STARLINGS

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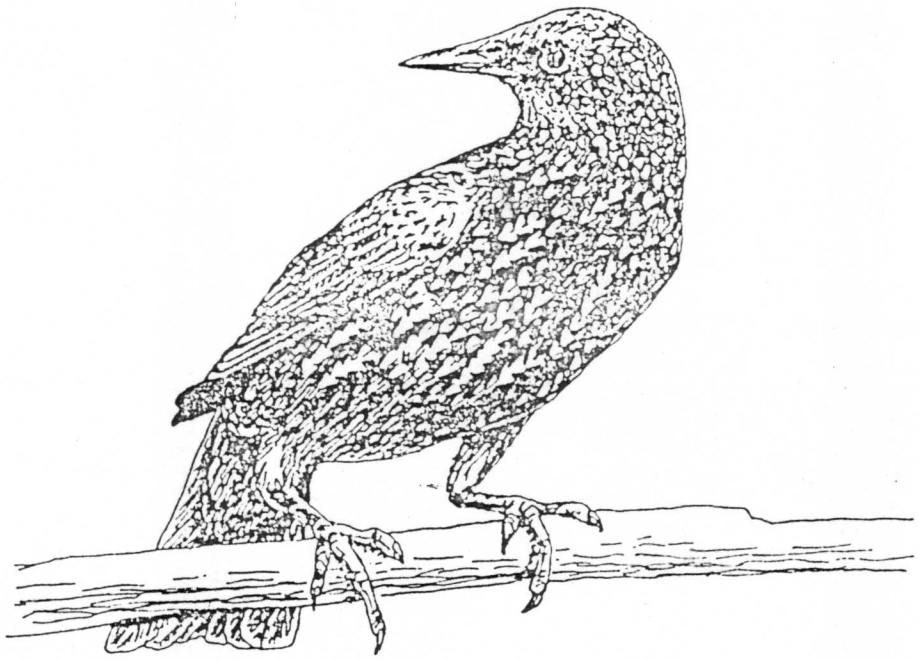


Figure 1. Adult European starling, *Sturnus vulgaris*

Damage Prevention and Control Methods

Exclusion

Close all openings larger than one inch (2.54 cm)
Boards or metal covering at 45° angle on ledges
Metal prongs or sticky repellents on ledges or rafters
Netting to prevent roosting on building rafters or to protect fruit crops
PVC strips to cover door openings

Cultural Methods and Habitat Modification

Reduce availability of food and water at livestock facilities: Remove spilled grain and standing water; use bird-proof feeders and storage facilities; feed livestock in open sheds; where appropriate, feed in late afternoon; lower water level in waterers.
Modify roost sites by closing building roosts or frightening.

Frightening

Use with fruit crops and starling roosts. Also useful at livestock facilities in warm weather and at facilities located near a major roost.
Frightening devices include recorded distress or alarm calls, various sound producing devices, chemical frightening agents (Avitrol®), lights, and bright objects.

Repellents

To protect ripening cherries or blueberries (Mesurol® 75% Wettable Powder)
To discourage roosting on ledges (soft sticky materials)

Toxicants

Starlicide® — poison bait for use around livestock facilities

Toxic Perches

Generally not recommended for starling control

Wetting (Detergent) Agents

Generally not recommended for starling control but may be useful for roost control in some situations; for use only by or under supervision of government agencies trained in bird control.

None registered. Engine exhaust (containing carbon monoxide) may be useful in some farm buildings, but is not registered

Nest-box traps, for use during nesting season

Decoy traps may be useful around orchards or livestock facilities. Proper care for trap and decoy birds is necessary.

Helpful as a dispersal or frightening technique. Not effective in reducing starling numbers.

Other Methods

The use of starlings as a protein source for livestock or pet food may warrant investigation.

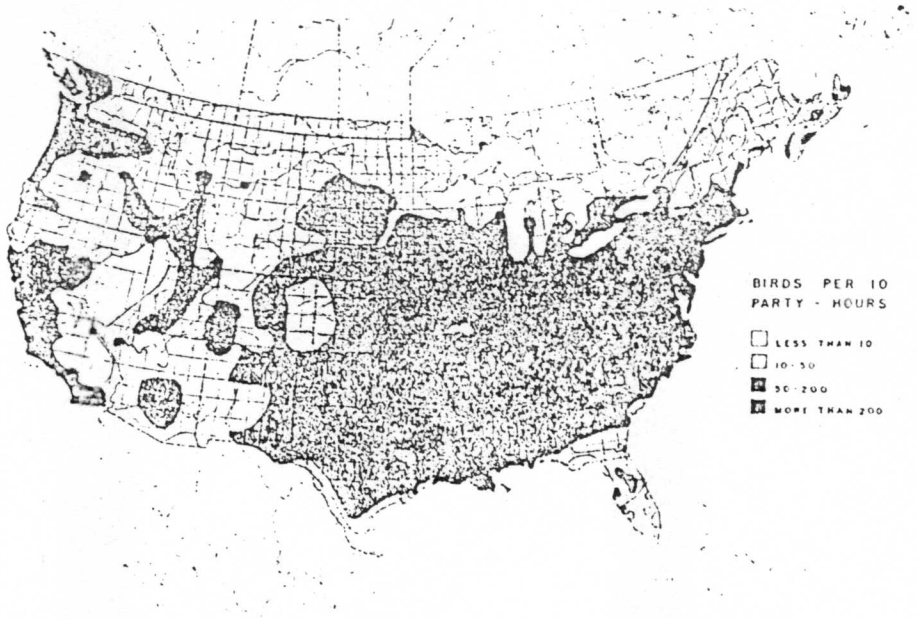


Figure 2 Starling wintering areas, 1972. Map by J.W. Rosahn, based on the National Audubon Society's annual Christmas Bird Count. Map reprinted by permission from "Wintering Areas of Bird Species Potentially Hazardous to Aircraft." D. Bystrak *et al.* 1974. National Audubon Society, Inc.

Identification

Starlings are robin-size birds weighing about 3.2 ounces (90 g). Adults are dark with light speckles on the feathers. The speckles may not show at a distance *(Figure 1)*. The bill of both sexes is yellow during the reproductive cycle (January to June) and dark at other times. Juveniles are greyish.

