

**Western Bat Working Group  
2005 Biennial Meeting  
Portland, Oregon**

**Cooperative Efforts to Assess the Impacts of Wind Turbines on Bats**

**Edward B. Arnett, Bat Conservation International, Austin , TX .**

Unexpectedly high numbers of bat fatalities reported at wind energy sites on ridge tops in the eastern United States have heightened the urgency to understand problems and identify solutions. The Bats and Wind Energy Cooperative was formed in 2003 by Bat Conservation International (BCI), the US Fish and Wildlife Service, the American Wind Energy Association (AWEA), and the National Renewable Energy Laboratory of the US Department of Energy (NREL). The cooperative is an alliance of state and federal agencies, private industry, academic institutions, and non-governmental organizations interested in cooperating to develop and coordinate research opportunities and identify solutions to prevent or minimize threats to bats posed by wind turbines. Here, I present an overview of the Cooperative and issues surrounding wind energy development, present our current state of knowledge, and discuss pre- and post-construction monitoring approaches, data needs, and limitations.

**Interactions Between Bats and Wind Turbines in West Virginia**

**Edward B. Arnett\* and Jason Horn , Bat Conservation International, Austin, TX (EBA), Department of Biology, Boston University, Boston, MA (JH).**

We used thermal imaging cameras to observe and document how bats behave while flying throughout the rotor-swept zone of wind turbines and conducted multiple full-night observation periods from which we enumerated and classified bats and insects aloft, scored behavior types, and collected variables that might be predictors of collisions. We also tested the effects of FAA aviation lighting on bat activity and number of collisions. We observed a total of 2,407 observations: 998 bats (41%), 503 insects (20%), 37 birds (1%), 2 aircraft (0.1%) and 866 unknown (35%). There was a significant difference in the number of bat passes observed on a nightly basis ( $n=10$ ,  $t=3.3664$ ,  $p=0.008$ ) and insect activity also was variable, but relatively proportional to bat activity. There was a significant, positive correlation between insect passes and bat passes observed across all nights ( $R^2=0.51$ ,  $F_{.05(2), 9, 9}=4.025$ ,  $p=0.039$ ). Average turbine RPMs was a significant, negative predictor for bat activity ( $R^2=0.42$ ,  $F=5.91$ ,  $p=0.04$ ). The number of minutes that average wind speed was under 4 m/s was a less significant negative predictor of bat activity ( $R^2=0.22$ ,  $F=2.3134$ ,  $p=0.1668$ ). Bat activity appears to be bi-modal is conspicuously higher in the first two hours after sunset and then tapers off, peaking again between 0330 and 0430 hr. We rarely observed contact with moving blades; 7 times out of a total 1,458 passes (0.4%). Contact was only observed with moving blades. In no cases did we observe a bat striking the turbine tower, nacelle, or still blades.

## **Technique for Nocturnal Airborne Tracking of Foraging Bats**

**Robert D. Berry, Brown-Berry Biological Consulting, Bishop, CA**

Aerial telemetry is the best way to significantly extend the radio reception range of tiny 0.5 gm transmitters mounted on bats. A light aircraft provides complete freedom of movement of the receiver while searching a wide area to locate the foraging areas of the telemetered bats. Over the past five years, we have conducted five radio-tracking sessions to determine foraging habitat and roost locations of *Leptonycteris nivalis*, *Macrotus californicus* and *Idionycteris phyllotis*. Cessna 150 and 172 aircraft are equipped with two scanning telemetry receivers connected to antennae on each wing strut. The recorded scanning receiver information is correlated with aircraft position, speed and heading data to determine the position of the transmitted bat at night with no terrain visible. Some of the practical aspects of night flying and tracking will also be covered.

## **A field recording technique to passively collect and time tag echolocation calls from free flying bats using a time expansion bat detector and a Digital 8 video camcorder**

**Robert D. Berry\* and Joe M. Szewczak, Brown-Berry Biological Consulting, Bishop, CA (RDB), Humboldt State University, Arcata, CA (JMS)**

Many bat biologists use the Anabat 6 software for passive monitoring of bat activity using a frequency division bat detector (Anabat II) connected to a laptop computer. Advances in computing technology and availability of full frequency spectrum analysis software (Sonobat) have sparked new interest in a more complete analysis of echolocation signals. A new technique is available to passively record echolocation calls in the field using an automatically resetting time expansion bat detector (Pettersson D240x) with a Sony Digital 8 camcorder. The camcorder automatically time tags every frame of video/audio data and stores it in a digital format. The camera's automatic gain control adjusts the sound level for maximum resolution in a 12 bit format. Sony's DV (i-link) connection to a VAIO laptop operating DV Gate software allows direct downloading of the digitally recorded stereo sound channel into a standard wav file on the PC with zero distortion. The DV Gate software provides precise selection of both starting and stopping frames from the camcorder which allows the user to precisely index the sound recording time to the camcorder clock. Software is being developed to search the hour long wav file now residing on the PC for time periods with bat calls and create time-tagged sub files for full frequency spectrum analysis using SonoBat. The technique is particularly well suited for passive recording of bat roost outflights where a visual as well as audio recording is desired to aid species identification.

## **The Effect of Fuels-Reduction Silvicultural Treatments on Bat Activity: Results from 2004.**

**Burr J. Betts, Eastern Oregon University, La Grande, OR 97850.**

Removal of dead wood is designed to reduce catastrophic fires, but we know little about the effect of such treatment on wildlife. I am investigating the effect of fuels reduction on bat activity in Starkey Experimental Forest in northeastern Oregon. In 1999, prior to

logging in 2002, I established 9 sample sites composed of 3 replicates of a control, a burn treatment (logged and slash burned), and a removal treatment (logged and slash removed). I used Anabat detector equipment to record bat calls on 3-6 nights during each of 4 weeks in mid-summer. Here I present the results from 2004. I predicted that the treatments would cause an increase in activity of species that forage in the open and a decrease in activity of species that forage in clutter. I also predicted that overall bat activity would increase. I classified 4711 call sequences into species groups or as “unknown”. As predicted, I found a significantly higher percentage of calls of clutter-avoiding species in all treatment sites combined compared to controls, but contrary to my prediction I found no significant differences between control and treatment sites in the percentage of calls reliably identifiable as clutter-foraging species. However, there were significantly fewer calls in treatment sites of sequences that I could only identify as from a *Myotis* species. Many of the latter may have been calls from other clutter-foraging species given their predominance in previous mist net captures. Overall there was no significant difference in activity between controls and treatments.

