IX. GUIDANCE FOR SCIENTIFIC ACTIVITIES

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Our knowledge of the natural history of bat species is less comprehensive than that of most other groups of mammals in Colorado. This lack of knowledge is due in part to the difficulties in the observation and identification of bats. Bats are small, nocturnal mammals that are generally silent to the human ear, and very mobile due to their flight abilities. In our efforts to learn more about bats, the development of research techniques continues to rely heavily on new technologies. Some techniques have adversely impacted individuals or significant portions of bat populations such improper banding techniques. Both field and lab techniques disturb bats to some degree and every attempt should be made to develop research techniques that maximize the collection of appropriate data while minimizing impacts to the bats.

We address four categories of scientific activities commonly used to study bats that have potential to negatively affect these animals: research, inventory, and monitoring at roosts; trapping and handling; marking; and telemetry.

RESEARCH, INVENTORY AND MONITORING

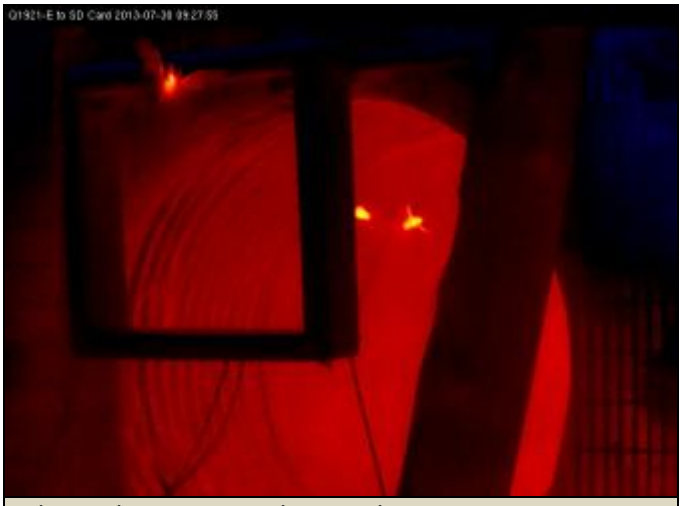
A number of guidelines and protocols have been developed to assist with the research, inventory, and monitoring of bats in Colorado. Any work proposing to capture and/or handle bats in Colorado requires a scientific collection permit from Colorado Parks and Wildlife (CPW). Each permit will include stipulations dealing with bat specific concerns that must be followed. CPW has also developed bat capture and handling guidelines that detail the use of acceptable techniques as well as standards and expectations (Neubaum and Jackson 2016).

GOAL

FOLLOW ESTABLISHED TECHNIQUES AND PROTOCOLS FOR RESEARCH, INVENTORY, AND MONITORING AT ROOSTS.

Objective 1: Monitoring of maternity roosts should be conducted by external evening exit counts when possible. The use of thermal and infrared imaging equipment is recommended to attain more accurate counts. Passive techniques such as acoustic recordings may also be useful. In Colorado, counts should be conducted from late May–late June, after the entire colony has returned to the roost but 1–2 weeks prior to parturition of the species. This "window" may vary by elevation, with higher sites in the mountains starting several weeks later than desert and plains locations. The roost may require several visits for this window to be ascertained. Roost counts in future years should be conducted as close to the same dates as possible. See Kunz et al. (2009) for a detailed discussion of

techniques recommended for counting maternity colonies and other roosts. Navo (2001) provides additional information for conducting such work at abandoned mines.



Thermal imaging used to conduct exit counts at mine entrance. Photo by D. Neubaum.

Because maternity roosts can be sensitive to disturbance, they should not be entered unless absolutely necessary. Under no conditions should animals be removed from or disturbed in a nursery cluster unless approved by an animal care and use committee. Harp traps should be used when capturing bats at maternity roost entrances. Any netting of bats at these roosts should be conducted outside the roost and away from the roost entrance when possible.

Objective 2: Because of the possible negative impacts of disturbance to hibernating bats, monitoring at hibernating sites should be kept to a minimum. Hibernacula should not be entered more than once every 2–3 years unless absolutely necessary. Surveys should be conducted as quickly and quietly as possible (Navo 2001).

TRAPPING AND HANDLING

Trapping is fundamental to many inventories and research studies. Species identification is difficult for *Myotis spp.* without handling individuals, and bats must be captured for markings or telemetry to be affixed. Trapping methods have improved substantially over the years, but all methods can adversely affect bats if done incorrectly. Bats can be captured during emergence from roosts, and while foraging or drinking away from roosts. Of these, capturing bats away from roost sites while they are foraging or drinking is expected to cause the least disturbance. Bats will often switch roosts (often to lesser-quality sites) in response to trapping at the primary roost. More significantly, capture during hibernation or lactation disrupts critical energy budgets required for these life stages. The proposed research question will often determine when trapping and handling occurs but it is important to understand the anticipated response of bats to these activities during different seasons. Hand capture, hand nets, bucket traps, bag and funnel traps, mist nets and harp traps all pose a risk of direct injury to bats. All trapping methods share the common issue of causing stress to the individuals

Bat caught in mist net. Photo by D. Neubaum.

captured. In addition to these risks, the onset of White-nose syndrome (WNS) in North America has created a situation where trapping and handling bats may expose uninfected individuals to the disease. More detailed information on trapping and handling can be found in Neubaum and Jackson (2016) and Kunz et al. (2009).

