CHAPTER 2
EXCLUSION AND RELOCATION

Bats that roost in human-occupied buildings are often considered a nuisance. Although they are not destructive, as are rodents, large numbers of bats can create an aesthetic problem when their guano accumulates on objects near the roost opening (e.g., cars, sidewalks, and the external walls of buildings) and a significant odor can often develop (Herreid, 1960). A considerable level of misunderstanding still surrounds these animals, in the general public, and bat colonies in human dwellings can create unfounded fear in the minds of the human occupants. In many states, it is legal to use poisons, sticky traps, etc., to eradicate bats from buildings. In Florida, no poisons or fumigants are registered for use against bats (see Belwood, 1992). In areas where poisons are illegal, or conservation is desired, the inhabitants are often evicted via exclusion (Greenhall, 1982; Constantine, 1982; Corrigan, 1984). A local example of exclusion was a colony evicted from the Education building at the University of Central Florida (UCF) in the winter of 1988.

Properly designed bat houses have potential as a management tool in situations that require exclusion. The goal of using bat houses for management is to provide a roost site where bats will not be a nuisance and where they will not be harassed or evicted. If bat houses are available prior to eviction of a

nuisance colony, these houses provide the animals with a potential roost site when their main roost is no longer available.

Can bats be expected to occupy a bat house when their present roost is slated for eviction or destruction? Bat houses erected before bats are excluded seem to have a slightly higher occupancy rate than bat houses erected in areas where bats have not been recently excluded from a known roost site (Bat Conservation International, 1987). In a bat house project conducted in Pennsylvania (Williams-Whitmer, 1994), bat houses placed on buildings where bats were excluded soon became occupied, while those on buildings where the bats were not excluded remained empty. The results of a relocation experiment performed in New York state (Frantz, 1989) were positive (three of five houses occupied), while similar experiments at the University of Florida (UF) and Auburn University (Kiser, 1996) were less successful. Bats moved into the UF house, but not due to any relocation attempt. They did not use this house until it had been up for almost 4 years (Anonymous, 1995; Marks, 1996).

In an attempt to populate local bat houses, I conducted relocation experiments over a period of two years (1994-1996). During my study three types of relocation experiments were attempted: (1) seeding, (2) relocation of bats, and (3) relocation of an occupied bat house.

Materials and Methods

All bats captured for use in my experiments were caught using fish nets (Cummings, landing net) and insect nets (Bioquip) with three foot handles. The design of the buildings the bats were using at Seminole Community College (SCC) made capturing animals as they attempted to re-enter the building relatively easy from either the breezeway or the flat roof. Capture of bats began 1-2 hours before sunrise as they were returning to the roost. This method insured the capture of bats with full stomachs to prevent hunger and water stress. However, bats used in the seeding experiments, which were also used in the controlled experiments (Chapter 3), were captured at night and maintained until the following morning. Placing bats in bat houses in the morning rather than at night provides a method to introduce bats to the bat house without confining them. It is my experience that bats will not leave bat houses during daylight hours.

Seeding

Seeding consisted of catching bats from a local colony and placing them into an unoccupied bat house. Close attention is not paid to locations of the bat colony source or target bat house. I hypothesized that even if the bats left, they would scent the house with their guano, and hopefully would return at a later date. Table 5 provides details on seeding experiments performed during my study.

Bats were collected from a source colony, in groups of 14-113 (x=24.2), and were placed into bat houses at the target site. The target in all experiments was 8-40 km east or northeast of the source colony. Bats were placed in bat houses as soon after capture as possible, usually in the morning or early afternoon, and were not caged.

Relocation

Relocation consisted of a focused attempt to relocate a specific bat colony to a specific bat house or bat house site. Generally the colony to be relocated was a nuisance colony and was slated for eviction Relocation in my study consisted of two types: (1) relocating bats, and (2) relocating an occupied bat house.

Relocating Bats

I am aware of at least three earlier bat relocation experiments (Cope, 1959; Anonymous, 1995; Franz, 1989) in the United States. In these experiments bats were captured in the evening as they left the main roost and were transported to the bat houses. Some of the animals were caged up to 24 hours. The experiment I performed was very different in its protocol and extreme care was taken to stress the animals as little as possible.

A mixed colony of *Nycticeius humeralis humeralis* and *Tadarida brasiliensis cynocephala* was in residence in the Science/Library building at SCC, Sanford, Florida, for at least the past 10 years. The colony consisted of over 1000 bats.

