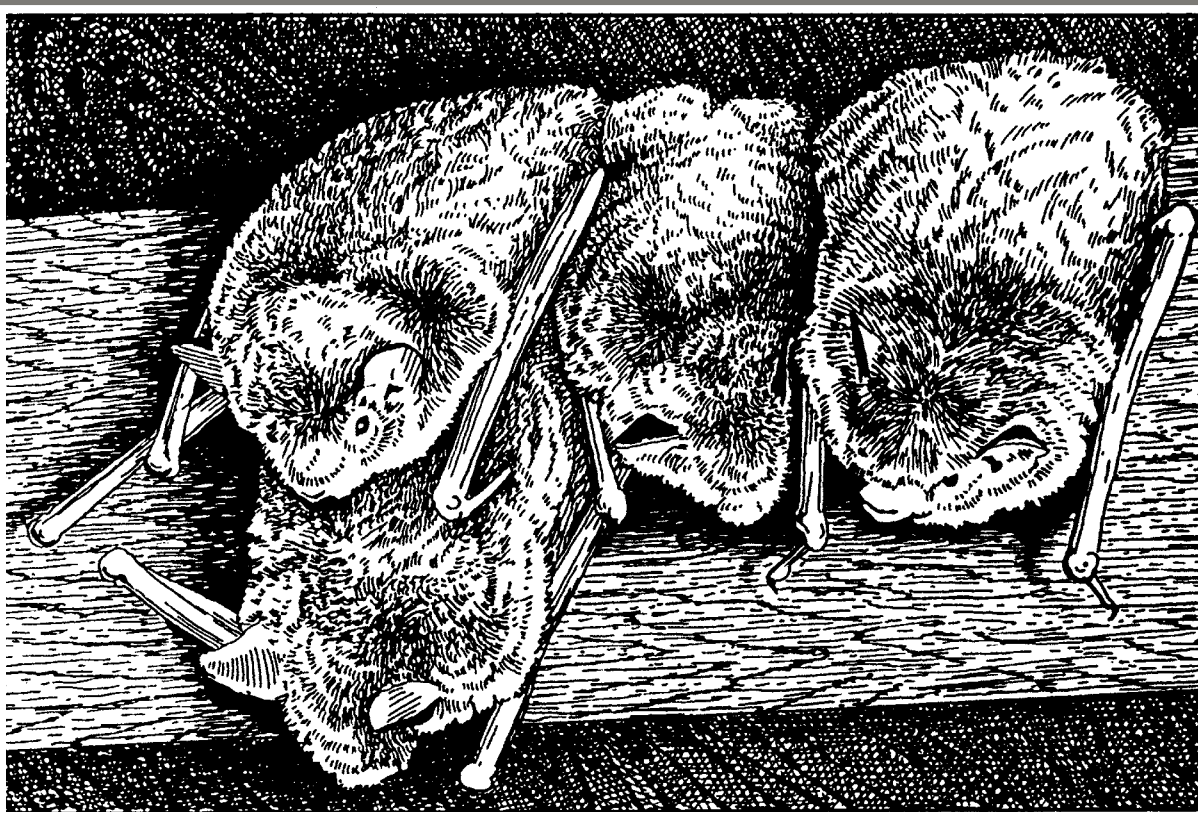
PennState Extension

A Homeowner's Guide To Northeastern Bats And Bat Problems



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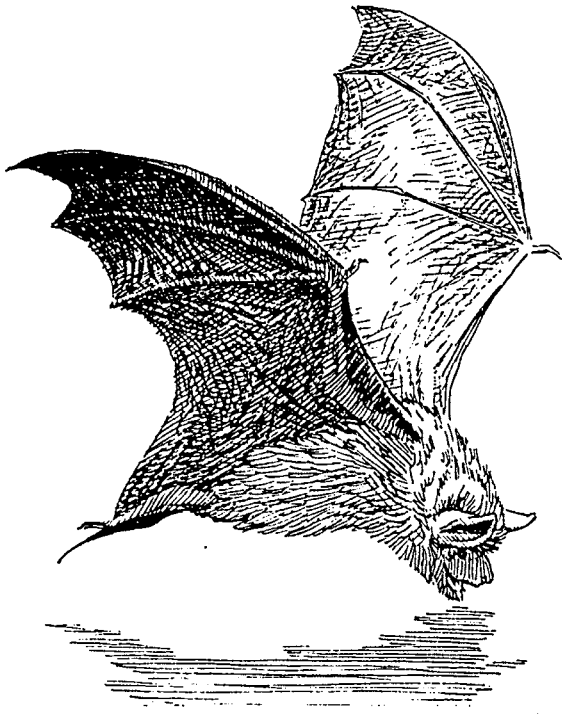


No other mammals in the Northeast are as misunderstood as bats. A variety of myths and misconceptions surround these small, nocturnal, flying mammals. Many people think of bats as vicious animals that carry diseases and get tangled in hair. Others consider them to be friendly, cuddly animals that need only our love and understanding. Both images are somewhat misguided.

This publication will describe the important role that bats play in our environment and will explain what to do if you find yourself sharing living quarters with them. It will also discuss the reality behind the most commonly held misconceptions surrounding these beneficial mammals.

Benefits of Bats

Bats make good neighbors. As the only major predators of night flying insects, bats play an important role in controlling many insect pests. A single bat can consume as many as 500 insects in just one hour, or nearly 3,000 insects every night. A colony of just 100 little brown bats, the most abundant species in the Northeast, may consume more than a quarter of a million mosquitoes and other small insects each night.

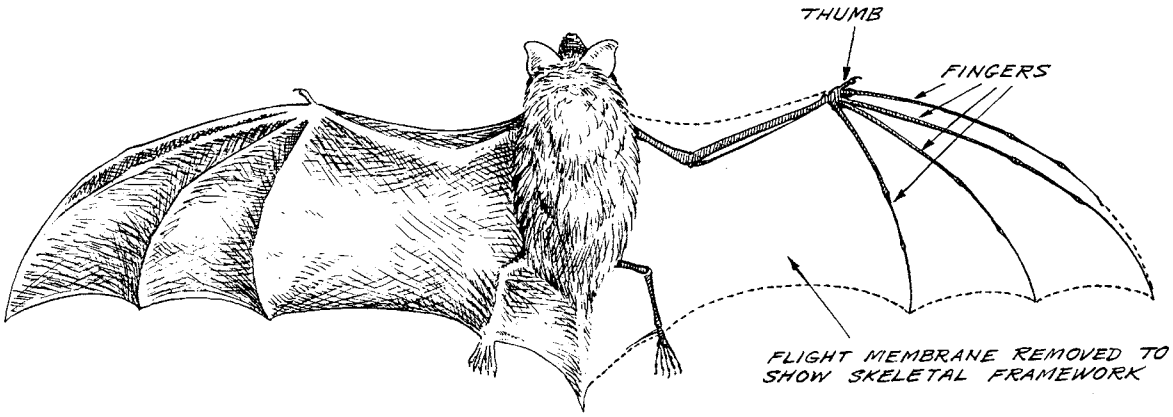
Big brown bats, which live primarily in agricultural areas, feed on June bugs, cucumber beetles, green and brown stinkbugs, and leafhoppers. Research has shown that over the course of a summer, a colony of 150 big brown bats can eat 38,000 cucumber beetles, 16,000 June bugs, 19,000 stinkbugs, and 50,000 leafhoppers and can prevent the hatching of 18 million corn rootworms by devouring the adult beetles.

The red, hoary, and silver-haired bats help to maintain forest health in the region by feeding on forest pests such as tent caterpillar moths. Because of their role in controlling insect numbers throughout the Northeast and elsewhere in the United States, the maintenance of wild bat populations is important for maintaining ecosystem health.

Big brown bats eat many agricultural pests, such as June beetles.

NORTHEASTERN BATS

Common Name	*Summer Roosts*	*Winter Roosts*	*Notes*
Little brown	buildings	caves, mines	most common species
Big brown	buildings	caves, mines	occasionally overwinters in buildings
Eastern pipistrelle	trees	caves, mines	smallest bat in region
Northern long-eared	trees, building exteriors	caves, mines	rarely seen by people
Indiana	hollow trees, beneath tree bark, caves, mines	caves, mines	federally endangered
Small-footed	beneath tree bark, rock piles	caves, mines	species of special concern
Silver-haired	tree crevices	migrates south	forest-dwelling bat
Red	tree foliage	migrates south	forest-dwelling bat
Hoary	tree foliage	migrates south	forest-dwelling bat
Seminole	tree foliage		rarely reported in Pennsylvania
Evening	buildings, hollow trees		rarely reported in Pennsylvania



Life History of Northeastern Bats

Nine species of bats live at least part of the year in the northeastern United States, and two southern species reside infrequently in Pennsylvania. (See box.) Northeastern bats range in size from the hoary bat (length 5.1 to 5.9 inches from nose to tail; wingspan 14.6 to 16.4 inches; weight 0.88 to 1.58 ounces) to the pipistrelle bat (length 2.9 to 3.5 inches; wingspan 8.1 to 10.1 inches; weight 0.14 to 0.25 ounces). Colors range from the drab brown of the little brown bat to the striking frosted red coat of the red bat.

