesticides include:

- Insecticides – kill or interrupt the life cycle of insects.
- Herbicides – kill or interrupt the life cycle of plants.
- Fungicides – kill or interrupt the life cycle of fungi.
- Rodenticides – kill or interrupt the life cycle of rodents.

Any use of pesticides requires the applicator to **read, understand and follow label directions.** The pesticide label will list the sites where the pesticide can be applied, such as lawns, vegetable gardens, trees and shrubs, and the pests the pesticide controls. Many times, you must peel back the pesticide label to read the entire label. Additionally, if the label directs you to a website, you need to go to the website and read, understand and follow those directions prior to applying the product.

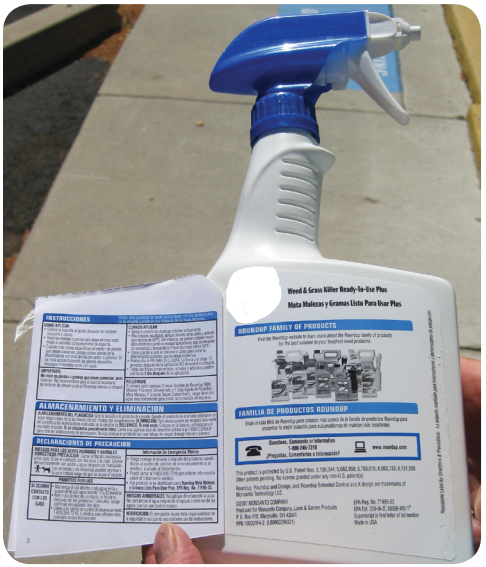


Photo by Susan Donaldson, University of Nevada Cooperative Extension.

Peel back the label to read all the information.

Beneficial Insects — Here's Your Workforce!

Beneficial insects are predators, preying on insect pests, such as aphids, thrips, scale, mealybugs, caterpillars and other immature or nymph stages of pest insects. They are a free workforce that helps keep insect pests at a tolerable level. Chemical insecticides applied to control pests will kill these beneficial insects as well. Monitor for beneficial insects as you monitor for pests. For more information, go to http://manageNVpests.info and click on the beneficial insects photo gallery.

Ladybird beetles: *This common beneficial insect is a voracious aphid-eater. Almost everyone recognizes the adult stage, but few recognize the larval stage, shown below the adults in the photo to the right. The larvae are better predators than the adults. Look for both life stages as you monitor for pests.*

Photo by Wendy Hanson Mazet, University of Nevada Cooperative Extension.

Photo by Whitney Cranshaw, Colorado State University, Bugwood.org.

Photo by Joseph Berger, Bugwood.org.

Green lacewings: *The larvae (above left) are great predators, eating soft-bodied insect pests, such as aphids, mealybugs and whiteflies, and their eggs. Adults (above center) are pale green with four see-through wings. They may produce five to six generations per year, providing continuous predation throughout the growing season.*

Photo by Wendy Hanson Mazet, University of Nevada Cooperative Extension.

Snakeflies: *Both the adult (above) and larva (lower left) of this beneficial insect are great predators. Snakefly larvae feed on eggs and larvae of various insects. Adults feed on aphids and other small insects.*

Photo by Maja Jurc, University of Ljubljana, Bugwood.org.

Photos by Frank Peairs, Colorado State University, Bugwood.org.

Photo by David Cappaert, Bugwood.org.

Photo by Bradley Higbee, Paramount Farming, Bugwood.org.

Syrphid flies: *The larvae (above left) of this fly are aphid predators. One larva can consume 400 to 500 aphids in its lifetime. They have three to seven generations per year. The adult flies must feed on pollen before they can reproduce. They prefer wild carrot and yarrow flowers. These flies resemble wasps or bees, but do not sting (above center).*

Minute pirate bugs: *Nymphs and adults of this predator feed on aphids, chinch bugs, whiteflies, spider mites and thrips. They are only about 1/8-inch long, so they are often overlooked (adult, above right).*

Assassin bugs: *Adults (below left) and nymphs feed on pest and beneficial insects, along with spiders and snails. They eat caterpillars and other immature stages of insects. Nymphs of the assassin bug resemble the adult, but do not have wings.*

Photo by Gerald J. Lenhard, Louisiana State University, Bugwood.org.

Photo by Stephen Ausmus, USDA Agricultural Research Service, Bugwood.org.

Photo by R.J. Reynolds Tobacco Company Slide Set, R.J. Reynolds Tobacco Company, Bugwood.org.