Starlings generally are chunky and hump-backed in appearance, with a shape similar to that of a meadowlark. The tail is short, and the wings have a triangular shape when outstretched in flight. Starling flight is direct and swift, not rising and falling like many blackbirds.

Range

Since their introduction into New York in the 1890's, starlings have spread across the continental United States, northward to Alaska and the southern half of Canada, and southward into northern Mexico. They are native to Eurasia, but have also been introduced in South Africa, Australia, New Zealand, and elsewhere. *Figure 2* shows starling wintering areas in the United States.

Habitat

Starlings are found in a wide variety of habitats, including cities, towns, farms, ranches, open woodlands, fields, and lawns.

Food Habits

Starlings consume a variety of foods, including fruits and seeds of both wild and cultivated varieties. Insects and other invertebrates total about half the diet overall, and are especially important during the spring breeding season. Other diet items include livestock rations and food in garbage.

General Biology

European starlings were brought into the United States from Europe. They were released in New York City in 1890 and 1891 by an individual who wanted to introduce to the United States all of the birds mentioned in Shakespeare's works. Since that time, they have increased in numbers and spread across the country. They were first observed in Nebraska in 1930 and in Colorado in 1939. The starling population in the United States is estimated at approximately 140 million birds.

Reproduction. Starlings nest in holes or cavities almost anywhere, including tree cavities, birdhouses, and holes in buildings or among rocks. Females lay 4 to 7 eggs which hatch after 11 to 13 days of incubation. Young leave the nest when they are about 21 days old. Both parents help build the nest, incubate the eggs, and feed the young. Usually two clutches of eggs are laid per season, but most of the production is from the first brood fledged.

Movements. Although not always migratory, some starlings will migrate up to several hundred miles, while others may remain in the same general area throughout the year. Hatching-year starlings are more likely than adults to migrate, and they tend to migrate farther.

When not nesting, starlings feed and roost together in flocks. During winter, they prefer to roost in dense vegetation such as coniferous trees, or in towns and other areas protected from wind and adverse weather. Each day they may fly 15 to 30 or more miles (24 to 48 km) from roosting to feeding sites.

Damage and Damage Identification

Starlings are frequently considered pests because of the damage problems they cause, especially to agriculture. At livestock facilities, they consume livestock feed and contaminate the feed and water with their droppings. Where high-protein supplements are added to feeds such as cattle rations, starlings may selectively eat the high-protein portion.

Starlings may also be responsible for transferring disease from one livestock facility to another. This is of particular concern to swine producers. Recent tests show that the TGE (transmissible gastroenteritis, or baby pig disease) virus can pass through the digestive tract of starlings and be infectious in the starling feces. However, researchers also found healthy swine in lots with infected starlings. This indicates that even infected starlings may not always transmit the disease, especially if starling interaction with pigs is minimized. Other ways that TGE may be transmitted include on boots or vehicles, by stray animals, or by infected swine added to the herd. Starlings have been implicated in the spread of other diseases; however, the role of starlings in these diseases is not yet clear and further research is needed.

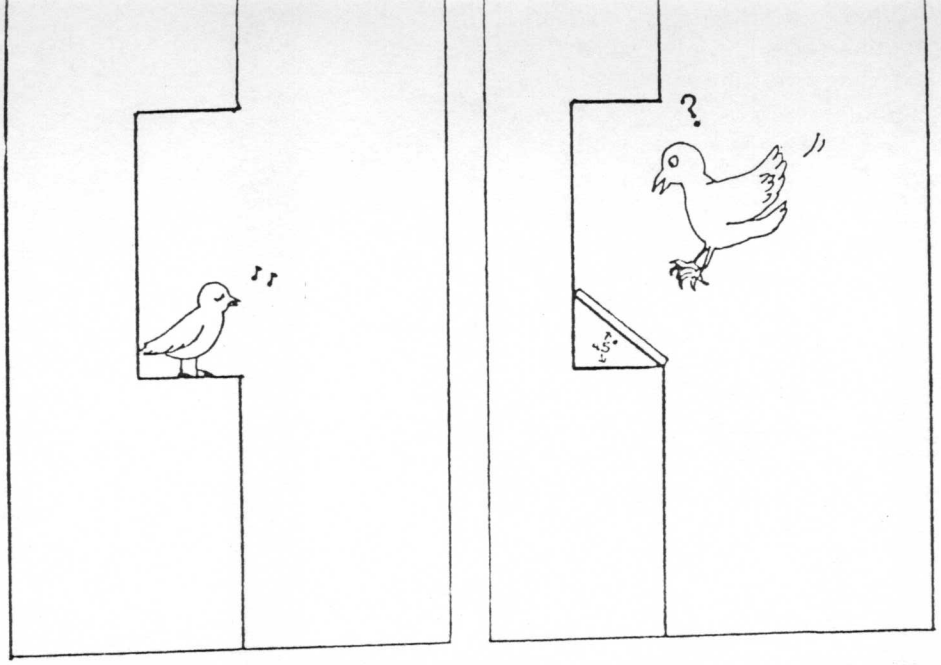


Figure 3. A board or metal covering over a ledge at a 45° angle prevents roosting on the ledge.

Starlings cause other agricultural damage by consuming cultivated fruits such as grapes, peaches, blueberries, strawberries, figs, apples and cherries. In some areas they pull sprouting grains, particularly winter wheat, and eat the planted seed. Starling roosts are also a frequent problem in rural and urban sites. In addition, starlings compete with native hole-nesting birds such as bluebirds, flickers, other woodpeckers, and purple martins for nest sites.

Legal Status

European starlings are not protected by federal law and in most cases not by state law. However, laws vary among states, so check with state wildlife officials before beginning a control program. In addition, state or local laws may regulate or prohibit certain control techniques such as shooting or the use of toxicants.

Damage Prevention and Control Methods

Exclusion

Where starlings are a problem inside buildings or other structures, close all openings larger than one inch (2.54 cm) so they cannot enter. This is a permanent solution to problems inside the structure.

