Bats

Figure 1. Little brown bat (*Myotis lucifugus*). Photo by BCI.

Figure 2. Big brown bat (*Eptesicus fuscus*). Photo by BCI.

Bat Conservation International (BCI) photos are NOT for public use.

Objectives

1. List the signs of the presence of bats.
2. Communicate to clients the process involved in excluding bats from their home.
3. List the three scenarios that will lead to the assumption that a client has been bitten and the bat needs to be tested for rabies.

Overview of Damage Prevention and Control Methods

Habitat Modification

Change exterior light bulbs to ones less attractive to insects.

Use lights and fans to make roosting sites unattractive to bats.

Exclusion

One-way doors

Frightening Devices

Not effective

Repellents

None registered in Alabama.

Toxicants

None registered

Shooting

Not practical; illegal in some states

Trapping

Bat traps; prevent unnecessary stress or death to the bats.

Other Control Methods

Glue boards in emergency situations

Conservation and Public Education

Despite the ecological value of bats, many people have phobias concerning these animals. While customers have the right to live in a bat-free home, it is important not to reinforce phobias

about bats. Many people fear contracting rabies from bats, though in reality only a very small percentage of bats actually have the disease. Bat conservation is even more important now than ever with White Nose Syndrome threatening bat populations.

Species Profile

Identification

Bats are the only mammals that can truly fly, and they belong to the order Chiroptera. The ability to fly, secretiveness, and nocturnal habits have contributed to bat folklore, superstition, and fear. About 1100 species are distributed worldwide, second in number only to Rodentia (rodents) among mammals. Among the 40 species of bats found north of Mexico, only a few cause problems for humans (note that vampire bats are not found in the US and Canada). Bats that congregate in colonies are called colonial bats; those that do not are solitary bats.

The species most often encountered in and around buildings in Alabama include little brown bats (*Myotis lucifugus*, Figure 1), big brown bats (*Eptesicus fuscus*, Figure 2), Brazilian free-tailed bats (*Tadarida brasiliensis*, Figure 3), evening bats (*Nycticeius humeralis*) and Tri-colored bat, formerly Eastern pipistrelle bat (*Perimyotis subflavus*, Figure 4).

Solitary bats typically roost in tree foliage or under bark but occasionally are found in buildings, usually as transients during migration. These include red bats (*Lasiurus borealis*), silver-haired bats (*Lasionycteris noctivagans*), hoary bats (*Lasiurus cinereus*). Some solitary bats such as the Tri-colored bat (*Perimyotis subflavus*) are usually found in caves but are also very regularly encountered in dwellings . Excellent illustrations of the bats discussed herein can be found at Bat Conservation International (http://www.batcon.org/index.php/all-about-bats/species-profiles.html) and the University of Michigan's Animal Diversity Web (http://animaldiversity.ummz.umich.edu/site/accounts/information/Chiroptera.html).

Figure 3. Brazilian free-tailed bat (*Tadarida brasilensis*).

Figure 4. Tri-colored bat (*Perimyotis subflavus)*

While species characteristics can differ greatly, methods required for control do not. Colonial and solitary bats have differences that serve to separate the species into groups (Figure 5). Much of the descriptive material that follows is adapted from Barbour and Davis (1979).

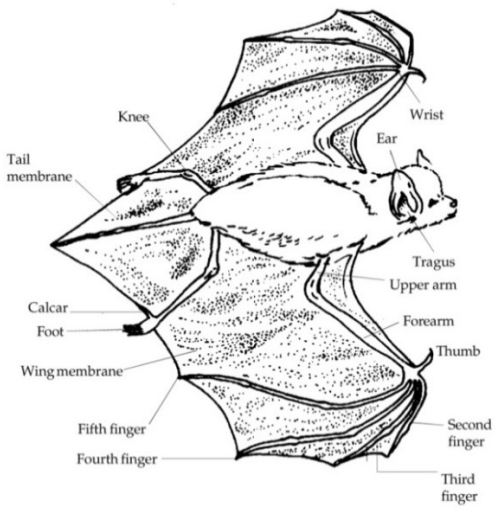

Figure 5. Anatomy of a bat. Image by PCWD.

Physical Description

Colonial Bats

Little brown bat (*Myotis lucifugus*)

Recognition: Figure 6

Forearm: 1.3 to 1.6 inches

Wingspan: 9.0 to 10.6 inches

Ears: 0.55 to 0.63 inches

Foot: Approximately 0.4 inches; long hairs on toes extend beyond claws.

Color: Pale tan to reddish brown to dark brown, depending on geographic location. It is a rich dark brown in the eastern US and most of the west coast. Fur is glossy and sleek.

Confusion may occur with other "house" bat species. Little brown bats are uncommon to rare in Alabama.

Figure 6. (Top to bottom) Foot with calcar (cartilage spur); Foot with hairs on toes; and Ear and tragus of the little brown bat. Photos by BCI.

Little brown bats are often found in and near buildings or a body of water where they forage for insect prey. Summer colonies are gregarious,

commonly roosting in dark, hot attics and roof spaces where maternity colonies may include hundreds to thousands of individuals. Colonies may form beneath shingles and siding, in tree hollows, beneath bridges, and in caves. Litter size is one in the Northeast; twins occasionally occur in other areas. Roosts often are shared with big brown bats, though the latter is less tolerant of high temperatures, often relocating if temperatures exceed 95°F. Separate groups of males and non-reproducing females tend to be smaller and roost in cool attics, behind shutters, under bark, in crevices, and within caves.

Generally, in August or September little brown bats in the eastern part of the range abandon buildings to hibernate in caves and mines (Figure 7). Hibernacula may be near summer roosts or up to a few hundred miles away. Little is known of little brown bat winter habits in the western US. The life span of little brown bats is up to 31 years, though the average life expectancy is probably only a few years.

Figure 7. Distribution of little brown bats. Image by PCWD.

Big brown bat (*Eptesicus fuscus*)

Recognition: Figure 2

Forearm: 1.7 to 2.0 inches

Wingspan: 12.8 to 13.8 inches

Ears: Rounded tragus

Color: From reddish brown, to copper colored, to a dark brown depending on geographic location. It is a large bat without distinctive markings. Confusion may occur with evening bats though the latter is much smaller.

Big brown bats are very common in Alabama. They are a hardy, rather sedentary species that favors buildings for roosting. Summer maternity colonies may include a dozen up to a few hundred individuals roosting behind chimneys, in enclosed eaves, in hollow walls, attics, barns, and behind shutters and unused sliding doors. They form colonies in rock crevices, beneath bridges, in hollow trees, and under loose bark. Litter size is two in the East to the Great Plains and one from the Rockies westward. Males typically roost in smaller groups or alone during the summer.