Although some mammals are able to glide, bats are the only mammals that truly fly. That is, they actually flap their wings to propel them in flight. They belong to their own unique order of mammals, called Chiroptera, meaning 'hand wing', which refers to how the finger bones of a bat support its wings. The wings of a bat are actually thin membranes of skin that stretch between the fingers of the front leg and extend to the hind legs and tail. The bat's finger bones are greatly elongated and serve a purpose similar to struts on an airplane wing, providing support and maneuverability during flight. When at rest, a bat folds its wings alongside its body to protect the delicate finger bones and wing membranes.

Bats live in a variety of habitats, including wetlands, fields, forests, cities, suburbs, and agricultural areas. They usually feed in areas where insects swarm, such as over water and agricultural fields, in forest clearings and along forest edges, and around street lights.

All northeastern bats eat insects and take their prey on the wing. Bats use their mouths to scoop small insects out of the air. Larger insects are often disabled with a quick bite and then carried to the ground or to a perch for eating. If an insect takes last-second evasive action, a bat can flick out a wing to nab the insect and draw it into its mouth. This maneuverability makes bats very efficient insect predators: A bat may consume nearly 50 percent of its body weight in insects in a single night!

Although bats can see quite well, they rely on their hearing for night flying. A highly sophisticated adaptation, called echolocation, enables bats to use their large and well developed ears to navigate and catch prey in total darkness. A bat's echolocation system makes use of ultrasonic sound pulses and echoes to locate objects. Bats open their mouths in flight and emit a series of ultrasonic sound pulses. These pulses bounce off nearby objects— such as bushes, fences, branches, and insects—then return as echoes to the bat's ears. Using the information gathered from these echoes, a bat can maneuver to capture an insect or avoid flying into an object.

Bats have one of the lowest reproductive rates for animals their size. Most northeastern bats have just one or two pups per year, and many females do not breed until their second year. This low reproductive rate is partially offset by their long life span. On average, bats live approximately four to six years,

and there are some incredible records of bats living twenty to thirty years in the wild.

Most bats mate in late summer or early fall. However, the male's sperm remains dormant in the female's reproductive system until spring, at which time the female ovulates and fertilization occurs. The pups are born approximately six to eight weeks later, during late May and early June.

Bat Behavior

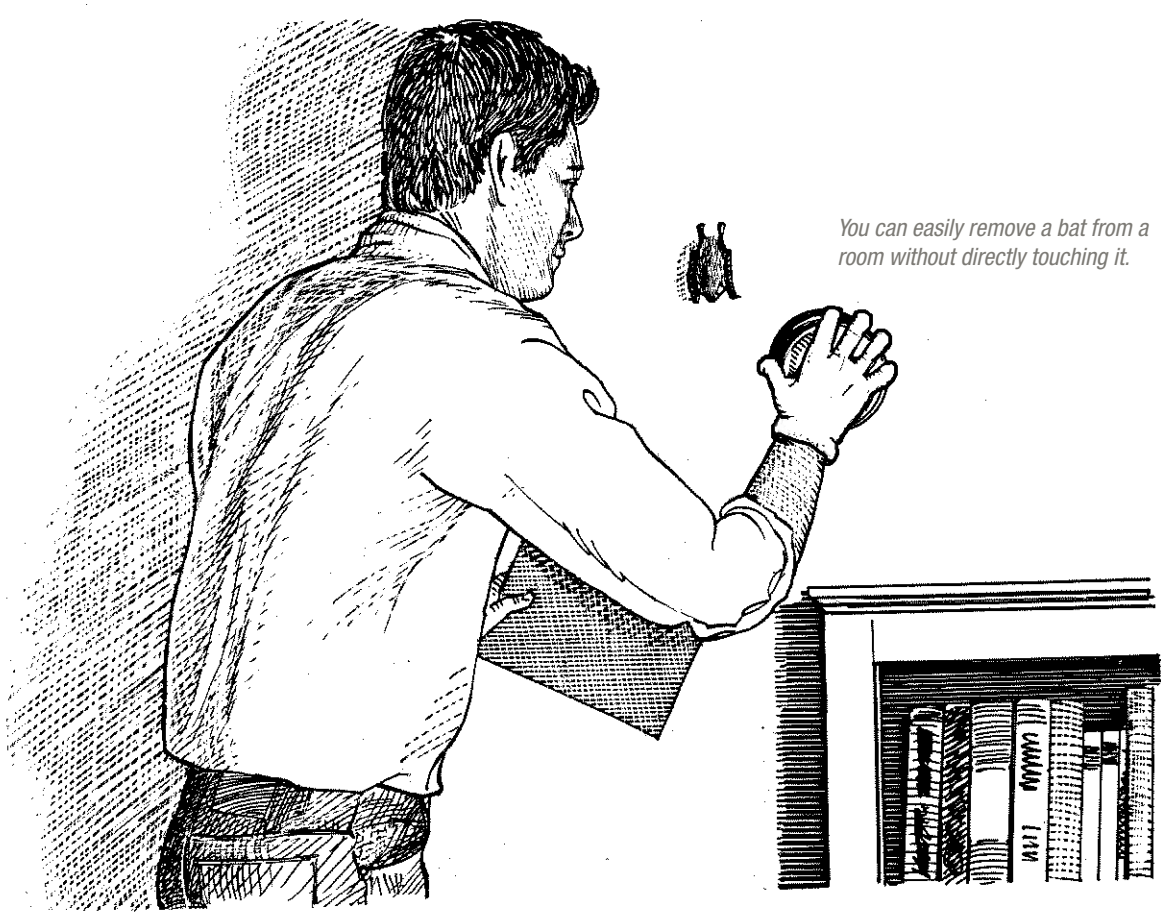
Because few flying insects are active during the winter months, bats that remain in the Northeast year-round gather in caves and abandoned mines to hibernate. Hibernation is a state of prolonged torpor during which bats greatly reduce their normal metabolic activities. Body temperature in hibernating bats falls from a normal level of more than 100° F to that of the surrounding cave temperature, usually 40–50° F. The heart rate slows to only about twenty beats per minute, as compared to 1,000 beats per minute during flight. By allowing their bodily processes to slow this way, hibernating bats can survive on a very small amount of stored fat during the five–to-six month hibernation period, losing from one-fourth to one-half of their prehibernation weight.

Bats arouse from hibernation during March and usually arrive at their summer roosts in April. At this time, pregnant females seek out sheltered roosts in rock crevices, tree cavities, and tree foliage in which to rear their pups. Female red, hoary, and silver-haired bats roost alone during the summer, while females of other species gather into large or small groupings called maternity colonies. Male bats usually roost alone in fairly exposed locations.

Depending upon the species, females give birth to one to three pups in late May and early June. The pups, which are born hairless, blind, and helpless, cling tightly to their mother in the maternity roost. On summer evenings, females leave the pups in the roost and hunt insects nearby, returning often throughout the night to nurse their offspring. As the pups grow older, the females return less frequently during the night. The pups begin to fly and hunt on their own by mid-July, when they are approximately five weeks old. However, the pups will continue to nurse until they can adequately feed themselves.

Maternity colonies begin to disband in late summer and early fall. At this time, males and females of hibernating species begin to swarm together. Large groups of these bats will swarm in and out of cave entrances throughout the night, often roosting in the caves during the day. This swarming behavior brings adults together for mating, and may also teach young bats the location of the hibernation caves. Autumn also prompts the silver-haired, red, and hoary bats to begin their migration to warmer climates.

Bat pups begin to fly and hunt in mid-July.



You can easily remove a bat from a room without directly touching it.

Bats In Homes and Buildings

There are primarily two scenarios in which humans and bats find themselves in conflict: (1) when a lone bat flies into a building, or (2) when a maternity colony of bats roosts in a building. The proper techniques for dealing with these uninvited visitors will be outlined in the following sections.

A Single Bat in the House

Individual bats occasionally enter houses, most often during summer evenings in mid-July and August. These wayward bats are usually pups that are just beginning to fly. Fortunately, these incidents can be dealt with quite easily. A bat flying in the house will usually circle a room several times in search of an exit. The best method for getting a bat out of the house is to allow it to find its own way out. Chasing or swatting at the bat will cause it to panic and fly erratically around the room, which needlessly prolongs the incident.

If you do encounter a bat flying in a room, follow this procedure:

1. Shut all doors leading into other rooms to confine the bat to as small an area as possible.
2. Open all windows and doors leading outside to give the bat a chance to escape. (Don't worry about other bats flying in from the outside.)
3. Remove pets from the room, leave the lights on, stand quietly against a wall or door, and watch the bat until it leaves.
4. Do not try to herd the bat toward a window. Just allow it to calmly get its bearings, and don't worry about it swooping at you. When indoors, a bat makes steep, banking turns, so it flies upwards as it approaches a wall and swoops lower near the center of the room.
5. Within ten to fifteen minutes the bat should settle down, locate the open door or window, and fly out of the room.

If the bat tires and comes to rest on a curtain or wall, you can easily remove it without directly touching it. (See diagram.) Follow the steps below, and remember to never handle a bat, or any other wild animal, with your bare hands.

1. Put on a pair of leather gardening or work gloves.
2. Place a container, such as a large plastic bowl,

over the bat as it rests on the wall. At this point, the bat is probably exhausted and disoriented, and will not fly as you approach it. (If it does take flight, follow the procedure for flying bats.)

