Bat Management: Excluding Bats from Man-made Structures

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INTRODUCTION AND HISTORY

Bats are among the most beneficial native wildlife species in North America. Most species that roost in structures feed exclusively on insects, making them extremely valuable for their natural pest control (Tuttle and Smith 1992a). Bats are not only vital to our ecosystem, but also to our economy. Recent research has revealed that Mexican free-tailed bats (*Tadarida brasiliensis*) in south-central Texas save farmers up to $1.7 million per year due to their consumption of agricultural pests (Boyles *et al*., 2011; Cleveland *et al*., 2006).

Several bat species have adapted to declines in natural roost habitat by roosting in man-made structures, and some now roost almost exclusively in buildings (Greenhall and Paradiso, 1968). This adaptation initially may have allowed several species to expand their ranges (Kunz and Reynolds, 2003). However, colonies that roost in buildings can be conspicuous, and may be vulnerable to destruction. Nuisance issues, including guano accumulation, stained walls, and odor are compounded by unwarranted fear and an abundance of misleading and conflicting information about bats (Strohm, 1982). As a result, most colonies in structures are unwanted and viewed as pests that require removal or control, and it appears that the relatively new strategy of roosting in man-made structures carries with it drawbacks for bats and humans alike (Humphrey, 1982; Whitaker and Gummer, 1993).

Although there were early advocates of bat-proofing buildings (Cope 1959; Silver, 1935), chemical control was considered easier than prevention, and a variety of lethal chemical control methods were used to destroy entire colonies as recently as the late 1980s (Bat Conservation International, 1987; Marsh and Howard, 1977). Most of these control methods were also potentially lethal to the public. Over the last century, solutions for an unwanted bat colony evolved from an emphasis on bat eradication and lethal chemical pest control to those that emphasized non-chemical control methods. Although safer for the public, most of these methods remained lethal for bats. Eventually techniques using bat-proofing and non-chemical exclusion were adopted (Constantine 2009, Kunz and Reynolds, 2003), and today conservation-based bat exclusion includes high safety standards for the public as well as bats (Frantz and Laniewicz, 2000; French *et al*., 2002).

Nonetheless, ignorance and misinformation that result in dead or injured bats are still among the greatest threats to bat populations. Mortality that is largely the result of misinformation or public ignorance is entirely preventable through education, and nuisance bat colonies can be most effectively controlled by excluding them from the structures where they roost. The objective is to get all bats safely out of a building and to keep them out permanently. This method requires simple techniques and safe, durable, high quality materials to prevent bats from re-entering a structure. However, successful exclusion is not the same as successful population management. Excluding bats without providing alternate roost sites does not solve the problem, it simply causes bats to move

from one structure to another. This chapter provides solutions for the average homeowner or property manager who has bats in a structure and wants them safely outside.

BATS IN BUILDINGS

Buildings can be divided into three parts with regard to their functions. One is the interior used by humans and their pets. If there is a bat in the interior, it is unlikely to go unnoticed. The second part is the exterior, where wildlife normally resides. Part three is the voids within walls, attics and under roofs, which are the areas most likely to be utilized by bats. A bat colony living within a void may sometimes go unnoticed for years.

BATS INSIDE THE HOUSE

The most urgent problems occur when bats are found in the living area of a home, although a single bat flying inside a house does not necessarily indicate that a colony is present in the voids of the structure. Occasionally a bat may fly through an open door or window, or be carried in by a pet. Bats can usually be prevented from entering a home by keeping doors and windows screened, chimneys capped, and exterior basement or attic doors closed and in good repair.

Small bat colonies often go unnoticed until a lost bat finds its way accidentally into the living area. This can occur with lost juveniles during the summer maternity season, or when a thirsty bat awakens briefly from torpor during the winter (see Chapter 10, Volume 2). Although these events are usually rare, they may occur once or twice a year if a colony is present in the voids.

A single bat flying in the house is rarely cause for alarm and can usually be dealt with easily. In most cases, the "lost" bat is trying frantically to locate an exit and will leave on its own. The animal can be assisted by opening a widow or exterior door. All lights should be turned on, and ceiling fans turned off. Doors to adjacent rooms should be closed. It is important to remain quiet while waiting for a bat to find its way outside. If it does not, wait for it to land. Allow several minutes for it to relax and cool down, then capture it by placing a small container (i.e., a box or can) over it, and sliding a stiff piece of paper or cardboard carefully under the animal to enclose it in the container (Fig. 8-1). If a container is not available, the bat can be captured in a gloved hand, or by covering it with a small towel. To prevent injuries to the captor or bat, a bat in flight should not be chased with objects such as a net,

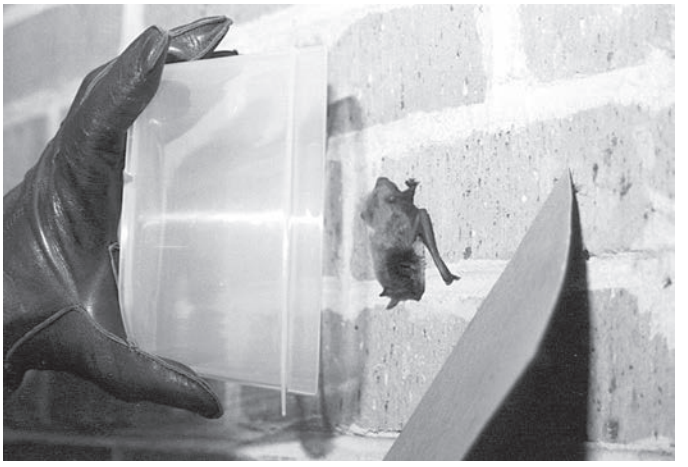

Fig. 8-1. Hand capture of an evening bat (*Nycticeius humeralis*). Photo courtesy of Kelli Deichmueller Gladding, © Fly By Night, Inc.

