Working Papers in Southwestern
Ponderosa Pine Forest Restoration

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Bat Habitat and Forest Restoration Treatments

January 2007

NORTHERN ARIZONA UNIVERSITY

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Ecological restoration is a practice that seeks to heal degraded ecosystems by reestablishing native species, structural characteristics, and ecological processes. The Society for Ecological Restoration International defines ecological restoration as "an intentional activity that initiates or accelerates the recovery of an ecosystem with respect to its health, integrity and sustainability….Restoration attempts to return an ecosystem to its historic trajectory" (Society for Ecological Restoration International Science & Policy Working Group 2004).

In the southwestern United States, most ponderosa pine forests have been degraded during the last 150 years. Many ponderosa pine areas are now dominated by dense thickets of small trees, and lack their once diverse understory of grasses, sedges, and forbs. Forests in this condition are highly susceptible to damaging, stand-replacing fires and increased insect and disease epidemics. Restoration of these forests centers on reintroducing frequent, low-intensity surface fires—often after thinning dense stands—and reestablishing productive understory plant communities.

The Ecological Restoration Institute at Northern Arizona University is a pioneer in researching, implementing, and monitoring ecological restoration of southwestern ponderosa pine forests. By allowing natural processes, such as fire, to resume self-sustaining patterns, we hope to reestablish healthy forests that provide ecosystem services, wildlife habitat, and recreational opportunities.

The ERI Working Papers series presents findings and management recommendations from research and observations by the ERI and its partner organizations. While the ERI staff recognizes that every restoration project needs to be site specific, we feel that the information provided in the Working Papers may help restoration practitioners elsewhere.

This publication would not have been possible without funding from the USDA Forest Service. The views and conclusions contained in this document are those of the authors and should not be interpreted as representing the opinions or policies of the United States Government. Mention of trade names or commercial products does not constitute their endorsement by the United States Government.

Cover photo: A silver-haired bat (*Lasionycteris noctivagans*) echolocating as it flies among ponderosa pines in northern Arizona. The process of echolocating requires bats to fly with their mouths open in order to transmit the reflected audible signals they use to determine the location of trees and other objects, including prey.

Photo by Bruce D. Taubert

Introduction

Northern Arizona is home to at least 20 species of bats—or two-thirds of the bat species found in the state (Cockburn 1960, Hinman and Snow 2003). Only a couple of these species live exclusively in ponderosa pine forests while the rest inhabit a variety of ecosystem types from desert scrub to pinyon-juniper to ponderosa pine-Gambel oak and mixed conifer (Arizona Game and Fish Department 1996, Hinman and Snow 2003). Bats are an important part of the forest ecology of northern Arizona because they prey on insects such as midges, moths, beetles, flies, mosquitoes, termites, and ants. They typically roost in the cavities of live trees and snags, under loose tree bark, in tree stumps and logs, in rock crevices, or in caves.

As the new era of ecologically restoring forest ecosystems in the Southwest moves from experiments to full implementation, the question arises: What effects will restoration treatments have on forest wildlife, including often forgotten or poorly understood animal groups, such as bats? Thinning, for instance, might remove snags where bats roost, and burning could inadvertently destroy or alter such roosting sites. While it's true that fire will create new snags, given the present forest conditions, they will be younger, smaller-diameter snags that are more susceptible to fire, and not the 27-inch-plus-diameter snags bats most often use.

In this working paper, we look at research and studies that provide some recommendations about ways to maintain bat habitat while restoring forest tree health and vitality.

Bats and Restoration Treatments

Early research results indicate that treatments designed to restore the health of crowded, fire-deficient ponderosa pine forests may be beneficial to bats. Shelly Johnson, a graduate student working with Professor Carol Chambers at the Northern Arizona University School of Forestry, has been recording bat calls in three thinning treatments at the Fort Valley Experimental Forest near Flagstaff, where seven of Arizona's bat species are known to live. The treatments consist of heavily thinned plots (57 trees/acre), moderately thinned plots (69 trees/acre), lightly thinned plots (98 trees/acre), and untreated plots (480 trees/acre).

Their preliminary results are showing trends that indicate bats seem to exhibit more activity in the treated plots than the untreated plots, although the researchers cannot say which species of bats they are recording. Johnson and Chambers say they need more data before they call the present trends conclusive, and they want to be sure that the low number of calls in the control areas are due to reduced bat activity and are not the result of acoustic interference from dense tree canopies.

Ben Solvesky, who is also working with Professor Chambers, has been surveying bat roosts in the ponderosa pine forests south of Flagstaff. He found that maternity colonies of roosting bats used relatively tall and large diameter snags with loose bark.

long-legged myotis

Michael Herder, a bat expert with the Bureau of Land Management, obtained similar results when he studied bat roost site preferences in pine and oak snags in restored areas of Mount Trumbull in northern Arizona (Herder and Jackson 1999). He and his colleagues captured more than 900 bats of 13 different species with long-legged myotis (*Myotis volans*), fringed myotis (M. *thysanodes*), and big brown bat (*Eptesicus fuscus*) being the most abundant species. They also located 45 roost sites using radio telemetry tracking methods. Of these, 40 day roosts of long-legged myotis were located in ponderosa pine snags. Roost snags used by long-legged myotis shared several characteristics including being large (28-inch dbh) and tall (70 feet) with large fissures and/or loose bark, and occurring within 1.5 miles from a water source—often in close proximity to a natural drainage. Given his findings, Herder suggests leaving all snags in ecological restoration treatment areas.

