This slide presentation was prepared by Jon Carpenter of the Nevada Department of Agriculture (NDOA). The presentation will focus on managing rodents and other vertebrate animals that can become pests in agricultural sites and ornamental areas, such as parks, golf courses and home gardens.
Ground squirrels feed on crops and ornamentals. They cause damage by burrowing and they also chew on drip tubing and wiring. There is more than one type of ground squirrel that can cause problems in the landscape and in agricultural sites. In central and northern Nevada, the most common are Richardson’s and Belding’s ground squirrels. In Washoe County, especially near the Sierra, the California ground squirrel is the most common. The California ground squirrel is also common in California, Oregon and Washington.
When dealing with living or dead rodents you should protect yourself from various diseased including the plague. This photo shows a flea which can carry the plague. These fleas live on rodents, feeding on their blood. If a sick rodent is bitten by one of these fleas, the flea then becomes a carrier or vector of the disease. When the sick rodent dies, the flea will find another warm-blooded creature to live on, whether a ground squirrel, rat or human. When the flea bites these animals, it passes on the disease.
Bubonic plague is also called the “Black Death.” During the Middle Ages, millions of people in Europe and Asia died from this disease, significantly decreasing the world’s population.
The plague can take four different forms, all of which were fatal before the advent of antibiotics. Technically, antibiotics are pesticides, but they are regulated by the Food and Drug Administration. Drugs used to control diseases of humans or animals, such as livestock and pets, are not considered pesticides. Such drugs are regulated by the Food and Drug Administration.
Antibiotics have dramatically altered the death statistics for bubonic plague. In the 1980s in the United States, an average of 18 cases of bubonic plague occurred per year. For each seven cases contracted, one case dies.
Several state and government agencies monitor parks and recreation areas for the presence of rodents carrying the bubonic plague. If the plague is found, parks or recreation areas may be closed.

The likelihood of contracting bubonic plague are very small, but if you are working near rodents, your risk is increased. Use proper precautions. Do not handle dead or ill animals unless absolutely necessary. If you are required to do so, use proper precautions, such as rubber gloves, etc.
A more likely consequence of ground squirrel infestation on a property is damage to plants or irrigation lines. This photo provides an example of burrowing rodent damage to buried irrigation tubing. It was likely done by gophers or ground squirrels.
This is an old photo of a levy that broke. Burrowing rodents, most likely California ground squirrels, caused this damage.
More recent flooding in Fernley Nevada was due to the same problem. Rodent tunnels weakened a levee along the Truckee Canal. The resultant flood damaged homes, agricultural fields, and other property.
Ground squirrels also damage landscape plants and crops. This slide shows a bait station. Most rodenticide baits must be applied in a bait station in order to minimize exposure to non target species. Information about bait stations will be included in the rodenticide label. Be sure to follow the label instructions to get the best results. Label instructions are also the law, so applying the product in a manner inconsistent with labeling is considered a pesticide-use violation.
Timing is key to effective ground squirrel control, especially if you plan to use a chemical rodenticide. You must understand their life cycle. Ground squirrels are not active all year round. They hibernate in the winter. Some estivate (hibernate) during the summer, becoming inactive during the hot weather. Some species return to their burrows in the late summer and do not emerge again until spring.
In Nevada, ground squirrels usually emerge from their burrows in early March or late February. The males are the first to emerge, followed by females. The animals mate and the female goes back into the burrow to give birth to as many as eight young. When they emerge early in the spring, there is usually very little green vegetation, which is their preferred food. At this time of year they are more likely to accept rodenticide baits. Later in the spring, after mating has occurred and green vegetation is available, ground squirrels are less likely to accept rodenticide baits. Additionally, if control is postponed until they have had young, your problem will have quadrupled in size!

Remember timing is the key. Be prepared early in the season to control ground squirrels.
Rodenticides that are available for ground squirrel control include various anticoagulant baits. Most are classified as “general use pesticides.” Remember to read and follow the label directions, as most of these substances require a bait box or bait station. Using a bait station or bait box reduces the likelihood of injury or death of non target species.
The device on the lower right of the photo is a smoke bomb that produces phosphorus gas. If you look closely, you can see a fuse. To properly use this device, you light the fuse and drop it down the rodent burrow. Be sure to cover the burrow and other surrounding burrows that are smoking. Also, be very careful when handling a smoke bomb as it is actually burning. Don’t use it near structures or hay stacks and stay out of the smoke.