broom, or tennis racket. Once captured, the bat can be released outdoors unless someone has been bitten or scratched, in which case the local health department or a physician should be consulted immediately. In such cases, the bat should be confined in an escape-proof container until it can be delivered to animal control. Although bats may contract rabies, health hazards are generally low (Brass, 1994; Constantine, 2009). Even though the number of human rabies cases linked to bats averaged less than 1.5 deaths per year in the United States over the last 20 years (CDC data; http://www.cdc.gov), any bat that bites or scratches a person should always be tested for rabies.

STRUCTURAL VOIDS

Bats enter voids through openings on the exterior of buildings. A colony in the voids may remain unnoticed unless someone sees, hears or smells them, or as mentioned above, if a bat is found in the interior of a building. When bats are found in a void, it is best to consider options and devise a strategy to permanently exclude them.

PREVENTING BATS FROM ENTERING BUILDING INTERIORS

During maternity season, or when bats are using a structure during winter, access to the interior can be prevented without disturbing the colony. Openings that allow access to a building are typically found around attic or basement doors, or holes leading into wall spaces for plumbing, electrical wiring, or HVAC systems. Openings leading from voids to building interiors are usually found in utility closets, cabinets, behind appliances, and under sinks, and should be sealed until bats can be safely excluded from the building.

CONFIRMATION OF BAT ACTIVITY

Evidence that bats are occupying voids includes finding them in the house, seeing them entering or exiting a roost, finding them roosting in the open on an exterior wall, or seeing one or more bats on the ground near the structure. Bat guano may also be seen on the ground, or scattered on exterior walls below a roost. In many situations, audible roost chatter (high-pitched chirping), a distinct musky odor (or putrid odors if there are dead bats), or staining and rub marks at active roost entries (Fig. 8-2) may also be observed. Thus, it is usually not necessary to enter an attic, basement or other areas inside structural voids to look for bats.

Fig. 8-2. Dark stain (top center of photo) from scent glands and body oils at a bat roost entrance. Guano also peppers the walls. Photo courtesy of Kelli Deichmueller Gladding, © Fly By Night, Inc.

In some instances, a bat watch may be necessary (Greenhall and Frantz, 1994; Kern, 1995) to confirm activity and locate openings where bats are entering and leaving. During this process, several persons may be stationed around a building to watch bats exit at dusk or return at dawn.

CONFUSING EVIDENCE

Bat guano can sometimes be confused with gecko or rodent droppings**.** Rodent droppings are similar in color and size, but are hard and not crushed easily. Gecko droppings are soft and crushed easily, and are tipped with white uric acid deposits.

Bats are occasionally confused with chimney swifts (*Chaetura pelagica*), small migratory birds that nest inside chimneys. When the adult birds return during the day to feed their hatchlings, high pitched calls can be heard near fireplaces. Checking inside a fireplace may reveal feathers and bird droppings when swifts are present. A bat watch can also be helpful to clear up confusion between bats and chimney swifts. Swifts leave the structure in the morning and return in the evening; bats do the opposite. To prevent interior access, the flu should be kept closed and the chimney capped after the birds leave in the fall.

BAT MANAGEMENT

Successful exclusion is not the same as successful management. Excluding bats always results in roost loss and colony displacement. Alternate roosts are vital but are rarely provided, leaving bats caught in a cycle of exclusion and displacement. When large numbers of displaced bats are forced to search for suitable roosts, colony fragmentation and population decline are masked by reports of sudden "population increases" that occur when displaced bats join colonies in nearby structures. Options for mitigation range from installation of standard bat houses, full site protection, or more complex projects involving temporary exclusion and custom modifications to already occupied sites. Each project is unique, and each management plan should be project specific.

Bat houses (Chapter 9) installed prior to exclusion have an occupancy rate of over 90% (Finn, 1997a) and can be effective management tools that break the exclusion/displacement cycle (Finn, 1997b). Most bat houses installed by Fly By Night, Inc. (FBN) in Osteen, Florida were occupied within a year. The record is less than 12 hours (L. S. Finn and T. G. Finn, unpublished data 1993-2011).

ENVIRONMENTAL AND ECOLOGICAL RULES FOR TIMING EXCLUSIONS

Before excluding bats, environmental and ecological variables such as geographic location, season, bat species, and local weather conditions should be carefully evaluated. Familiarity with local species-specific variations in seasonal activity, reproductive timing, and roosting preferences are also important because bats in structures may consist of more than one species. These variables dictate project scheduling and general timing for exclusions. Timing of attachment and removal of exit tubes for final sealing (see below) can be significantly affected by weather, and local conditions must be monitored during every project. Nonspecific seasonal roosting activity is briefly summarized below.