Parasitic wasps: *These tiny black insects are very small, usually less than 1/8 inch (above right). They lay eggs on or in the body of host insects. After hatching, the larvae feed on and kill the host (left). They prey on aphids, whiteflies, scales, leafminers and caterpillars.*

Native Bees Are Essential to Pollination

There are over 1,000 native bee species in Nevada. Most of these bees are solitary and nonaggressive. Some of the most common native bees are blue orchard mason bee, Nevada bumblebee, alkali bee, leafcutter bee, mining bee, cuckoo bee and green sweat bee. All are good pollinators. Most rarely travel more than 300 to 400 yards from their nest to pollinate. Some, such as the mason bee, are out in early spring, pollinating fruit trees and other plants long before honeybees are active.

Clockwise from top left: blue orchard bee, bumblebee, leafcutter bee, bee fly, cuckoo bee, alfalfa leaf cutting bee and green sweat bee.

All photos from Bugwood.org. Clockwise from top left photos by: Scott Bauer, USDA Agricultural Research Service; David Cappaert; Whitney Cranshaw, Colorado State University; Whitney Cranshaw, Colorado State University; Joseph Berger; Pest and Diseases Image Library; Joseph Berger.

Ways You Can Protect Pollinators

- Limit use of pesticides to times when they are really needed.
- If pesticide application is required, apply early in the morning or late in the evening, when pollinators are not as active.
- Avoid spraying flowers, if possible.
- Communicate with local beekeepers to protect beehives.
- Some pesticides are toxic to bees, through direct contact from applications or from residues left on plants after application. Prior to purchasing or applying pesticides, read, understand and follow label directions. Pay special attention to the "Environmental Hazards" section of the label.
- Minimize pesticide drift to nontarget areas. Do not apply pesticides when it is windy or temperatures are higher than 85 F.
- Consider planting a pollinator garden. Check out Gardening for Native Bees in Utah and Beyond *http://extension.usu.edu/files/publications/factsheet/plants-pollinators09.pdf*.
- Bee Basics, An Introduction to Our Native Bees may be helpful. Go to *http://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5306468.pdf*.
- Flowers at the Border: Plant Native Flowers Around Your Yard to Attract Native Pollinators and Other Beneficial Insects may also be helpful. Go to *http://www.unce.unr.edu/publications/files/ho/2014/sp1407.pdf*.
- Learn about Extended Residual Activity (ERT or RT), the amount of time pesticide residues may be harmful to bees. Go to *https://catalog.extension.oregonstate.edu/sites/catalog/files/project/pdf/pnw591_1.pdf* for more information.

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University of California Statewide IPM Program. *http://ipm.ucanr.edu/index.html*.

University of Nevada Cooperative Extension Integrated Pest Management Program. *http://manageNVpests.info*.

What Are Your Goals for Your Property?

Now that you know more IPM, write down the goals for your property and use the next few pages to plan your strategy.

What about your landscape is important to you?

How do you use your landscape?

When you have friends and family over, what do you want them to notice about your landscape?

When you have friends and family over, what do you NOT want them to notice about your landscape?

What are the top three things you would like to change about your landscape?

What Are the Barriers to Using IPM?

After reading the different pest control methods, list three controls you might be willing to try on your property.

1. _____

2. _____

3. _____

List three control methods you would NOT be willing to try.

1. _____

2. _____

3. _____

- Think about your goals for your property. Are there any control methods listed above that might help you reach your goals?
- Maybe you've decided you don't believe in using chemical pesticides. That's okay! Are there other methods that could work?
- Consider lowering or changing your expectations of how your landscape "should" look. Is there value in leaving a few nuisance weeds in your lawn to attract pollinators?
- Remember that our landscapes are like mini-ecosystems. If you work with nature by using the right plants for our climate and maintain plants for their best health, you are doing a lot to prevent pests from attacking in the first place.
- Contact the University of Nevada Cooperative Extension Master Gardener office in Washoe County at 775-336-0265 or *mastergardeners@unce.unr.edu* for the best ways to protect your landscape and keep it looking its best.

Recordkeeping

Recordkeeping of activities on your property is an important part of IPM.

- You can predict pest outbreaks, so start scouting early and initiate a control plan while the pest outbreak is still small.
- Document your efforts and their effectiveness.
- Recordkeeping for controls is important to prevent overapplication of chemicals or duplicate applications.

Date:_____ Area:_____

What did you find?_____

_____

What did you do?_____

Did it work?_____

_____

What alternative method will you try?_____

_____

Date:_____ Area:_____

What did you find?_____

_____

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Did it work?_____

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For additional forms go to: *http://www.unce.unr.edu/programs/sites/IPM/IPMRecordKeepingForms/*

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