3. Slide a piece of rigid cardboard between the container and the wall to trap the bat. Hold the cardboard firmly against the container and carry the container outside.
4. Place the container (facing away from you) on a secure place above the ground—such as on a ledge, or against a tree—and slide away the cardboard. The bat will not fly right away, so releasing it above the ground keeps it safe from predators until it has its bearings. And unlike birds, most bats must drop from a perch and catch air under their wings before they can fly.

If you have recurring problems with bats entering your home, you may want to inspect your attic to determine if you are housing a bat maternity colony.

House Bat Maternity Colonies

Most bats in the Northeast roost in secluded locations away from humans, but two species, the little brown bat and the big brown bat, often attract attention because they repeatedly roost in buildings. These bats once roosted in hollow trees, but adapted to roosting in human structures after early settlers eliminated large expanses of forests. These 'house bats' situate their roosts in hot attics, which act as incubators for the growing pups.

Because they live in such close quarters with humans, unique challenges are involved in the conservation of house bats. House bats have only one or two pups per year, so the protection of their maternity colonies is important to the survival of these beneficial mammals. The destruction of just one maternity colony through chemical extermination or vandalism can have a long-term impact on the populations of both bats and insects in a local area. Unfortunately, homeowners often consider maternity colonies a nuisance and may mistakenly believe that extermination or destruction of the colony is their only solution. There is, however, a safe, humane, and effective procedure for removing a bat colony from a building. This procedure, called bat-proofing, is described in the following sections.

If You Are Housing a Bat Colony

One way to tell if you are sharing your house with a bat colony is to simply go into the attic and look for roosting bats. During the day, bats will likely be roosting in narrow crevices in the attic walls, between the rafters, or tucked into the space between the rafters and roofing material. When you enter the attic, the bats will quickly retreat out of sight (rather than taking flight). If you can't see them, listen for the squeaking or scurrying sounds that will verify their presence.

If you are uncomfortable entering the attic when bats may be present, you can inspect the attic at night for bat droppings. The dry, black droppings are about the size of a grain of rice, and accumulate in piles below areas where the bats roost. (Mouse droppings look similar, but you would find them scattered in small amounts throughout the attic.) If you find bats living in your attic during the day, or if you find large accumulations of bat droppings, then you probably have a maternity colony in your house.

Maternity colonies of little brown and big brown bats roost in attics.

Bats usually enter at points where joined materials have warped or shrunk.

Sometimes, when homeowners understand the important role that bats play in controlling insects, they decide to allow the colony to remain in the attic or eaves. In this case, the homeowner must seal all openings that would give bats access into the living spaces. This safety measure is particularly important for families with small children and pets.

If you have a bat colony in your attic and you want to remove it, you must use the proper methods to do so. Do not use chemical poisons or repellents to eliminate a bat colony. Poisons often scatter dead, dying, or disoriented bats throughout the house and neighborhood, which increases the risk of children or pets coming into contact with sick bats (Constantine 1979). Repellents, such as moth balls or flakes (naphthalene), sulfur candles, or electromagnetic or ultrasonic sound devices do not permanently remove bats from a home. Unless their entrances are sealed, the bats will return as soon as the chemical repellents wear off.

The best way to safely and permanently evict a maternity colony is to seal all of the colony's entrances. This inexpensive procedure, called bat-proofing, is described in the following sections. In addition, the Penn State College of Agricultural Sciences video entitled "Bat-free Belfries: A Guide to Bat-proofing" is available through the Penn State Cooperative Extension office in your county or from: Publication Distribution Center, The Pennsylvania State University, 112 Agricultural Administration Building, University Park, PA 16802-2801.

Bat-Proofing

Bat-proofing a building involves sealing the bats' entrance holes and then providing the maternity colony with an alternate roost, or bat box. Bat-proofing a building is usually a simple procedure that does not require the skills of a professional or any expensive materials. To bat-proof your home: (1) stage a 'bat watch' to identify bat entrances, (2) seal the holes to prevent their entry, (3) provide an alternative roost, or bat box, for the colony to occupy.

Identifying Entrances

The first step in bat-proofing is to locate the holes that bats use to enter and exit the attic. Bats commonly enter at points where joined materials have warped, shrunk, or pulled away from one another. Some common points of access occur at louvered vents with loose screening, at the roof peak, and in areas where flashing has pulled away from the roof or siding. (See diagram.)

To identify which of these areas are providing access, look for tell-tale bat droppings on the side of the house below a suspicious crack or crevice. Also, entrances that have been used for a long time may have a slight brown discoloration at the edges. Inspecting inside the attic can also reveal openings that need to be sealed. Inside, bat droppings often accumulate below bat entrances and exits. During

the day, turn off the attic's lights and look for openings that are allowing outside light, and possibly bats, to pass through.

Staging a 'bat watch' can also help you locate the bats' entrances. At dusk, station a person on each side of the building and watch as the bats exit the building. Once the first bats are seen leaving, focus on that area of the building and watch for other exiting bats until you have pinpointed their exit(s). Dawn is another good time to identify their entrances, because the returning bats will swarm around their entrances a few times before actually entering the building.

Sealing Entrances

Once the bat entrances have been located, the next step in bat-proofing is to seal these openings. Use window screening or hardware cloth to cover louvered vents or large gaps and cracks in the building. To fill in smaller cracks, use expanding foam insulation or caulking compound. After hardening, these can be trimmed or painted as needed. Unlike mice, bats will not gnaw new holes in the building, so sealing the existing holes will keep them out. Most bat-proofing materials can be obtained in local hardware or building supply stores. A listing of suppliers of bat exclusion products is included at the end of this booklet (Appendix 1).

Timing of Bat-proofing

One important aspect to consider before bat-proofing your building is the timing of the procedure. *Because pups remain confined in the roost until they are old enough to fly, bat-proofing should never be completed from late May through mid-July. Otherwise the young, flightless bats would be trapped inside the building.* Bat-proofing during these months would result in potential health risks and obvious odor problems as the young bats die and decay inside the building. Also, the pups may enter human living areas in search of a way out, and females may frantically attempt to reenter the building, even during daylight hours, to rejoin their young.

Occasionally, a homeowner may encounter the difficult situation of bat-proofing while the pups are still confined to the attic. This happens when a roofing or siding contractor discovers bats at the worksite but cannot stop the project. In this case, the contractor should complete the project, but allow one of the bats' access points to remain open, so that nursing females can enter and exit the attic. Then, after the pups are able to fly, a one-way door can be installed to evict the bats. Once all of the bats have left the attic, the remaining bat entrance can be sealed.

The best time for bat-proofing is in the spring, before bats enter the roost, or in the fall, after the bats have left. If bat-proofing must be done while bats are inhabiting the building, it should be done by installing a one-way door after the pups are able to fly. One-way doors, which are discussed below, are designed to allow bats to leave and not reenter a building.

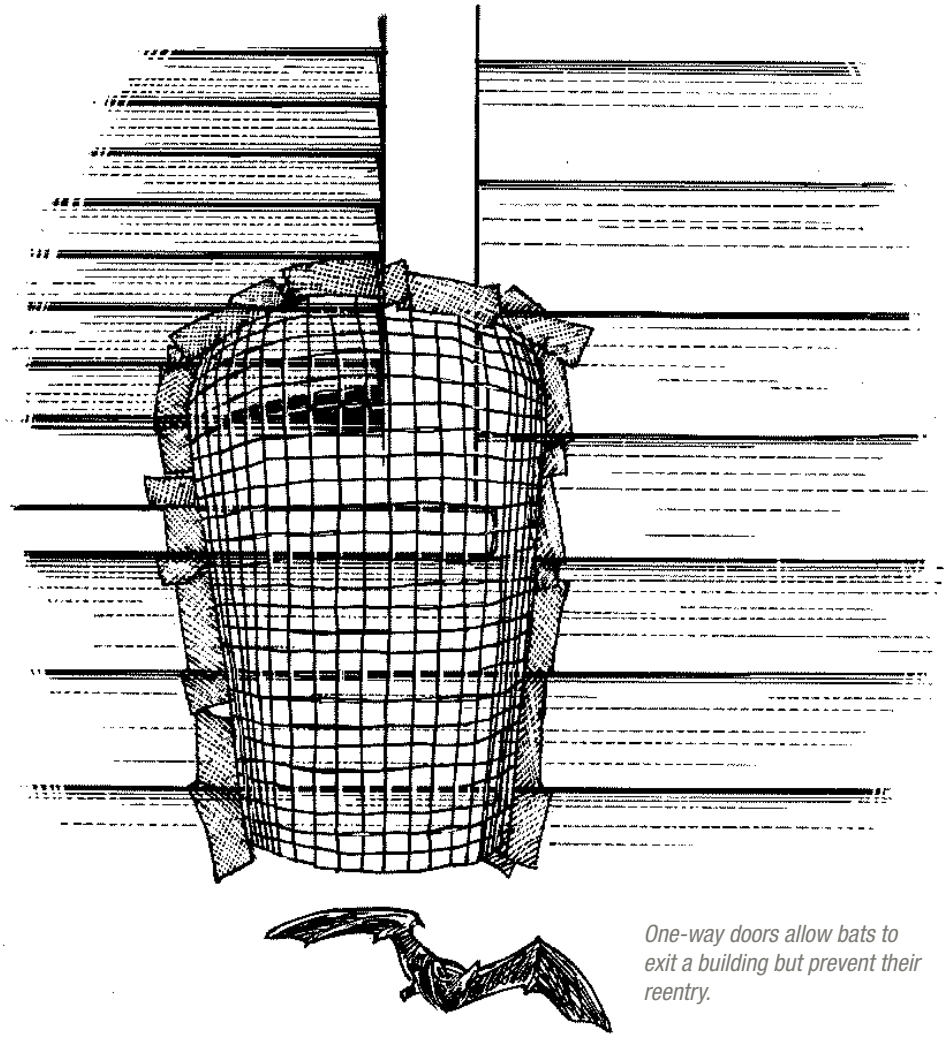
Big brown bats occasionally overwinter in a building by hibernating in the attic or basement. If the homeowner suspects this is the case, bat-proofing should be done by installing a one-way door in the fall, before the bats begin hibernating, or in the spring, before the pups are born.