### **Bats and Mines: External survey techniques to assess bat use of mines**

**Patricia E. Brown\* and Robert D. Berry, Physiological Science Department, UCLA, Los Angeles, CA, Brown-Berry Biological Consulting, Bishop, CA**

The Western United States is covered with abandoned mine sites that are hazardous to humans and habitat to bats and other wildlife. If bat habitat is identified, the installation of bat-compatible closures is recommended. Most agency biologists are not allowed to perform underground surveys to search for bats and guano, and even for consultants with the proper training and equipment, many mines are too dangerous to enter. This poster/demonstration will discuss how agencies and companies with limited resources can do initial assessments for bats and their potential habitat. Preliminary external data forms will be available, as will survey equipment (such as the down-the-hole camera) needed to ascertain if a mine shaft has the potential to provide bat habitat, and needs further surveys at night and/or at different seasons. The cameras are not designed to see bats (unless we're very lucky), but rather to assess mine complexity and habitat potential. External survey techniques (night vision equipment, IR camera and acoustic) will also be discussed.

### **Foraging habitat and the large home range of Allen's big-eared bat (*Idionycteris phyllotis*) in the Arizona Desert as determined by radio-telemetry**

**Patricia E. Brown\* and Robert D. Berry, Physiological Science Department, UCLA, Los Angeles, CA, Brown-Berry Biological Consulting, Bishop, CA**

In making bat management decisions, both the foraging and roosting requirements must be considered. Allen's big-eared bat (*Idionycteris phyllotis*) is one of the rarest North American bat species. Three mines in the Black Mountains in Mojave County, Arizona are the only currently-occupied known roosts for the desert subspecies (*I. p. hualapaiensis*). When bat gates were installed in three of four occupied roosts in 2001, the bats abandoned two of the gated mines, and moved to another ungated mine.

In August 2004, 0.4g Holohil transmitters were attached to 12 post-lactating *Idionycteris* captured at dusk exiting from the ungated mine. The bats were tracked for the next 12 nights to determine foraging habitat and home range. Each evening for 3-4 hours, the authors were able to locate all 12 bats from the air in a Cessna 150 (see poster by R. Berry). Ground crews were directed to positions from which they could accurately triangulate the bats' positions. The bats traveled approximately 70 km. roundtrip nightly between the roost in creosote bush scrub at 1000 meters and the foraging areas in mesquite grassland and pinyon/juniper woodland (1500 -2000 meters). All but one of the tagged bats returned to their home roost nightly, while the lone bat would return every other night, suggesting an alternate roost to the northeast near the foraging area. The majority of the bats commuted a great distance each night from the Union Pass roost, despite the fact that many abandoned mines are located in the Cerbat Mountain foraging area. By the end of the study, all 12 of the bats were recaptured and weighed at the mine where they were banded. Ten transmitters were recovered in the roost; and two were retrieved about 33 km. from the roost, one in pinyon/juniper below a granite cliff and another in scrub oak on the east side of the Cerbats.

### **Gating a Cave Protects a Bat Roost...Eventually.**

**Debbie C. Buecher\* and Andrea K. Goodbar, University of Arizona , Tucson AZ (DCB), Bureau of Land Management, Carlsbad NM (AKG)**

The Guadalupe Mountain range in southeastern New Mexico is known for its famous Mexican free-tailed bat cave ( Carlsbad Caverns ) but it is also recognized for numerous smaller, less spectacular caves that are a critical resource for other bat species. The Guadalupe have three federal agencies managing the cave resources: National Park Service, USDA Forest Service and Bureau of Land Management (BLM). We present a timeline illustrating efforts to protect a maternity colony of *Myotis velifer* (cave myotis) on BLM land near Carlsbad , New Mexico . A monitoring project spanning over 14 years documents the near-demise of a significant bat colony, resulting both from human vandalism and the consequences of a cave gate. We discuss how the size and placement of a cave gate, designed to protect the bats from human disturbance, resulted in the abandonment of the site by *M. velifer*. We will illustrate how BLM management appropriately addressed this issue and altered the gate placement such that bats have reoccupied the cave in numbers similar to previously known. We discuss possible consequences of gating caves without understanding how the bats specific to the site might accept a gate. Because of the 'before' and 'after' documentation of how this particular bat population responded to a gate, we strongly recommend long-term monitoring after the installation of any gate designed to protect a bat roost.

### **Which colour of light should you use to monitor insect abundance?**

**Douglas W. Burles\* and Richard A. Ring, Gwaii Haanas National Park Reserve and Haida Heritage Site, Sandspit, B.C. (DWB), Victoria B.C. (RAR)**

Researchers studying bat diet frequently use light traps to monitor the relative abundance of insects in the habitat in which the bats are foraging. Ultraviolet light is often the light chosen because Lepidoptera are attracted to this wavelength. Using only UV lights

however, may not provide a true indication of insect presence because not all insects are attracted to this wavelength. We experimented with lights emitting four different wavelengths (blue, green, white and UV) in a north Pacific coastal rainforest environment on Haida Gwaii (Queen Charlotte Islands), British Columbia to determine which colour, if any, attracted the greatest number and diversity of insects. An effort was made to minimize the influence of location by placing five light traps (including one without a light) up in a line across a forest clearing, and then rotating the traps through the sequence each subsequent night. Although green and blue lights appeared to attract more insects, we found no statistically significant differences in mean total numbers of insects that each light captured, or in the number of orders/families represented in each sample. Combining samples of all four light traps however, did result in greater nightly diversity than from individual light traps. In spite of our effort to minimize the influence of location on trap success, it still remained an important factor. We recommend that if light traps are to be used to monitor insect abundance, a number of traps, each with different light colours be used, and that the location of each be carefully chosen.