Big brown bats are one of the most widely distributed species of bats in the US (Figure 8), and are probably familiar to more people than any other species. People recognize their large, easy-to-observe size, but also to their habit of overwintering in buildings (attics, wall spaces, and basements). Their close proximity to humans coupled with the tendency to move about during temperature shifts, often brings big brown bats into human living quarters and basements. Big brown bats occasionally hibernate in caves, mines, storm sewers, burial vaults, and other underground harborage. They travel as far as 150

miles to hibernacula, though their winter quarters are largely unknown. Big brown bats may live to 18 years.

Figure 8. Distribution of the big brown bat. Image by PCWD.

Brazilian free-tailed bat (Called Mexican free-tailed bats in their western range) (*Tadarida brasiliensis*)

Recognition: Figure 3

Forearm: 1.4 to 1.8 inches

Wingspan: 11.4 to 12.8 inches; long narrow wings

Tail: interfemoral membrane does not enclose the lower one-third to one-half of the tail (hence the name free-tailed).

Foot: stiff hairs, as long as the foot, protrude from the toes.

Color: dark brown or dark gray. Fur of some individuals may have been bleached to a pale brown due to ammonia fumes from urine and decomposing guano. Confusion is not likely to occur with other species that commonly inhabit human buildings.

Brazilian free-tailed bats form the largest colonies of any warm-blooded animal, establishing sizable colonies in buildings, particularly on the West Coast and in the Gulf states from Texas east (Figure 9). Hundreds to thousands of individuals may be found in buildings or under bridges. It primarily is a cave species in Arizona, New Mexico, Oklahoma, and Texas. In the eastern United States it is primarily found in man-made structures. Buildings are used as temporary roosts during migrations. Litter size is one.

Figure 9. Distribution of the Brazailian free-tailed bat in the U.S. Image by Brandon Berrey, ADCNR.

Free-tailed bats often share roosts with other species. A few individuals may overwinter in buildings as far north as South Carolina in the east and Oregon in the west. Most migrate hundreds of miles to warmer climates (Mexico) for the winter.

Most colonies are small, ranging from a dozen to 100 individuals. Roost sites include buildings, bridges, and rock crevices; less frequently, tree cavities, caves, and mines. Litter size is most commonly two. The roost frequently is shared with big brown bats. While some males segregate during the nursery period (sometimes in the same building), others are found within the maternity colony.

Evening bat (*Nycticeius humeralis*)

Recognition: Figure 10

Forearm: 1.3 to 1.5 inches

Wingspan: 10.3 to 11.0 inches

Ears: with short, curved, and rounded tragus

Color: Medium-brown with some variation to yellow-brown in subtropical Florida. No distinctive markings. Confusion may occur with big brown bats, which are readily distinguished by their larger size. Evening bats bear some resemblance to the smaller little brown bats but can be identified by their characteristic blunt tragus (Figure 10).

Figure 10. Evening bat (photo by BCI) and its distribution. Map by PCWD.

Summer maternity colonies in buildings may consist of hundreds of individuals. Litter size is usually two. Colonies form in tree cavities, in Spanish moss, beneath dead palm fronds and under loose tree bark. In the Southeast, Mexican free-tailed bats commonly inhabit the same building with evening bats. Evening bats are one of the most common bats in towns throughout southern coastal states. Little is known of their feeding behavior or seasonal movements except that they almost never enter caves.

Solitary Bats

Red Bat(*Lasiurus borealis*)

Recognition: Figure 11

Forearm: 1.4 to 1.8 inches

Wingspan: 11.4 to 13.1 inches; long, pointed wings

Ears: very short and rounded

Tail membrane: heavily furred on upper surface, with a distinctive long tail.

Color: Bright orange to yellow-brown; usually with a distinctive white mark on the shoulders**.** Red bats are most likely to be confused with Seminole bats, a species of nearly identical size and appearance except for the latter's deep mahogany color. Confusion also may occur with Hoary bats, which is frosted-gray in appearance and larger (Figure 11).

Red bats are solitary, coming together only to mate and migrate. Few people are familiar with this species. They typically spend summer days hidden in the foliage of deciduous trees. Litter size ranges from one to four. Red bats often chase insects that are attracted to lights, such as street lamps, which may bring them in close proximity to people.

Red bats are well-adapted for drastic temperature fluctuations. They do not hibernate in caves, but apparently in trees. Some migrate long distances. During migration red bats have been known to land on high-rise buildings and on ships at sea.

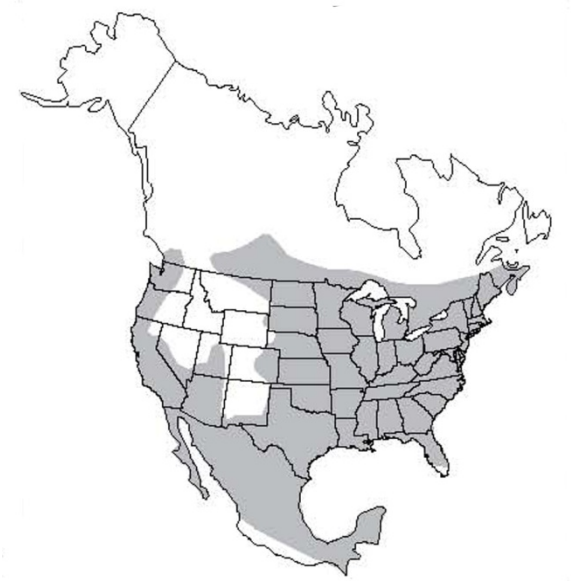

Figure 11. Eastern red bat and its distribution. Photo by BCI and map by PCWD.

Silver-haired bat (*Lasionycteris noctivagans*)

Recognition: Figure 12

Forearm: 1.5 to 1.7 inches

Wingspan: 10.3 to 12.2 inches

Ears: short, rounded, hairless

Tail membrane: upper surface is sparsely furred on the anterior one-half

Color: black with silver-tipped fur; some with dark brown, yellowish-tipped fur (Figure 12). Confusion may occur with larger Hoary bats, which have patches of hair on the ears and wings, heavy fur on the upper surface of the tail membrane, and a distinctive throat "collar."

Figure 12.. Silver-haired bat and its distribution. Photo by BCI. Map by PCWD.

Silver-haired bats roost in a variety of harborages. A typical roost is behind loose tree bark; other sites include tree hollows, woodpecker holes, and bird nests. They are a solitary species except when with young. There are unconfirmed reports that they are sometimes colonial (Dalquest and Walton 1970) and may roost in and on buildings. Litter size is two. The sexes segregate through much of the summer range.

Silver haired bats hibernate in tree crevices, under loose bark, in buildings (including churches, sky scrapers, and wharf houses), hulls of ships, rock crevices, silica mines, and non-limestone caves. They may migrate, during which time they are encountered in buildings (they favor open sheds, garages, and outbuildings rather than enclosed attics), in lumber piles, and on ships at sea.

Hoary bat (*Lasiurus cinereus*)

Recognition: Figure 13

Forearm: 1.8 to 2.3 inches

Wingspan: 15.0 to 16.1 inches

Ears: relatively short, rounded, edged with black, and with fur

Tail membrane: completely furred on upper surface

Color: Dark, but many hairs are tipped in white, giving it a frosted appearance. These bats have a yellowish or orangish throat “collar.”