Where starlings are roosting on the ledge of a building, place a board or metal covering over the ledge at a 45° angle to prevent roosting on the ledge *(Figure 3)*. Metal protectors or wire prongs (Nixalite® and Cat Claw®) and sticky repellents (see below) are also available for preventing roosting on ledges or rafters *(Figure 4)*.

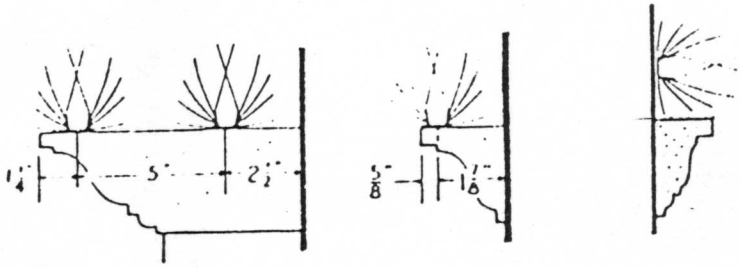


Figure 4. Metal protectors or wire prongs can be used to prevent roosting on ledges or rafters.

Nylon or plastic netting is another option for exclusion *(Figure 5)*. Starlings roosting inside open farm buildings can be excluded from the roost by covering the underside of the rafters with netting. The netting prevents the birds' access to rafters where they perch. Netting is also useful for covering fruit crops such as backyard cherry trees or high-value table grapes.

Heavy plastic (PVC, polyvinyl chloride) strips hung in open doorways of farm buildings have been successful in some areas in excluding birds, while allowing people, machinery, or livestock to enter *(Figure 6)*. These strips might also be useful for protecting feed bunkers. Netting over doorways may also exclude birds from buildings, but would be easily torn by machinery or livestock. While these techniques are promising, they need further testing in farm situations.

Cultural Methods and Habitat Modification

Starlings are attracted to livestock operations by the food or water that is available to them. Feedlots offer an especially attractive food source to starlings during winter when snow cover and frozen ground impede their normal feeding in open fields or other areas. The snow cover and frozen ground increase the likelihood of damage as well as the severity.

Recent research by the U.S. Fish and Wildlife Service shows that some livestock operations are more attractive to starlings than others. Operations that have large quantities of feed always available, especially when located near a starling roost, are the most likely to have damage problems. Results emphasize the importance of farm management practices in long-term starling control. These practices limit the availability of food and water to starlings, thus making the livestock environment less attractive to the birds. The following

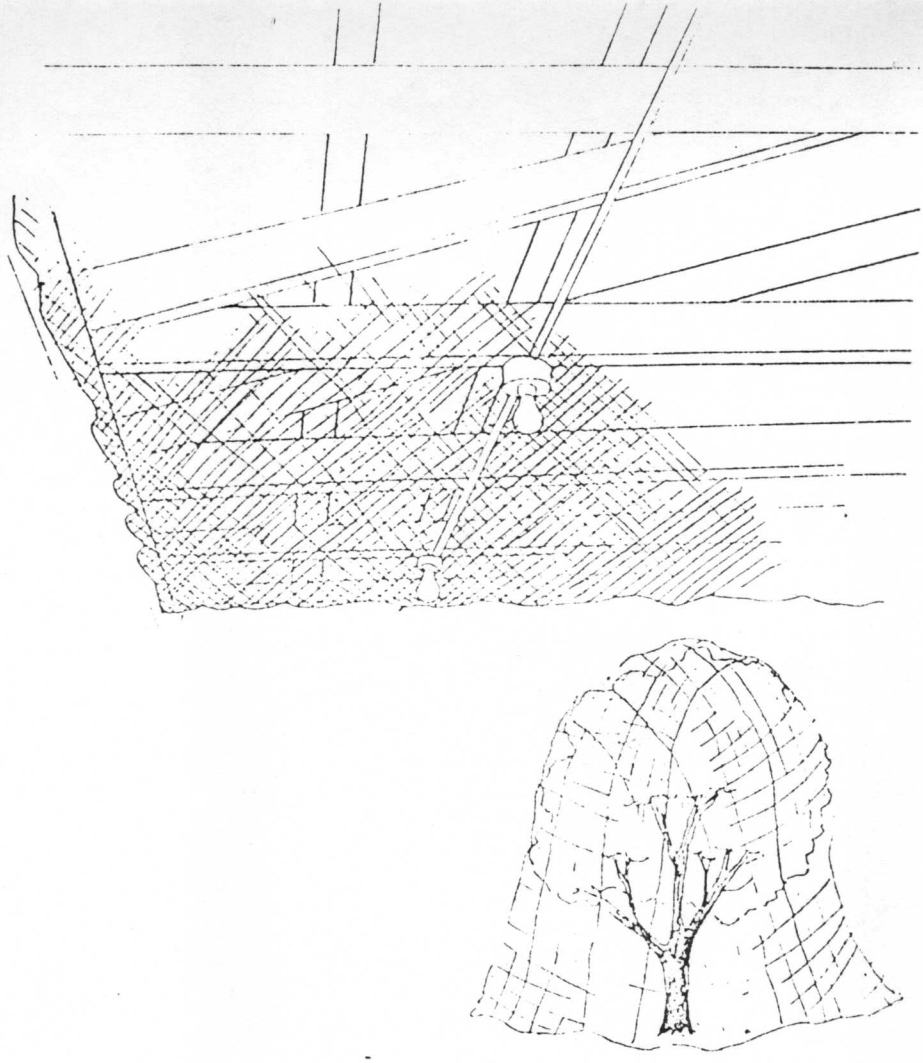


Figure 5. Netting can be useful for excluding birds from building rafters and from fruit trees.

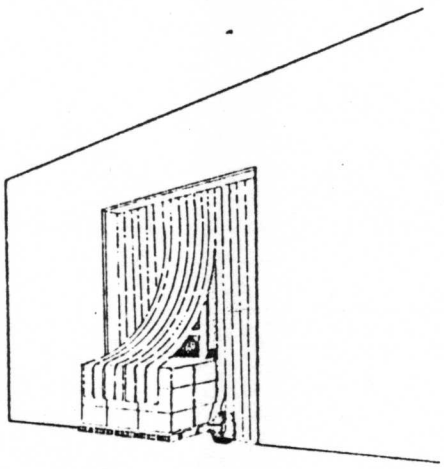


Figure 6. Heavy plastic (PVC) strips can be hung from doorways to exclude birds.

