

COURSE CODE:	<i>CPT 508</i>
COURSE TITLE:	<i>Vertebrate Pest in Agriculture</i>
NUMBER OF UNITS:	<i>2 Units</i>
COURSE DURATION:	<i>Two hours per week</i>

COURSE DETAILS:

Course Coordinator: *Prof. A. Y. A. Adeoti*
Email: *yahayaadeoti@yahoo.com*
Office Location: *Room 156, COLPLANT*
Other Lecturers: *Dr. Fajinmi Ayodele Anthony*

COURSE CONTENT:

Distribution and abundance of vertebrate pest in Nigeria; Factors predisposing crops and stored produce to vertebrate pest attacks; Assessments of vertebrate pest damage; Management and Control of vertebrate pests.

COURSE REQUIREMENTS:

This is an elective course in the University. Students are expected to participate in all the course activities and have minimum of 75% attendance to be able to write the final examination

READING LIST:

1. Animal damage control in Washington State University Cooperative Extension. EB 1147. 88pp.
2. Pest Management Study Manual for pest Control Operators. Washington State University Cooperative Extension. MISC. 0096, 139pp
3. Prevention and Control of Wildlife Damage. University of Nebraska Cooperative Extension, Great Plains Agricultural Council Wildlife Committee, USDA/APHIS/Animal Damage control Vol. 1 and 2

LECTURE NOTES

PRINCIPLES OF VERTEBRATE PEST MANAGEMENT

Statement of Issues and Justification

Vertebrate animals cause billions of dollars of damage in agricultural, forest, wilderness, and urban settings every year. The diverse settings where damage is caused and the variety of animals causing damage make mitigation efforts difficult. To have the necessary tools available for pest control requires a concerted effort toward development, registration, training, and outreach. At a time when problems are increasing due to increased interface between humans and animals as well as invasive species incursions, the tools available for control are actually decreasing due to increased regulation and public demand.

WHAT IS VERTEBRATE PEST MANAGEMENT?

Vertebrate pest damage management is an activity that seeks to balance the needs of human activity with the needs of wildlife to the mutual enhancement of both.

Introduction

A pest can be defined as an organism that causes, or is perceived to cause, or is likely to cause economic or aesthetic damage to humans or their property. When attempting to manage a vertebrate pest there are many things you need to consider first.

Before beginning any direct control action, such as the use of traps or poison baits, think if there are alternative ways the animals can be managed.

First, is control really necessary? There are several variables that should affect your decision.

- ② 1. For example,... What kind of animal is it? Positive **identification** of the pest is essential for effective management. This must often be done by studying the signs left by the animal as most vertebrates are nocturnal or difficult to observe.
- 2. How much **damage** might occur without any control? AND....
- 3. What are the **benefits of control** vs. the **cost of damage**?

In other words, what are the economic or aesthetic thresholds?

- 4. Is there any **aesthetic** or **recreational** value of the species involved, or are they legally protected? This may limit the action you would otherwise take.
- 5. Finally, What will be the **effect** of a control program on non-target animals and the environment?

Population dynamics and pest management

Some pests can be managed indirectly, without resorting to chemicals or traps, by manipulating the habitat. To do this most effectively, one should have a working knowledge of population dynamics—or how populations change in relation to the environment.

In its simplest form -- each living area has a limited **CARRYING CAPACITY** for a given species. Each living area or habitat, will hold only a limited number of any given species. Excess population either dies or migrates.

The carrying capacity is determined in part by three limiting factors -- **FOOD**, **WATER**, and **SHELTER**. If we can control these factors, especially food and shelter, we can manipulate the population density, even if we do nothing else.

Common vertebrate pests & how to manage them

Rats and Mice

Worldwide, rats and mice are the most notorious of all the vertebrate pests that plague humankind, of these, **Rat**, (*Rattus norvegicus*) and the **House Mouse**, (*Mus musculus*) are the most common.

Adult **Rats** are robust, weighing 10-17 ounces and are 13-18 inches total length. The tail is usually shorter than the head and body. Colors range from gray to brown to almost black.

The **Roof Rat**, (*Rattus rattus*), is the same length but lighter in build than and not as widespread as the Norway rat. The tail is LONGER than combined head and body length and the belly is often white.

The common **House Mouse** is another Asian Murine rodent, second only to the rats as a destructive pest. House mice can be distinguished from young rats by their proportionally smaller heads and feet.