Confusion may occur with the much smaller silver-haired bats, which lack fur patches and markings on the ears, markings on the throat, and has a tail membrane that is only lightly furred on the upper surface.

Hoary bats generally spend summer days concealed in tree foliage (often evergreens), rarely enter houses, and are not commonly encountered by people. At day roosts they usually are solitary except when with young. Litter size is two. The sexes segregate through most of the summer range.

Figure 13. Hoary bat and its distribution. Photo by BCI. Map by PCWD.

Hoary bats are one of the largest bat species in North America, powerful fliers, and accomplished migrants. Some individuals may hibernate in northern parts of the range.

General Bat Biology

Voice and Sounds

Most North American bats emit high frequency sounds (ultrasound) inaudible to humans and similar to sonar to avoid obstacles, locate and capture insect prey, and to communicate. Bats also emit audible sounds that may be used for communication between individuals.

Reproduction

Bats generally mate in the fall and winter but females retain sperm in the uterus until spring, when ovulation and fertilization take place. Pregnant females may congregate in maternity colonies in buildings, behind chimneys, beneath bridges, in tree hollows, caves, mines, or other dark retreats. No nests are built. Birth typically occurs from May through July. Young bats grow rapidly and are able to fly within three weeks. Weaning occurs in July and August, after which nursery colonies disperse.

Behavior

Bats prepare for winter around the first frost. Some species migrate relatively short distances, whereas certain populations of Mexican free-tailed bats may migrate up to 1,000 miles. Bats in the northern US and Canada may hibernate from September through May. Hibernation for the same species in the southern part of their range may be shorter or even sporadic. Some species fly during warm winter spells (e.g., red bats in the southeastern US).

Habitat

Bats tend to invade structures that have significant exposure to sunlight, are large, and are within ½ mile of a freshwater source.

Food Habits

Bats in Alabama are insectivorous, feeding on a variety of flying insects, though the Hoary bat may occasionally take other bats. Many of these insects are harmful to humans. Although there are some limitations such as body size, flight capabilities, and jaw opening, insectivorous bats

apparently consume a wide range of prey (Barbour and Davis 1979).

The diet of little brown bats includes mayflies, midges, mosquitoes, caddis flies, moths, and beetles. An individual can consume insects equal to $^{1}/_{3}$ its body weight in ½ hour of foraging. Big brown bats may fill their stomach in about one hour (roughly 0.1 ounce per hour) with prey including beetles, moths, flying ants, true bugs, mayflies, caddis flies, and other insects. The nightly consumption of insects by a colony of bats can be extremely large.

Legal Status

The lethal control of bats, even when there is a proven potential danger to humans, is often subjected to careful scrutiny and interagency coordination. A survey of federal legislative actions, court decisions, and agency interpretations concerning bats can be found in Bat Management in the US (Lera and Fortune 1979).

Some states have laws that specifically mention bats, either providing or denying protection. Others have legislation that applies to bats only by interpretation because bats may be considered nongame wildlife or indigenous state mammals. Some species are protected as either federal or state-listed endangered species. Enforcement and public education must accompany legislation to accomplish the intended goal of protecting the public and endangered bats. Familiarity with the appropriate federal and state laws should precede any nuisance management activities.

In Alabama, bats that are protected include the Federally listed Gray bat *(Myotis grisescens)* and Indiana bat (*Myotis sodalis*). Additional bats protected under Alabama's Nongame Species Regulation include Rafinesque's big-eared bat (*Corynorhinus rafinesquii*), Southeastern Myotis (*Myotis austroriparius*), Little brown bat (*Myotis lucifugus*), Northern yellow bat (*Lasiurus intermedius*) and Northern long-eared Myotis (*Myotis septentrionalis*). Except for the before mentioned species, there is currently (2012) no protection on Alabama's other bat species.

Damage Identification

Bat Presence

Bats commonly enter buildings through openings associated with the roof edge and valleys, eaves, apex of the gable, chimney, attic or roof vent, dormers, and siding (Figure 14).

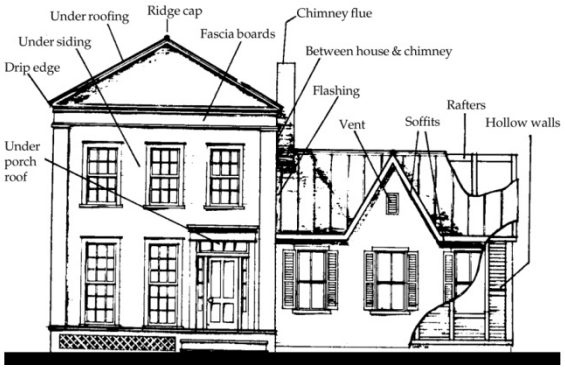

Figure 14. Common entry points for bats. Image by PCWD.

Bats use the outside of buildings, often behind shutters and where the siding and edge boards are not joined properly, lapped, or sealed. Other openings may be found under loose-fitting doors, around windows, gaps around various conduits (wiring, plumbing, air conditioning) that pass through walls, and through utility vents.

Bats squeeze through narrow slits and cracks. For purposes of bat management, the focus should be on any gap measuring approximately ¼ x 1½ inches or hole measuring $^{5}/_{8}$ x $^{7}/_{8}$ inch. Such openings must be considered potential entries for the smaller species, such as little brown bats. Smaller species require an opening no wider than

$^3/_8$ inch, or the diameter of a US dime coin. Openings of these dimensions are not uncommon in older wood frame structures where boards have shrunk, warped, or otherwise loosened. Big brown bats may hibernate in the cooler recesses of heated buildings, and they may suddenly appear (flying indoors or outdoors) in midwinter during a warm spell or a cold snap as they move about adjusting to the temperature shift.

Damage to Structures

Rub Marks. Surface areas on walls, under loose woodwork, between bricks and around other bat entryways often have a smooth, polished appearance. The stained area is slightly sticky, may contain a few bat hairs, and is yellow-brown to blackish brown in color. The smooth gloss of the rub marks is due to oils from fur and other bodily secretions mixed with dust, deposited there as many animals pass repeatedly for a long period over the same surface. Openings marked in this way have been used heavily by bats.

Guano and Urine. Fecal pellets indicate the presence of bats and are found on attic floors, in wall recesses, and outside the house. Fecal pellets along and inside walls may indicate the presence of mice, rats, or even roaches. Most house bats north of Mexico are insectivorous and their droppings are easily distinguished from those of small rodents. Bat droppings tend to be segmented, elongated, and friable (Figure 15). When crushed, they become powdery and reveal shiny bits of undigested insect remains. In contrast, mice and rat droppings tend to taper, are unsegmented, harder and more fibrous, and do not become powdery when crushed (unless they are extremely aged).