### **Foraging and roosting sites for male spotted bats (*Euderma maculatum*), northern Arizona**

**Carol L. Chambers\*, Michael J. Herder, Mikele L. Painter, and David G. Mikesic, Northern Arizona University, Flagstaff, AZ, (CLC), Bureau of Land Management Arizona Strip Field Office, St. George, UT (MJH), Kaibab National Forest, Fredonia, AZ (MLP), Navajo Nation Department of Fish and Wildlife, Window Rock, AZ (DGM)**

We attached radio transmitters to 4 spotted bats (*Euderma maculatum*) captured at their cave roost site, June 2003. We tracked bats for 13 days to identify roosts, foraging locations and travel corridors. All tagged bats immediately relocated to different day roosts. New roost sites were in cracks, crevices, or small caves in the upper-most portions of vertical cliffs along the upper Colorado River ( Marble Canyon ). Spotted bats also night roosted: 1 bat in Marble Canyon ; others in pinyon-juniper woodlands up to 20 km away from day roosts. Bats emerged from day roosts ~2030 h each night, foraged for several hours, night roosted for  $\leq 3$  hours, and returned to day roost predawn. Bats spent much of their time foraging in Great Basin desertscrub vegetation. Marble Canyon and adjacent tributaries were used as foraging areas and travel corridors. Total distance traveled nightly was estimated as ~80 km for 2 bats. A maximum flight speed of 54 km/h was estimated for 1 bat. Previous work in northern Arizona with female spotted bats indicated similar travel distances and flight speeds; however, known roosts for females are >70 km from known male roosts with a 1700 m elevation gain/loss. Spotted bats appear to be locally common in northern Arizona and use similar habitat compared with other populations; however foraging distances are much greater than reported elsewhere in the literature.

## **Differences in roost selection and behavior among *Myotis evotis*, *M. volans*, and *M. thysanodes* in pinyon-juniper woodland and ponderosa pine forests of New Mexico .**

**Alice L. Chung-MacCoubrey, Rocky Mountain Research Station, USDA Forest Service, Albuquerque , NM .**

Despite numerous studies on bat species in western forests, little is known about the roost ecology of bats at a community level (e.g. Do species compete for roosts?, Are resources partitioned among species?, etc.). In this study, I compared roost selection and behavior of 3 *Myotis* species in two adjacent vegetation types. From 1995-1999, field crews and I radiotracked reproductive female *Myotis evotis*, *M. volans*, and *M. thysanodes* to their day roosts in pinyon-juniper woodlands and ponderosa pine forest of west-central New Mexico . Each of the 3 species exhibited distinct roost behaviors that were relatively consistent across vegetation types. In addition, patterns of roost use by the bat species suggest a partitioning of roost tree resources among species based on tree structure. In pinyon-juniper woodland, *M. evotis* used shrubby trees (juniper), *M. volans* used small trees (pinyon), and *M. thysanodes* used tall trees (ponderosa pine) in proportions greater than their availability. In ponderosa pine forest, both *M. volans* and *M. thysanodes* relied primarily on tall trees (ponderosa pine, Douglas fir), but *M. evotis* continued to use shrubby trees (junipers and oaks) in proportions greater than their availability. Results of this study show that bat species within a particular area may occupy different roost niches and that a single, generalized roost profile for bats is not possible in some forest types.

### **Recent advances in use of Anabat as a survey tool**

**Chris Corben\* and W. E. Rainey**

We present recent advances in the use of Anabat technology for acoustic bat surveys. For active monitoring, it is now possible to use a PDA to display output from an Anabat detector. This provides an in-hand, real-time display of bat call characteristics which can be used in place of a laptop, while providing greatly improved portability. In addition, the PDA can be linked to a GPS unit via a wireless interface, providing a GPS position for every bat detected. The observer mobility allowed by this approach opens up new possibilities for realtime bat surveys.

For long-term passive monitoring, storage ZCAIMs can be used to record bat calls onto CF cards. Practical field application dictates the use of weather protection and an adequate power source. We demonstrate a monitoring-station design which has been employed effectively in California and elsewhere. This design uses a reflector plate to deflect ultrasound upwards into a microphone protected from precipitation. A solar panel is used to charge a sealed lead-acid battery, allowing maintenance-free, continuous monitoring over extended periods of weeks or months.

These advances extend the capabilities of Anabat in directions not available to other technologies. Improved observer mobility and extended passive monitoring offer new ways to see how bats move about in space and time. The resulting insights will help us protect bats through a better understanding of their conservation needs.

## **Slocan Valley Bat Project: A Community Approach to Bat Inventory and Conservation**

**Juliet Craig\* and Mike Sarell, Silverwing Ecological Consulting, Nelson, BC (JC); Ophiuchus Consulting, Oliver, BC (MS)**

The Slocan Valley Bat Project was initiated in 2004 as a community approach to bat inventory and conservation. This project, located in southeastern BC, promoted education and awareness of bats, identified bat roost sites (particularly on private land), and assisted landowners with roost conservation planning. Extension activities included numerous press releases, bat-house building workshops, interpretive programs and public mist-netting nights. Residents were encouraged to report their bats so that Project biologists could visit their roost sites, identify species present, and discuss and address their issues. As well, they provided strategies to conserve and enhance roosts, and encouraged residents to monitor their bat populations. During the summer of 2004, over 75 roost sites (including 37 maternity roosts) were identified for seven species of bats including California myotis, western long-eared myotis, little brown myotis, Yuma myotis, long-legged myotis, big brown bat, and Townsend's big-eared bat. Two of these roost sites were maternity colonies for the threatened Townsend's big-eared bat, including the largest known colony in the region and a unique colony living *within* a resident's living room. One of the greatest values of this project was the education and awareness component that was integral to each of the project activities. As a result of this project, residents are conserving bats and their roosts, and collecting unique and valuable data that contributes to the understanding and conservation of local bat species. It is hoped that this project will expand in 2005 as the Kootenay Community Bat Project.