Outlying areas are likely to have native **Deer Mice** (*Peromyscus maniculatus*) rather than the imported House Mice. Deer mice have white under parts of the body and tail.

Rats and mice are mostly nocturnal in their habits so an infestation often goes undetected until the rodents become very numerous. By knowing what signs to look for, a rodent problem can usually be caught before it gets out of hand.

Rats and mice tend to move over regular routes and usually produce defined runways. These show up particularly well in dusty areas, especially if flour or other tracking powder is sprinkled around likely spots.

Outdoors, rats will leave trails through vegetation and dig or gnaw holes around buildings and foundations.

Another tell-tail is that rats leave grease smudges when traveling close to a wall, around a beam or through a hole.

Finally, fresh rat and mouse droppings which are moist and soft, are a very reliable sign of infestation.

CONTROL

There are four important steps to effective rat and mouse control.

- 1. **Elimination of shelter or harborage**
- 2. **Rodent-proofing structures**
- 3. **Elimination of food and water**
- 4. **Killing rodents**

Bats

Bats are the only true flying mammals. These "non-rodents" are sometimes persistent invaders of attics and wall voids. Although they don't usually cause any structural damage, and are, in fact, very beneficial insect eaters, many homeowners dislike the noises they sometimes make.

The surest way to eliminate or prevent a bat problem is to **build them out**. Depending on the species, bats can enter cracks as narrow as **3/8 of an inch**.

Moles

Our number one animal pest in yards is probably the mole. This animal is **not a rodent** as is commonly thought, but an **insectivore**, there are four separate species; the **Shrew-mole** (*Neurotrichus gibbsi*), the **Coast Mole** (*Scapanus orarius*), the **Broadhanded Mole** (*Scapanus latimanus*) and one of the largest moles in the world, the **Townsend Mole** (*Scapanus townsendi*).

Moles feed almost exclusively on **earthworms**, **soil insects** and **grubs** found while tunneling. Occasionally, they may sample bulbs, root crops and sprouting seeds but there is much disagreement on this point. Most plant damage blamed on the mole is actually caused by **meadow voles** (*Microtus sp.*) which often use the mole's tunnel systems.

Controls

Where moles are a definite problem, the only sure way to control them is by **trapping**. The scissors-type mole trap such as the "Tunnel trap" or "Out-of-Sight" trap is one of the better designs and is very effective if used properly. Other mole traps may also work well if used according to label directions.

Other Controls

The application of **soil insecticides** that kill worms and grubs will, apparently, sometimes cause moles to move. However, this method can be quite expensive, may take several weeks to show results and is hazardous to the environment. There are NO pesticides registered for killing beneficial earthworms, which comprise a mole's main diet..

Mole baits are inconsistent as a control measure. Most species of moles will generally not eat these products. The majority of mole baits use zinc phosphide as the active ingredient. "RCO Mole Patrol" , using chlorophacinone as the A.I., has shown apparent effectiveness on **Eastern moles** (*Scalopus aquaticus*) but has not, so far, been effective in deterring Townsend's moles.

Smoke bombs - see under Pocket Gopher.

Mole-plants, chewing gum, mothballs, etc. have not been proven effective.

Pocket Gophers

Pocket gophers (*Thomomys sp.*) are burrowing rodents that can cause a great deal of damage to vegetation, buried cables, dikes and irrigation pipe. Unlike moles, pocket gophers feed almost exclusively on plant material below and occasionally above ground.

There are **six species** of pocket gopher. Most are 5 to 6 1/2 inches in length with a 2 to 3 inch tail. Fur is usually brown or grayish in color and the typical rodent's "buck teeth" are easily visible. The name "pocket gopher" comes from the external, fur-lined cheek pouches on each side of the mouth that are used for transporting food to storage areas.

Moles or Gophers?

While moles usually prefer moist lowland areas and gophers are mostly found East of the range, they do occur together in some localities. Since most controls are very different for the two species, accurate identification is a must.

The **appearance of the mound** will tell us which pest we must deal with. Mole mounds are usually conical with a "cloddy" look to the soil while gopher mounds, consisting of finer soil, are usually flatter and somewhat fan-shaped with an obvious plug in one end.

Controls

Pocket gophers may be controlled any time of the year but it is most successful when new mounds are appearing, usually in the Spring and Fall. **Trapping** and **toxic baits** are both available to the public and are both effective.