The other product is aluminum or magnesium phosphide. It comes in large pellets as shown at the bottom of the photo. This compound is classified as a “restricted use pesticide” and may only be used by individuals who are certified by the Nevada Department of Agriculture. The pellets are dropped down into a burrow where they react with moisture in the air to form phosphine gas. Because of its toxicity, this product requires that applicator complete a fumigation management plan before using it. A certified applicator must be physically present during applications of this material. Read the pesticide label for information related to a fumigation management plan.
There are other options to rodent control besides using rodenticides. Live trapping and subsequent euthanasia is one option. Many people balk at killing a helpless animal in a trap, so they opt for live trapping followed by relocation. Unless you relocate them significant distances away, they may just return. Relocating them near other homes, ranches or farms just makes them a problem for someone else. This is not a neighborly thing to do! Live trapping and subsequent release seems on the surface to be more humane, but is it really? When you relocate the animal, you are dropping it in an area where the existing animals are already competing for water, food, shelter and mates. The “native” animals will likely drive off or kill the intruder. Is this really more humane?
Other rodenticides include zinc phosphide, which may be restricted use or general use depending on the concentration. Zinc phosphide forms a gas in the animal that eats it. By the time the poisoned animal dies and is consumed by another animal, the gas has dissipated and causes the consumer no harm. Zinc phosphide is also commonly used for vole control.

Strychnine is a restricted use pesticide in Nevada. It may only be applied below ground by a state certified pesticide applicator. It is generally mixed with vegetables, like cabbage, and placed in the burrow system.
Hmmm… looks like something’s going on down there - must be working!
Propane/compressed air devices are another method of ground squirrel control some people swear by. In this method, the burrows are filled with gas and ignited. This, in theory, blows up the rodents. This method is very labor-intensive, since all the burrow exits or entrances must be blocked off except the one you are using to fill the burrow system with gas. It is not very effective, since the burrow systems are extensive. The potential for fire makes this method quite dangerous. There are better methods for controlling ground squirrels.
In Nevada yellow-bellied marmots, also known as rockchucks, are very common along the Eastern Sierra. They are also found in other areas of the state. They tend to like areas with large boulders where they can sun themselves and quickly duck for cover when predators are around. Marmots cause damage by consuming ornamental plants and burrowing.
Marmots love exclusive golf courses!
“Pennington greens” in Reno
Check out the man-made habitat

This is an example of ideal marmot habitat. Note the large landscape boulders used for sunning and cover. They are located right next to a grassy area where the marmots can feed.
Marmot control is similar to ground squirrel control. Live trapping and strychnine may be used. However, if you use strychnine, be sure to remember that it may only be applied below ground. If you are using strychnine in an urban area, where marmots tend to do the most damage, be aware of other wildlife and dogs. Strychnine is especially poisonous to dogs. Dogs will often eat a dead animal like a marmot or ground squirrel that died from a strychnine dose. When an animal eats another animal that died from a pesticide and is itself killed, it is called a "secondary kill."
Meadow mice are more commonly known as voles. Voles construct “halfpipe” tunnels in soil and in vegetation as shown here. They cause damage by burrowing and feeding on vegetation. They prefer to inhabit areas where there is vegetative cover. This prevents them from being seen and eaten by predators such as birds, coyotes or house cats.
Another form of damage caused by voles is girdling. Girdling is the removal of bark in a ring around the trunk of a tree. This is the condition shown on the lower left and upper right, where the voles have chewed the bark off the base of the tree or off the base of the juniper branches.

Junipers offer great vole habitat because there is excellent cover and plenty to eat. Voles are active all year and will burrow through and under snow. After the snow melts, you may notice damage to turfgrass or other plants. This may have been caused by voles.
Meadow mice or voles do not hibernate. They are active day and night all year long. Keep in mind that vole populations fluctuate, so some years there may be thousands per acre and in other years there may be so few you don’t even know they are there. They have very small home ranges.
Traps only work on very small populations. If you choose to use a chemical for vole control, zinc phosphide baits are usually the best choice. Remember some formulations are restricted use pesticides. Always read the label before you purchase the material and before you apply it.
Another means of vole management is habitat manipulation. By removing the cover, such as grasses or shrubs, you expose the voles to predators.
Jackrabbits may cause serious damage by feeding on crops and ornamentals.
In agricultural cropland, jackrabbits usually come in from surrounding rangeland at night and feed on the perimeter of farm fields and haystacks.
Jackrabbit populations fluctuate and may reach as many as 400 per square mile.