Seasonal Activity Patterns

Bat activity is generally synchronized with seasonal availability of food and local weather. In temperate regions, seasonal population fluctuations can be distinct and roosts can be described as maternity or hibernation sites. Activity fluctuations and seasonal changes are less obvious in warmer regions, where bats may be active year-round and do not hibernate.

Seasonal movement and roost switching is common among some species (e.g., *Nycticeius humeralis* and *T. b. mexicana*), whereas others may remain at the same site year-round (e.g., *Eptesicus fuscus* and *T. b. cynocephala*). Bats that are observed roosting alone or in small groups in open, easy-to-access areas are often transient occupants that are resting during spring or fall migration. These bats usually leave within in few days without intervention.

Since its discovery in 2006, the fungal disease white-nose syndrome (WNS) has resulted in bat population declines of 50% to 90% in some locations. Currently, WNS is only a risk to cave-roosting bats during winter, but many of these species form summer colonies in structures. Among affected species, the little brown myotis (*Myotis lucifugus*), one of the most common "nuisance" bats in the northeastern United States and Canada, is now in danger of extirpation by WNS (Frick *et al*., 2010).

Summer Activity

Most colonial bat species give birth to one or two pups a year. This low birth rate, combined with pre-weaning mortality (i.e., predation and falling from roosts) results in slow population growth (Hermanson and Wilkins, 1986), which greatly strengthens the need for conservation-based management efforts. The annual maternity season occurs between mid-spring and late-summer for temperate species, but in subtropical and tropical regions of the world a second maternity season may occur in early fall for some species.

Females of colonial species rarely carry their pups, which remain in the roost until they are old enough to fly. Until then, with few exceptions, the adults return to the roost to nurse their young several times each night. Disturbance to a roost during maternity season may prevent adults from returning to feed their pups, resulting in significant mortality from starvation. Although adult males often roost away from females and pups (Kunz and Reynolds, 2003), they are often solitary during the maternity season, but may remain in the same structure. It should not be assumed that a small colony is simply a bachelor group that can be excluded. Population fluctuations observed before and after maternity season are generally the result of local movement between roosts, or dispersal following roost disturbance.

The time between birth and weaning can vary from 3 to 8 weeks (approximately from 15 April through 1 September in the United States). For specific information on the growth and development of selected bat species in North America and Europe, see Pages 306-308 and Pages 342-343 respectively (Chapter 13, Volume 2).

Winter Activity

When planning an exclusion project, do not assume that all bats leave a roost in a structure during the winter. Although some bat species leave their summer roosts and migrate

to other locations for the winter, other species such as *E. fuscus* and *T. b. cynocephala* may roost in buildings year-round (Henry *et al.*, 2000; Hermanson and Wilkins, 1986; Kunz and Reynolds, 2003). Bat activity is significantly reduced during periods of cold weather and torpid bats may not be noticed.

As a general rule, bats enter torpor to conserve energy during periods of reduced food availability (Altringham, 1996; see also Altringham, Chapter 10, Volume 2). In regions with distinct seasonal changes, most bats hibernate during the winter months and management efforts should be postponed until spring, when night temperatures are above 50 °F (10 °C). In the southern United States, the non-migratory *T. b. cynocephalus* is a common resident of man-made structures, and like other members of the family Molossidae, these animals do not hibernate. This species can be stunned by cold at prolonged temperatures below the mid 30s F (2s C) and individuals are often found on the ground during cold weather (L. S. Finn and T. G. Finn, pers. obs.).

ROOST MODIFICATION AND THE EXCLUSION PROCESS

Materials required for exclusions should be placed in a bucket for ready access. These include rigid plastic mesh (or galvanized mesh if rodents are an issue), adhesive caulk and caulk gun, scissors, staples and staple gun, screws and screw gun, masonry bit, and a length of rope. A bucket of water and a rag are also needed to clean up caulk residue, and for storing caulk tubes for recycling as they are emptied.

Mesh

Mesh is the preferred material for bat-proofing. It does not restrict air or water flow, and can be attached with adhesive caulk, staples or screws, as needed. Only heavy-gauge, plastic or metal mesh with an opening size of ¼ in. (0.64 cm) or smaller is appropriate for bat-proofing. Rigid or extruded plastic mesh is preferred (see *Products Mentioned in Text*). It can be cut to size with a pair of sturdy scissors or fabric shears and custom fit to cover large spaces (i.e., shutters, attic and soffit vents), or folded and slipped into cracks, concrete expansion joints, or similar crevices that are too large for caulk alone (Fig. 8-3). This product is versatile, easy to work with, durable, UV resistant and does not tear easily, but it is not rodent-proof. Galvanized hardware cloth or other metal mesh should be used when squirrels or other rodents are an issue.

Fig. 8-3. Heavy-gauge, plastic mesh being installed during a bat exclusion. This type of mesh is versatile and easy to install. Photo courtesy of Mark Kiser, © Bat Conservation International.

Adhesive Caulk

High quality water-based adhesive caulk and a high quality caulk gun are the most important tools for sealing small crevices, and for the secure attachment of exclusion materials, such as mesh and modified caulk tubes (see below). Adhesive caulk should be thick, durable and aesthetically unobtrusive. It should dry quickly and have a minimal risk of failure, even on dusty surfaces. Clear PolyseamSeal® All Purpose Adhesive caulk is preferred by FBN. To prevent risk of attachment failure or potential for bats being exposed to wet caulk, it should not be applied during wet weather or less than an hour before sunset (see product label for specifications).