Voles

There are several species of **voles** (*Microtus sp.*) or "meadow mice". All of them are plant feeders and many are proficient burrowers. Voles can cause damage in orchards by feeding on the roots and girdling trunks. These **small, short-eared, short-tailed rodents** will also tunnel through vegetable and flower gardens, feeding on juicy roots, tubers and bulbs -- damage that is often blamed on our poor, insect-eating moles! Voles will even use the moles' tunnels when making these raids.

Voles are active day and night in all seasons. They are seldom seen as they spend most of their time underground or in dense grass. They can have up to 5 litters per year with up to 11 per litter and are the main food source for many predators.

SIGNS

How can you tell if you have a vole problem? Obvious signs include **gnawed roots** and **root crops** (note the small **grooves** left by the 2 large front teeth). **Girdling of tree trunks** extending to just above soil line (rabbits usually damage trunks and twigs higher up and leave larger tooth marks at 45 degree angles while Mountain Beavers clip the branches, leaving 2 inch stubs) and extensive, well-used tunnels through the soil and/or in the grass or thatch are other signs of infestation. Finally, voles often leave open, **1 inch** holes in areas of heavy activity.

MANAGEMENT

Vegetation management is a key issue in keeping vole populations low. In orchards, keep the tree rows free of vegetation at least 36 inches on both sides of the trunk. This can be done by weeding or by using a registered herbicide. If you are using a string weeder (Weedeater, Weed Whacker, etc.) be sure not to hit trunks. **Hardware cloth cylinders** (1/4 inch mesh) can be placed around shrubs and young trees to exclude voles if the lower edge is buried 6 inches deep.

In gardens, try to keep surrounding areas free of tall grass and thatch and don't leave root vegetables in the ground over winter.

CONTROL

Biological: Almost all small meat-eaters love to feed on voles. By encouraging hawks, owls, coyotes, foxes, weasels and shrews you can help keep vole populations from exploding.

Mechanical: For very small populations, trapping may be sufficient. Ordinary **mouse-traps** can be baited with peanut butter or apple and set IN the runs. Dig into the underground tunnels to place the traps and then cover with a board for the most effective set. Check traps daily and re-set as needed. This is a very time-consuming method but useful where poisoned baits are not wanted. Tree guards that are effective in controlling rabbit damage will NOT discourage voles since they feed largely underground. In fact, voles have been known to nest under loose-fitting guards!

Chemical: There is one rodenticide, "Adios Mouse Killer in a Block" (warfarin is the active ingredient) registered for homeowner use against voles in Washington State (2008).

Most "Mole & Gopher" baits registered for home use will kill voles when applied according to label directions but they are not specifically registered for use on these rodents.

Ground Squirrels

Ground squirrels (*Spermophilus sp.*) of several species range in size from the tiny **Idaho ground squirrel** (8 1/2 in.) up to the **California ground squirrel**, our only coastal ground squirrel in Oregon and California (18 in.). Ground squirrels feed mostly on vegetation and can be very damaging to gardens. They are also vigorous burrowers, leaving many open holes throughout their home ranges and have been implicated in the transmission of plague and other diseases.

Controls

Ground squirrels can be excluded from buildings with standard **rodent-proofing** techniques. Metal rodent guards will usually keep them out of fruit and nut trees.

Fencing is usually **not** effective in barring these rodents from an area and scare-devices also do not work.

Trapping the rodents can be effective in small infestations. **Cage-type** traps may be used but check with your local Extension office or Wildlife department before releasing these rodents back into the environment. Relocation may not be legal. If the animal must be destroyed, the entire trap can be dropped into a large garbage can full of water. **Lethal traps** such as the "Better Squirrel and Rat Trap" (a choker-type trap) or the Conibear 110 body-catch trap may be used. For small ground squirrels, you may be able to use regular **rat traps**. One trap for every 10 - 15 squirrel present should be used to quickly control the population. Be sure to keep the traps inaccessible to non-target wildlife and pets. Ground squirrels are generally unprotected but check with your local laws before using lethal methods.

Gas bombs are available for the home gardener and can be quite effective if used when the rodents are active. They work best when the soil is moist and dense, which helps keep the gas in the burrows.

Rodenticides are usually not registered for the home gardener to use on ground squirrels. Check with your Extension office to see if any are legal to use in your State.