TIMING OF BAT-PROOFING

Months	*Methods for Bat-proofing*
Jan.–April	Seal entrances before bats return to the building.
May–August	Watch bats to identify entrances. Do not seal openings.
August–Oct.	Install one way door(s).
Nov.–Dec.	Seal entrances once bats have left the building. (If you suspect bats are hibernating in the building, install a one-way door in Sept.–Oct.)

One-way Doors

One-way doors are pieces of mesh or screening placed over a bat entrance to form a long sleeve or tent. (See diagram.) These doors allow bats to exit at night but prevent their reentry at dawn. One-way doors work because bats use their sense of smell, rather than their vision, to locate their entrances. The bats will exit at the bottom, but when they return, they will land on the mesh near their entrance hole. They will smell their entrance through the mesh, and will crawl around in the vicinity of the entrance, trying to find a way inside. The smell of the entrance focuses their attention on that portion of the mesh, and the bats will not move to the opening at the bottom of the door to gain entrance. An easy-to-install one-way door, designed by Dr. Stephen Frantz of the New York Department of Health (Frantz 1986), is described in the following section.



One-way doors allow bats to exit a building but prevent their reentry.

Installing One-way Doors

1. Choose 1/4 to 1/2 inch wire screening or heavy plastic mesh to cover the bats' points of entry. Cut the screening so that it covers the width of the hole and extends approximately three feet below the hole. The screening should project three-to-five inches clear of the hole, so that the bats can crawl between the screen and the building and exit at the bottom.
2. Secure the mesh at the top and sides with duct tape or staples and leave the bottom open.
3. Leave the door in place for at least three to four days, or until you are sure that all bats have left the building, then remove the one-way door and permanently seal the opening.
4. Again, never use a one-way door during May through August, or young bats will be trapped inside and die.

Providing an Alternative Roost

Bat-proofing has two potential drawbacks. One is that exclusion can be very stressful for a maternity colony. When prevented from using their traditional roost, the bats may move into a nearby building, where they may be expelled again, or even exterminated. Also, research has shown that displaced colonies will not relocate into buildings that already house other maternity colonies (Neilson 1991). In other words, an excluded colony cannot just move down the road into a barn or church that already has bats. If a displaced colony cannot find a new roost, it may leave the area. In fact, researchers have found that expelling bat colonies can contribute to serious declines in local bat populations (Humphrey and Cope 1976, Neilson 1991).

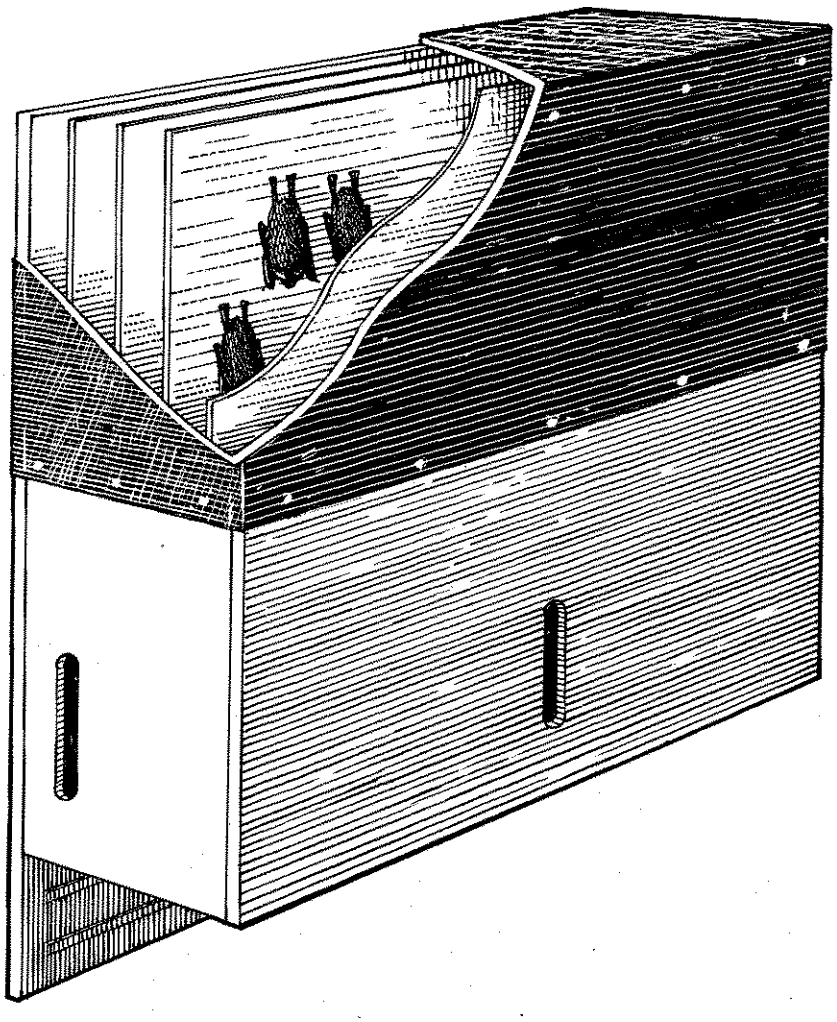
The second drawback is that homeowners may find it difficult to completely bat-proof their home. Bats can crawl through a crack as small as 1/2 by 1 1/4 inches, so persistent bats may find a way to reenter their traditional roost.

Bat boxes may solve both of these problems because they provide alternative roosting sites for maternity colonies. When constructed properly, bat boxes can serve as suitable places for females to raise their pups. With bat boxes, the bats get a safe roosting site outside the home, while homeowners still benefit from the bats' control of insects.

Bat Box Design

Size, interior construction, and temperature control are the three most important design elements of bat boxes. Homeowners should consider building their own bat box, because commercial bat boxes do not provide the living space or roosting temperatures that maternity colonies require.

A bat box must be large enough to adequately house a maternity colony. Boxes should be at least 7 inches deep, 24 inches wide, and either 12 or 24 inches tall (depending on the size of the colony). Boxes 12 inches in height will house up to 100 bats, and boxes 24 inches in height will house as many



The interior of a bat box is divided into several roosting crevices.

as 200 bats. (Appendix 2.) To house even larger colonies, you can join two boxes side-by-side, or you can install one large box that measures 14 to 21 inches from front to back.

The interior construction of a bat box is important because maternity colonies have particular requirements for their roosting chambers. Baffles should be used to divide the interior space into multiple roosting crevices. (See diagram.) The crevices should measure from 3/4 inches up to 1 1/2 inches in depth, with the majority in the 3/4 inch to 1 inch range. In addition, all of the baffles, interior surfaces, and the landing board below the box should be roughened with saw cuts to provide footholds for bats.

Finally, the boxes must provide high incubation temperatures for the pregnant females and growing pups. Staining the bat boxes dark brown or black enhances a box's ability to absorb sunlight. The boxes must also have cooler areas for the bats to move into, in case temperatures rise too high. Tacking black roofing paper to the upper portions of the box and cutting ventilation slits into the lower sides and front will help to control interior temperature ranges.

Bat Box Placement

Because of the importance of high temperatures in the maternity roost, the amount of sunlight a bat box receives may be the most important factor to consider. In a study recently completed at Penn State, all bat boxes that received seven or more hours of direct sunlight were successful in housing maternity colonies displaced by bat-proofing, while boxes that received fewer hours of direct sunlight were unsuccessful in housing colonies.

Bat boxes in Pennsylvania should face southeast or southwest, so that they receive at least seven hours of direct sunlight during the spring and summer. (In areas north of Pennsylvania, bat boxes would likely need to receive more than the minimum seven hours of sunlight.)

A bat box intended to house a displaced maternity colony should be placed on or very near the building in which the bats roosted. Place the box on an outside wall or chimney, or on a pole within 10 to 20 feet of the building. If placed on the building, the box should have at least 3 feet of open space under it, so that bats can enter and exit from the bottom. Do not place a bat box in an area that is heavily trafficked by people, or anywhere that droppings from the box will pose a problem. Bat boxes also can be placed on trees—as long as the boxes will receive the required seven hours of sunlight. Whether on a building, pole, or tree, bat boxes should always be placed at least 10 to 15 feet above the ground.

Once the bats move into the box and establish it as their roost, the box can gradually be moved farther away from the building. This should be done in the fall or winter when bats are not present. Moving the box more than 20 yards per year is not recommended.