Build-up of guano was significant in the attic, below the areas where the bats were roosting. Twenty-five 10 gallon bags of guano were removed from the Science building at a later date, evidence of the length of time the bats had occupied this building. Due to this build-up of guano, the distinctive odor of *Tadarida* permeated the buildings. Bats were causing aesthetic problems and on at least one occasion caused secondary student injury (upon seeing a bat, a college co-ed ran out of the women's rest room, and hit a wall knocking herself unconscious). Finding dead or grounded bats in and around the campus buildings was an almost weekly occurrence. A decision was made to exclude the bats from the buildings. In preparation for the exclusion eight bat houses were erected on SCC property (Chapter 1, and Appendix B), .4 km from the main roost. An attempt was made to relocate bats from the campus buildings into the bat houses, while the exclusion was being performed.

Entryways used by bats at SCC were small expansion areas between two concrete slabs (Figure 4). The bats entered through this space and traveled under the metal flashing attached around the perimeter of the building. Bats were never found roosting in the open attic spaces. They remained localized on the extreme edge of the building in the concrete expansion joints and under the metal flashing. The west and south sides of the building seemed to be preferred, but some activity also occurred on the east side. The north side was occupied on only one occasion. Due to the design of this building, it was impossible to make

observations concerning behavior in the roost (e.g., exact location, clustering, species composition).

The exclusion was begun in April 1995. All buildings that did not contain bats had all small openings sealed with .55 cm metal hardware cloth or polypropylene mesh (Tensar, heavy duty hardware net) secured with siliconized latex caulk (Red Devil, Lifetime) to prevent bats from later entering. After the potential alternate roosts were preventively sealed, exclusion on the main buildings began (4 May 1995). This late exclusion date was made necessary by the class schedule at the college. All efforts were made to monitor the reproductive condition of the colony to prevent the possibility of sealing nonvolant pups inside buildings.

For bat occupied buildings, the exclusion occurred systematically by first sealing inactive holes as described above. Then active holes were covered with excluders made of fiberglass window screen, and secured to the building on the top and sides with duct tape. As the exclusion progressed, bats were eventually localized to a few key areas that were logistically difficult to exclude and were left open until late summer.

While the exclusion was taking place, I captured bats in the early morning as they attempted to return to the building. Captured bats were placed into clean, empty, 5 gallon buckets lined on the lower half with fiberglass screen or cotton rags. This lining allowed bats to hang in a normal fashion. Cloth rags were placed on the bottom of the bucket to absorb urine and guano, in an attempt to

keep the animals as clean as possible. A 53 cm piece of cotton sleeving (Bioquip, stockinette sleeve) was attached with duct tape to the mouth of the bucket. This material enabled easy closure of the bucket (without increasing humidity), with a clip or knot.

Once bats no longer attempted to return to the building (usually 20-30 minutes after sunrise), captives were transported to the bat house site, .4 km away (see Appendix B). Bats were identified to species, reproductive condition was determined, and interesting markings or injuries were noted. To minimize stress to the animals, additional detail (weight, wing measurements, etc.) was not collected. Bats were not banded at this time, but I did make note of several bats of both species that had been banded on an earlier date and released at another bat house site during the seeding experiments.

After processing, bats were injected into bat houses in groups of not less than five bats per house. Over a period of eight days an average of 58.23 bats per day (range 13-127) were injected into all bat houses on this site (Table 6). No attempt was made to confine the bats to the bat houses once night-fall came. The relocation and exclusion were discontinued when a lactating *Nycticeius* was captured on 12 May 1995.

Bats were captured from the last remaining areas of the building on several dates in July to determine reproductive status. On 22 July, volant *Tadarida* pups were captured. At the request of the college administrators the relocation and exclusion was continued on this date (I probably should have waited until

mid- to late-August to be positive of volancy and weaning of all pups). Bats were again captured while returning to the roost in the early morning and injected into the bat houses on two dates in late July. The exclusion of the main roost was then finalized and bats could no longer enter the campus buildings.

Relocating an Occupied Bat House

In August of 1993, I became aware of an old, two-story brick building located in downtown Sanford (roughly 3.13 km north of SCC), which was the site of a moderate-sized colony (200-500) of *Tadarida* and *Nycticeius.* The bats inhabited the first story awning that was badly deteriorated and weathered (see Appendix A: Aikins, for more detail). In June 1994, a BCI large maternity bat house (natural stain, no insulation) was mounted on the east side of the building, 1.3 meters above the main colony entrance. At this time I began to monitoring the thermal profile of both the roost and bat house. Bats did not occupy the bat house until late winter 1995/6.