Mountain Beaver

Is the world's most primitive living rodent, the **Mountain Beaver** (*Aplodontia rufa*). This animal does not usually live high in the mountains and is not a beaver of any kind, being more closely related to squirrels. It is found only in the Coastal areas and foothills of Western North America.

The Mountain Beaver belongs to its very own taxonomic family (Aplodontiidae) and is known by several common names including "boomer", "whistler", "chehalis" and "sewellel". This rodent weighs two to four pounds and is about a foot in length, resembling a tailless muskrat with large, digging claws. It usually lives in or near wooded lands having large masses of tangled vegetation such as sword fern, blackberry and salal, its primary foods.

These solitary animals dig shallow tunnels 4 - 8 inches in diameter throughout their half-acre territories and feed on any available vegetation which they sometimes stack near their burrows.

The Mountain Beaver becomes a pest when it begins feeding in reforestation units, Christmas tree farms and home yards and gardens. It generally destroys much more vegetation than it eats. In home gardens, the Mountain Beaver is primarily a pest of **rhododendrons**. It usually damages the plants by clipping off stems and branches, leaving **2 inch stubs**. They will also occasionally gnaw the bark from the bases of larger trees.

Controlling Mountain Beaver

In an area where there is only limited damage such as a single rhodie or tree being stripped, enclosing the plant in a **wire fence** will often discourage the pest. A two-strand **electric fence** with the bottom wire about 4 inches above the ground should also work. One can also fence the entire yard with a rabbit-proof fence (chain-link, chicken wire, etc.) to protect the landscape. Be sure the bottom of the fence is tight against the ground or even buried a foot or two.

Repellents have not proven consistently effective but some researchers have had fair results with 36% putrescent egg solid based products. Other researchers have found the Thiram based repellents of some value for protecting Douglas fir seedlings.

Mountain Beavers can also be easily **cage-trapped** and re-located, although some studies have shown that most re-located wildlife does not long survive. Drowning the animals in a garbage can full of cold water may be the most humane treatment. Check with your local State Wildlife Department for their recommendations.

Wildlife control professionals can also be hired to deal with these problems. The local State Wildlife Department usually has a list of licensed nuisance animal trappers.

Beavers

Beavers are accomplished engineers and are famous for their well-built dams and beaver lodges. Dams and lodges are not ALWAYS present where beavers are living but the damage inflicted on trees and shrubs by the beaver's huge incisor teeth is a positive sign that these animals are around.

Breeding usually takes place between January and March, with an average of four "kits" being born after a gestation of about three months. The young stay with the adults for about 1-2 years before migrating away to form their own colonies of between 2 and 12 individuals.

Damage & Management

Beaver dams are beneficial to wildlife but they can flood a considerable area and can not always be tolerated. Where dams are causing problems, the water level can sometimes be altered by flow devices to keep flooding within reasonable limits. Installation of flow-control devices (or removal of dams, which is generally a waste of time) requires a Hydraulic Project Permit from your local office to provide information on designs and installation of such devices.

If beavers are damaging trees and/or ornamental shrubs, there are several ways plants can be protected.

Large trees and shrubs can be loosely wrapped with layers of chicken wire, hardware cloth or galvanized wire fencing, at least three feet high. Be sure you monitor the trees as they grow and/or leave room for the plant to expand. More slender trees can be protected by splitting 3 foot lengths of plastic pipe and fitting them around the trunks. Be aware that dark colored plastic may cause overheating and damage to young trees.

Large plantings can be protected with a variety of fencing. Four foot field fencing, installed so that the bottom is tight against the ground, works well as does a 2-strand electric fence with the strands stretched off the ground at 8 and 12 inches.

Repellents can also be helpful in reducing beaver damage, especially if the animals are new to the area. Even so, repellents are seldom 100% effective. Commercial repellents containing egg solids have shown some success but must be reapplied often.

If beavers must be removed, it is best to locate a professional wildlife control operator. In some cases, you may be allowed to shoot the offending animals but removal is seldom a permanent solution as good habitats are usually repopulated by migrating beavers within a couple years.

Deer and Elk

In most places they are highly valued as game animals and "watchable wildlife". In a garden or orchard, however, they can cause extensive and continuing damage to crops and ornamentals.