Frightening

Frightening is effective in dispersing starlings from roosts, small-scale fruit crops, and some other troublesome situations. Frightening devices include recorded distress or alarm calls, gas-operated exploders, battery-operated alarms, exploding shotgun shells (shell-crackers), chemical frightening agents (see Avitrol® below), lights, bright objects, and various other noisemakers. Beating on tin sheets or barrels with clubs also works well in scaring birds. A combination of several scare techniques used together works better than a single technique used alone. Varying the location, intensity, and types of scare devices improves their effectiveness. Ultrasonic (high frequency, above 20 kHz) sounds are not effective in frightening birds because birds, like humans, do not hear these sounds. For a more detailed discussion of frightening techniques, see the Bird Dispersal Techniques chapter.

In the mid to northern Great Plains states, starlings concentrate at livestock facilities primarily during the cold winter months when snow covers natural food sources. At this time, frightening devices and agents may be less effective because few alternative foods are available. However, frightening can be useful around livestock operations that have warm climates year-round, and where major concentrations of wintering starlings exist. Baiting programs with toxicants generally are less successful during warm weather because starlings have an adequate supply of alternative foods. Toxicants may provide only short-term control where large concentrations of starlings are wintering.

Avitrol®. Avitrol (active ingredient: 4-aminopyridine) is registered in several bait formulations as a chemical frightening agent. The current label indicates that use is restricted to government agencies, pest control operators, or persons under their supervision. It is not for sale to the public. This label is currently undergoing revision, and Avitrol is expected to be classified during 1983 as a Restricted Use Pesticide.

Avitrol baits contain a small number of treated grains or pellets mixed with many others that are untreated. Birds that eat the treated portion of the bait behave erratically and/or give warning cries that frighten other birds from the area. Generally, the small number of birds that eat the treated particles will die. Avitrol baits are available for starling-control use at feedlots and structures. A discussion of field-use of Avitrol for blackbird control is included in the Blackbirds chapter.

Around livestock operations, Avitrol could be useful in situations where the goal is to frighten or disperse the birds rather than to kill them. For example, frightening might be more effective than lethal control at a livestock facility located near a major starling roost. The behavior patterns of frightened starlings could help minimize reinfestation following control. However, frightening starlings may disperse them to other livestock facilities, a point that should be considered if disease transfer is a concern.

Four Avitrol formulations are federally registered for starling control at feedlots. The formulation most appropriate for a given situation may vary, particularly if large numbers of blackbirds are mixed with the starlings. However, the Pelletized Feed formulation is generally recommended for starling control because they usually prefer pellets over cracked corn (corn chops). In addition, one treated pellet contains an effective dose, a help in reducing the possibility of bait shyness. Because Avitrol is designed as a frightening agent, birds can develop bait shyness (bait rejection) fairly quickly. Prebaiting for several days with untreated pellets may be helpful for effective bait consumption and control. If the problem persists, changing bait locations and additional prebaiting may be needed. If any Avitrol baits are to be used, we recommend you contact a qualified person trained in bird control work (e.g. from the Cooperative Extension Service; U.S. Fish and Wildlife Service, Division of Animal Damage Control) for technical assistance.

Repellents

Two types of repellents are helpful in controlling starling problems. One type (Mesurol® 75% wettable powder) can be used to protect ripening cherries or blueberries from bird depredation, and the other type (soft, sticky materials) can be used to discourage birds from roosting on ledges, rafters, or other perches.

Mesurol 75% wettable powder (active ingredient methiocarb: 3,5 dimethyl-4-(methylthio)phenol methylcarbamate) is federally registered as a bird repellent for use on cherries and, except for California and Massachusetts, on blueberries. Use on other fruit crops such as grapes is being researched. For one or two backyard cherry trees, we recommend covering them with nylon or plastic netting, or else using frightening devices such as several aluminum pie pans, aluminum strips, and hawk, snake, or human effigies. These frightening devices should be moved occasionally so the birds do not become used to them.

Soft, sticky repellents such as Roost-No-More®, Bird Tanglefoot®, and others, are non-toxic materials that can be useful in discouraging starlings from roosting on sites such as ledges, rafters, or shopping-center signs. It is often helpful to put masking tape on the surface needing protection first, then apply the repellent onto the tape; this makes removal, if desired, easier. Netting and metal protectors or wire prongs, as described above under "Exclusion", are possible alternatives to consider.

Toxicants

When using toxicants or other pesticides, always refer to the current pesticide label and follow its instructions as the final authority on pesticide use.

Starlicide. A chemical compound developed for starling control during the 1960's by the U.S. Fish and Wildlife Service is now commercially available as a pelletized bait. It is sold under the trade name Starlicide Complete® (0.1% 3-chloro p-toluidine hydrochloride) and in some other formulations.

Starlicide is a slow-acting poison for controlling starlings and blackbirds around livestock and poultry operations. It is toxic to other types of birds in differing amounts, but will not kill house (English) sparrows. Mammals are generally resistant to its toxic effects.

Poisoned birds experience a slow, non-violent death. They usually die from one to three days after feeding, often at their roost. Generally, few dead starlings will be found at the baiting site.

Poisoned starlings are not dangerous to scavengers or predators. However, to provide good sanitation and to prevent the spread of diseases which the birds may carry, pick up and bury or incinerate any dead starlings found.

How to Use. Field tests in Nebraska, Kansas and other states have established guidelines for using Starlicide. For the best success in a control program, we recommend the following steps:

1. ***Observe*** birds feeding in and around the livestock operation. Note the number of starlings and when and where they prefer to feed. The best time for observing is usually during the first few hours following sunrise when birds will be seeking their morning meal.

2. ***Determine*** what kinds of birds are feeding. If any protected birds such as doves, quail, pheasants, or songbirds are present, contact your county Extension office or the state wildlife agency. ***Do not apply toxic bait if protected bird species are present.***

3. ***Time of Application*** — Use of bait is more effective on very cold days when snow covers the ground. At this time, starlings become stressed for food and concentrate in livestock feeding areas. In the mid to northern Great Plains states, these conditions usually occur in late December or January.