In December 1994, the building was sold to a local realty company and in June 1995, the lower half of the building was leased to a local minister and became 'Lion of Judah House of Worship.' The new tenant was not open-minded about the bats and wanted them exterminated.

Florida Game and Fresh Water Fish Commission (FGFC) guidelines (FGFC, 1995) on eviction of bats from buildings recommend exclusions not be performed during maternity season (1 May - 1 September, in Florida). The new tenant was

made aware of these guidelines, but was not respectful of them. On 11 June the awning that housed the main colony was torn down under his direction. The adult bats (primarily *Nycticeius*) flew into the nearby bat house, that was already populated by a colony consisting primarily of *Tadarida*. However, the pre-volant juveniles fell to the sidewalk in front of the building. After receiving a phone call from the building owner, I arrived to find fifty to 75 *Nycticeius* pups and four adults with young had been swept against the wall, and behind a sheet of plywood, with a push broom. I collected the animals and placed them into a holding bucket. They were injected into the populated bat house in hopes they would be reunited with their mothers. The tenant continued to be uncooperative and now wanted the bat house removed from the property.

The occupied bat house was removed from the building the morning of 15 June 1996. Polypropylene mesh was attached to the bottom of the house to prevent bats from exiting during the move. A site 8 km northeast was chosen as the new location and the house was mounted on the east side of a one-story residence.

Results and Discussion

Relocation experiments must be designed with the homing instincts of bats as a consideration (Cope, 1959). Both *Tadarida* and *Nycticeius* home well (Davis, 1966; Cope and Humphrey, 1967) and I observed behavior during and after the SCC exclusion that suggested strong site fidelity by these animals.

Seeding

At least one local nuisance wildlife control operator advocates seeding bat houses to his clients. I am aware of several occasions when this was attempted unsuccessfully. In order to test the hypothesis that seeding bat houses is useful, I performed thirteen seeding experiments. In an attempt to optimize the possibility of bats returning to the bat houses I did not confine them. I believe that stressing bats by caging them in an unfamiliar location will result in the animals leaving the area immediately upon release in a defensive-escape response. However, most of the bats used in the seeding experiments were used in the controlled experiments of bat house preferences (see Chapter 3). Those animals were captured in the evening and used in the controlled experiments that night, before being placed in the bat houses in the morning. They surely underwent some stress due to the length of time they were held, and to handling for banding and measuring purposes.

When the bats left the bat houses in the evening, it was usually early enough for me to make visual observations. Invariably the bats behaved the same way. They would exit the house, then fly around the property and circle the bat houses three or four times. After a minute or two of 'orienting' they generally flew in the direction of 'home'. In none of the 13 seeding experiments I conducted did bats return to the target bat house after the evening exodus. Bats used in the flight cage experiments (Chapter 3), which were also used in the seeding experiments,

were banded, and many were later recaptured back at the source colony 10.3 km to the southeast.

Seeding bat houses does nothing more than stress the animals involved and likely increases the risk of mortality due to predation or exposure in unfamiliar territory. Due to the homing ability of bats these animals probably attempted to return to their 'home' roost or to an alternate roost in the familiar area (Leffler et al., 1979). I can not recommend seeding as a means to populate a bat house under any circumstances, and I would be skeptical of anyone who made a claim that this practice would result in successful occupation

Relocation

Relocating Bats

Bats were captured during their return to the roost in the morning and injected into the bat houses; however, these bats were free to leave. It was expected they would attempt to return to the original roost (Davis, 1966; Cope, 1959; Cope and Humphrey, 1967) after leaving the bat houses in the evening. Upon return to the excluded roost, the bats would either go to alternate roosts in the area (Leffler et al., 1979; Clem, 1993) or accept the bat houses as a new roost site.

After the bats in the SCC buildings were excluded, they were tenacious in their attempt to re-enter the roost in the morning and many continued until after sunrise indicating strong site fidelity. Bats were seen roosting in exposed areas

immediately after the exclusion. At this time I witnessed the taking of bats by fish crows (*Corvis ossifragus*) on several occasions.

Table 6 details the activities that took place during the relocation attempt. One week prior to this, a single *Tadarida* was noted in the NW small maternity house. This was the first time a bat had been seen in any of the eight houses on this site since their placement one year earlier. A single *Nycticeius* was noted in the same bat house on the second and third morning of the relocation. The morning prior to this two pregnant *Nycticeius* were placed into a nearby bat house. It is not known if this was one of those bats or if it was the same animal both mornings.