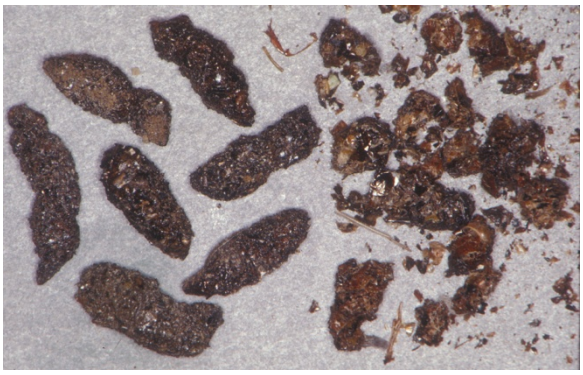

Figure 15. Bat guano (whole (left) crushed (right) looks similar to mouse droppings except for the shiny speckles and susceptibility to crumble. Photo by UNL.

The droppings of some birds and lizards occasionally may be found along with those of bats. Bat droppings never contain the white chalky material characteristic of the feces of these other animals.

Bat excrement produces an unpleasant odor as it decomposes in attics, wall spaces, and other voids. The pungent, musty, acrid odor often can be detected from outside a building containing a large or long-term colony. Similar odor problems occur when animals die in inaccessible locations. The odor also attracts arthropods which may later invade other areas of a building. Bats urinate and defecate when exiting a roost (Figure 16), causing multiple spotting and staining on sides of buildings, windows, patio furniture, automobiles, objects at and near entry and exit holes, or beneath roosts.

Figure 16. Bat droppings outside an attic vent. Photo by Stephen M. Vantassel.

Damage to Livestock and Pets

Bats infected with rabies can transmit the disease to pets and livestock during encounters.

Damage to Landscapes

Bats do not damage gardens or landscapes.

Nuisance Problems

Some people are frightened by the presence of bats flying around the outside of their house. Bats often fly around swimming pools, from which they drink or catch insects. White light with an ultraviolet component, commonly used for porch lights, building illumination, street and parking-lot lights, may attract flying insects, which in turn attract bats. The mere presence of a bat outdoors is sometimes beyond the tolerance of some uninformed people. Education is a good remedy for such situations.

Disturbing sounds may be heard from vocalizations and grooming, scratching, crawling, or climbing in attics, under eaves, behind walls, and between floors. Bats become particularly noisy on hot days in attics, before leaving the roost at dusk, and upon returning at dawn. Rustling sounds in chimneys also may be caused by birds or raccoons and scratching and thumping sounds in attics and behind walls may indicate rats, mice, or squirrels.

Health and Safety Concerns

Bats have very sharp, short teeth. Most leather gloves provide suitable protection.

White Nose Syndrome (WNS) is a fungal infection that appears as a white “cottony” growth on an infected bat’s nose, ears or wing membrane. This infection has occurred simultaneously with massive die-offs in hibernating bat colonies from Canada to Alabama and continues to spread westward. It is unclear whether the fungus is causing the deaths or whether it is an opportunistic infection. There is no evidence suggesting that white nose fungus infects humans. Research continues on WNS as biologists hope to stem these massive die-offs. WNS is proving to be extremely harmful to colonial bats. Many caves are closed due to the occurrence of WNS or potential for contamination. Strict equipment decontamination protocols are strongly recommended.

Guano and Urine. Bat guano may provide a growth medium for microorganisms, some of which are pathogenic (e.g., histoplasmosis) to humans. Guano accumulations may fill spaces between walls, floors, and ceilings. Guano may create a safety hazard on floors, steps, and ladders, and may even collapse ceilings. Accumulations stain ceilings, soffits, and siding, producing unsightly and unsanitary conditions. The weight of droppings and urine can potentially compromise structures. Bat excrement may contaminate stored food, commercial products, and work surfaces.

Bat urine readily crystallizes at room temperature. In warm conditions, such as under roofs exposed to sun and on chimney walls, urine evaporates so quickly that it crystallizes in great accumulations. Boards and beams saturated with urine acquire a whitish powder-like coating. With large numbers of bats, thick and hard stalactites and stalagmites of crystallized bat urine occasionally are formed.

Although fresh urine of a single bat is relatively odorless, that of any moderate-sized colony is obvious. The odor increases during damp weather. Over a long period of time, urine may cause mild wood deterioration. As urine saturates the surfaces of dry wood beams and crystallizes, the wood fibers expand and separate. These fibers then are torn loose by the bats crawling over such surfaces, resulting in wood fibers being mixed with guano accumulations underneath.

The close proximity of bat roosts to human living quarters can result in excreta, animal dander, fragments of arthropods, and various microorganisms entering air ducts as well as falling onto the unfortunate residents below. Such contaminants can result in airborne particles of public health significance.

Guano deposits and guano-enriched soils should not be unnecessarily disturbed. Dampening with water or scheduling outdoor work at a time when the ground is relatively wet will minimize airborne dust. To protect the environment, decontamination must be conducted in accordance with state and local regulations. Decontamination of an active bat roost should be conducted only after the bats have been excluded or after bats have departed for hibernation.

Ectoparasites and other Arthropods. Several arthropods (fungivores, detritivores, predators, and bat ectoparasites) often are associated with bat colonies in buildings. The diversity depends on the number of bats, age and quantity of excreta deposits, and season. Arthropods such as dermestid beetles (*Attagenus megatoma*) contribute to the decomposition of guano and insect remnants, but also may become a pest of stored goods and/or a nuisance within the living quarters. Cockroaches (e.g.,*Blatta orientalis*) attracted to guano may invade other parts of a building. Bat bugs (*Cimex* spp.,Figure 17) are sometimes found crawling on the surface of beams or around holes leading to secluded recesses used by bats.

Figure 17. Bat bug (left) with bed bug (right). Photo by Jim Kalisch.

Bat ectoparasites (ticks, mites, fleas, and bugs) rarely attack humans or pets, and quickly die in the absence of bats. Ectoparasites may become a nuisance, however, following exclusion of large numbers of bats from a well-established roost site. Area fumigation with a total release pyrethrum-based aerosol may be an appropriate solution for arthropod knockdown within an enclosed space, but only after bats have departed. For long-term arthropod control, lightly dust appropriate surfaces (affected attic beams, soffits) with boric acid powder or diatomaceous earth. Carefully read all product labels before using any pesticide. Neither rabies nor Lyme disease is

transmitted by any arthropods associated with bats.

Rabies. Rabies in a bat colony can pass through generations. Estimates vary, but most agree that less than 3% of all bats carry rabies. Bats that are found on the ground and bats that have interacted with humans are more likely to carry rabies. Do not assume a bite mark can be identified (Figure 18).