In warm-weather climates, such as the southernmost Great Plains states, good bait acceptance may be more difficult to obtain. If this occurs, and the Starlicide Complete bait is not eaten, an alternative may be to use Starlicide Technical® (98% active ingredient) applied to baits such as French-fried potatoes, small fruits, or livestock feed. The French fries and fruits may be more attractive to starlings, but they can spoil rapidly. Generally, livestock feed makes an acceptable bait because starlings are accustomed to feeding on it.

Starlicide Technical can be used only by or under supervision of U.S. Fish and Wildlife Service employees. Contact the USFWS, Division of Animal Damage Control for help. Extra precautions should be employed to ensure that desirable non-target birds are not present in the baiting area. Procedures for using baits prepared using Starlicide Technical are generally the same as for Starlicide Complete.

4. ***Prebaiting*** is usually desirable. Use a prebait (non-poisonous bait) to accustom starlings to feeding on bait at particular locations. Place the prebait in areas where the starlings concentrate to feed, but where it will not be accessible to livestock or other non-target animals. The best prebait is a high quality food that resembles the toxic bait in color, size and texture. If such prebait is unavailble, use a good quality feed such as that normally fed to livestock.

Prebait for 1 to 4 days until the birds readily feed on the prebait. If good consumption is not obtained, move the prebait to another location where starlings are concentrating to feed.

5. ***Bait Placement*** — Bait containers permit easier handling of the prebait and toxic bait and protect it from the weather *(Figure 9)*. Black rubber calf feeder pans work well for this. They do not tip easily, their dark color does not frighten the birds, and the bait is openly exposed. Empty farm wagons, feeder lids turned upside down, wooden troughs or other containers may also work. Avoid brightly colored or shiny containers or ones which might tip and spill bait. At night, the containers can be covered to protect the bait from the weather. However, they must be uncovered at dawn so that the starlings can feed as soon as they arrive. At large feedlots where large numbers of starlings (more than 100,000) are involved, and where large quantities of feed are available on the ground, broadcast baiting as per label directions is recommended.

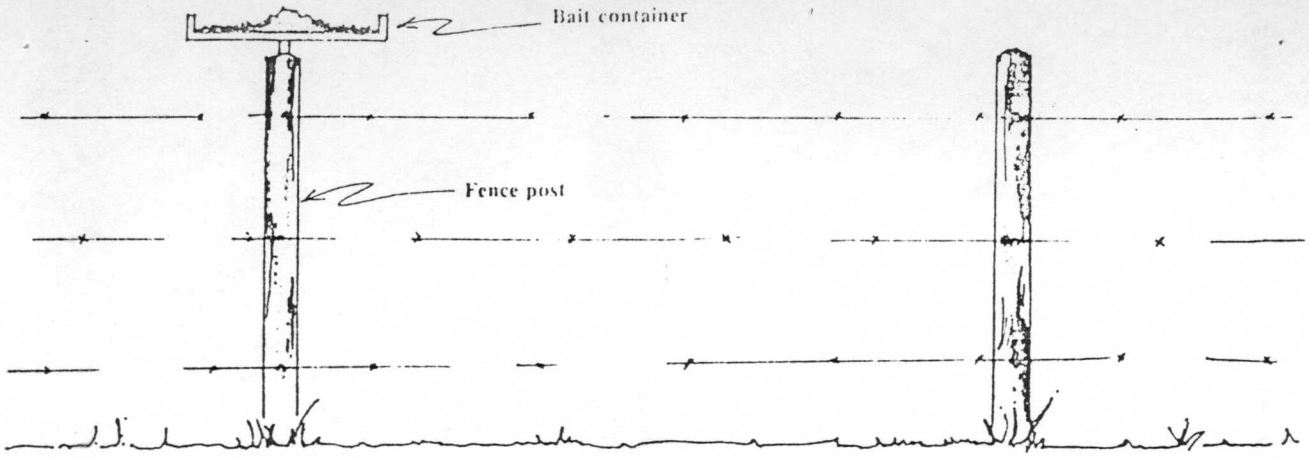


Figure 9. Use bait containers when baiting starlings. One example is shown here.

6. *Toxic Bait* — After the starlings feed readily on the prebait, remove all prebait and replace it with the toxic (poison) bait. Consult the label directions for the amount to use [one pound (0.45 kg) of Starlicide Complete used properly will kill about 100 to 200 starlings]. The total number of starlings using a farm over a long period of time may greatly exceed the numbers observed on a given day, so continue baiting for at least two or three days or until bait consumption diminishes. Bait should be available to the starlings at all times when they are present.

7. ***Remove Bait*** — At the end of three days, remove any remaining bait. Observe any birds arriving at the feedlot the next two to three mornings after baiting. Reduced bird numbers at this time indicate bird control, as most birds will die at the roost. If starlings continue to be present, or if they gradually return in increasing numbers, wait until a number of birds are regularly returning to feed at the area. Then apply prebait and toxic bait (Steps 4 to 6) as before. Do not leave Starlicide baits exposed for prolonged periods because this may cause bait shyness (bait rejection), and may also increase hazards to protected bird species.

8. *Group Baiting* — For most effective control, consider coordinating control efforts with your neighbors. Because starlings may forage over a large geographic area and may change feeding sites from day to day, several persons baiting at the same time will produce better control. Notify local wildlife officials of your plans so that if large numbers of starlings are removed, the officials will be able to explain the die-off.

9. ***Cautions*** — Starlicide is poisonous to chickens, turkeys, ducks, and some other birds. Never expose bait where poultry, livestock, or nontarget wildlife can feed on it.

Do not re-package pesticides into anything other than their original containers. Read and follow all label directions.