## **Bat Conservation Strategy for British Columbia and Alberta**

**Vanessa Craig, Susan Holroyd Rasheed, Laura Friis, and Lisa Wilkinson\* EcoLogic Research, Gabriola Island, BC (VC), Holroyd Consulting, Calgary, AB (SHR) BC Ministry of Water, Land and Air Protection, Victoria, BC (LF), Alberta Fish and Wildlife Division, Edson, AB (LW)**

Lack of even basic information for many species such as locations of maternity roosts and hibernacula, population trends, and issues affecting habitat have limited the effectiveness of bat conservation to date. In addition, coordination of inventory and research on bats in western Canada has been informal. The BC and Alberta governments are collaborating on a Bat Conservation Strategy for the region. The Strategy provides a framework for future conservation and management activities for bats in BC and Alberta. It identifies issues that have the potential to affect bats and bat habitat, outlines conservation goals and objectives, and identifies key knowledge gaps. In addition, the Strategy identifies research and inventory work necessary to fill information gaps. The Conservation Strategy will integrate with the Recovery Strategy process and pro-actively extend the same themes to a guild of all bat species (both listed and unlisted), in an effort to prevent future declines in bat populations. We provide a brief outline of the Strategy, which is still under development, and provide an example of one of the conservation issues affecting bats in BC and Alberta: forest management.

## **Evolutionary relationships among North American *Myotis* species and evidence of cryptic variation**

**Tanya Dewey, University of Michigan Museum of Zoology , Ann Arbor , MI**

Bats in the genus *Myotis* are a diverse and successful group, occurring nearly worldwide and occupying a variety of ecological niches. Recent systematic research on *Myotis* suggests that the functional constraints of flight, echolocation, and particular foraging ecologies may result in morphological similarities that mask the underlying pattern of evolutionary relationships. Although the monophyly of American *Myotis* species is supported by recent research, relationships among these species are poorly understood. In addition, many North American species are difficult to distinguish reliably with morphological characters. This research presents the results of phylogenetic analyses of cytochrome *b* data for nearly all North American *Myotis*. Dense intra-specific sampling across the geographic ranges of putative species yields a level of resolution that permits testing for regional differentiation at the specific level. Results suggest that ecomorphological convergence is widespread, resulting in confusion regarding the affinities of individual species, and that these morphological similarities mask profound genetic discontinuities within some recognized species.

## **Protocols for Estimating Bat Fatality at Wind Farms**

**Wallace P. Erickson\*, Jessica Kerns, and Edward B. Arnett. Western Ecosystems Technology, Cheyenne, WY (WPE), University of Maryland, Center for Environmental Science, Appalachian Laboratory, Frostburg, MD (JK), Bat Conservation International, Austin, TX (EBA)**

We present results of an intensive 6-week sampling period at two wind energy facilities in Pennsylvania and West Virginia . Our primary objectives were to 1) conduct daily and weekly carcass searches to evaluate search intervals; 2) improve quantification of bias correction factors for searcher efficiency and scavenger removal of bats; 3) account for differences in bias correction factors among different habitat conditions; 4) develop recommendations for improving and standardizing fatality search protocols for bats at turbines; and 5) correlate fresh bat fatalities collected daily with weather and turbine characteristics. Weekly searches at the West Virginia site underestimated the fatality rate by a factor of 3. It appears the primary reason for this is that the timing of the fatality searches at this site, which tended to occur before the larger period fatality events. The much lower rate from weekly searches at this site also is due in part to the very high carcass removal rates. Estimates for daily and weekly searches were similar at the Pennsylvania site, suggesting that longer search intervals yields reasonable estimates when scavenging rates are low. We also discuss relationships between daily bat fatalities and covariates relating to weather and turbine characteristics.

## **Do Large Colonies Create Long Commutes? Examining Myotis Bat Foraging Distance and Duration**

**Greg Falxa, Cascadia Research Collective, Olympia , WA**

During spring and summer 2003-4, I tracked radio-tagged bats from the largest known maternity colony in Washington State to investigate foraging dispersal patterns and foraging habitat. This colony of Yuma (*Myotis yumanensis*) and Little brown (*M. lucifugus*) bats is located under a pier at the Woodard Bay Natural Resources Area in southern Puget Sound . I radio-tagged adult bats as they left the roost at dusk and tracked their movements each night to gather detailed data on their foraging and night-roosting behavior. This effort revealed that these bats travel further than has been reported for these species, 12-14 km from day roosts to foraging sites. After 2003 data showed this long distance trend, we hypothesized that the unusually large colony (> 3,000 bats) put more pressure on closer foraging areas, therefore required greater commute distances for members of this colony. Based on 3 bats tagged and tracked 3 bats captured at Capitol Lake, the most frequently used foraging site of the Woodard Bay colony, 2004 tracking data did not support this theory. These bats arrived at the lake from a different direction than Woodard Bay and individuals traveled maximum distances up to 14 km to smaller maternity roosts than the Woodard Bay colony. Additionally, the bats night roosted much less than expected during nightly foraging. Species accounts for Yuma and Little brown bats characterize a typical night as 2 or 3 foraging bouts interrupted by significant inactivity periods, often roosting for several hours in the middle of the night. However, in some cases the bats in this study flew from dusk-to-dawn with no night roosting, and most of those that did night roost typically did so for only brief periods. Why these bats are commuting greater distances and foraging over more time than reported in other studies is unclear. This method of tagging and tracking only a single animal for the 12-day lifespan of the radio tag rather than tracking multiple subjects may lower bias towards locating animals foraging closer to the roost or the observer. More detailed data for each bat can be collected for each bat, albeit from fewer animals, and we learned a great deal about the busy nightlife of Little brown and Yuma bats in the South Puget Sound region.