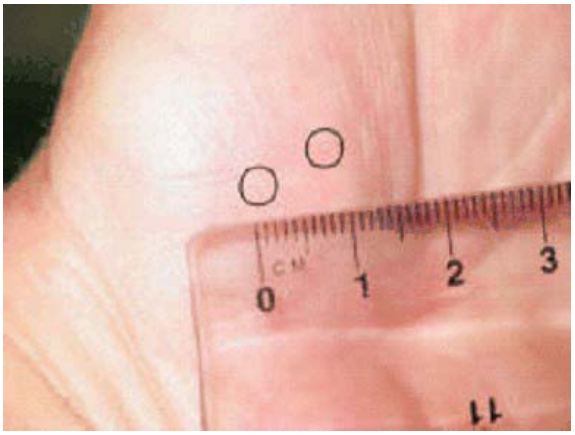

Figure 18. Do not assume the client would be able to visually identify whether he/she was bitten by a bat. Photo by Nebraska Health Dept.

A rabid bat transmits the disease by biting another mammal. As the disease progresses, the bat becomes increasingly paralyzed and dies as a result of the infection. The virus in the carcass remains infectious until decomposition is well advanced. Therefore, every bat bite or contact must be considered a potential exposure to rabies. While aerial transmission of the rabies virus from bats in caves to humans and some other mammals has been reported, this is not a likely route of infection for humans entering bat roosts in buildings in temperate North America. Vampire bats do not occur north of Mexico and they do not attack the throat of humans; they lap blood from the open wounds on animals.

Identifying Potential Rabies Exposures. Assume that a client or others in the building was bitten by a bat if:

- He/she awakened to find a bat flying in his/her room.
- The client found a bat in a room with an unattended child, whether sleeping or not.
- The client found a bat in a room with someone who is mentally unable to assess whether he/she was bitten by a bat.

If possible, the bat should be captured in a manner that does not damage the head and delivered to your local Alabama Department of Public Health office for testing in accordance with Alabama's guidelines. In situations where the bat's whereabouts are unknown the client should consult his/her physician immediately.

Rabies Preventive Measures. Newspapers, television, and other mass media sometimes misrepresent the risk of rabid bats to humans. However, the unfortunate recent (1983 to 1993) death of a 22 year old man in Texas, a 30 year old bat scientist in Finland, a university student in British Columbia, a 5 year old girl in Michigan, a man in Arkansas, an 11 year old girl in New York, and women in Georgia and Alabama, amply underscore the need to pay prompt attention to bat bites and other exposures.

Many rabies exposures can be avoided if people refrain from handling bats. Adults and children should be strongly cautioned never to touch bats with bare hands. All necessary measures should be taken to ensure that bats cannot enter living quarters in houses and apartments.

Pet cats and dogs should be kept up-to-date in rabies vaccinations. This also is true for pets confined indoors, because contact with bats

frequently occurs indoors. Valuable livestock also should be vaccinated if kept in buildings harboring bats or if in a rabies outbreak area (NASPHV 1993). While transmission of rabies from bats to terrestrial mammals apparently is not common, such incidents have been reported. Dogs, cats, and livestock that have been exposed to a rabid or suspected-rabid animal, but are not currently vaccinated, must be either quarantined or destroyed as determined by local health officials.

If a bat is captured and immediate transportation to the testing laboratory is possible, and if immediate testing can be arranged, post-exposure treatment may be delayed several hours until the test results are known. Post-exposure treatment must be administered immediately if the bat cannot be captured, if prompt transportation to the laboratory is not possible, if the specimen is not suitable for reliable diagnosis, or if the test results prove positive for rabies.

The prophylaxis (treatment) has little resemblance to that of many years ago. Today, it consists of one dose of rabies immune globulin (human origin) and one dose of rabies vaccine (human diploid cell) administered preferably on the day of the incident. Additional shots may be necessary.

Histoplasmosis. Histoplasmosis is a common lung disease of worldwide distribution caused by a microscopic fungus, *Histoplasma capsulatum*. *H. capsulatum*is a saprophytic mold that grows in soil with high nitrogen content, generally associated with the guano and debris of birds (particularly starlings, *Sturnus vulgaris*, and chickens) and bats. Wind is probably the main agent of dispersal but the fungus can survive and be transmitted from one site to another in the intestinal contents of bats and in the dermal appendages of both bats and birds. The disease can be acquired by the casual inhalation of windblown spores, but infection is more likely to result from a visit to a point source of growth of the fungus. Relative to bats, such sources include roosts in barns, attics, and belfries, and soil enriched with guano.

Wild and domestic animals are susceptible to histoplasmosis but bats are the most important animal vectors. Unlike bats, birds do not appear to become infected with the fungus. Both the presence of guano and particular environmental conditions are necessary for *H. capsulatum* to proliferate. In avian habitats, the organism apparently grows best where the guano is in large deposits, rotting, and mixed with soil, rather than in nests or in fresh deposits. Specific requirements regarding bats have not been described, though bat roosts with long-term infestations are often mentioned in the literature.

While histoplasmosis in the US is particularly endemic to the Ohio-Mississippi Valley region (which is also an area with the greatest starling concentration) and areas along the Appalachian Mountains, it is found also in other states. In addition to areas with “appropriate” environmental conditions, there are scattered foci with high infection rates usually associated with caves inhabited by bats or birds.

When soil or guano containing *H. capsulatum* is physically disturbed, the spores become airborne. Persons at particular risk of histoplasmosis of bat origin include cavers, bat biologists, pest control technicians, WCOs, people who clean or work in areas where bats have habitually roosted, and people in contact with guano-enriched soil (e.g., the foundation of a building where guano has sifted down through the walls).

Infection occurs upon inhalation of spores and can result in a variety of clinical manifestations;

severity partially depends on the quantity of spores inhaled. The infection may remain localized in the lungs where it may resolve uneventfully. Such infections are identified only by the presence of a positive histoplasmin skin test and/or calcified lesions on routine radiographs. Other individuals may have chronic or progressive lung disease requiring treatment. Less severe forms of these infections may be accompanied by fever, cough, and generalized symptoms similar to a prolonged influenza. Resolution of the disease confers a degree of immunity to reinfection. Resolution confers varying degrees of hypersensitivity to *H. capsulatum*. Massive reinfection in highly sensitized lungs may result in a fatal acute allergic reaction.

In a small percentage of chronic histoplasmosis cases, the fungus disseminates to involve multiple organ systems and may be fatal. This usually is seen in young children (one year or older) and in immuno-compromised adults. In recent years, systemic infections have been increasing in frequency globally as an opportunistic infection of AIDS patients.

Roosts known or suspected to be contaminated with *H. capsulatum* should only be entered wearing OSHA approved protective masks capable of filtering out particles as small as 2 microns in diameter or a self-contained breathing apparatus. In known contaminated areas, wear PPE that can be removed at the site and placed in a plastic bag for later decontamination via formalin and washing. Clean all footwear before leaving the site to prevent spore dissemination in cars, the office, at home, and elsewhere.

Damage Prevention and Control Methods

Bat problems fall into three main categories:

1. Bats living in the structure
2. Lone bat encounters inside the living space
3. Bats loafing and/or flying around the exterior of a structure

Management of Bats Living Inside a Structure

Step 1: Confirm bats are present

There are two ways to confirm the presence of bats.