Toxic Perches. Generally, toxic perches are not recommended for starling control because of the considerations mentioned below and because there is limited usefulness of these perches for removing starlings. Toxic perches are perforated metal tubes several feet long that contain a wick saturated with a contact poison that enters the birds' feet as they perch on the tube. Two chemicals, endrin (Rid-A-Bird Control Liquid®) and fenthion (Rid-A-Bird 1100®) are federally registered for use in these perches. Endrin is a Restricted Use Pesticide. Labels of both chemicals indicate that they are restricted to persons trained in bird control work. Both chemicals are rapidly absorbed through the skin and should be used with caution to avoid spillage and exposure to the handler. Both chemicals are highly toxic to birds; however, fenthion has a much lower toxicity to mammals, a safety consideration for handlers. For additional information on the chemicals, see the section **Pesticides**.

One potential use of these perches is for starling control inside some farm buildings where other controls are not feasible. Complications arising from use outside buildings include a generally greater potential for exposure of non-target birds and hazards to hawks that feed on affected birds. All killed birds should be picked up and buried or burned. In addition, studies with dyes at livestock feeding areas have shown that starlings landing on the perches carry the perch liquid on their feet into the feed bunks. This may create a hazard to livestock.

Wetting (Detergent) Agents. Compound PA-14 (Tergitol®) is a wetting agent that can be sprayed from aircraft onto blackbirds or starlings at night while they roost. The detergent solution removes the protective oils on the birds' feathers and they die of exposure. It is registered for use only by or under the supervision of government agencies trained in bird control work and is effective only during cold wet conditions. Temperatures must be between 33 and 45°F and one-half inch (1.3 cm) or more rain is needed during or immediately after the spraying. Some data indicate that starlings are more resistant to this treatment than are blackbirds. In areas where starlings are the birds causing problems, spraying a starling/blackbird roost may kill mostly blackbirds, leaving more resources and better roost sites for the remaining starlings. This could potentially increase starling problems rather than reduce them. In spite of these difficulties, wetting agents may have application in starling control in some situations. However, the problem situation and control alternatives should be carefully considered before deciding to use a wetting agent. For further discussion of PA-14, see the **Blackbirds** chapter.

Fumigants

Fumigation is generally not practical for starling control, and no fumigants are specifically registered for this purpose. However, starlings roosting inside farm buildings have been successfully controlled by closing building exits at night, then fumigating the building with carbon monoxide from the exhaust of an older model engine (without catalytic converter). Such exhaust fumes may affect straw, hay, feeds, or other materials in the building, and their use would require proper precautions to ensure safety from exhaust fumes for the operator and other non-targets. In addition, engine exhaust gases are not registered for starling control.

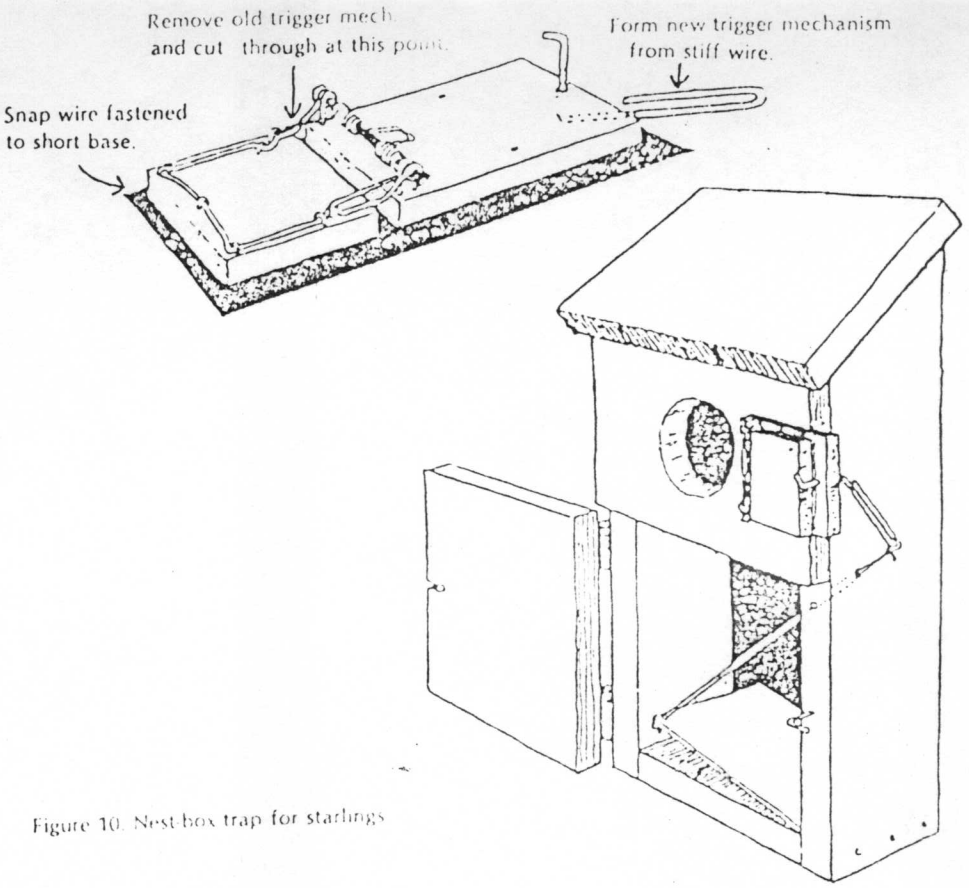


Figure 10. Nest-box trap for starlings

Trapping

Trapping and removing starlings can be a successful method of control at locations where a resident population is causing damage or where other techniques cannot be used. An example is trapping starlings in a fruit orchard. Often, however, the wide ranging movements of starlings and the time necessary to maintain and manage traps make this an impractical control.

Two types of traps, nest-box and decoy traps, are commonly used. Nest-box traps *(Figure 10)* are successful only during the nesting season, whereas decoy traps *(Figure 11)* are most effective during other times when the birds are flocking. Non-target birds captured in traps should be immediately released unharmed.