## **A Successful Pallid Bat Mitigation Project on the Hanford Site in Richland , Washington**

**Kenneth A. Gano, Bechtel Hanford Inc., Richland , Washington**

For a number of years, former reactor buildings on the Hanford Site have served as roost sites to several species of bats. However, during decontamination and decommissioning (D&D) activities, these sites are disturbed. In 2003, a colony of pallid bats, along with a small number of myotis, needed to be evicted from “F Reactor” as D&D work began to demolish parts of the reactor building, seal up all openings, and construct a new roof to prevent animal intrusion. To provide a way for these bats to maintain their residence, bat houses were installed on the outside of the building as alternative roost sites. Both species of bats were observed using the bat houses immediately after the building was closed in August 2003. The following spring, both species returned to the building and again occupied the houses. The myotis preferred roost sites with a southern exposure,

while the pallid bats preferred an eastern exposure. The acceptance of the new roost sites by the pallid bats was especially significant, as during the project, few citations were found of pallid bats being successfully relocated. This presentation discusses the process of evicting the bats from the building, installing the bat houses, and observing the response.

### **Exploring habitat selection by insectivorous bats: the conflicting roles of energy and water**

**Jeffery C. Gruver\* and Robert M.R. Barclay, University of Calgary , Calgary , AB**

Although torpor is typically considered from an energetic standpoint, this research is exploring an alternate explanation for what influences decisions about torpor use and, therefore, habitat use. Traditionally, torpor has been viewed as a means of saving energy, but torpor may impose fitness costs on reproductive females. These females are thus thought to select warm roosts that help minimize energy expenditure and fitness costs. However, by maintaining high body temperature, females may experience considerable loss of water through evapotranspiration. Therefore, we hypothesize an antagonistic relationship between energy and water balance such that torpor may be necessary in some cases to effect water balance. This hypothesis implies that although energy savings are important in shaping roost choice, water conservation may be of greater consequence in some environments. Through a combination of experiments and field observation, we will test hypotheses about how water and energy requirements interact to influence roost choice by the western long-eared myotis (*Myotis evotis*). Bats will be tested under controlled conditions to clarify the relationship between temperature, metabolic rate, relative humidity, and evaporative water loss. These results will generate ecologically meaningful predictions relating roost selection to energy and water balance, and these predictions will be tested with field observation of free-living bats. Understanding the trade-offs between energy balance and water conservation may help to refine our ability to explain and predict ecological responses by bats.

### **Novel Techniques to Improve Long-term Acoustic Monitoring of Bats on the Nevada Test Site, South-central Nevada**

**Derek B. Hall\*, Michael J. O'Farrell, Robert G. Peppard, Bechtel Nevada , Las Vegas , NV (DBH and RGP), O'Farrell Biological Consulting, Las Vegas, NV(MJO)**

Recent advances in bat detector technology have enabled biologists to design systems that acoustically monitor bat activity continuously for long periods of time. A system using an Anabat compact flash storage zero crossings analysis interface module was set up at a water source on the Nevada Test Site in September 2003, and has been continuously collecting data to the present time. Climatic data are being gathered to compare bat activity with parameters such as wind, barometric pressure, and temperature. We present the components of the system and the data analysis process. Current analysis addresses research and management needs such as: (1) species inventory, (2) activity patterns at various temporal scales (e.g., time from sunset, seasonally, between years) by species, and (3) species activity correlated with weather patterns. Data can also be used to compare species activity patterns across regions with other researchers. Data from our

site reveal new winter-active species and previously undocumented winter bat activity in the late night and early morning hours for the region.

### **New Acoustic Methods Developed for Improved Management of Southeast Alaska Bats**

**Matthew J. Heavner\*, Michael Glista, Edwin Knuth, Dept. Natural Sciences, University of Alaska Southeast, Juneau , AK**

The most recent and extensive effort to document the occurrence of bats in Alaska confirms that five species inhabit certain parts of the state for at least a portion of the year. However, much remains uncertain about the geographic range, seasonal distribution, and population size and dynamics of these northern bats—issues critical for developing management strategies. We are developing a robust, sophisticated bat sensor system capable of monitoring bat activity for extended periods of time. The acoustic system is built around inexpensive, low-power, durable very small computers for digitization and real-time call analysis. We will describe our efforts to develop the hardware and software necessary for addressing management issues. For this component of the study, in addition to the development of the bat detector system, bat calls recorded in Southeast Alaska by D. Parker et al. (1997) have been analyzed in order to determine what sounds are likely to be recorded during the bioacoustical monitoring of the region. We will describe both the system being developed and a preliminary investigation of the parameters that can be used to identify different species of bats in Southeast Alaska by their echolocation. Two factors, duration and frequency of maximum power, were found to be useful in discriminating between sound types.

### **A Free-Floating Mist Net System for Capturing Bats**

**Michael J. Herder, Arizona Strip Field Office, Bureau of Land Management, St. George , UT**

Studies of the occurrence and distribution of free-flying bats in arid environments frequently involve capturing the animals in mist nets as they drink or forage over water. However, waters larger than 18 m (60 ft) across are typically difficult to net due to problems associated with placing net poles and stakes in mud. Water depths exceeding the height of the net poles limit placement and generally require a boat to remove captured bats. Mist nets typically stretch during use, requiring fixed poles and guys to be reset. In an effort to address these problems and permit netting on larger bodies of water, the author developed a free-floating mist net system. Designed to remain afloat indefinitely, the system provides a floating platform of ABS pipe at each end to support the net poles and a set of rigid aluminum separator poles to maintain tension between the platforms. By adding or removing 1.8 m (6 ft) separator poles and adjusting the sliding cross bars on each platform, nets up to about 30 m may be used. For spans greater than 20 m or where two or more shorter nets are joined, it is advisable to use a center platform. Bats are removed from the floating nets either by using a boat or by pulling one or both ends of the system to the shore. The rigid separator poles make it possible to rotate the entire net from one end to move the net to a location more convenient for removing bats. The nets may also be re-tensioned by adjusting the sliding cross bars. A

floating net system designed to accommodate two 18 m mist nets was constructed from materials commonly available in most hardware stores at a cost of less than \$300. A system using ABS or PVC separator poles would reduce the cost to less than \$120.