Jackrabbit Biology

- Nocturnal
- Don’t hibernate – active all year long
- 2 –8 young/litter
- Several litters/year
- Populations fluctuate - can reach 400 jackrabbits /sq. mi.
- Will travel long distances to food
Jackrabbit Management

New leading edge system - based on public lands equine management model

The next slide shows a method of Jackrabbit control formerly used.
Vertebrate Pest Management

Jackrabbit Management

- Long term control – exclusion
- Protect individual plants with cylinders of 1” mesh wire 36” high. Other materials/products also available.
- Fence areas with 1” mesh 36” high. Bury 6” deep.

Realistically, your best option for jackrabbit control is exclusion. Protect individual plants with cylinders made of 1-inch wire mesh. The cylinders should be 36 inches high. Haystacks or other small areas, such as a raised bed gardens, can be protected using 1-inch wire mesh fencing that is 36 inches high. Be sure to bury the fencing 6 inches deep because jackrabbits will burrow.
Here’s a photo of a jackrabbit burrowing under a fence. It is important to bury the fence 6 inches to prevent jackrabbits or cottontail rabbits from burrowing under the fence and damaging the plants, crops or hay stacks the fence is intended to protect.
Jackrabbit Management

- **Electric Fencing** - 6 wire, alternate hot and ground, wires 6” apart
- **Repellents** – sulfur odors tend to repel herbivores, limited testing, temporary effects
- **Live traps** – jackrabbits are not easily trapped

Electric fencing is not always practical or effective. The wires need to be close-spaced and near the ground, which can present a fire hazard.

Consider repellents for jackrabbits and other animals such as deer. Be aware that repellents may be washed off by rain or sprinkler irrigation and they break down with exposure to sunlight. Due to these factors, repellants must be re-applied frequently. Most repellents are not designed or recommended for use on plants grown for human consumption, so they are not options for vegetable gardens or other edibles.

Jackrabbits are not easily trapped and usually there are so many that live trapping may not be the best option. Generally, jackrabbits come in from adjacent rangeland. When you trap one, another moves in to take its place. Exclusion is the best option.
Cottontails are usually considered pests in the landscape. Their control is similar to jackrabbits:

• exclusion is the best control method
• they can be live trapped, but it is not the best method of control
• there are no toxicants registered for use on rabbits in the state of Nevada

The information provided for jackrabbits applies to cottontails, with one exception: cottontails are a game species in the state of Nevada.

Since cottontails are a game species, to hunt them, you must live in an area that permits discharge of firearms, it must be cottontail rabbit hunting season, and you must have a hunting license. Similar to trapping, shooting does not really eliminate a rabbit problem. Removal of one rabbit by shooting or trapping simply allows another rabbit to move in and take the vacated space. Exclusion is still the best option for control.
Pocket gophers can be one of the most damaging rodent pests in Nevada. They live underground and can damage crops and ornamentals by feeding on roots and sometimes foliage. Their burrows also cause damage to farm equipment and sprinkler systems.
Pocket gophers have pockets on either side of their head that are used for storing plant material. The gophers gather and store plant material in the cheek “pockets” and then take it to the burrow for storage or to feed to their young.

A typical pocket gopher mound is horseshoe-shaped, with a hole or plug in the center. Not all mounds have the horseshoe shape. If there is an open hole, then it is very likely an active burrow, meaning the gopher is working in the burrow nearby.
Rodenticide control methods for gophers include restricted use strychnine grain, which may be hand-applied or applied through a burrow builder. A burrow builder is a device that is pulled behind a tractor. The machine actually forms a burrow in the soil and deposits a small amount of rodenticide-treated grain in the man-made burrow. Gophers will use the man made burrows and feed on the grain. The best results are achieved when burrows are built 25 feet apart. It is essential to synchronize control efforts with neighboring property owners and managers to minimize re-invasion from the surrounding area.
As mentioned in the ground squirrel section, aluminum and magnesium phosphide are control options for gophers as well. The pellets are placed in the burrow, where they react with moisture in the air and form phosphine gas. Remember this is a restricted use pesticide.