GOAL

MINIMIZE STRESS AND DISEASE TRANSFER TO BATS BY ENSURING THAT ALL FIELD STAFF HAVE RECEIVED THOROUGH TRAINING ON CAPTURE AND HANDLING METHODS.

Objective 1: Follow standard bat trapping and handling protocols, such as the CPW Bat capture and handling guidelines, to minimize disease transmission, disruption and stress to bats.

Objective 2: Encourage the Colorado Bat Working Group to host bat trapping workshops that educate researchers.

Objective 3: Encourage the use of passive techniques such as acoustic detectors where feasible.

Bat marked with glow tag. Photo by K. Keisling.

Objective 4: Implement US Fish and Wildlife Service (USFWS) WNS decontamination measures, as required by CPW permit stipulations, to ensure that capturing and handling bats does not spread diseases (see https://www.whitenosesyndrome.org/topics/decontamination for USFWS Decontamination Protocol).

RESEARCH NEEDS

- Develop new trapping techniques that minimize stress on bats.

MARKING

Marking bats is typically used to study general population dynamics and movement patterns. All marking techniques have the potential to affect the survival of the bats under study. The use of metallic and plastic bands has been borrowed from techniques developed for birds and has been employed since the 1940s. More recent marking techniques include the use of necklaces (made of either beaded keychains or plastic ratchet loops) and Passive Integrated Transponder (PIT) tags. Additionally, light marking of individuals to study real-time movement patterns has employed Light Emitting Diodes (LED), reflective tape, and chemiluminescent and Betalight markers.

All of these marking techniques require the capture and handling of bats which can alter their energy budgets, cause roost-site abandonment, and stress animals. Metallic bands, PIT tags and necklaces can

affect mobility and even cause direct injury if inappropriately applied, and bats must be recaptured either in hand or by a PIT reader to determine identity. Plastic bands and light tagging/marking techniques help minimize the need for recapture, but still may affect mobility, cause wing damage, and increase predation. More detail can be found on all of the marking techniques in the CPW Bat capture and handling guidelines (Neubaum and Jackson 2016) as well as Kunz and Weise (2009).

GOAL

MINIMIZE IMPACTS TO BATS USED IN RESEARCH BY REFINING CURRENT MARKING METHODS WHERE NECESSARY AND DEVELOPING LESS INVASIVE TECHNIQUES.

Objective 1: Limit the banding of bats to necessary and justified research proposals. Due to past problems associated with banding of some species, banding studies will need to provide good justification with clear and obtainable objectives to CPW when applying for a scientific collection permit. Banding of bats should only be conducted by experienced bat biologists, preferably using lipped bands. Band numbers and banding locations must be documented and provided to CPW for future reference. Widespread and indiscriminate banding of bats is discouraged. Banding of a large percentage of any one colony is discouraged and should not be permitted unless accompanied by clear scientific objectives that harm to bats will be limited.

Objective 2: Work with bat researchers to target less-sensitive bat populations for studies.

Objective 3: Encourage the use of marking techniques such as PIT tags that limit the need for recapture of individuals. Share techniques and improvements so that others are aware of pros and cons of methods.

Objective 4: Encourage use of developed protocols that minimize adverse effects from marking bats (see CPW Bat capture and handling guidelines).

PIT tag reader and antenna outside of mine entrance to detect bats that have had PIT tags implanted. Photo by D. Neubaum.

RESEARCH NEEDS

- Develop less invasive marking techniques.
- Investigate analytical methods that minimize the need to mark individuals.

TELEMETRY

Radio-transmitter technology has allowed researchers to learn about movement patterns and roosting behavior for most North American bat species. Keeping transmitter-to-bat body weight ratios below 5%

(Aldridge and Brigham 1988) has been shown to minimize adverse effects to bat movements and has been shown not to affect long-term survival (Neubaum et al. 2005) for some species. This weight limitation is often accomplished by using smaller, shorter lived batteries which makes tracking of bats, particularly those migrating, less successful. In addition, these transmitter weight limits restrict what knowledge is collected on smaller species, such as *Myotis* and *Parastrellus*. It is currently unknown if bats can accommodate heavier radio transmitters as few studies have exceeded the "5% rule" and included long-term tracking of individuals.

Bat with radio transmitter. Photo by D. Neubaum.

Objective 1: Encourage use of the "5% rule" for all bat radio work.

Objective 2: Recommend that bat research using radio-transmitters at levels exceeding 5% of body mass only do so if they are able to also track long-term survival.

RESEARCH NEEDS

- Evaluate the long term survival and condition for radio tracking species inhabiting heavily cluttered areas where maneuverability and high energetic demands are a concern.
- Design a research study to test long-term survival and condition of bats where radio-transmitter size exceeds the "5% rule".

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