### **Winter roosting ecology of pallid bats (*Antrozous pallidus*) in Central California**

**Dave Johnston, H.T. Harvey & Associates, San Jose , CA 95123**

Pallid bats have been studied extensively during summer months, but few studies provide information on the winter ecology of this species. In late October and early November, temperature-sensitive radio tags were attached to three males and two females. Males and females typically roosted together in a primary winter roost, the attic of a building located near a stream, but these bats occasionally used other nearby roosts. Bats exited their primary roost intermittently throughout the winter in temperatures as low as 4° C although it was not determined if bats actually foraged during all forays (i.e., some bats may have only emerged to drink water). Day roosts comprised the attic of an unheated building; trees including a mature valley oak (*Quercus lobata*, diameter at breast height [dbh] = 52 cm), coast live oaks (*Quercus agrifolia*, dbh = 10 - 39 cm), California bay (*Umbellularia californica*, dbh 45 cm), and ground roosts (one under rags on the earthen bottom a tool shed and one at ground level alongside an outhouse foundation). Winter roosts were located along the edges of a riparian oak woodland forest all within 100 M of a perennial stream. These data suggested wintering bats selected cool roosts with relatively even temperatures. Females began roosting at a maternity roost (approximately 2 KM from the winter roost and stream) in mid-March while males continued to roost at and in the vicinity of the primary winter roost. Various males within the winter roost appeared reproductively active from late October to early January.

### **Mitigation Strategies for Bats in Bridges: Lessons Learned and Where do we go from here.**

**Dave Johnston\*, Greg Tatarian, and Dixie Pierson, H. T. Harvey and Associates, San Jose CA (DJ); Wildlife Research Associates, Santa Rosa , CA (GT); and Consultant, Berkeley , CA (DP)**

We examined mitigation efforts in California for transportation-related, roosting habitat loss impacts to bats. Whereas some projects are not yet complete, data from newly built bridges suggest that replacement roosting habitat should be site specific and tailored to specific species. Bats are a diverse group, and each species' habitat requirements are unique; in fact, mitigation can be difficult because of the lack of natural history information for many species. Structures occupied by bats that were left intact provided excellent mitigation but each had structural issues that added to projects' costs when retrofitted or preserved. Evicted Mexican free-tailed bats (*Tadarida brasiliensis*) and Yuma myotis (*Myotis yumanensis*) used recently installed bat houses after eviction from bridges in some cases, but in much smaller numbers than in the original roosts suggesting most bats emigrated. The use of bat houses for lost day roosts and maternity roosts may only work for a few species. On-site replacement roosting habitat that mimicked the originally occupied roosts was more effective than adjacent off-site replacement (bat house) roosting habitat. The most promising mitigation strategies for bat habitat were

cast-in-place crevices, such as those incorporated in a new concrete bridge in Sacramento Valley, California, where over 15,000 Mexican free-tailed bats roosted two months after the bridge was completed, and closure pours with crevices created by attached panels, such as is found on another rebuilt bridge in Sacramento Valley. Bat habitat mitigation should address species-specific requirements for the preferred type of roosting habitat, and in some cases, foraging habitat.

### **The Great Basin Bat Cooperative: Utah's new collaborative research framework for bats**

**Adam J. Kozlowski\*, Christopher Witt, Northern Region Office, Utah Division of Wildlife Resources, Ogden, UT (AJK); Ecological Services Field Office, U.S. Fish and Wildlife Service, West Valley City, UT (CW)**

Currently 6 of Utah's 18 species of bat have been identified as having populations limited in distribution or declining in nature. As a result, the Utah state Sensitive Species list currently registers more species from the order Chiroptera than any other taxonomic group of mammals. Of the remaining 12 species of bat known to inhabit Utah, many of these remain poorly understood with their local population status often being extrapolated from national datasets. For virtually all of Utah's 18 species of bats there exists a disparity between what is known and what is needed in order to implement effective statewide management plans. The lack of accurate data concerning bat distribution, habitat requirements, population status, and threats to their sustainability are especially acute in the northern and central portions of the state.

In direct response to the need for landscape scale distribution and population data, the Great Basin Bat Cooperative (GBBC) was formed as a multiple partner mechanism to address Utah's bat conservation priorities. In recognition that landscape scale bat research remains difficult for any single agency to successfully engage in, the GBBC draws its strength from the financial and in-kind investments of 12 different organizations and their biologists. Although still in its infancy, the authors would like to introduce the advantages of the GBBC's collaborative structure with respect to unifying the objectives of private and public organizations, consolidation of resources, merging of current and historical databases, and implementation of research to address conservation priorities identified at local (GBBC), regional (Regional Working Groups), and national (NABCP) levels.

### **Winter bat activity in the Alberta prairies.**

**Cori L. Lausen, University of Calgary, Calgary, Alberta, Canada.**

It has long been hypothesized that bats in the temperate climate of the Alberta prairies move to caves in the west (Rocky Mountains) or the south (e.g. Sweetgrass Hills, MT) to hibernate for the winter. Using ANABAT CF Storage ZCAIM systems powered by solar panels, I monitored the Red Deer River in the Alberta prairies for fall, winter and spring bat activity. Waves of bat activity were detected in the fall suggesting movement along the river corridors and possible swarming events. I detected bats during every month, including January when temperatures fell below -40°C, suggesting bats hibernate

in prairie river valleys rather than moving to mountainous areas. Most winter passes were of *Eptesicus fuscus*, but *Myotis* species were detected in late December and early February. Bats were detected flying in the Red Deer River valley on nights when daytime temperatures had not risen above freezing. Temperatures at which bats were active varied, but *Myotis* were detected at temperatures lower than  $-6^{\circ}\text{C}$ , and *E. fuscus* at temperatures lower than  $-7.5^{\circ}\text{C}$ . I mistnetted *E. fuscus* throughout February, and radio-tracked both sexes to their rock-crevice roosts. These hibernacula are deep ( $>3$  m) rock cracks and erosion holes with small openings. The winter bat activity data collected by these ANABAT systems were unexpected, and I suggest that strategic winter placement of solar-powered ANABAT/CF Storage ZCAIM systems recording onto high capacity digital memory cards is an excellent way to uncover what bats are doing in the winter months.