Bats first began to return to the bat houses on the fourth morning of injecting bats into bat houses at the SCC site. The northwest (NW) small maternity house had an even mix of *Nycticeius* and *Tadarida* consisting of a minimum of 20 animals. The relocation continued for another four mornings and bats were injected into bat houses. At the end of the eighth morning the NW small maternity house contained 75 -100 bats of both species. These bats had returned to the bat house on their own. Although a single bat was noted in the SE small maternity house and in each of the large maternity houses on the fifth morning, these were slow to gain occupancy. Within two weeks, bats using the NW small maternity house were too numerous to count. Four days later, bats were found in the SE small maternity, most were in the middle chamber.

Three weeks after the relocation attempt and successful occupation of the bat houses, I began to notice the fiberglass window screen, which was used as a liner in the roosting chambers, was beginning to deteriorate and was hanging out of the bat houses. At this time I also noted that *Nycticeius* pups were present in the SE small maternity house. Both small maternity houses were occupied.

By 1 July, nearly two months later, very few bats were in any houses, and by 9 July all bat houses were again empty. *Tadarida* pups would not have been volant by this date and it was never confirmed that *Tadarida* used the bat houses as a maternity site during this occupation. *Nycticeius* pups, however, would have been volant by this date and probably flew away with the adults. The failed fiberglass screen was theorized to be the main cause of the abandonment. It was removed as well as possible from all bat houses.

A maternity group of *Tadarida* remained in the two roost areas left open on the SCC campus. After the pups were confirmed to be volant, the relocation was resumed. On two dates in late July, bats were captured at the building as they returned in the morning and the exclusion was completed. Bats were injected into all of the maternity houses. They again began to return to the small maternity houses.

In December 1995, bats began to occupy the large maternity houses. In November, some modifications were made to them. Polypropylene mesh was added to the landing pad in an attempt to make it easier for the bats to enter the houses, and the Reflectix insulation was removed. The small maternity houses,

which the bats seem to prefer, still had insulation and did not have a landing pad.

At the time of this writing (April 1997) bats are still present in the SCC bat houses. Bats are now utilizing all four of the maternity style houses. The simple style houses remain empty and although small numbers of bats have been seen in the two larger houses on several occasions, they remain largely unoccupied.

Exclusion of a bat colony can lead to an increased mortality rate. Lack of suitable alternate roosts can result in increased predation. Although excluded bats probably move into alternate roosts in the area on most occasions (if they are available), provision of bat houses prior to an exclusion can be successful and beneficial to the bats. If the persons or company performing the exclusion have the time necessary for a thorough relocation effort, it should be attempted. As illustrated in this relocation experiment, it can be a success if the following factors are taken into consideration: (1) the bat houses used should be a style that is known to be acceptable by the target species; (2) the bat houses should be located as close to the original roost as possible; (3) repeat the relocation attempt at least five mornings; (4) if possible begin the relocation prior to the exclusion in order to introduce the bats to the potential alternate roost site; and (5) limit stress to the animals as much as possible.

Bats often have alternate roost sites in the area, and are loyal to these sites. If adequate alternate roosts are available, the bats will generally opt to utilize these familiar areas rather than unfamiliar bat houses (see Appendix A: Sea World, for details of another, not as successful, relocation experiment). A

successful relocation will not only utilize proper eviction and exclusion techniques on the building used by the bat colony, but will also attempt to preventively seal and exclude potential alternate roosts in the immediate area.

Relocating an Occupied Bat House

I witnessed *Tadarida* and *Nycticeius* roosting side by side like 'spoons in a drawer,' in the awning roost at this site (Aikins) on earlier dates. They had apparently segregated during pupping season. Although there was still some mixing, the majority of the bats in the awning were *Nycticeius* while most of those in the bat house were *Tadarida*. *Nycticeius* adults utilized the bat house after their awning roost was destroyed and I placed their nonvolant pups into the house. Within two days, most of the *Nycticeius* abandoned the bat house, presumably carrying their pups with them (see Davis, 1970).

The occupied bat house was moved the evening of 15 June and mounted at the new site. I counted a minimum of 126 bats leaving the bat house. My inspection revealed many bats, primarily *Tadarida*, (>50) remained inside. The following evening only 13 bats were seen to exit, while a large number remained. The bats remaining in the bat house were *Tadarida* pups, pinkish in coloration and with no fur. On 20 June, the pups began to hang close to the bottom of the bat house and on 21 June, six days after the move, I recovered the first starved pup. At that time I attempted to remove the *Tadarida* pups from the bat house

in an effort to hand-raise them. A total of 39 starving and emaciated *Tadarida* pups were eventually removed from the bat house.