Option 1. Perform a detailed building inspection (interior and exterior). Discovery of rub marks, bat guano, and sightings of bats, coupled with client information are usually sufficient to confirm the presence of bats.

Option 2. A bat watch can be conducted by two people posted at opposite corners of a structure (more may be necessary to observe large or complex sites). An evening watch begins about 30 minutes before dark and a morning watch begins about an hour before dawn. Observations should continue for approximately one hour. Bat watches can indicate exit and entry points and the number of bats. It may be necessary to watch for more than one night to compensate for weather conditions, bat sensitivity to observers, noisy or inexperienced observers, and improper use of light. Observations can be enhanced with a standard flashlight, but be certain to project the beam as far as possible away from the exit hole being observed. Bright light will increase the reluctance of bats to exit and may result in an incomplete count of the colony. A valuable observation aid is a powerful, rechargeable flashlight equipped with a plastic, red pop-off

filter. Also, an electric headlamp supplied with rechargeable batteries and fitted to a climbing or caving helmet allows hands-off illumination when exploring roost locations. Bats are sensitive to light intensity and can visually discriminate shapes and patterns in extremely low light situations. They see in black and white, so low-contrast illumination and soft shadows produced by red light has little effect on bats.

Step 2: Exclusion

Timing. To reduce the risk of separating adults from flightless young, one-way doors should not be installed from May through August. One option is to seal unused holes, but active holes should be left open until the exclusion date is past. Consult your local wildlife agency for exclusion dates in your area. The exclusion process may cause bats to find their way into the living quarters of a home, a behavior most often associated with young bats.

Exclusion is the gold standard for eliminating and preventing bats from residing in structures. It is tedious work to locate all active and potential openings available to bats. Active holes can be identified by rub marks, guano, and sometimes odor. Except for the actively used holes, seal all gaps of ¼ x 1½ inches and openings $^{5}/_{8}$ x $^{7}/_{8}$ inch or greater. Bats use some of the same holes in buildings through which heat (or cooled air) is lost; bat-proofing often reduces client energy costs.

Exclusion Materials and Methods. Caulk, flashing, screening, and insulation often are needed to complete an exclusion job. The combination of materials used will depend on the location, size, and number of openings, and the need for ventilation. Greenhall (1982) provides details of bat-proofing methods and materials and is a practical guide. Weather stripping and knitted wire mesh (Guard-All®, Stuf-fit®) are best applied during dry periods when wood cracks are widest. Caulk can be applied with a caulking gun (in gaps up to about 0.4 inch wide) and include latex, butyl, and acrylic compounds, which last about 5 years. Elastomeric caulks, such as silicone rubber, will last indefinitely, expand and contract, do not dry or crack, and tolerate temperature extremes.

Oakum packs easily and firmly into small cracks. Other fillers include sponge rubber, glass fiber, knitted wire mesh, and quick-setting putty. Self-expanding polyurethane foam applied from pressurized containers can be used for openings larger than 3 inches. It must be applied with caution so as to not lift clapboards, shingles, and other surfaces. Exposed surfaces should be sealed with epoxy paint to prevent insect infestation and ultraviolet degradation.

Conventional draft sweeps (metal, rubber) and other weather stripping supplies (felt, vinyl, metal) will seal the space between a door bottom and the threshold or around windows (Figure 19). Treat attic and basement doors whenever the gap exceeds ¼ inch. Flashing may be used to close gaps at joints (e.g., where the roof meets a chimney). Materials may include galvanized metal, copper, aluminum, stainless steel, and self-adhesive stainless steel “tape.” Insulation provides some barrier to bat movements. It is available in a number of forms and types including fiberglass, rock wool, urethane, vermiculite, polystyrene, and extruded polystyrene foam. Inorganic materials are fire and moisture resistant; the safest appear to be fiberglass and rock wool.

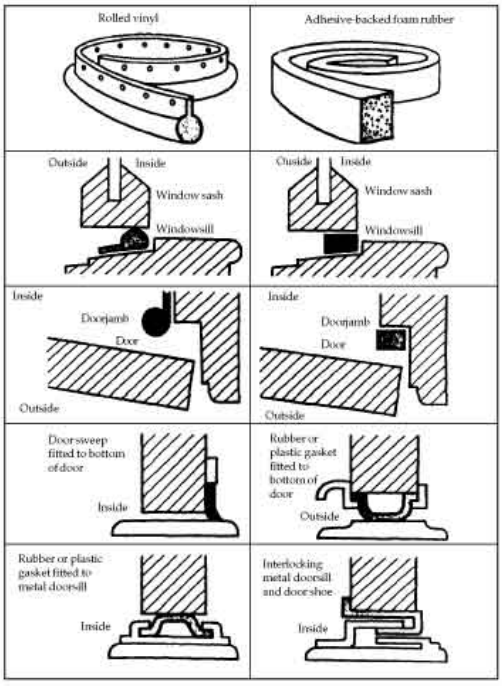

Figure 19. Exclusion techniques for doors. Image by PCWD.

The mesh size of screening must be small enough to prevent access of bats and other species. Hardware cloth with ¼-inch mesh will exclude bats and mice; screening with 16 meshes per inch will exclude most insects. Soffits (underside of overhanging eaves) usually have ventilators of various shapes and sizes. The slots should not exceed ¼- x 1-inch and should be covered inside with insect mesh.

To prevent bats from entering chimney flues, completely enclose the flue discharge area with rust resistant spark arresters or pest screens secured to the top of the chimney. They should not be permanently attached (e.g., with screws) in case they must be rapidly removed in the event of a chimney fire. Review fire codes before installing flue covers. Dampers should be kept closed except during heating season.

Roof Problems. Bats, particularly Brazilian free-tailed bats, often roost under Spanish or concrete tile roofing by entering the open ends at the lowermost row or where the tiles overlap. Tight-fitting plugs are difficult to make due to the variation in opening sizes and thermal expansion and contraction. A solution was found by Constantine (1979) in which a layer of coarse fiberglass batting was laid under the tiles so that bats entering holes would contact the fiberglass and be repelled. A layer of knitted wire mesh would undoubtedly work well for this purpose (and would not hold moisture). Bats also may be excluded from the tiles if rain gutters are installed directly under the open ends. Gaps under corrugated and galvanized roofing may be closed with knitted wire mesh, self-expanding foam (avoid causing roofing to lift), or with fiberglass batting (may retain moisture).

One-way Doors. A variety of one-way doors are available, and no single device is suitable for every situation. Install one-way doors on holes that are actively used by bats to enter or exit the structure. One-way doors should be left in place for at least 3 to 5 days. During periods of inclement weather (e.g., rain) one-way doors should be left in place longer. As in any exclusion intervention, the excluded animals will go elsewhere. This shift may be to an alternative roost already in use such as a night roost, or one used in previous years.