### **The Status of Allen's Big-eared Bats in New Mexico**

#### **Lyle Lewis , U.S. Fish and Wildlife Service, New Mexico Ecological Services Field Office, Albuquerque , NM**

Very little is known about the life history of the Allen's big-eared bat (*Idionycteris phyllotis*) in New Mexico . Limited information suggests their roosting requirements are very specialized. Between 1957 and 1975, although not abundant, Allen's big-eared bat were fairly consistently captured at some survey sites by bat researchers in New Mexico . During that time period, they made up about three percent of all bats captured. Over the last 30 years, they have been captured less frequently. In spite of significant survey efforts within their historical range since 1999, only two Allen's lappet-eared bats are known to have been captured in New Mexico . An analysis of historical occurrence records, limited roosting information, and recent negative survey information suggests that viable populations of Allen's big-eared bats, if they exist, may be limited to New Mexico 's wilderness areas. Conversely, "managed" forests may be population sinks.

### **There is no silver bullet: the importance of morphologic, acoustic, and genetic data to decipher *Myotis* species in the Pacific Northwest**

#### **Patricia C. Ormsbee, Willamette N. F., USDA Forest Service, Eugene , OR**

Morphometrics and more recently acoustic assessments have been the primary standards used for identifying bats to species, including members of the genus *Myotis*. Standardized surveys across Oregon and parts of Washington , that included morphometrics, acoustic, and genetic sampling provided insight to using all three of these methods and their value for species identification within the *Myotis* genus. In some cases, the morphological and acoustic characteristics we have historically used to decipher species did not prove to be consistently reliable when compared to genetic results. Additionally, genetics did not always prove to be a clarifying standard. I will discuss the strengths and weaknesses associated with using these three methods and the importance of incorporating all three methods in to our tool box for species identification.

## **Guano collection techniques and analysis for conducting bridge surveys**

**Patricia C. Ormsbee\* , Aimee Hart\* , Lee Templeman, and Jan Zinck; Willamette N. F., USDA Forest Service, Eugene , OR (PCO, AH, LT), Portland State University , Portland , OR (JZ)**

Bridges are used by numerous bat species as roost sites during summer. Bats often congregate under bridges at night, along the wall and ceiling seams of chambers formed by the bridge decking. Guano collection at these sites can serve as a relative index of use over time. Additionally, techniques to identify species by analyzing DNA extracted from the guano are available. Two techniques and a protocol for collecting guano, as well as a reprint on species identification using DNA extracted from guano will be presented.

## **Capture techniques for bats night roosting under bridges using modified hand nets**

**Patricia C. Ormsbee\* , Elizabeth D. Pierson\* , and David L. Waldien, Willamette N. F., USDA Forest Service, Eugene, OR (PCO), Berkeley, CA (EDP), Bat Conservation International, Austin, TX (DLW)**

Bridges are used by numerous bat species as roost sites, especially for night roosting. Bats typically night roost under concrete bridges that have chambers below the bridge deck as part of their design. The concrete absorbs solar heat during the day and retains it through the night, warming the chambers to approximately 10° C above that of the external, ambient temperature. Bats take advantage of these heated roosts and multiple species can be found clustering or roosting solitarily throughout the night. Bats tend to roost along the ceiling, along the wall and ceiling seam, or in corners of the heated chambers. Bats night roosting in these locations can be difficult to capture without harming them or having them escape. Three styles of modified hand nets have been developed to safely capture bats roosting under bridges: the cluster buster, a modified butterfly net, and the H-net. All 3 designs will be available for inspection and discussion.

## **How Much is Enough?**

**J. Mark Perkins\* and Joshua R. Peterson, PPNW Bat Research Team, Portland , Oregon**

Mist netting is the most common method for hands-on sampling of bats. We attempt to determine how much sampling is enough, what is the time frame and at what point can we be relatively certain we have captured at least 95 % of resident species? We sampled four sites repetitively (once per week) from late May through the first week of September, 1994. Our goal was to determine if our protocol of twice per summer sampling over five years provided us with a set of species and individual captures that would fall within a statistically significant 95% confidence interval. Our results suggest that a minimum sample of 7 nights spread over 1-4 years will result in detecting by mist net capture, 95% or greater of all local bat species. An inspection of prior results (1989-1993) regarding species diversity and numbers of bats captured from these four sites and approximately 35 others on the Willowa-Whitman National Forest , indicates results of 7 sample nights will fall well within minimum limits for the 95% confidence interval and in some cases exceed the upper bounds, especially for species' diversity. Our original

intent was to only sample twice per season for one or two seasons. Sampling twice per year for one season will likely produce a list of resident species and an estimate of numbers of bats that one would likely encounter 95% of the time. However, there are shortcomings to only sampling two times one season: 1) Statistical analysis is weak, a sampling schedule which gives you three or more sample points will increase the statistical precision by at least a factor of four, 2) One would be less likely to net rare or hard to catch species (most of which are federal C2 species), 3) Weather and other such vagaries can bias short term results.

### **Conducting Bat Inventories in the Sierra Nevada: Examples from Sequoia-Kings Canyon National Parks and Devil's Postpile National Monument .**

**Elizabeth D. Pierson\* and William E. Rainey, Berkeley , CA (EDP); University of California , Berkeley , CA (WER)**

We are engaged in bat inventory efforts in Sequoia-Kings Canyon National Park and Devil's Postpile National Monument . This study, initiated in 2001, will be completed in 2005. Simultaneously, the Forest Service Redwood Sciences Lab has been working collaboratively with the Western Bat Working Group to develop a standardized survey protocol for bats. Using post-hoc analysis, we subject sample survey efforts to scrutiny, examining how well our efforts met the criteria of the developing draft protocol. We evaluate how successful we were at detecting the species expected to occur in three sample units: one in the Kern River drainage of Sequoia National Park , one in the Cedar Grove area of Kings Canyon National Park , and one in Devil's Postpile National Monument . Our examples illustrate how mist-netting and acoustic techniques can be used in parallel to maximize species detection and increase survey efficiency.