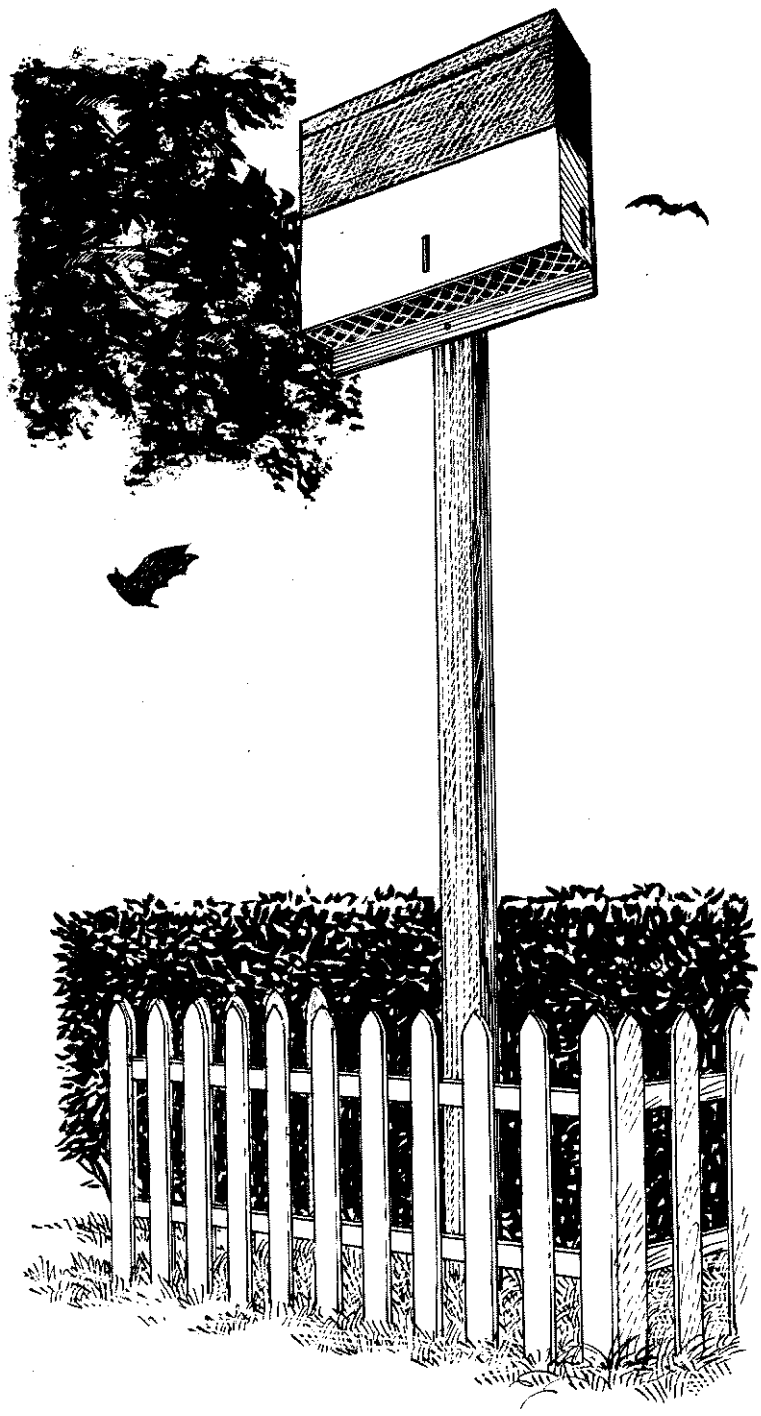
Timing of Installation

Ideally, bats should be allowed to familiarize themselves with the bat box before being expelled from their traditional roost. This can be done by installing the box in the winter or spring, then allowing the bats to remain in the attic over the summer, during which time they will investigate the box. Bat-proofing should then be completed in the fall after the bats have left the building. The following spring, when the bats return, they will not be able to get into the building, but they will be familiar with the bat box and ready to inhabit it. This timing of events makes the task of bat-proofing easier for the homeowner, because the bats should be less persistent in trying to reenter the house.

If you cannot allow the bats to remain in the building for an additional summer, then install the bat box and bat-proof the house before the bats arrive in April. The bats may not move into the unfamiliar box right away, but this option is still preferable to expelling a colony without providing an alternative roost.

Colonies identify their roosts, in part, by their smell, so it may help to scent the box with the colony's droppings before installation. Gather a cup of droppings from the attic, mix them with water to make a slurry, and pour this mixture into the bat box. Allow the slurry to soak into the bat box before installing it. If scenting the box is not feasible, new boxes should at least be stored outside prior to installation, so the scent of new materials weathers out of them.

Fencing or planting an ornamental ground cover below a bat box will prevent people from walking underneath it.



Care of Your Bat Box

Once bats move in, homeowners should never disturb a bat box during the day and should always watch the bats' evening departure from a distance. Fencing off the area under the bat box will prevent people and pets from walking underneath it, and also helps to minimize any disturbance to the bats. (See diagram.) If fencing is not practical, planting ornamental ground cover beneath the box can serve the same purpose. (This option also takes advantage of the fertilizing quality of bat droppings.)

Bat boxes require no maintenance when bats are present in the spring and summer. However, any active wasp nests can be removed with a long stick during cool mornings or evenings when wasps are less active. (Do not disturb the box if bats are present.) In the fall and winter (after the bats have left the area), homeowners can inspect the box and make any necessary repairs to it. Also, old wasp nests should be removed at this time.

Occasionally, a bat pup may fall from the box. A fallen pup will die unless it is retrieved by its mother or it crawls back into the box. If a grounded bat or bat pup must be handled, homeowners should wear thick work gloves. Also, children should be taught never to approach a grounded bat or bat pup.

Bat-proofing Summary

The simplest procedure for expelling a maternity colony begins in the spring with the installation of a bat box. After that, the bats' entrances into the building can be identified during the summer and sealed when the colony leaves in the fall.

With a little patience and effort, you can exclude bats from your building permanently and successfully. With a bat box, you can take advantage of the bats' ability to control insects, while making a valuable contribution to the protection and management of these beneficial mammals.

BAT-PROOFING SUMMARY

Months	*Bat-proofing Schedule*
Jan.–April	Install a bat box near the building in a location where it can receive seven hours of sunlight.
May–August	Allow bats to remain in the building and watch them exit at dusk to identify openings.
Sept.–April	Seal openings.

Attracting Bats With Bat Boxes

Once people learn of the beneficial role that bats play in controlling insects, they often want to attract bats to their yards and gardens. It is difficult to predict whether a bat box will attract bats to hunt and feed in a desired area. Bat boxes provide shelter, but an ample supply of food and water is also needed to attract bats. Even in a location that has bats living nearby, a new bat box may remain vacant because the bats have other roosts in the area. Conversely, in areas where roosts are scarce, bats may move into a new bat box right away.

When trying to attract a maternity colony to an area, it is important to remember that these colonies are very loyal to their traditional roosts and will not readily seek out new roosts. This means that a bat box may sit unoccupied for years, even in areas that have several maternity colonies. However, an unoccupied box can always serve as an emergency shelter for a colony displaced from a nearby building. Also, a male bat may move into a bat box even when a maternity colony will not, and even one bat can consume nearly 3,000 insects per night.

A recent survey of bat box owners, conducted by Bat Conservation International, showed that the overall occupancy rate of bat boxes was approximately 52 percent. Success rates were somewhat lower for smaller boxes (32 percent), and somewhat higher for larger boxes (71 percent). The key to attracting bats to your property is to be patient at first and to experiment if your initial attempts are unsuccessful.

It is not known yet whether forest-dwelling bats will use bat boxes.

Bats and Public Health

Rabies

Rabies is the most important public health hazard associated with bats, but its impact has often been exaggerated. All mammals are vulnerable to this potentially fatal disease, which is caused by a virus that attacks the central nervous system.

Animals with rabies will go through either a 'furious' stage, in which they attack anything in their path, or a 'dumb' stage, in which they become progressively paralyzed before death. Bats can experience either of these stages, although the majority of infected bats display behavior associated with the dumb stage of rabies (Constantine 1979). Once the symptoms of rabies appear, bats usually become immobilized within two days and die within four days (Fenton 1992).

The incidence of rabies in the wild bat population is low, and the spread of rabies within individual colonies appears to be very rare (Constantine 1979). Scientific surveys of wild bats in the United States and Canada indicate that the incidence of rabies in clinically normal bats is less than 0.5 percent (Fenton 1992). However, of the sick, dead, or suspect bats submitted to health departments for testing, approximately 2–5 percent test positive for rabies. Thus it is import to take precautions when handling grounded bats. Most human exposure to infected bats results from careless handling of grounded bats.

Almost everyone recognizes the need to seek immediate medical attention after an unprovoked attack by a bat (or any other animal). However, a bat lying helplessly on the ground will often arouse humanitarian instincts. The person trying to help the grounded bat may get bitten and ignore the bite, because it occurred in self-defense. Regardless of the circumstances, anyone bitten by a wild animal should immediately wash the wound with soap and water and seek medical attention. (See Rabies Precautions.)