Trapping is a non-chemical option that can prove to be quite effective if done properly. There are several kill traps available. The best for gophers in Nevada is the “cinch trap,” shown on the lower part of the photo. It is best to stake the trap down.
Moles can prove to be a pest in some areas, however, generally speaking, they are not much of a problem in Nevada. This is most likely because Nevada is very dry and moles don't like hard, dry soil.
The main thing to remember about moles is that they don’t eat plants. Moles are insectivores, meaning they eat insects and worms. They do damage to vegetation in the process of hunting soil insects, but they do not consume plants.
In the process of searching for food, moles dig shallow feeding tunnels, as you can see on either side of this walkway. The feeding tunnels can cause damage to landscapes.
Mole damage in turf grass is associated with other pest problems like insect larvae or grubs that are feeding on turf. If you remove the insects with an insecticide, the moles will move on in search of food in other places.
There is no easy way to control moles. You may try to dry out the soil. Trapping is marginally effective. Reducing the food supply by controlling insects is another option.
In general, none of these control methods work. They are not good long-term methods for mole control. In fact, the use of moth balls for mole control may actually be a label violation, as moth balls are probably not labeled for mole control.
Also called pack rats, these critters will set up house in sheds, attics, garages and other structures. They are messy and carry diseases. Like all rodents, their teeth continue to grow all their lives. They must gnaw or chew on things all the time to wear away their teeth. Control for these rodents is much the same as control for ground squirrels. Exclusion is the best control method.
Both the Norway rat and the roof rat are non native species. Norway rats were introduced to this country in colonial times via ships and rapidly spread as the colonists spread. The roof rat was introduced to southern Nevada on palm trees that were imported to Las Vegas. Both species are very adaptable.
Rats and mice can be significant pests in urban areas. They are usually problems in food and feed storage areas, eating and contaminating food and animal feed. They also cause structural damage by chewing both wood and wiring.
Diseases

- **Rickettsial pox** - mice, Norway rat, mite vector
- **Plague** – roof rat, flea vector
- **Leptospirosis** – live in rat’s kidneys, infection thru bites/urine (fluoresces)
- Plus many others….!!

Most importantly, they can carry diseases. This slide lists only a few of the diseases they can carry and may pass to humans, pets and livestock.
Roof rats are an introduced species and have recently become pests in Southern Nevada, primarily the Las Vegas urban area. They like to nest up high in trees, in debris piles and in the upper parts of buildings, such as attics, or within dropped ceilings. They prefer fresh food but will feed on just about anything. They can gain access to structures through very small spaces.
Roof Rats

- Travel along:
  - Edges of rooms, next to walls
  - Pipes
  - Rafters
  - Utility lines

Rats travel along pipes, rafters, and utility lines.
The picture at the top of the page shows a house mouse; the picture at the bottom of the page shows a deer mouse. Deer mice have white bellies and hairy tails, while house mice do not.

Like rats, these rodents can cause damage by consuming and contaminating food and animal feed and chewing wood and wiring. Both deer mice and house mice have small home ranges. Controls are similar to rats: good sanitation, exclusion, trapping and poison.

The deer mouse also carries Hantavirus, which is passed through feces and urine. Clean up of mice feces and urine should be done carefully, to reduce dust. Stirring up dust increases the levels of airborne virus. Breathing contaminated air is the major route of transmission in humans. Use a disinfecting solution, such as Lysol or bleach solution to thoroughly wet the feces and urine. Let it sit for 10 minutes and then wipe it up. Wear rubber gloves. It is believed that the virus only remains viable for 3-4 days in feces and urine. If you can trap the deer mice and wait 3-4 days for clean-up, you can significantly reduce levels of the virus present. If you must enter an area with fresh feces and urine, wear a respirator or dust mask with a HEPA filter to remove viruses.
Sanitation

- Remove food supply by good sanitation
- Store food and feed in rodent proof containers

Exclusion

¼” mesh will exclude mice also

Sanitation is a very important component in rat and mouse management. To prevent rat or mice infestation, don't allow a food source to become available. Keep areas free from pet and livestock foods and edible trash. Store foods in mouse- and rat-proof containers.

Exclusion is also important. Mice can fit through a quarter-inch-wide hole or crack. Rats do not need much more than a quarter inch to enter many structures. Use sealant or fine metal screen to excluded mice and rats.
There are many types of traps that can be used for rat and mice control: snap traps, live traps, glue boards, etc. When locating traps, place them perpendicular to the wall, with the baited end nearest the wall. Bait the snap traps with something sticky that cannot be pulled from the trap without springing it. Gumdrops, Jujubes, peanut butter, etc. are good baits for snap traps. All types of traps should be inspected daily. Be sure to wear protective clothing when handling dead rodents. For rats, who are very wary, you may need to pre-bait areas before setting traps.