Exclusion Tubes

Exclusion tubes are one-way devises that allow bats to exit a roost easily, but not to re-enter. The use of tubes as one-way devices for excluding bats was first described by Constantine (1982). Nearly twenty years later, T. G. Finn developed a method that involves recycling empty caulk tubes used for excluding bats (French *et al.*, 2002). Empty 10-oz. plastic caulk tubes (Fig. 8-4) can be washed and modified to create effective, durable exclusion devices (Fig.8-5). The plunger from an empty caulk tube is removed by hand and the tip is cut off. After it is washed, each tube can be modified easily to facilitate attachment, using scissors to cut flair-out tabs.

Exclusion tubes can also be made from conduit, PVC pipe, hose or tubing (Greenhall and Franz, 1994). In most cases, a smooth surface without seams is preferable for making exclusion tubes, and the final product should be at least 8 in. (20 cm) long with a diameter of 2 to 3 in. (5 to 8 cm).

Fig. 8-4. Empty caulk tubes can be recycled by washing and hollowing them out to create exit tubes for bats during exclusion. Photo by Laura S. Finn, © Fly By Night, Inc.

MECHANICS OF EXCLUSION

Although the average homeowner may not be qualified to perform difficult exclusions, the following information should be useful in understanding the process. Efficient bat exclusion requires comfortable access to all exterior surfaces of a structure. A stable temporary work platform such as a ladder, scaffold, or hydraulic lift provides a safe base of operations. Workers should follow the standards set by the Occupational Safety and Health Administration's regulations and personal protective equipment guidelines for protection against falls.

It is best to begin an exclusion immediately adjacent to the most active roost entry, but to leave that opening or openings until last so bats can leave to feed while work