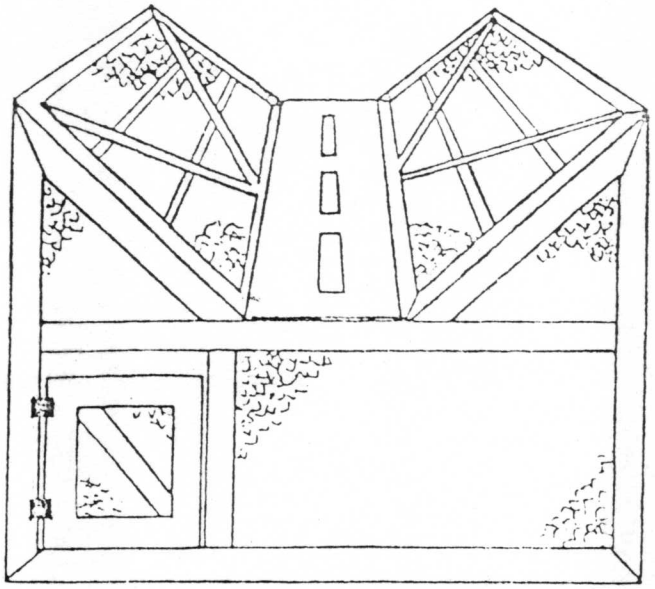
Decoy traps for starlings can be made in nearly any size but should be at least 8 to 10 feet (2.4 to 3 m) square and 5 feet (1.5 m) high. If desired, the sides and top can be constructed in panels to facilitate transportation and storage. In addition, decoy traps can be set up on a farm wagon and thereby moved to the best places to catch starlings. To be successful, the trap should be placed where starlings are likely to congregate. Always leave 10 to 20 starlings in the trap as decoys; their feeding behavior and calls attract other starlings that are nearby. Decoy birds in the trap must be well watered (including a bird bath) and fed. A well-maintained decoy trap can capture 10 to 100 or more starlings per day depending on its size and location, the time of year, and how well the trap is maintained. However, as mentioned above, the time necessary to maintain the trap and the number of starlings that can be captured compared to the total number in the area, often makes this technique less attractive than others for starling control.

Figure 11. Starling decoy trap.

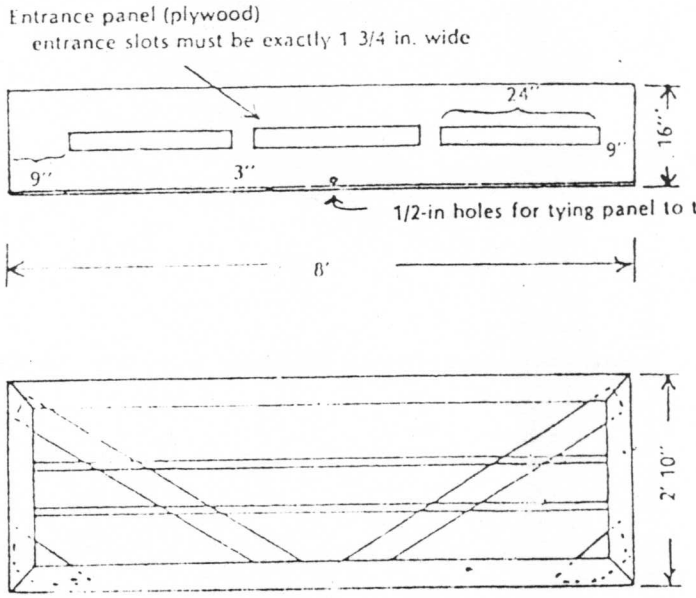
Materials Needed for Trap

15 pieces 1 x 4s 8 feet long
25 pieces 1 x 4s 6 feet long
4 pieces 1 x 1s 8 feet long

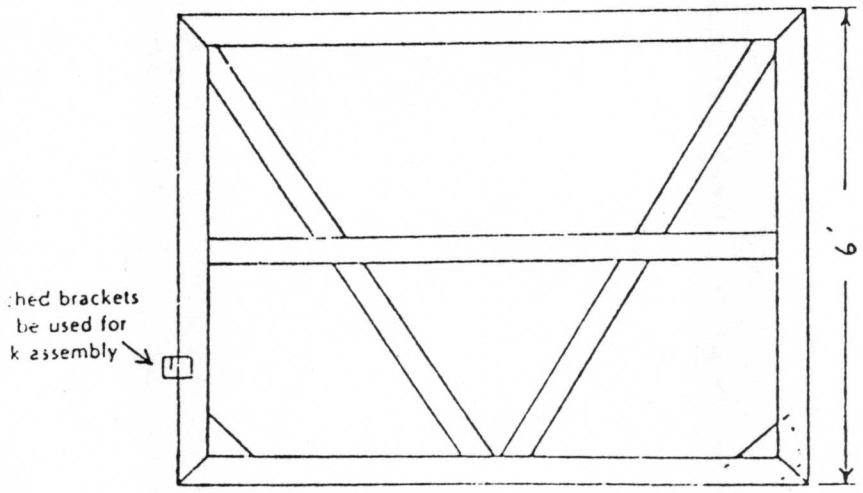
1 piece 1/2 x 16-in exterior plywood, 8 feet long
2 hinges
2 lbs staples
40-ft. length of 6-ft. chicken wire, 1-inch mesh



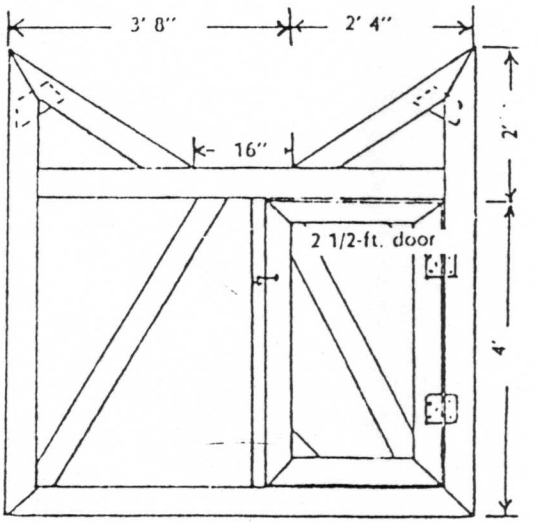
Assembled starling trap



Top panel (make two)



Side panel (make two)



Front panel
Rear panel (omit door)

Shooting

Shooting is more effective as a dispersal technique than as a way to reduce starling numbers. The number of starlings that can be killed by shooting is very small in relation to the numbers of starlings usually involved in pest situations. However, where shooting is used as part of a dispersal program, it can be a helpful technique to supplement and reinforce others. For more detail on dispersal, see the **Bird Dispersal Techniques** chapter.