Types of poison baits include anticoagulant (warfarin, bromadiolone, brodifacoum, chlorophacinone, etc.), zinc phosphide (USDA concentrate) and others. As with traps, you may need to pre-bait as rats are very wary. Be careful with rodenticide baits. The number one pesticide poisoning reported is d-Con® in children, followed closely by d-Con® in dogs.
Raccoons are nocturnal and very adapted to urban areas. They use the storm drain system for both dens and travel paths. They will nest beneath decks, in attics and in garages. They can be mean and can harm domestic pets, such as cats and small dogs.
Raccoons also carry many diseases, some of which are harmful to humans. Rabies is passed through saliva, generally in a bite. Stay away from raccoons, especially those behaving strangely.

Leptospirosis is a bacterial disease that can affect both humans and domestic animals. It is generally passed through urine. Contaminated water and food can cause infections.

Raccoons like to defecate in the same areas and they prefer sandy soils to set up their restrooms. Unfortunately, children's sandboxes can be the restroom of choice! Kids who play in the sandbox and do not wash before eating food may infect themselves with raccoon roundworms. These roundworms are serious health threats.
The best option for controlling raccoons is to discourage them. Don’t feed them or allow them in your home. They will set up house in garages, attics, sheds, beneath decks and in other structures if allowed to. Exclude them and other animals from these areas. Do not feed them directly or indirectly. Indirect feeding might include leaving out dog food overnight, not cleaning up windfall fruit from under fruit trees, placing tasty fruit or vegetable scraps in an open compost pile, etc. Trapping, with subsequent relocation or euthanasia, is an option. It is recommended NOT to use cat food as bait, so you don’t trap the neighbors cat!
Like raccoons, skunks are nocturnal and will make dens in burrows, holes and buildings. They have the added potential for spraying!
Like raccoons, skunks can carry diseases that affect both humans and domestic animals. The two diseases of most concern are rabies and leptospirosis.
As with many vertebrate pests, exclusion is the answer! Reduce access to possible den sites by cutting back overgrown shrubs and covering all holes into building with one-quarter-inch hardware cloth. If you have an animal already present at a site, make sure they have left the den before implementing exclusion measures.

Trapping, with subsequent release or euthanasia, is an option, but use a plastic box-style trap to reduce the potential for getting sprayed.
Pigeons and starlings are the predominant bird pests in Nevada. These are introduced birds, not native species.
Nuisance Birds

- Damage
  - Fecal contamination
  - Consume crops
  - Drive out native species

- Significant maintenance/cleanup costs

Damage includes fecal contamination of urban sites and livestock feed. Nuisance birds consume crops and are capable of outcompeting native species. They can cause serious damage to property and significant cleanup costs once removed.
Pesticides used for bird control are called avicides. Most are classified as restricted use and may only be applied by a state certified pesticide applicator. Pre-baiting is required by the pesticide label. This is the process of offering untreated baits several days prior to using treated baits. When the birds are feeding readily on untreated baits, applicators switch to the toxic bait.
Do not feed pigeons or encourage them in any way! Exclusion from food sources and nesting or roosting sites is the best control method.

Needle strips discourage pigeons, starlings and other birds from roosting and are an option for bird management. Be sure to purchase the correct type of needle strip, because there are different types and sizes for different species of birds.

Exclude both pigeons and starlings from nesting sites. Properly installed fine-mesh wire will keep the birds out of nesting and roosting places.
Starlings consume livestock feed and contaminate both feed and water with their droppings. Reducing availability of food sources and exclusion from nesting and roosting sites are the best methods to reduce starling populations. Starlicide is the most common pesticide used for starling control. Like pigeon control pesticides, a period of pre-baiting is required. It is probably best to obtain the services of a professional company for any sort of extensive control program using pesticides for pigeons or starlings.
Exclusion or reduction of food sources is the best control.
Visit the Nevada Department of Agriculture Web site at http://agri.nv.gov/PLANT_Pestcontrol_Index.htm or the University of Nevada Cooperative Extension Web site at http://www.unce.unr.edu/programs/sites/pesticide for further information.