Of course, not all grounded bats are rabid. For example, young pups often become grounded when learning to fly. However, bats that can be caught, particularly grounded bats or bats found in unusual places, are more likely to be sick than others. Always handle all bats with leather work gloves, and warn children never to approach or pick up grounded bats. Also, cats and dogs, which come into contact with bats and other wild animals far

RABIES PRECAUTIONS

1. Bats of all sizes will bite in self-defense, but they almost never attack people.
2. If you must handle a bat, take precautions to minimize the chance of being bitten. By wearing leather gloves and scooping a grounded bat into a coffee can or some other container, you make it virtually impossible for a bat to bite you.
3. If you are bitten by a bat, immediately wash the bite with soap and water and see a physician. If the bat is captured, it should be killed (without destroying the head) and submitted for testing. If there is any possibility that you have been infected, the physician will recommend rabies shots. Today, most people receive the rabies vaccine in a series of five relatively painless shots in the arm administered during a one month period.
4. People usually know when they are bitten by a bat. However, because bats have very small teeth, the bite is rarely obvious. Consequently, if a bat is found in the same room with a young child or mentally incapacitated person or even a very heavy sleeper, and the possibility of a bite cannot be eliminated, rabies treatment should be given.

more often than their owners, should be immunized regularly for rabies.

There is little evidence to support the notion that bats with rabies contribute to outbreaks of the disease in other wild animals (Tuttle and Kern 1981). The World Health Organization's Expert Committee on Rabies found no evidence of natural bite transmission from insect-eating bats to carnivores (Tuttle and Kern 1981). Laboratory experiments showed that animals could be infected with rabies if they ate large amounts of infected tissue (Fenton 1992). Although the significance of this finding to animals in the wild is unknown, it again highlights the need to immunize dogs and cats.

Humans and other mammals have contracted rabies through airborne transmission, but this happened in a large southwestern cave harboring about 13 million bats. The cave's unique conditions of high temperature and humidity, and air saturated with the bats' saliva and urine, probably contributed to the airborne transmission of the virus (Fenton 1992). Most bat roosts do not have the right conditions for transmitting rabies through the air, and there are no records of airborne transmissions from maternity colonies living in buildings (Fenton 1992).

Histoplasmosis

Histoplasmosis is an airborne disease caused by a microscopic fungus that occurs in soil and in the nitrogen-rich droppings of birds and bats (Tuttle and Kern 1981, Greenhall 1982, Fenton 1992). A dry cough and other flu-like symptoms are the usual signs of histoplasmosis, which is often mistaken for influenza. While histoplasmosis often does not produce any symptoms, severe symptoms such as high fever, problems with vision, and life-threatening complications occasionally do occur (Greenhall 1982, Fenton 1992).

The fungus that causes the disease occurs naturally in soils throughout warmer regions of the world, including parts of North America (Fenton 1992). The fungus also is associated with bat droppings, called guano, which accumulates in caves where bats live in summer months. Hibernating bats do not produce guano, and therefore do not deposit the fungus in caves where they hibernate (Fenton 1992). In the eastern United States, surveys in buildings that had accumulations of guano from several colonies of big brown and little brown bats produced no evidence of the fungus causing histoplasmosis (Fenton 1992).

Homeowners should still take safety precautions against inhaling any particles that may contain the fungus, particularly if large amounts of bat droppings are to be disturbed in an attic. To limit the amount of airborne particles, the droppings should be vacuumed, rather than swept or shoveled. Homeowners also should use a properly fitted respirator capable of filtering particles as small as two microns in diameter to further minimize the risk of exposure (Tuttle and Kern 1981).

Bat Parasites

Like other animals, bats are hosts to a number of internal and external parasites. Most of these parasites are specialized and cannot survive away from the bats, so they pose little threat to humans and other animals (Fenton 1992). A species of bedbug, which resembles the species that feeds on humans, lives on the bats and in their roosts. However, reports of these bedbugs biting humans or domestic animals are rare. Once a bat colony is evicted from a building, any parasites that remain behind may move around the attic (and possibly the house) in search of bats. Fortunately, these parasites usually die quickly when separated from the bats.

A homeowner can sprinkle diatomaceous earth in the roost area to eliminate any parasites that may remain after the bats are evicted. (Appendix 1.) This organic powder, which is made from the fossils of single-celled organisms, is abrasive to the exoskeletons of insects. As an insect crawls over the powder, its protective cuticle is scratched, and the insect dies of dehydration. Diatomaceous earth is effective in killing a variety of other insects in addition to bat parasites.

Bats In Caves

People occasionally come into close contact with bats in caves, particularly during winter, when bats are hibernating. As stated earlier, the risk of exposure to histoplasmosis and airborne transmission of rabies in northeastern hibernation caves is negligible. In fact, bats experience the greater risk when people enter their caves in winter.

Recreational cave exploring, or spelunking, can threaten the survival of bat colonies. During hibernation, bats survive without eating by slowly metabolizing stored fat. To conserve their fat resources, bats drastically lower their metabolic rate and enter a state of deep sleep. When people enter a cave, their lights, voices, and body heat disturb the bats' sleep, often to the point where they awake completely and take flight. It is estimated that a bat can burn ten to thirty days worth of stored fat reserves during each of these awakenings. If this happens too many times over the course of a winter, the bats may starve to death before spring or leave the cave in such a weakened condition that they cannot successfully reproduce.

Recreational cavers can prevent disturbing bats by avoiding trips to recreational and commercial caves during the hibernation season (December through March). When cavers do encounter hibernating bats, they should leave the cave quickly and quietly, taking care not to shine their lights on the sleeping bats. Fortunately, most spelunkers are very considerate of bats and have found ways to minimize their impact on bats and cave environments.

Responsible caving is an important aspect of bat conservation. Some caves in the Northeast have had gates installed to limit human access. This is usually done to protect vulnerable bat populations or caves that have been heavily vandalized. These gates should be respected to give the caves and bat populations time to recover.

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Most northeastern bats hibernate in caves and mines during the winter months.

Appendix 1
Bat-Proofing Materials And Suppliers

Materials for Sealing Holes:

Expanding Foam Insulation/Caulking Compound
Available from most building supply stores. Expanding foam insulation is available as an aerosol and can be sprayed into cracks and crevices. The foam expands to fill the opening and then hardens, after which it can be trimmed or painted.

"Flashband"
"Flashband" is a self-adhesive, aluminum-faced sealant that permanently adheres to almost any surface. It can be useful for sealing roof junctions, loose flashing, eaves, and gaps between chimneys and walls. It is easily applied, requires no special tools, and resists water, rust, mold, and mildew.

Andek Corporation
850 Glen Avenue
P.O. Box 392
Moorestown, NJ 08057-0392
856-786-6900
888-462-6335
www.andek.com

Copper Mesh
Copper cleaning mesh is a rolled, flattened strip of knitted copper mesh that can be cut to any length. (It is similar to flattened steel wool.) It will not rust and is excellent for stuffing into cracks and crevices in buildings.

Koch-Otto York
6611 Killough Rd.
Houston, TX 77086
800-736-7036
koch-glitsch.com

"Stuff-It"
"Stuff-It" is a copper gauze product which is useful for plugging holes that are too big to caulk and too small to warrant carpentry repair (such as openings around eaves). It will not rust, stain, or break down.

Allen Special Products, Inc.
P.O. Box 605
Montgomeryville, PA 18936
800-848-6805

Chimney Caps

Chim-a-lator Co.
5205 208th St.
Farmington, MN 55024
800-729-9505
www.dalsinmfg.com

Vestal Manufacturing
P.O. Box 420
Sweetwater, TN 37874
423-337-6125
800-456-9562
www.vestalmfg.com

One-Way Doors:

Metal Hardware Cloth/Window Screening/Plastic Structural Grade Bird-Netting
Available from most garden supply stores. Any material used for one-way doors should have a mesh no larger than 1/4" to 1/2" in diameter. (Mesh diameter is measured on the diagonal, from corner to corner.) Mesh with larger size openings will allow bats to crawl through and reenter the building.

InterNet, Inc.
1201 Lund Blvd.
Anoka, MN 55303-1092
800-328-8456
www.industrialnetting.com
(netting and fastener clips)

"Bat Net"
The "Bat Net" kit contains a 14 x 20 foot piece of structural grade bird netting with Velcro fasteners for attachment to buildings. They also sell rolls of netting for making one-way doors of any size.

Wildlife Control Technology, Inc.
2501 N. Sunnyside Ave.
Fresno, CA 93727
800-235-0262
www.wildlife-control.com

"Bat Check Valve"
The "Bat Check Valve" kit includes a 100 square foot (7 x 14 foot) section of structural grade bird netting, including mounting clips and installation instructions. The company also sells rolls of netting for making one-way doors of any size.

Wildlife Management Supplies
9435 E. Cherry Bend
Traverse City, MI 49684
800-451-6544
www.wildlifems.com

Diatomaceous Earth:

Diatomaceous earth scratches the cuticle of insects as they crawl through it. It is useful in eliminating bat parasites from an attic after the bats have been evicted.

"Shell Shock"
Biocontrol Network
615-370-4301
www.biconet.com

Appendix 2
Bat Box Construction Plans

Tools:

circular saw

jigsaw

screwdriver

hammer

Materials:

3/4" board or exterior grade plywood for front and back

3/4" board or 1/2" to 3/4" exterior grade plywood for roof

1/4" lightweight plywood for interior baffles

1"x8" board for sides (actual width after planing– 7 3/4")

10 – 1"x1"x10" wood strips for spacing interior baffles

latex siliconized caulk

dark brown latex paint or stain

black roofing paper

exterior grade wood screws

galvanized finishing nails

Small Bat Box (12"x12"x8") Assembly

Capacity: 50 Bats

This bat box should be useful when trying to attract bats to an area. It may be accepted by male bats or non-reproductive females. It is not large enough for most bat colonies.