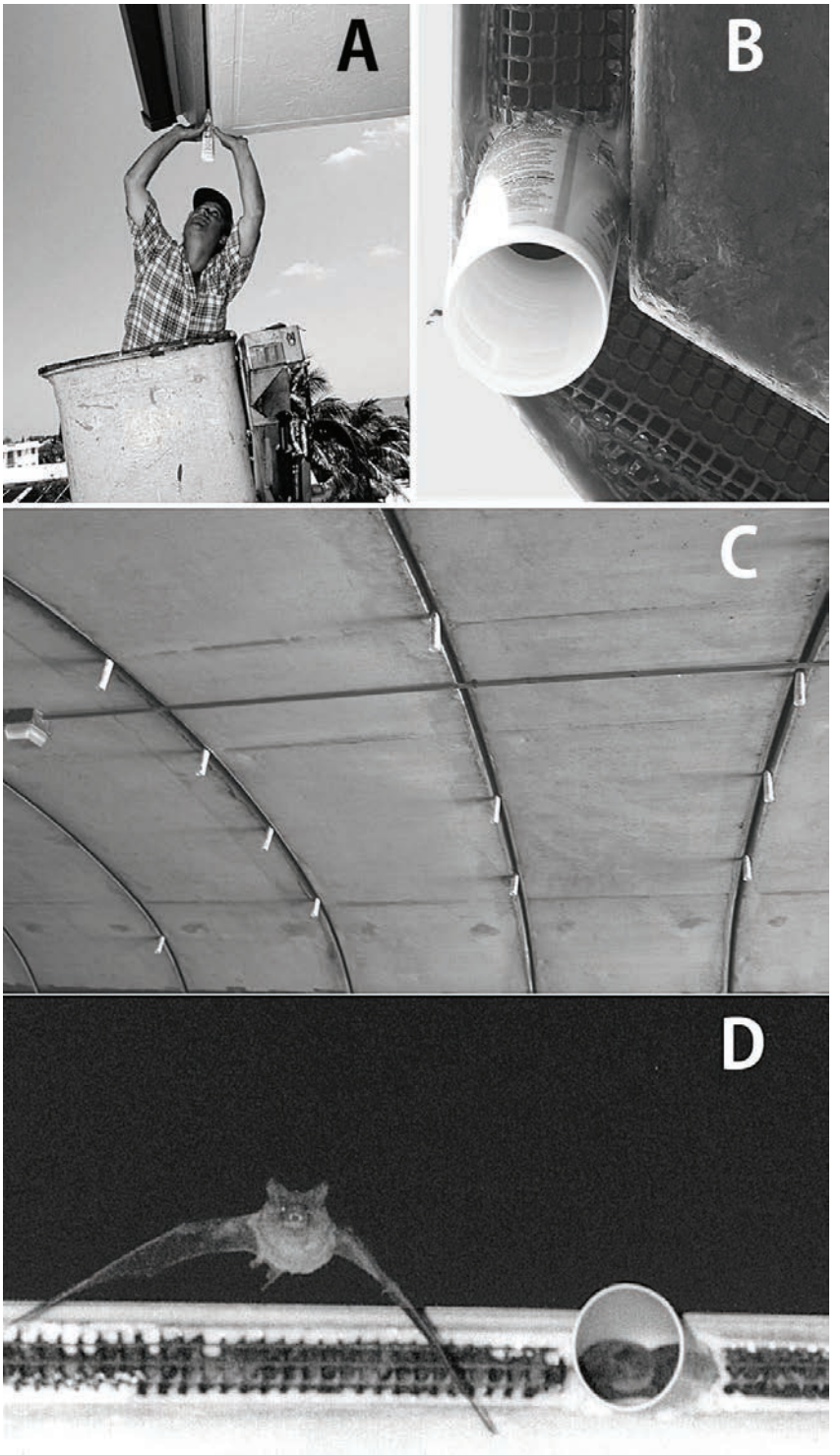

Fig. 8-5. Examples of the caulk-tube exclusion method. A) installing a recycled caulk tube at an exclusion site. B) close-up of installed caulk tube. C) heavy-gauge mesh placed between exit tubes and attached securely using adhesive caulk. Installing many exit tubes mitigates bat entrapment during emergence. D) bats exiting a roost through a modified caulk tube. A) photo courtesy of Mark Kiser, © Bat Conservation International; B-D) photos by Laura S. Finn, © Fly By Night, Inc.

is being conducted. First install an exit tube at the widest opening into the void of a building. To prevent re-entry, a near vertical placement angle is necessary. Sometimes because of difficult or unusual architecture, an exit tube extension may be needed to place the tube in an upright position (Fig. 8-6). Mesh should be attached with caulk, placing it so it flairs away from both sides of the exit tube, covering the gap completely (see Fig. 8-5a). No opening should be overlooked. As a general rule, if one can fit a pinky or little finger into a penetration, a bat can enter the void (Fig. 8-7).

Although exit tubes should be installed at all active locations (Fig. 8-8), if an active roost entry is found, leave it open and attach mesh at the point where the exit tube will be. Eventually mesh and exit tubes will have been applied at all openings around the perimeter of the structure, leaving only the primary high-activity areas for final lockout. It is impossible to install too many exit tubes, but installing too few can result in bottle necking or entrapment of bats.

Although exit tubes are not permanent, they should be securely attached so that they do not slip out of position. Any breach that allows bats to re-enter a roost requires repair or reinstallation, which prolongs the exclusion process.

Where minor structural repairs may be needed (e.g., rotten wood, rusted

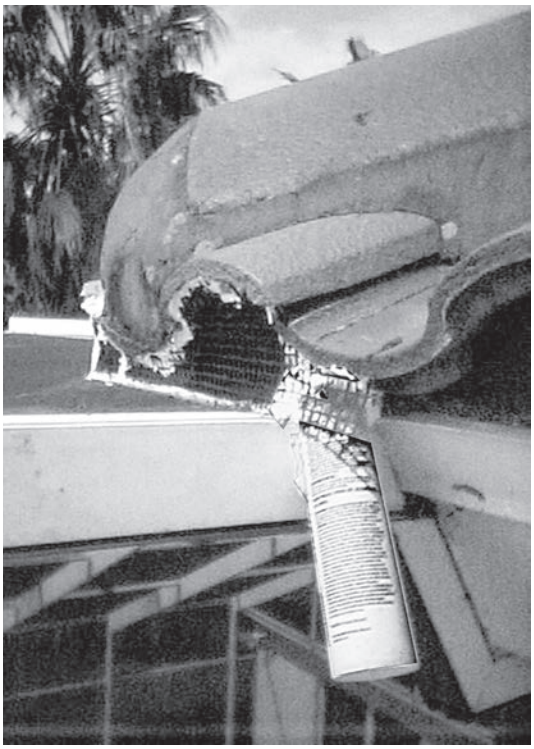

Fig. 8-6. If caulk tubes can not be placed in an upright position, extensions are needed to achieve the correct angle. Photo by Thomas G. Finn, © Fly By Night, Inc.

Fig. 8-7. "Pinky test" used to identify potential access openings. If a little finger can fit through an opening, so can a bat. Photo by Thomas G. Finn, © Fly By Night, Inc.

Fig. 8-8. Exit tubes should be installed at all active locations. Photo by Laura S. Finn, © Fly By Night, Inc.

sheet metal, broken or missing roof tiles or other damage), they should be postponed until exclusion is complete. Install mesh over the damaged areas until repairs can be made.

FINAL LOCKOUT AND SEALING

After all bat-proofing is complete, for the final lockout attach exit tubes at all entry points that were left open. It is normal for bats to swarm near the roost entrance when they return before sunrise. However, when this occurs during the first morning after a final lockout and there is no available alternate roost such as a bat house, bats are at risk of predation as the displaced animals try unsuccessfully to re-enter the roost. At this time they may also be hit by cars or impaled on bird spikes (T. G. Finn pers. obs.). Displaced bats commonly roost in the open near the roost entrance, or in other suboptimal locations (Fig. 8-9). It is best to leave them alone. Bats roosting in the open typically leave at sunset and do not return the following day.

To reduce problems during and immediately after exclusion, exterior doors and windows should be closed to prevent bats from entering the living area of a home. Pet cats and dogs should be kept indoors until all bats are gone. Neighbors and their children should be advised not to disturb bats seen roosting in the open, or pick up those found on the ground.