Damage

Deer and elk feed on a wide variety of plants, both woody and herbaceous. Most damage is caused by browsing on woody ornamentals and crops. Browsing damage is easily identified by the **ragged tips** where the twigs have been broken. Rodents and rabbits leave a clean cut when they browse.

Management

The only consistently effective management tool for reducing deer and elk damage is some sort of **fencing system**. These range from simple, baited electric fences to expensive 7 foot high-tension New Zealand-type fences or woven-wire fences. The simple fences are quite effective in areas where deer are just beginning to cause damage. In areas where deer and elk have been feeding for some time, the more impenetrable fences are necessary. It is also important that the fences are visible so the animals don't accidentally stampede through them.

If deer or elk are browsing on a few plants, cylinders of welded wire mesh can be placed around each one. New seedlings can be protected with plastic mesh tubes or netting.

In some cases registered **repellents** can reduce damage sufficiently but must be re-applied periodically - especially after a heavy rain. If the animals are habituated to feeding in the area, repellents are less effective.

There are many home remedies mentioned in the literature ranging from hanging bars of deodorant soap to scattering lion dung about the garden. Sometimes these methods work but many times they do not.

Replacing heavily damaged plants with more **resistant varieties** is another option. There are many kinds of ornamental plants that deer and elk don't like. Even some of these will be browsed if the animals are really hungry

In areas where **hunting** is allowed, opening your land to responsible sportspeople can help reduce browsing damage.

For more information specific to your location, contact your State Fish and Wildlife Department.

Tree Squirrels

The native **Douglas squirrel** (*Tamiasciurus douglasii*) with its dark red coat and orange belly is still quite common although the large, introduced **Eastern gray squirrel** (*Sciurus carolinensis*) with its rusty-gray pelage and white belly has taken over in many areas. On the East side of the Cascade Range the common species is the **Red squirrel** (*Tamiasciurus hudsonicus*) with its dark red back and white belly. The introduced **Eastern Fox squirrel** (*Sciurus niger*) with its reddish coat and belly is the largest of the North American squirrels and is not common in most areas. The shy, native **Western gray squirrel** (*Sciurus griseus*) with its gray coat and dusky feet is not common, either, being found mainly in areas where the Gary oak thrives west of Idaho and Nevada. Finally, a common but seldom seen native is the nocturnal **Northern flying squirrel** (*Glaucomys sabrinus*). This little glider thrives wherever there are coniferous forests.

Damage

Squirrels can become troublesome when they attack **fruit, nut and vegetable crops**. They are also incessant raiders of bird feeders and bird nests and can damage ornamental trees by **clipping twigs** and **stripping bark**. In areas where nesting places are scarce they will gnaw into attics and wall voids, causing serious damage.

Management

Methods used for controlling squirrels vary according to location and species to be managed. Native squirrels are usually protected by law so a combination of non-lethal methods can be used, including **exclusion**, **repellents** and **cage-trapping**. In many places, non-native squirrels are not protected (check with your local wildlife department) so trapped animals may be humanely destroyed. Euthanasia is often recommended when dealing with Eastern grays since re-location would spread these destructive rodents into new areas or place them in an area already at carrying capacity where they would probably suffer a lingering death.

Raccoons

Raccoons (*Procyon lotor*) are native carnivores that live throughout most of the United States. These animals, which can grow up to 50 lbs., readily adapt to suburban environments. With few predators and human-supplied food, populations often grow out of control.

Damage

Raccoons are generally nocturnal in habit and omnivorous in diet. They will often stage midnight raids on gardens and orchards. They can easily climb fruit trees, tip over garbage cans and will even roll up newly laid turf to get at the worms and grubs living underneath. In addition, 'coons will try to invade crawlspaces and can destroy the insulation under houses,

leaving quantities of odorous feces. In some areas they are important vectors of rabies and the raccoon roundworm.

Management

Exclusion is usually the most effective way of managing raccoon damage. Orchards and gardens can be protected by erecting a two-strand electric fence with the first wire about 6 inches from the ground and the second wire 6 inches higher. Chain link and chicken wire fences will also work if a single strand of electric fence is stretched along the top.

Large fruit trees can be protected by installing sheet metal "rodent guards" as suggested for squirrels.

In some situations, a radio left playing in the garden will repel the pests until harvest but this is usually a temporary measure.

A noisy dog patrolling the yard is usually an effective deterrent for many vertebrate pests.