Netting. The basic design attaches netting (fiberglass mosquito netting works well) around an exit hole except at the bottom where the bats will escape (see Frantz 1986, for details). Designs must be open enough not to impede exiting bats (Figure 20). Impeding routine exit points may force bats to seek alternative exits, often causing some bats to find their way into the living quarters of homes. Do not lay netting flush against the wall, as this will prevent bats from exiting. Fold the netting to provide the exiting bats a little gap to move into then down and out. The width and

shape of check-valves is highly variable so as to cover the necessary exit point(s) such as a single hole, a series of holes, or a long slit-like opening. The top can be much larger than the bottom. Restrict the bottom opening to no larger than about 1.6 x 1.6 feet. The length of the netting (the distance from the lowest enclosed point of egress to the bottom of the netting) should be about 3.3 feet. The above specifications usually are sufficient to abort reentry attempts.

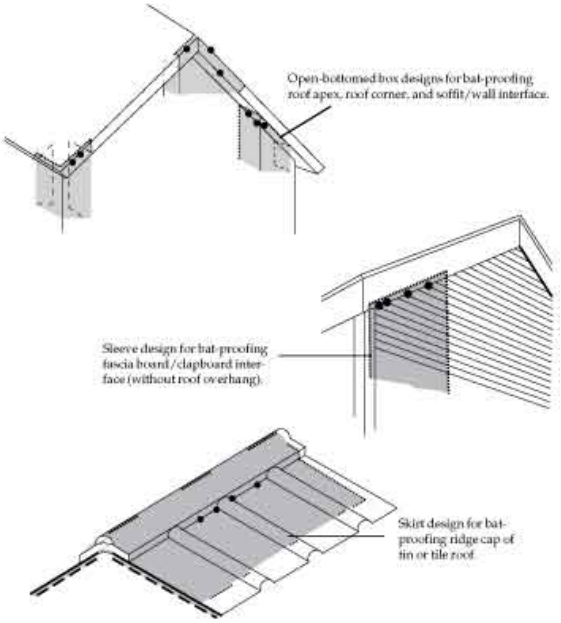

Figure 20. Hanging netting is one type of one-way door for bat exclusion. Image by PCWD.

Tubes. Tubes, such as the ProCone Wildlife Excluder (Figure 21), provide another tool to exclude bats. Center the tube hole over the exit hole used by the bats to provide an easy exodus.

Figure 21. ProCone Wildlife Excluder by Westchester Wildlife. Photo by same.

Lone Bat Encounters

Step 1. Ask the client to watch the bat, as locating missing bats is extremely difficult. If the bat is still flying upon your arrival, wait for it to tire and land. DO NOT LEAVE THE ROOM. Close doors, cabinets, and closets to reduce potential hiding areas.

Step 2. Wear leather gloves, take a wide mouthed plastic storage container or tube (Figure 22), and place it over the bat. Slide the lid between the bat and the wall trapping the bat inside. Tape the cover in place. If the bat is to be tested for rabies the head must not be damaged. Do not use tennis racquets, baseball bats, or shotguns inside the house.

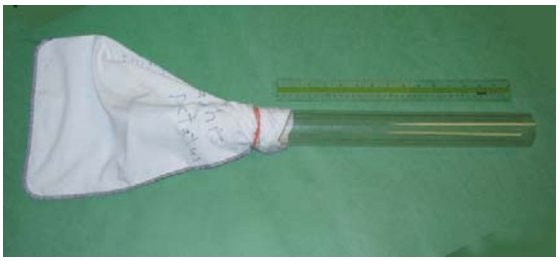

Figure 22. A 2-inch tube attached to a pillow case makes an excellent device to capture bats resting on walls. Photo by UNL.

Step 3. Diligently interview the client to determine if there has been human exposure to the bat. If not, release the bat outdoors on an elevated surface at least 5 feet above ground. Otherwise, take the bat for testing to a local health department. Investigate the rabies submission procedure prior to advertising bat control services, as these events may not occur during normal business hours.

In emergency situations and when bats have landed in locations too difficult to place a ladder, attach a glueboard onto your painter's extension pole. After capture and removal to the out-of-doors, use vegetable oil to free the bat from the glue. Dispose of the bat according to health department guidelines.

Bats on Exterior Structures

Temporary Roosts. Bats will sometimes temporarily roost on porches and patios, in garages, and behind shutters, shingles, and roof gutters. Roosting behind shutters also may be long-term in duration. Actual control measures may not be necessary unless bat droppings become a problem or the risk of human contact is significant. Coarse fiberglass batting tacked to the surfaces where bats prefer to hang sometimes discourages them. A potentially useful intervention for the wall-ceiling interface is the application of a wide 45 degree molding strip to eliminate the 90 degree angle corner and force the bats to roost in a more exposed area.

Damage Prevention and Control Methods

Integrated Pest Management

Timing, Economics, and Methods

Bat guano still is considered a valuable fertilizer resource in some parts of the world (e.g., Thailand and Mexico).

No figures are available to determine the extent of damage caused by nuisance bats or the cost for their control. The problem is widespread in this and other countries.

Costs for remedial services are highly variable, depending on the nature of the problem and who will do the work. For example, to fabricate a few bat check-valves on the "average" 2-story house would probably require 2 workers about a half day, mostly on stepladders, and less than $50 in materials. Much more time would be required to seal all the other active and potential bat exit and entry holes. In addition, if a deteriorated roof, eaves, or other woodwork must be replaced, the costs can increase rapidly.

It often is difficult or expensive for the public to obtain the services of reliable, licensed pest control operators (PCOs). Many PCOs have limited knowledge of basic bat biology and are apprehensive to work with bats. They may want to avoid any liabilities should bat-human contact occur. Select a qualified, professional, wildlife control service that concentrates on the exclusion of live bats from a structure rather than on use of lethal chemicals. The Alabama Wildlife and Freshwater Fisheries Division can provide a list of persons/businesses who do bat exclusion, control and management in Alabama. Contact your local wildlife division office.

Habitat Modification

Swap white-light bulbs for bulbs less attractive to insects.

Exclusion

One-way doors are excellent for restricting bats from structures. Always ensure that all individuals have left the enclosure before one-way doors are installed. Netting also can be used to exclude bats. Ensure that the mesh size is appropriate for bats (Figure 23).

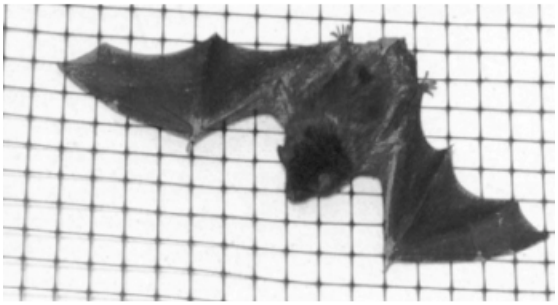

Figure 23. ¼-inch netting can be used to exclude bats. Photo by PCWD.

Frightening Devices

Frightening devices are not appropriate for bat control.

Repellents

While many chemical aromatics and irritants have been proposed and tested for bat repellency, efficacy has been very limited thus far.