After the final lockout, exit tubes should not be removed until after it is determined that all bats have left a roost. Most bats do not fly during inclement weather, or when temperatures are less than 50 °F (10 °C). The general rule is to leave exit tubes in place a minimum of 5-7 consecutive nights during optimal weather conditions, with night temperatures above 50 °F (10 °C). Work should be halted if it is suspected that bats are still in a roost while exclusion tubes are being removed. In some instances, there may be bats getting around an exclusion failure or breach. At this time, materials used for the exclusion should be inspected carefully to ensure that everything is secure. When exit tubes are removed, rigid mesh should be installed at all exclusion points for final sealing.

DIFFICULT ARCHITECTURE AND UNIQUE PROJECTS

Some architectural designs and roof types, such as clay tile, shake and thatch roofs, have so many access points for bats that it may seem nearly impossible to exclude them, particularly when the structure is very large or complex. Occasionally, such bat-occupied structures may require temporary exclusion of the animals prior to maintenance or renovation. Repairs and renovations can be followed by projects that include bat-proof designs.

Tile Roofs

Clay tile roofs are often seen as problematic to bat proof (Constantine, 1979; Corrigan, 1984; Loven, 2003). Although bat proofing clay tiles is time-consuming and challenging, permanent exclusion is not impossible and can be completed successfully, using the same combination of rigid mesh, exit tubes, and adhesive caulk described earlier in this chapter (Fig. 8-10).

Fig. 8-9. After excluders are installed, bats may hang near access area(s). Photo by Laura S. Finn, © Fly By Night, Inc.

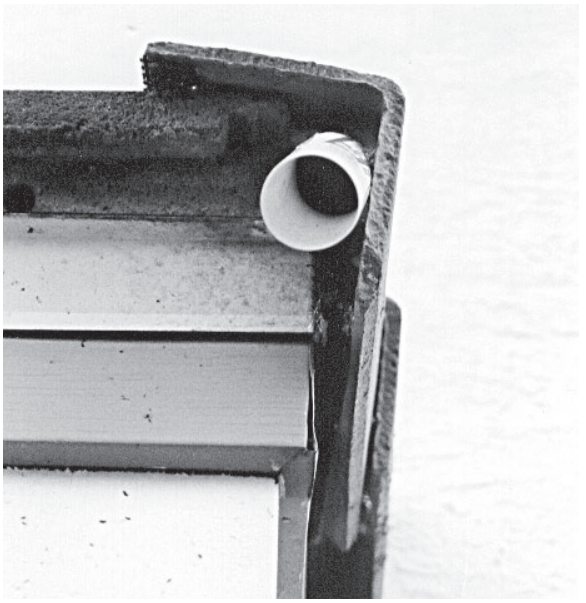

Fig. 8-10. Bats can be excluded from tile roofs using exit tubes and heavy gauge mesh. Photo by Thomas G. Finn, © Fly By Night, Inc.

Night Projects

When exclusion requires night work, such as projects in high-traffic public areas like theme parks, a thin layer of tissue paper, sand, leaves, or similar materials can be applied to cover exposed caulk while it is wet. This serves as a barrier, leaving a surface that is safe for bats instead of sticky glue. This method can also be used to camouflage exit tubes (Fig. 8-11) until they are removed

Porch Roosts

Some species such as pallid bats (*Antrozous pallidus*) use open porches, patios, or garages as temporary night roosts for feeding or social activity (Kunz, 1982). Bats are absent from these sites during the day, and insect parts or guano may be the only evidence that bats were roosting the night before. These animals can often be discouraged from roosting by attaching strips of aluminum foil or mylar balloons to the ceiling. The movement of these items in the breeze frighten the bats (French *et al.*, 2002). A smooth surface that bats can not traverse can also be created by attaching a sheet of plastic at the roost site. Course fiberglass batting tacked to the roost surface has been suggested as well (Constantine, 1979; Loven, 2003). Chemical dog and cat repellents have also been suggested (Greenhall and Frantz, 1994) as a temporary solution, but these products are not currently legally approved bat repellents and should not be used when bats are present. Bats roosting behind shutters can be discouraged by opening the shutters at night. Rigid mesh is then attached the following day to prevent future entry.

Fig. 8-11. As mentioned in the text, various materials can be used to cover wet caulk, or to camouflage an exclusion device. Photo by Laura S. Finn, © Fly By Night, Inc.

PREVENTING PROBLEMS RELATED TO EXCLUSION

Injury or mortality as a consequence of incorrect exclusion methods or attachment failures often results in bats becoming entangled or trapped. Entrapment occurs after an active exit is improperly blocked by sealing a structure at the wrong time of year or by not allowing enough time for bats to exit before sealing a roost. Bats can also become trapped inside a building after an exit is closed inadvertently by construction workers such as roofers or painters.

Evidence of entrapment includes numerous bats found alive or dead and dying in the living space of a building. Most trapped bats die of dehydration and starvation, and mortality is often hidden inside the walls and attic. Decaying bats may cause dark, moist stains on walls or ceilings, seepage near blocked roost entries (Fig. 8-12), and putrid odors. These conditions may constitute a health hazard. Although mortality in such cases may be significant, it is rarely documented. Cleanup following such an event can be costly and is totally preventable.