For animals nesting under houses, find out where they are getting in and **securely** block the entrance when they leave at night to forage. Be sure any young have left, also. A tracking patch at the entrance can indicate when the animals have emerged.

If you choose to try a cage-trap, check with your local State wildlife department for instructions.

Opossums

They are often described as "giant gray rats" since they have a naked, rat-like tail. They may reach lengths of up to 40 inches and weight up to 14 lbs.

Damage

'Possums are omnivorous feeders and are usually quite beneficial as they eat a wide variety of insects and other invertebrates. They will, however, also raid gardens, fruit trees, bird feeders, garbage cans and bird nests. As with raccoons, they will also nest under houses, causing considerable damage and odor problems.

Management

Controls for this animal are the same as for raccoon. If you choose to use a cage trap, check with your local State wildlife department. Since this animal is not native to the PNW, your State may not allow releasing back to the wild.

Rabbits

Whitetail and Blacktail "Jackrabbits" (*Lepus townsendii* and *L. californicus*) are actually hares, other hare is the **Snowshoe hare** (*L. americanus*)

The true rabbits include the **Mountain Cottontail** (*Sylvilagus nuttalli*) and **Pygmy Rabbit** (*S. idahoensis*). The **Brush Rabbit** (*S. bachmani*). The **Eastern Cottontail** (*S. floridanus*) and **Domestic Rabbit** (*Oryctolagus cuniculus*).

Rabbits and hares are very prolific, having up to 6 (or more) litters per year with several in each litter.

Damage

Hares and rabbits will eat a wide variety of herbaceous and woody plants. A diet of bark and stems is often preferred during the colder months when much damage to gardens and orchards may occur, especially during peak population years. In the Spring and Summer, they develop an appetite for flowers (especially tulips) and vegetables.

Rabbit-damaged trees and shrubs are easily identified by the characteristic **toothmarks** left when the animals feed. Twigs are usually clipped cleanly at a **45 degree angle** and bark on lower stems and branches is gnawed away, leaving **parallel grooves** in the wood.

Management

Since rabbits and hares are usually classified as game animals, one should contact the local Fish and Wildlife department for regulations about trapping or shooting.

Habitat manipulation can also help reduce rabbit/hare damage. Removing briar patches, brush piles and other hiding places will reduce the overall number of animals in the area.

There are several **repellents** registered for rabbit and hare management. Most of these are somewhat effective if the feeding pressure is not too great. Many are labeled only for use on ornamentals.

Birds

Birds can cause problems in farm and home garden situations by their **roosting**, **nesting** and **feeding** habits, depending on the species. The most common culprits are **crows**, **starlings**, **woodpeckers**, **pigeons**, **house ("English") sparrows**, **robins**, and **geese**. Other species may be occasional pests.

Bird management can present special problems since most species are protected by law but there are many tools available for reducing damage.

Roosting and Nesting Damage

Where birds roost or nest, droppings must fall. Bird droppings can damage machinery, stored feed and present possible disease hazards.

Roosting can be prevented by making the area uncomfortable for birds through the use of **barriers**. Solid, angled barriers or wire obstructions ("porcupine" wires and stretched wire) can prevent birds from using ledges as roosts. The wire obstructions also work well on building peaks.

"**Bird glues**" can also be used to reduce roosting. Birds don't like getting these sticky materials on their feathers so they will usually avoid contact. Glues must be re-applied occasionally and don't work well in dusty or wet conditions.

Crop Damage

Birds can cause extensive damage to all kinds of crops. Those most prone to damage include **strawberries**, **cherries**, **blueberries**, **apples**, **grapes** and **hazelnuts**.

Low growing plants can be covered with **bird netting** to prevent damage. Be sure the netting reaches the ground or is gathered around the trunk of the plant or the birds will fly up underneath to attack.

Various "scare devices" (scare-crows, hanging flashers, flags, balloons, etc.) can reduce damage if they are moved about so the birds do not become accustomed to them.

Sonic devices that broadcast **alarm calls** are useful for the particular species making the call. Ultrasonic and sub-sonic devices have not been proven effective on any pest species.

The **repellent**, Methyl anthranilate, has recently been registered for home use on a variety of crops. This material is derived from grape skins and has proven useful in reducing bird damage in test plots. Effectiveness in field situations is variable.

Trapping can only be used against **non-protected** birds (house sparrows, domestic pigeons and starlings) but it can still be of use for reducing local populations of those species. Cage traps of various kinds must be used to avoid harming protected species.