Illumination has been reported to be an effective repellent. Floodlights strung through an attic to illuminate all roosting sites may cause bats to leave. Large attics may require many 100-watt bulbs or 150-watt spotlights to be effective. Fluorescent bulbs may be used. In some situations such lighting is difficult, costly, and is an electrical hazard. Where possible, the addition of windows to brighten an attic will help to reduce the desirability of the roost site and is not likely to introduce additional problems. All wiring should be done by a qualified electrician. Note that bright light may drive bats into wall voids where control can be more difficult.

Air drafts have been successful in repelling bats in areas where building owners can open doors and windows, or create strong breezes with electric fans. The addition of wall and roof vents will enhance this effort, as this will lower roost temperature. The above described measures will increase the thermoregulatory burden on the bats, making the roost less desirable. Colonies in soffits, behind cornices, and other closed-in areas can be discouraged by opening these areas to eliminate dark recesses. Discourage bats from roosting behind shutters by removing the shutters completely or by adding small blocks at the corners to space them a few inches away from the wall.

Ultrasonic devices have been tested under natural conditions, both indoors and outdoors, to repel little brown and big brown bats either in the roost or as they fly toward an entrance hole (Frantz, unpublished data). The results are not promising. Numerous ultrasonic devices have been removed from clients' homes because the bats remained in the roost after the devices were activated. Hurley and Fenton (1980) exposed little brown bats to ultrasound in semi-natural roosts with virtually no effect. This lack of known scientific efficacy for ultrasonic devices has caused the New York State Consumer Protection Board to caution against the use of such devices (NYSCPB 1988). Part of the concern is that such devices will provide consumers with a false sense of security and may prevent them from taking effective preventive actions.

Distress cries of bats recorded on tape and rebroadcast can be used to attract other bats to nets or traps, but they do not serve as an effective repellent. Little brown and big brown bats respond to their own distress cries, but not to the cries of other species.

Contact repellents, such as sticky-type bird repellents and rodent glues, have been used successfully in situations where roost surfaces and bat accesses may be coated. Apply masking tape to the surface first if you desire to remove the repellent after treatment is finished. Replenish contact repellents occasionally since dust accumulation causes a loss in tackiness. Apply coatings that will be sticky but will not entrap bats. This technique may not be legal in some states.

Toxicants

No toxicants are registered for bat control.

Fumigants

No fumigants are registered for bat control.

Shooting

Shooting bats is not practical. It is not legal in many states.

Trapping

Bat trapping is controversial. Bat Conservation International does not promote wildlife control operators who use bat traps. Kunz and Kurta (1988) reviewed an extensive variety of efficient methods for trapping bats from buildings and other roosting sites or foraging areas. For purposes of WDM, exclusion is less complicated, less time-consuming, more effective, and requires no handling of bats.

Handling

Relocation

Bats can be released outside provided they have not bitten people or pets. Bats should be released on a tree at least 5 feet off the ground.

Translocation

If legal in your state, drive at least 20 miles and release bats in an area with abundant insects such as lakes and ponds. Effectiveness of this method is questionable, and many bats often migrate hundreds of miles between summer and winter roosts.

Euthanasia

Check federal, state and local laws. Some bats are protected and all are beneficial to our environment. Bats should only be euthanized if they are ill. Euthanize bats with carbon-dioxide.

Disposal

Check your state regulations regarding carcass disposal.

Sanitation and Cleanup

After bats are excluded, repelled, or have departed at the end of the summer, measures must be completed to make re-infestation less likely, and to eliminate odor and problematic bioaerosols. As a prelude to such work, it sometimes is useful to apply a pyrethrum-based, total-release, aerosol insecticide to eliminate unwanted arthropods.

The safe handling and removal of bat guano has been discussed previously in this chapter. In addition to the bulky accumulations of excreta,

there are often diffuse deposits of guano under and among insulation materials, caked urine and guano on roof beams, and splattered urine on windows. Such clean-up work during hot summer weather may be the least desirable activity of a management program, but it is necessary.

All caked or crystallized bat urine and droppings should be scraped and wire-brushed, as necessary, from all roof and attic beams. For this procedure, workers should take the same precautions as outlined for histoplasmosis-related work. Accumulated excreta and contaminated insulation should be sealed in plastic bags and removed for disposal in accordance with state and local laws. Remove all remaining droppings and debris with a vacuum cleaner, preferably one that has a water filter to reduce the amount of dust that escapes from the cleaner's exhaust.

Where possible, wash all contaminated surfaces with soap and water. Allow the surfaces to dry and disinfect them by misting or swabbing on a solution of one part household bleach and 20 parts tap water. Ventilate the roost site to allow odors and moisture to escape. Installation of tight-fitting window screens, roof and/or wall ventilators in attics will enhance this process. Sanitation and cleanup accompanies bat-proofing and exclusion measures; it does not replace them.

Acknowledgments

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Resources

Key Words

Bats, wildlife control, damage management, wildlife control operator, hibernacula

Online Resources

http://wildlifecontroltraining.com

http://icwdm.org/

http://wildlifecontrol.info

Questions for Reflection

1. What signs would you look for to determine if a client's home has bats?
2. What differences are there in the techniques used on excluding solitary bats as compared to colonial bats?

3. How does one distinguish a bat dropping from a mouse dropping?

4. A client woke up and found a bat flying in the room. Unfortunately, she is unable to locate it. What should you do?

5. A client witnessed a bat fly into the house through an open door and land on the wall. Should this bat be tested for rabies?

6. Provide a suggestion for the elimination of bats roosting behind a shutter.

Objective Questions

1. Image map. Identify the tragus

2. Circle correct words: Bat droppings differ from mouse droppings by being scattered/grouped and by being dark black/speckled.

3. What is the smallest size hole a bat can enter?

a. $^{1}/_{5}$inch
b. ¼ inch
c. $^{1}/_{3}$inch
d. ½ inch

4. Active entry holes are often identified by:

a. rub marks
b. droppings
c. location
d. exposure to sun
e. a and c only
f. a and b only

5. Structural exclusion of bats should not take place during what period to prevent young from being abandoned?

a. March to April
b. May to August
c. July to August
d. August to October

6. If a homeowner in the Northern portion of the US complains of bats during December, the bats are likely:

a. hibernating in his home
b. mating
c. just resting on their migratory journey
d. none of the above

7. If you are bitten by a bat during a job but unable to capture it, what should you do?

a. Continue with the job and monitor the bite
b. Ignore the bite
c. Immediately go to the hospital and receive the rabies post-exposure

prophylaxis even though you do not know if the bat had rabies

d. None of the above

Disclaimer

Implementation of wildlife damage management involves risks. Readers are advised to implement the safety information contained in Volume 1 of the National Wildlife Control Training Program.

Some control methods mentioned in this document may not be legal in your location. Wildlife control providers must consult relevant authorities before instituting any wildlife control action. Always use repellents and toxicants in accordance with the EPA-approved label and your local regulations.

Mention of any products, trademarks or brand names does not constitute endorsement, nor does omission constitute criticism.