Pieces: (height x width)

front– 12"x12" exterior plywood or board

back/landing board– 18"x12" exterior plywood or board

sides– 12"x 7 3/4" board

baffles– 1/4" lightweight plywood

3– 10"x10 1/2" (if using spacer strips)

2– 11"x10 1/2"

3– 10"x11" (if router)

2– 11"x11"

spacer strips– 10 - 1"x1"x10" board strips

1. Cut out pieces.
2. Use a knife, saw, or router to roughen all interior surfaces with horizontal scratches or grooves 1/4" to1/2" apart. Pay special attention to landing board at bottom of box. (The portion of the back that extends below the box will serve as the landing board.)

   Note for router users: At this point, use a router to cut 1/4" vertical grooves in side pieces at 1 inch intervals, then skip the following instructions on installing spacer strips and baffles. Simply fit the baffles into the side piece grooves, then attach front, back, and roof.

If not using a router:

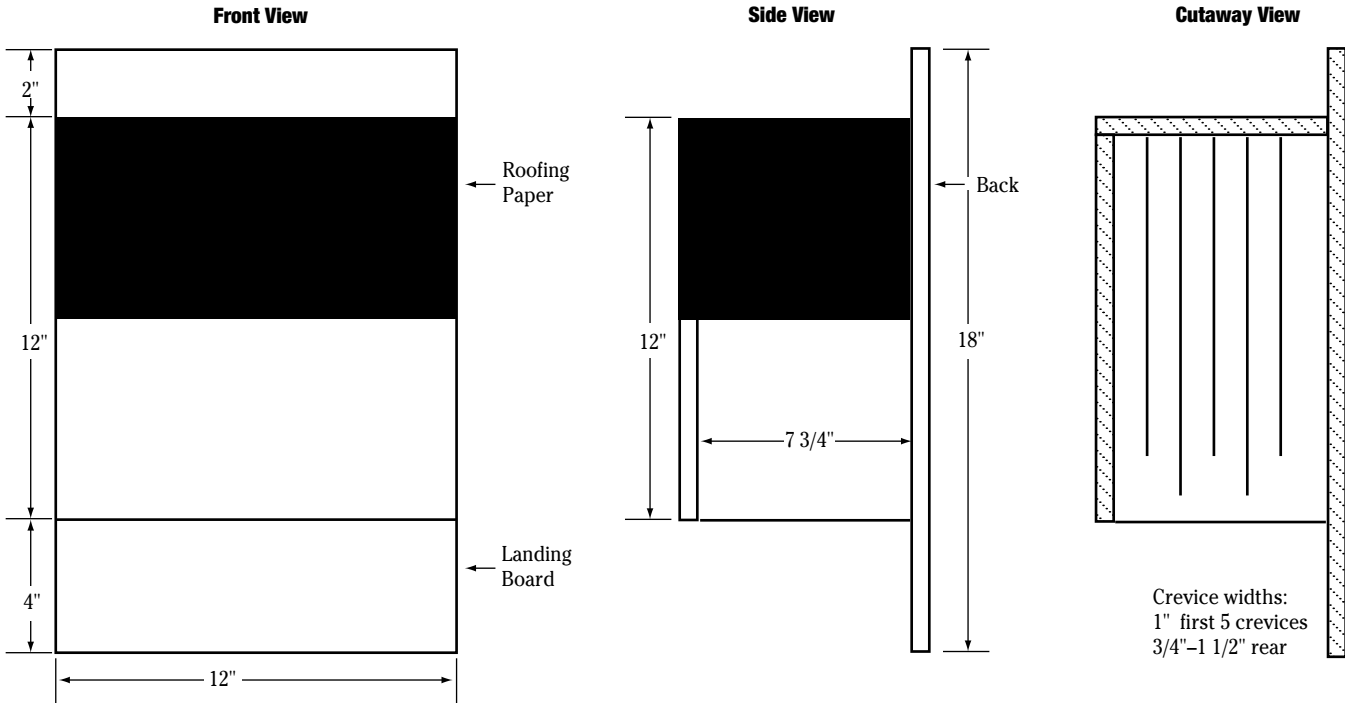
3. Attach sides to front using wood screws. (Caulk the seams, but do not use wood glue on any part of the bat box.)
4. Attach roof to sides and front using wood screws (caulk the seams). Roof can be slightly slanted to promote water runoff.

Installing spacer strips and baffles:

5. Position the box so that the front rests on a table top, and the sides and roof extend upwards.
6. Attach two 1"x1"x10" interior spacer strips to inside of front piece using finishing nails or wood screws. Make sure the strips fit tightly against the side pieces.
7. Attach first 1/4"x10"x10 1/2" baffle to the spacer strips using finishing nails.
8. Attach two 1"x1"x10" interior spacer strips onto the first baffle using finishing nails or wood screws. Make sure the strips fit tightly against the sides of box.
9. Attach 1/4"x11"x10 1/2" baffle to the spacer strips using finishing nails.

10–15. Continue attaching interior spacer strips and baffles as previously directed. This box should have a total of five baffles.

Small Bat Box (12"x12"x8")



16. Attach the back of box to the roof and sides (caulk the seams). The back piece should extend below the body of the box. (The portion that extends below the box will serve as the landing board.)
17. Paint or stain the exterior using a latex-based stain. (Do not stain the interior.)
18. Attach roofing paper to roof. Caulk the seam at the back where the roof attaches to the back panel.
19. Tack roofing paper onto the front and sides, extending it approximately six inches down from the top. This will help create differences in temperatures from the top of the box to the bottom. (This step is very important.)

Installation:

Orient the box towards the southeast or southwest. To attract a maternity colony, a box should be placed in a location that receives at least seven hours of sunlight. Box can be placed in a cooler location to attract males or non-reproductive females.

Install the box at least ten feet high onto the side of a building or pole. Boxes can be placed on trees, but they must receive adequate sunlight.

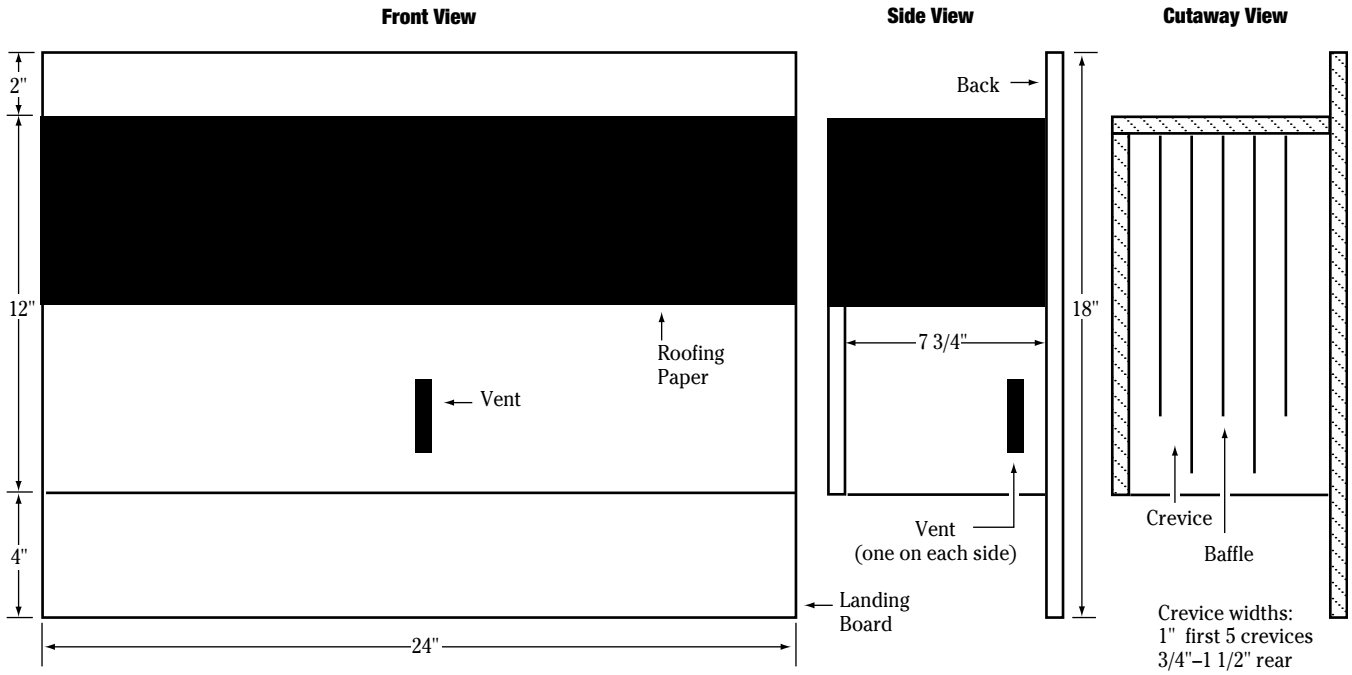
Do not install a box over a window sill, deck, porch, or any other area where droppings that fall from the box will be a nuisance.

Maintenance:

Bat boxes require no maintenance when bats are present in the spring and summer. Inspect the box every winter to identify areas in need of repair.