Controlling Birds at Aquaculture Facilities

The open-water areas and large concentrations of fish at aquaculture facilities appear to be a virtual smorgasbord for wildlife that eats fish. Most mammals are either large enough that they can be easily excluded or small enough that they do not pose an economic threat to the facility. Birds are more difficult to exclude and can have a significant economic impact if no control methods are used.

General Biology

Reducing damage by fish-eating birds requires accurate bird identification and some knowledge of avian biology and habits. Responsible bird management means knowing both the problem species and other birds that use the aquatic habitat without harming aquaculture efforts. Not all birds harm production. Birds become a problem only if their activities directly or indirectly result in a significant loss of fish. The following birds have been implicated in some level of damage at Pennsylvania aquaculture facilities. It is important to identify problem species accurately. Field guides to birds are available at local libraries and bookstores.

Damage Identification

Many fish-eating birds are highly mobile and adaptable predators, rapidly able to exploit situations of food abundance. Aquaculture facilities are ideal feeding sites for these predators. The severity of bird problems will vary with the species and number of birds present and whether the birds reside only seasonally or tend to remain at the facility throughout the year. The proximity of nesting or roosting sites and the availability of alternative feeding sites also are important factors. Because most species of fish-eating birds are diurnal or active during daylight hours, direct observation is the usual means of confirming bird presence and damage. Obvious signs of hunting and feeding include birds perched on trees or wires near raceways or ponds, hovering overhead and then plunging into the water, standing or stalking along the edges of ponds, or swimming and diving in ponds. Some species, such as the black-crowned night heron, feed at dusk and during the night. Additional observations at night should be made to verify bird depredation. Some fish may show scars from predatory attempts. Herons sometimes spear but do not kill or eat larger brood stock. Chewed or partly eaten fish may be a sign of predatory mammals, including raccoon and mink. *Belted kingfisher*

Damage Control

With the exception of total exclusion, single control methods rarely solve a bird control problem. Results obtained from non-exclusion techniques may vary. Keep in mind that all methods succeed or fail to some degree, and a combination of methods is usually required. The choice of control methods is determined by a number of factors, including the species of birds involved, the extent of the damage, the projected cost of the control program, the type of facility to be protected, the species of fish grown, the size of the water impoundments, and the long-term effect on facility management. Finally, economics plays a role in the selection process. Although methods such as exclusion are initially costly, the long-term economic benefits usually outweigh the costs. Other methods are less costly initially but do not provide the long-term benefits.

Facility Location

The physical location, design, and construction of an aquaculture facility influence the susceptibility of fish to bird predation. Although water availability, water quality, and other parameters essential to fish production are prime considerations in selecting a site, locations away from obvious bird

concentrations also should be considered. Establishing facilities in close proximity to rivers, roosting areas, marshes, and other wetlands will increase interactions with bird populations.

Fish Management

Fish management and the ability to adjust programs based on changing bird habits are important. Since fingerlings are more susceptible to bird predation, they should be located close to the center of human activity and near buildings that might be incorporated into a bird exclusion system. Larger fish usually need less protection because they are better able to avoid predators. Feeding techniques also may influence the effectiveness of bird management programs. Floating rations produce surface feeding activity among fish that aids the grower in monitoring fish health, but this activity also may attract birds that consume the floating food and feeding fish. The advantages of using floating rations should be weighed against the problems they may cause.

Exclusion

Impediments

Overhead Wires or Lines—

Metal Spines—

Frightening

Automatic Exploder—

Alarm or Distress Calls—

Lights—

Water Spray Devices—

Effigies and Scarecrows—

Chemical Frightening Agents—

Lethal Methods

Summary

Birds can cause serious monetary damage to aquaculture facilities. Consequently, it is in the grower's best interest to take necessary precautions to minimize the likelihood that birds will become a problem. First, when selecting a site for an aquaculture facility, avoid areas near known concentrations of fish-eating birds. Second, when designing a facility, design it so that total exclusion is possible over at least most of the ponds and raceways. Third, if birds do become a problem, identify the species causing the damage and use control methods effective for that particular species. Consult Wildlife Services personnel to determine which control techniques will work best. Finally, start control programs early, before birds are a major problem, use a variety of techniques, and be persistent. Lethal methods should only be used as a last resort, and permits are required before lethal methods are begun.