Other Methods

A possibility that may warrant further investigation is using starlings as a protein source, particularly for livestock or pet food.

Economics of Damage and Control

At livestock facilities, starlings consume livestock feeds, contaminate feed and water with their droppings, and in some situations, may transmit disease. The costs associated with these problems are often difficult to determine but some data are available.

Data reported in 1968 from Colorado feedlots estimate the costs of cattle rations consumed during winter by starlings to be $84 per 1,000 starlings. Current feed costs and the associated losses would certainly be much higher. A 1967 report indicated that one million starlings at a California feedlot resulted in losses of $1,000 per day because of food consumption and contamination, and starling interference with cattle feeding activity. Another report estimated that starlings in Idaho consumed a ton of cattle feed per hour, or 15 to 20 tons (13.5 to 18 mt) per day. A 1978 study in England estimated that the food eaten by starlings in a calf-rearing unit over three winters was 6 to 12 percent of the food presented to the calves. Two other studies in England since then found 4 percent losses and negligible damage, respectively. These examples demonstrate that starling consumption of livestock feeds can at times be a substantial economic consideration.

Producers who wish to estimate feed losses to starlings at their facilities can do so using one of two methods developed for this purpose. The following equation, which is appropriate for problems in the Northern Great Plains because it was developed from data in Colorado, estimates the cost of feed consumed per day:

> Cost of feed ration consumed/day = estimated starlings (to nearest thousand) x fraction of birds using trough x cost of feed ration per pound x 0.0625 pound (0.02813 kg) consumed per starling per day.

A second method recently developed may be applicable to most geographic areas and precludes the need of estimating starling populations. This requires that the operator observe the feed troughs several times during the day and estimate from these samples the number of starlings entering the troughs per day. From this estimate the cost of the feed ration consumed per day can be estimated with the following equation:

> Cost of feed ration consumed per day = estimated starling entries into troughs x 0.0033 pounds (0.001485 kg) consumed per starling entry x cost of feed ration per pound (0.45 kg).

These losses projected over a 3- to 4-month damage season can assist in evaluating the cost-benefits of proposed control measures.

Feed contamination from starling excreta may not be an economic loss for cattle or pig operations. In two years of testing by the U.S. Fish and Wildlife Service, neither pigs nor cattle were adversely affected by long-term exposure to feed heavily contaminated with starling excreta. As compared to controls, no significant differences were observed in weight gain or feed efficiency (ratio of weight gain to weight of feed offered). In addition, there were no observed differences in feed rejection or disease incidence. These results indicate that there is no economic justification for starling control based solely on feed contamination. The effects of livestock water contamination from starling excreta have not been well studied, but this area warrants investigation.

Starling interference with livestock feeding patterns may have economic importance. A study in England reported that calves in pens protected from starlings showed higher growth rates and better feed conversion than those in unprotected pens. This led to an increased profit margin. However, the difference observed might have been caused by starlings consuming the calf food, especially the high protein portion, rather than by actual interference with the calf feeding.

The costs associated with starlings in the spread of disease are difficult to quantify and can only be estimated. However, for TGE, the costs may be substantial. For example, during the severe 1978-1979 winter, a TGE outbreak occurred in southeast Nebraska with over 10,000 pigs lost in one month in Gage County alone. Because this TGE outbreak was concurrent with large flocks of starlings feeding at the same facilities, starlings were implicated in this outbreak. More recent data show that starlings are capable of carrying this disease in their feces. The role of starlings in disease transfer, however, needs further study.

Bird damage to grapes in the United States was estimated to be at least $4.4 million in 1972; starlings were one of the most damaging species. Starlings, as well as many other species of birds, also damage ripening cherry crops. A 1972 study in Michigan found 17.4 percent of the total crop lost to birds. A 1975 study in England estimated damage to be 14 percent (lower branches) to 21 percent (tree canopy) of the crop; similar 1976 data showed less damage. The Great Plains has very little grape or cherry production; however, it appears that bird damage control would be cost-effective for small-scale growers.

On the beneficial side, starlings eat large quantities of insects, especially during the spring breeding season. Many of these insects are considered pests. However this benefit is partially offset by the fact that starlings often take over nest cavities of native insect-eating birds.

Although starlings are frequently associated with damage problems, some of which clearly cause substantial economic losses, the economics of damage in relation to the cost and effectiveness of controls are not well understood. Several factors contribute to this: (1) Starlings are difficult to monitor because they often move long distances daily from roost to feeding areas, and many migrate. (2) Effectiveness of controls, particularly in relation to the total population in an area, is difficult to document. For example, does population reduction in a particular situation reduce the problem or merely allow an influx of starlings from other areas, and how does this vary seasonally or annually? In addition, does lethal control just substitute for natural mortality or is it additive? (3) The economics of interactions with other species are difficult to measure. For example, how much is a bluebird or flicker worth, and what net benefits occur from starlings eating pest insects when their interference with native hole nesting birds is considered? (4) Other factors such as weather and variation among problem situations complicates accurate evaluation of damage and the overall or long-term effectiveness of controls. These points, as well as others mentioned in this chapter, are examples of factors that must be considered in assessing the total economic impact of starlings. Clearly, the goal of minimizing starling/agriculture conflicts needs a better understanding of the interactions among starlings, agricultural systems, and control measures.

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Figure 1 by Emily Oseas Routman, University of Nebraska-Lincoln.

Figure 2 from Bystrak *et al.* (1974), used with permission. Figure copyrighted by the National Audubon Society, Inc. Adapted by Jill Sack Johnson.

Figures 3, 4, and 5 by Jill Sack Johnson.

Figure 6 from Salmon and Gorenzel's chapter Cliff Swallows in this publication.

Figures 7, 8, and 9 from Johnson and Timm (1981), drawn by John Eggers, Cooperative Extension Service, University of Nebraska-Lincoln.

Figure 10 from DeHaven and Guarino (1969), adapted by Jill Sack Johnson.

Figure 11 from U.S. Fish and Wildlife Service (no date), "Trapping Starlings," Bulletin AC 210, Purdue University, West Lafayette, Indiana.

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