During the time the *Tadarida* pups were starving, a small population of adult *Nycticeius* remained within the bat house and with the *Tadarida* pups. These bats had not vacated the bat house after the move. I witnessed *Tadarida* pups crawling on *Nycticeius* adults and attempting to nurse. On several occasions *Tadarida* pups were 'nursing' on the faces and shoulders of *Nycticeius* adults. I never observed a *Nycticeius* adult allowing a *Tadarida* pup to nurse. They, however, did not react adversely to the presence or activity of the pups; the *Tadarida* pups were simply ignored.

Conditions were suitable in the relocated bat house for *Nycticeius* and these bats remained on site, often moving between other bat houses on the property for 2 months after the bat house relocation. Literature accounts of *Nycticeius* abandoning a roost that was disturbed (i.e., Watkins, 1970) led me to believe it would not be appropriate to determine age or sex of these *Nycticeius* adults (all animals were volant, but it is possible some of the animals were juvenile). After the *Nycticeius* colony disappeared on 19 August 1996, I was glad I had not disturbed them and would have blamed the exit on my intrusion. That these bats left in mid-August was not surprising. I am aware of at least two other central Florida *Nycticeius* colonies that showed this behavior (See Appendix A: Paisley, and Stevens). Although this species is present year-round in central Florida, some aspect of its summer roost requirements changes and the animals often

leave maternity roosts for other fall and winter quarters. Bain and Humphrey (1986) reported *Nycticeius* to be predictably absent from a north Florida roost only in mid-April. They hypothesized that perhaps the bats were using a tree hollow or other similarly enclosed roost site that would be more thermally stable to endure the late winter months.

Although this small group of *Nycticeius* remained with the bat house after it was moved, the *Tadarida* adults were highly stressed, and left soon after, resulting in high mortality of the pups. It is not known why the *Tadarida* adults did not attempt to move their pups to a new site. I hypothesized that the presence of young in the bat house relocation would play a factor in the bats activity and that either (1) all the bats would leave with their pups, or (2) that the bats would return to this bat house to care for their flightless pups. I did not anticipate that adults would leave nonvolant pups to starve.

Four days after the bat house was mounted at the new site, another set of bat houses was added that may have been more acceptable to *Tadarida*. I suspect the relocated bat house was placed in an area that was suboptimal for this species. The bottom of the bat house was only 2.6 m above ground and a small aluminum shed was within 1.05 m of it. When bats were exiting the first night, I witnessed several bats (presumably *Tadarida*) hit the tool shed and saw one fall to the ground. Given the lack of maneuverability (in cluttered spaces) in the Molossid family (Norberg and Rayner, 1987), I believe these bats may have

remained if the bat house had been mounted higher and in a more open area or if other houses of that fashion were already in place as alternate roost sites.

The relocation of an occupied bat house should be performed only as a last resort and never during maternity season. In areas where bats are absent during the colder months of the year, moving a bat house to a new site can be done while the bats are absent. However, in Florida these conditions may not occur. Careful planning should accompany any bat house relocation and should include the following: (1) the bat house should remain as close as possible to the original site; (2) bat houses should not be moved during maternity season; (3) if a maternity season move is unavoidable, care should be taken to monitor the bat house for the potential of abandoned pups; if present, pups should be immediately removed and turned over to a qualified wildlife rehabilitator; and (4) the bat house should be placed in an optimal site (greater than 3.96 m above ground, with the opening and surrounding area unobstructed).

It is unfortunate that FGFC recommendations not to disturb bat colonies during maternity season are only recommendations and can not be enforced. Although Florida bats are protected by a loophole because no poisons or fumigants are registered for use against bats in the state, little is done to protect bats from exclusion during maternity season. Although exclusion is legal, it leads to increased mortality, and if alternate roosts are not available where bats will not be harassed or excluded in the future, they will continue to undergo decreases in population numbers. If, however, bat houses are available and

used by bats, and the land owner later decides the bat house is no longer wanted, the problem has not been solved. Any homeowner accepting the placement of a bat house on his/her property should be certain the animals will be allowed to remain should they colonize the bat house.

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BAT HOUSE USE IN CENTRAL FLORIDA, WITH EMPHASIS ON *Nycticeius humeralis* AND *Tadarida brasiliensis cynocephala*

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