Fig. 8-12. When bats are trapped and die after a roost exit is blocked, decaying carcasses produce fluids that may cause seepage. In this example, seepage occurred after a roost was blocked using expandable foam. Note the difference in appearance between seepage and staining from body oils and glands shown in Figure 8-2. Photo by Laura S. Finn, © Fly By Night, Inc.

Bats are also known to enter openings in metal frames around windows, support beams for screen patio enclosures (Fig. 8-13), and light fixtures (Fig. 8-14). These can become problematic "bat traps."

Any event that significantly alters the microclimate may cause bats to move within a roost, become trapped in a void, or to leave a structure and roost in exposed areas outside, if no alternative is available.

MAINTENANCE AND PREVENTION OF FUTURE PROBLEMS

Although a structure may be bat proofed and free of bats after a project is completed, bats are generally faithful to a roost site, and if new access areas are created by squirrels or woodpeckers, lack of general maintenance, storm damage, or natural deterioration of building materials, they may attempt re-entry. To prevent re-occupation, property owners should maintain structures and make repairs as needed. Maintenance workers like pressure washers, painters, and handymen should be instructed not to disturb or remove any bat-proofing materials.

CLEANING UP AFTER BATS ARE GONE

After bats are excluded, insects and other arthropods may be noticed near guano accumulations. These are bat ectoparasites such as bat bugs, mites, and bat flies that usually die quickly in the absence of their hosts and are rarely a problem (Greenhall and Frantz,

Fig. 8-13. Hundreds of bats died accidentally at this central Florida home. Although they roosted below the roof tiles outside the pool enclosure, they sometimes exited from the tiles inside the enclosure. When they were unable to re-enter the roof tiles, they tried to leave the screened-in pool through small openings at the top of the hollow aluminum frame, where they were trapped inside the vertical support beams (top arrow). The stain on the pool deck was seepage from decomposing bats (bottom arrow), mistaken for rust by the homeowner, who also complained of a persistent odor. Photo by Laura S. Finn, © Fly By Night, Inc.

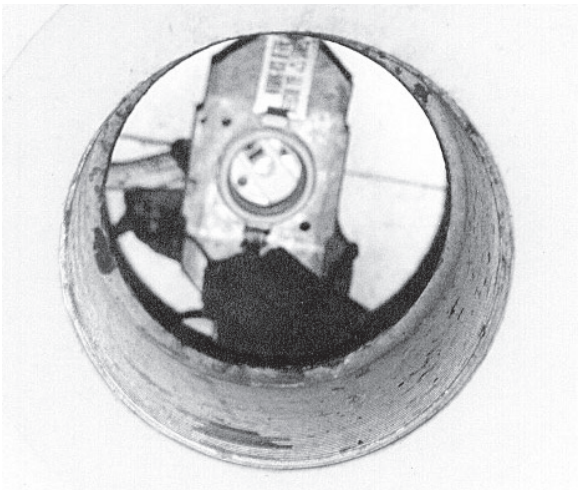

Fig. 8-14. Mexican free-tailed bats (*Tadarida brasiliensis cynocephala*) roosting in a light fixture on a porch in Jacksonville, FL. Light fixtures are often overlooked as roost sites during bat-proofing. Photo by Laura S. Finn, © Fly By Night, Inc.

1994). If parasites are a concern, application of boric acid or diatomaceous earth can provide safe long-term control.

Direct contact with bat guano or inhalation of guano dust should be avoided. However, removal of guano may be necessary if the histoplasmosis-causing fungus (*Histoplasma capsulatum*) has been confirmed or when guano is found in the living area of a house (e.g., around ceiling tiles, light fixtures, electrical outlets, or heating and air systems). Respirator masks should always be worn when working around dried guano, and both respirators and vacuums should be equipped with high efficiency particulate absorbing (HEPA) filters, effective for particles as small as 2 microns, to avoid breathing dust that may be laden with fungal spores. Before cleaning up bat guano, it is best to consult with the Centers for Disease Control and Prevention, Atlanta, Georgia, local health department, and a hazardous waste disposal company concerning safety precautions and disposal regulations.

REGULATIONS GOVERNING BATS

It is important to be familiar with local, state, and federal wildlife and environmental regulations pertaining to bats before beginning an exclusion project (see Chapter 1). Over 50% of bat species in the United States and Canada are included on official status lists, or are otherwise considered of management concern. In the United States, any chemical use by professionals is regulated by the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA), and there are currently no pesticides registered for bat control. Most states prohibit lethal bat control methods, and many require special permits or certification to work with these animals.

In the United Kingdom (UK), bat exclusion without prior notification to the proper authorities is a punishable offense. UK residents should seek guidance from one of the following: English Nature, Scottish Natural Heritage, The Countryside Council for Wales, or the Countryside and Wildlife Branch of the Department of the Environment in Northern Ireland. For additional information on bat legislation throughout Europe, see Mitchell-Jones (Chapter 1). Chapter 1 also covers bat legislation in Australia, Canada, and the United States.

DO-IT-YOURSELF OR HIRE A PROFESSIONAL?