Wasps: Use a long thin stick to remove old wasp nests in the fall or winter. New nests can be knocked out in May or early June during cool mornings or evenings when wasps are less active. *Do not disturb the box if bats are present.*

Small Maternity Colony Bat Box (12"x24"x8")



Small Maternity Colony Bat Box (12"x24"x8") Assembly

Capacity: 150 Bats

This bat box is suitable for small to medium-sized summer maternity colonies (up to 150 bats). This box should be installed in the spring before the colony is evicted from the building.

Tools/Materials:

See Small Bat Box Instructions

Pieces: (height x width)

front– 12"x24" exterior plywood or board

back/landing board - 18"x24" exterior plywood or board

sides– 12"x~7 3/4" board

baffles– 1/4" lightweight plywood

3– 10"x22 1/2" (if using spacer strips)

2– 11"x22 1/2"

3– 10"x23" (if router)

2– 11"x23

spacer strips: 10 - 1"x1"x10" board strips

1. Cut out pieces. Cut vents (3"x 1/2") into front and sides using jigsaw.

2–4. Follow steps 2 through 4 in the Small Bat Box Assembly instructions.

Installing spacer strips and baffles:

5. Position the box so that the front rests on a table top, and the sides and roof extend upwards.
6. Attach two 1"x1"x10" interior spacer strips to the inside of the front piece using finishing nails or wood screws. Make sure the strips fit tight against the side pieces.
7. Attach first 1/4"x10"x22 1/2" baffle to the spacer strips using finishing nails.
8. Attach two 1"x1"x10" interior spacer strips onto the first baffle using finishing nails or wood screws. Make sure the strips fit tight against the sides of the box.
9. Attach 1/4"x11"x22 1/2" baffle to the spacer strips using finishing nails.

10–15. Continue attaching interior spacer strips and baffles as previously directed. This box should have a total of five baffles.

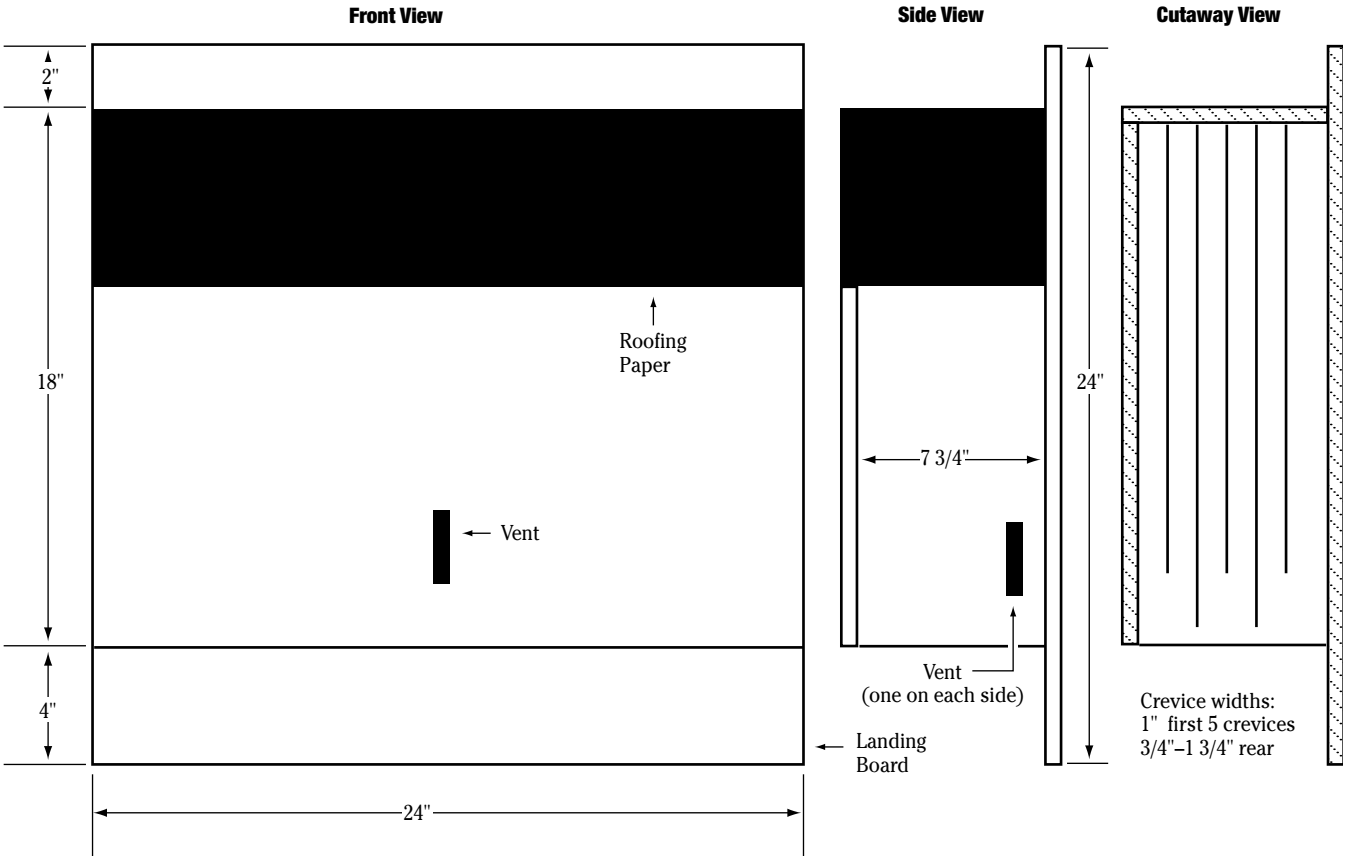
16–19. Follow steps 16 through 19 in the Small Bat Box Assembly instructions.

Note: If a greater capacity is needed, additional boxes can be placed side-by-side, or a larger maternity box can be built.

Installation and Maintenance:

See installation and maintenance notes for Small Bat Box.

Large Maternity Colony Bat Box (18"x24"x8")



Large Maternity Colony Bat Box (18"x24"x8")

Capacity: 150–300 Bats

This bat box is suitable for large summer maternity colonies of 150-300 bats. It should be installed in the spring before the colony is evicted. If a colony larger than 300 bats is to be evicted, two boxes can be installed side by side or a larger bat box can be used. Contact the Pennsylvania Game Commission or Penn State for further information on larger bat box designs.

Tools:

circular saw

jigsaw

hammer

screwdriver

Materials:

3/4" board or exterior grade plywood for front and back

3/4" board or 1/2" to 3/4" exterior grade plywood for roof

1"x8" board for sides (actual width after planing ~7 3/4")

1/4" lightweight plywood for interior baffles

10– 1"x1"x22" wood strips for spacing interior baffles

latex siliconized caulk

dark brown latex paint or stain

black roofing paper

exterior grade wood screws

galvanized finishing nails

Pieces: (height x width)

front– 24"x24" exterior plywood or board

back/landing board– 30"x24" exterior plywood or board

sides– 24"x7 3/4" board

baffles– 1/4" lightweight plywood

3– 22"x22 1/2" (if using spacer strips)

2– 23"x22 1/2"

3– 22"x23" (if using router)

2– 23"x23"

spacer strips: 10– 1"x1"x22" board strips

Assembly:

1. Cut out pieces.
2. Use a knife, saw, or router to roughen all interior surfaces with horizontal scratches or grooves 1/4" to1/2" apart. Pay special attention to landing board at bottom of box. (The portion of the back that extends below the box will serve as the landing board.)

   Note for router users: At this point, use a router to cut 1/4" vertical grooves in side pieces at 1 inch intervals, then skip the following instructions on installing spacer strips and baffles. Simply fit the baffles into the side piece grooves, then attach front, back, and roof.

If not using a router:

3. Attach sides to front using wood screws. (Caulk the seams, but do not use wood glue on any part of the bat box.)
4. Attach roof to sides and front using wood screws (caulk the seams). Roof can be slightly slanted to promote water runoff.

Installing spacer strips and baffles:

5. Position the box so that the front rests on a table top, and the sides and roof extend upwards.
6. Attach two 1"x1"x22" interior spacer strips to the inside of the front piece using finishing nails or wood screws. Make sure the strips fit tightly against the side pieces.
7. Attach the first 1/4"x22"x22 1/2" baffle to the spacer strips using finishing nails.
8. Attach two 1"x1"x22" interior spacer strips to that baffle using finishing nails or wood screws. Make sure the strips fit tightly against the side pieces.
9. Attach the 1/4"x23"x22 1/2" baffle to spacer strips using finishing nails.

10–15. Continue attaching interior spacer strips and baffles as previously directed. This box should have a total of five baffles.

16. Attach the back of box to the roof and sides (caulk the seams). The back piece should extend below the body of the box. (The portion that extends below the box will serve as the landing board.)
17. Paint or stain the exterior using a latex-based stain. (Do not stain the interior.)
18. Attach roofing paper to roof. Caulk the seam at the back where the roof attaches to the back panel.
19. Tack roofing paper onto the front and sides, extending it approximately six inches down from the top. This will help create differences in temperatures from the top of the box to the bottom. (This step is very important.)

Note: If more capacity is needed, additional boxes can be placed side-by-side.

Installation and Maintenance: See installation and maintenance notes for Small Bat Box.

Appendix 3
Further Information

General Information

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Web sites

Bat Conservation and Management
BCM is a Pennsylvania company that provides extensive information and on-site assistance for both attracting and excluding bats.
www.batmanagement.com

Bat Conservation International
The BCI Web site has information on bat ecology, management, and conservation.
www.batcon.org

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