### **Ecology of Pallid Bats in British Columbia , Canada**

**Daniela Rambaldini, University of Regina , Regina , SK**

*Antrozous pallidus* reaches the northern limits of its North American range in the Okanagan Valley , in the southern interior of British Columbia . Little is known of the species' ecology and behaviour in Canada . It is naturally rare and is federally listed as Threatened (COSEWIC 2002). The purpose of my research over the past 3 years has been to gather as much information about Pallid bats in Canada as I could. During the summers of 2002, 2003, and 2004, I conducted mist net surveys, visual 'foraging surveys', emergence counts, and radio tracking studies. I characterized day and night roosts, recorded temperature within accessible day and night roosts, located foraging areas, quantified use of vineyards as foraging habitat, monitored torpor use, assessed diet, and searched for hibernacula. Over the 3 summers, I captured adult ( $n = 36$ ) and juvenile ( $n = 3$ ) males only. I located 3 areas of high concentration within the Valley, and found 29 new roosts. During the day bats roosted in warm (26 - 30 °C / 79 - 86 °F) rock crevices and at night bats either returned to the day roost, occupied a different rock crevice or cave, or roosted in Ponderosa pines, Douglas firs, deciduous trees along riparian corridors, or fruit trees in orchards. The largest aggregation I found was a bachelor colony of more than 130 bats. Bats used torpor every day but not at night. I tracked and/or (with a night vision monocular) observed bats foraging over native

antelope brush and low-elevation open Ponderosa pine habitats, talus slopes, vineyards, fruit orchards, and gravel roads. Preliminary foraging surveys suggest that bats forage more frequently in native habitat than in vineyards. They eat mostly beetles, but also Jerusalem crickets, field crickets, grasshoppers, and other unidentified invertebrates. I did not locate any hibernacula. Future research is scheduled for this summer to fill in knowledge gaps, including the locations of maternity colonies and hibernacula, and further quantification of habitat use versus availability.

### **How Do They Do It? Revisiting the Constraints of Over-wintering by Nectar-feeding Bats in Arizona**

**Ronnie Sidner, Ecological Consulting and University of Arizona , Tucson , AZ**

In 1990, I presented documentation of “tropical” nectar-feeding bats over-wintering in Tucson , Arizona . Winter residence by nectar feeding bats was not supported by the literature at that time; both species were supposed to migrate south. Photographs of bats at hummingbird feeders on various dates in winter of 1989-1990 showed both *Leptonycteris curasoae* and *Choeronycteris mexicana* were indeed present. Their continued presence during observation periods through April of 1990 showed that at least some of these bats survived the winter. At the NASBR meetings in fall of 1990, I wondered whether we would see nectar bats in Arizona in winter again. They have continued to be present every winter since. A comparison of body mass of summer-netted *C. mexicana* in southeastern Arizona with those netted at feeders in winters of 1991-1999 shows that winter bats appear to be in good health. When I posed the question of physiological constraints of cold climates to non-hibernating tropical bats, and in particular, when they had no forage plants available, no winter roosts in Arizona were known. I suggested that it would be likely that nectar bats might utilize warm roosts in winter like *Macrotus californicus* does. For the past two years, *C. mexicana* has been using a winter roost inside a rock shelter that provides the thermal constancy they require to survive sub-freezing temperatures. Research questions now being addressed are presented.

### **Collaborative Effort to Improve Access and Reduce Drowning for Bats and other Wildlife at Water Developments on Western Rangelands**

Daniel A. R. Taylor\*, Miriam L. Austin, and Stu Tuttle, Bat Conservation International, Austin, TX (DART); Red Willow Research Inc., Twin Falls, ID(MLA); and Flagstaff Field Office, USDA-NRCS, Flagstaff, AZ (ST).

Water resources in the arid west are vital to wildlife survival. As natural water sources have been depleted, livestock and wildlife water developments have become one of the few sources of water available to wildlife. Bats are especially vulnerable to water shortages, sometimes losing up to 50% of their body weight in evaporative water loss in an afternoon. Drinking rates of more than one bat per second have been recorded at desert water developments. Unfortunately, water developments for livestock and wildlife can be difficult to access for bats and birds, and can cause significant losses from drowning. Factors affecting wildlife access include development size, configuration, water level from rim, and the presence of obstructions and escape ramps. Fencing, bracing, and other

obstructions over and adjacent to water developments can cause bats to alter their flight paths, increase approach attempts, result in collisions, or completely deny access. Development size, configuration, and water level all interact with bat species size and flight morphology to determine accessibility. Losses may be particularly acute in areas experiencing drought, and where the majority of surface water is captured in developments. Without properly designed escape ramps, bats and other animals that fall into water developments are vulnerable to drowning. Recent evidence from western rangelands suggests that less than seven percent of all water developments have adequate escape ramps. Additionally, point-source mortality doesn't reflect the true cost to populations due to displacement and reductions in fitness. BCI, the USDA-NRCS, the USDI-BLM and other partners are addressing this issue by producing a comprehensive manual, providing training, and implementing policies that will improve bat access and reduce drowning on thousands of acres of western rangelands.

### **Using long-term passive acoustic monitoring stations to study bats in Nevada**

**Jason A. Williams and Michael J. O'Farrell, Nevada Department of Wildlife, Ely, NV (JAW), and O'Farrell Biological Consulting, Las Vegas, NV (MJO)**

Technological advances have enabled continuous passive collection of bat acoustic data from remote areas where conventional power sources are not available. Advances have also provided for the benefit of limited human presence and maintenance of acoustic monitoring equipment. The use of this equipment, coupled with the collection of meteorological data, provides insight into activity patterns and habitat use by bats which were previously impractical or impossible to determine. Fifteen acoustic monitoring stations are now deployed in Nevada. Efforts are underway to better understand migration patterns, species diversity across seasons, and how weather variables affect bat activity. This information is lacking in the current literature, but necessary for effective management of bat species. Interpretations of initial data analyses and observed pros and cons of passive acoustic monitoring systems will be presented.