If the services of a professional are required, homeowners should seek the following information:

- Is the company approved by Bat Conservation International's Bats in Buildings Program (see http://www.batcon.org/index.php/bats-a-people/bats-in-buildings/professional-excluders.html). In countries outside the United States, local or regional wildlife organizations or bat groups should be consulted (see also *Legislation*, Chapter 1).
- Does the professional understand the facts and provide truthful information regarding bats in buildings? Are scare and high-pressure tactics used to sell add-on services? If so, do not use the service.
- Can the professional provide proof of rabies immunization?
- Is the professional willing to provide at least three recent client references and a guarantee of two or more years?
- What rating does the professional have with the Better Business Bureau (United States) or similar agencies in other countries, and can the professional provide proof of appropriate insurance and permits?
- Does the professional plan to use the approved methods outlined in this chapter?
- Is the professional planning to trap and relocate bats? If this is the case, do not use the service.

EXCLUSION MATERIALS AND TECHNIQUES TO AVOID

Bat-proofing materials should be durable, permanently attached, preserve the aesthetics of a structure, and should not alter natural ventilation or water flow. The following is a checklist of common exclusion materials and techniques that do not work.

- Avoid using temporary materials that deteriorate quickly to close holes, such as paper towels, steel wool, or soft rags.
- Avoid using products or making structural modifications that may block natural ventilation, like hanging plastic sheeting over an active roost entrance, thereby altering roost microclimate.
- Avoid using chemical and ultrasonic repellents. These items are ineffective and do not resolve problems for the long-term. Ultrasonic devices may even *attract* bats (Tuttle, 1988).
- Avoid the use of traps to remove bats from a structure. Traps require frequent monitoring to prevent overcrowding. Furthermore, not all bats leave a roost each night, and because these animals have excellent homing instincts, they may return to their roosts, even when released far from the trap site.
- Avoid the use of silicone, polyurethane, or similar non-water-based caulk products. They are odorous, take several hours to dry, and solvents are required for cleanup.

- Avoid the use of metal window screen and metal flashing, which have sharp edges that may injure or impale bats if not attached properly.
- Avoid the use of expandable foam products at occupied sites. Foam can block ventilation and alter the microclimate. Expandable foam products can also kill bats that come into contact with the material before it dries. Dead bats have been found entombed in foam (T. G. Finn pers. obs.; Mark Kiser, pers. comm.).
- Avoid the use of flexible netting attached with duct tape. These products may be the most widely suggested and commonly used materials for excluding bats (Corrigan, 1984; Greenhall and Frantz, 1994; Kern, 1995; Loven, 2003; Marks and Marks, 2006; Tuttle and Smith, 1992b; Williams-Whitmer and Brittingham, 1995). Duct tape or similar adhesive tapes fail when surfaces are rough, coated with dust, mold or mildew, or when used in high humidity or during rain. Failure to adhere properly can result in re-entry or entrapment when a closure is breached. Installation of bird (flexible) netting is overly complicated, and there are multiple drawbacks. The most significant flaw is that the ½-in. (1.27-cm) or even the ¼-in. (0.64-cm) mesh can entangle bats (Fig. 8-15), resulting in permanent injury or death (T. G. Finn, pers. obs.; M. Kiser, pers. comm.). There is also a high risk of attachment failure and undetected bat re-entry. Flexible netting also loses integrity over time. Holes, tears or other damage can be caused by severe weather, fallen tree limbs, maintenance

Fig. 8-15. An evening bat (*Nycticeius humeralis*) caught in flexible bird netting. Photo by Laura S. Finn, © Fly By Night, Inc.

activities and birds or rodents, all of which may allow bats to re-enter a building.

- Although technically not exclusion materials, items to avoid when controlling bats are sticky bird repellents and glue boards because these are lethal traps and not approved for use against bats in most states (Fig. 8-16; see also *Dermatological Hazards from Crude Oil Substances*, Chapter 6, Volume 1). Other lethal items to avoid are wasp sprays, car exhaust, fire extinguishers, and termite tents.

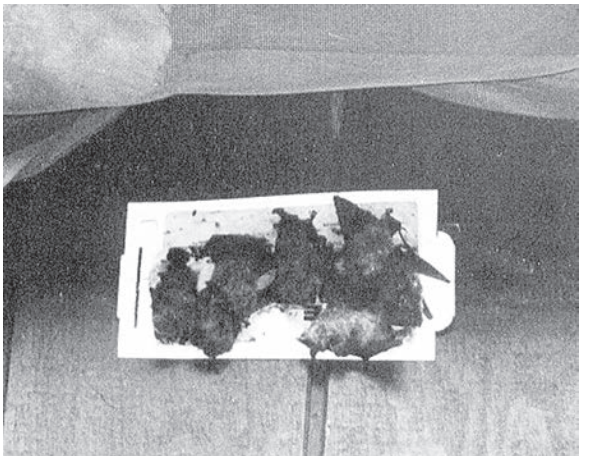

Fig. 8-16. Bats trapped on a glue board stapled below a roost entrance. The animals were left to die by the pest control operator. Photo courtesy of Elise Able, © Foxwood Wildlife Rescue, Inc.

PRODUCTS MENTIONED IN TEXT

Rigid plastic mesh (XV1170): Industrial Netting, 7681 Setzler Pkwy N. Minneapolis, MN 55445 USA; http://www.industrialnetting.com/plastic_extruded.htm.

PolyseamSeal® All Purpose Adhesive Caulk: Henkel Corporation, 1600 Executive Drive, LaGrange, GA 30240 USA; http://www.polyseamseal.com/pdf/tech_all-purpose.pdf.

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