Importance of Forest Roost Sites

Research points to roost sites as key habitats for bats because bats spend more than half their lives roosting (Kunz and Pierson 1994). Roosts provide a place for bats to raise their young and they shelter bats from the elements and predators. Roosts also contain microclimates suited to bats and typically occur near foraging areas and water (Hinman and Snow 2003).

Bat researchers have also observed that tree-roosting species, such as silver-haired bats (*Lasionycteris noctivagans*), fringed myotis, big brown bats, Arizona myotis (*Myotis occultus*) and Yuma myotis (*Myotis yumanensis*), tend to switch maternity roost sites throughout the year. This behavior may be a way to avoid predators or a response to unfavorable conditions in the roost. Since a maternity colony may require multiple roosts for raising young each summer, managers should recognize that estimates of snags needed for birds may be insufficient for bat populations (Hinman and Snow 2003).

While more research needs to be done, some researchers have found that maternity roosts tend to occur where there are clusters of large ponderosa pine snags or Gambel oaks with internal cavities (Rabe et al. 1998, Hinman and Snow 2003, Bernardos et al. 2004). This suggests that female tree-roosting bats may seek out clusters of appropriate trees in order to save energy, protect their young, and aid their roost-switching tendencies.

Given the importance of bat roosts, both Herder and Chambers caution that any restoration treatment should maintain adequate numbers of snags because these are the sites where females raise their young.

Foraging Habitat

Bats in northern Arizona are insectivorous, which means that the type and availability of prey may change dramatically between seasons or habitat types. Insectivorous bats typically feed at the edges of forests or within opening in forested areas (Hinman and Snow 2003). Researchers know that bats are relatively loyal to foraging sites and they suspect that dramatic changes to such sites, such as clearing and fire, may affect bat foraging behavior. Unfortunately, we do not know enough the relationship between foraging area and bat requirements to provide management recommendations.

Water Features

Water features are very important to bats because they provide drinking water and excellent foraging habitat. The usefulness of a water feature to bats depends on its accessibility, how long and when it holds water, the surrounding vegetation, and its location in terms of the other two major habitat components—roosting sites and forage habitat.

Recommendations

These findings suggest the following consideration for bats when developing a restoration treatment for a forested landscape in the Southwest:

- Leave as many tall, large-diameter snags as possible. In general, the larger the snag the better, although a variety of decay classes should be kept to accommodate different species of bats (see ERI Working Paper 16 for information about snags and decay classes).
- Optimum minimum size for ponderosa pine roost snags is 26 inches dbh and 70 feet tall. For Gambel oak, snags should have internal cavities and be at least 10 inches in diameter (Bernardos et al. 2004).
- Preserve clumps of large-diameter ponderosa pine snags or groups of large oaks.
- Snags along draws that lead to water or snags near bodies of water should be considered a high priority because bats tend to select roosts that are close to water features since they are excellent foraging habitat.
- Preserve water features such as lakes, streams, wildlife drinkers, springs, livestock tanks, and ponds. Keep artificial water features full during droughty periods and keep all water features clear of anything (e.g., fencing) that would impede clear flight paths for bats (Tuttle et al. 2006).
- Save any snags that have evidence of use by bats (roosts and guano droppings).
- Replace snags and roost trees lost through prescribed fire or logging whenever possible by installing artificial roosts, if necessary.
- Be aware that spraying pesticides for moths or beetles can negatively affect the distribution of insects that serve as prey for bats (Hinman and Snow 2003). Seek and use alternatives to pesticides whenever possible.
- Maintain forest edges and openings within stands as foraging habitats for insectivorous bat species.
- Make sure there is a continuous supply of large ponderosa pine or oak that will provide bat habitat. A monoculture of small trees is not likely to contain adequate snags for bats now or in the future.

Artificial roosts, such as this one made of fiberglass, can provide habitat for bats. They can be used when snags and other roosts sites are limited, but should not be used to simply replace natural roosting sites.

Photo by Carol Chambers

Bats will also use wooden bat houses like this one. There are many designs available.

Photo by Carol Chambers

Artificial Roosts

Artificial roosts are a viable alternative to natural snags, especially for situations where fire has destroyed natural snags. In such cases, artificial roost sites can provide temporary shelter for some species until natural roosts develop. Michael Rabe, of the Arizona Game and Fish Department, and his colleagues have seen bats switch roosts, especially after rains, which Rabe believes may indicate a need for more roosts than are naturally available.

Experiments involving artificial roosts attached to tree trunks have revealed that bats do use such roosts when they are available (Rabe et al. 1998, Chambers et al. 2002). Chambers and her colleagues (2002) showed that bats will use artificial bat roosts made of either fiberglass resin or wood. The resin roosts made by Wesco Enterprises cost $51 apiece (plus $250 or $300 for the construction of a casting mold) and can last indefinitely with annual maintenance (re-caulking the top and sides of the roost). The company can fashion and paint the roosts to look like any tree species, if provided with a tree bark sample. Wooden roosts are significantly cheaper—about $5 apiece—but deteriorate more quickly and are more visible.

Valerie Horncastle, a researcher with the Arizona Game and Fish Department, found in the first two years of an ongoing study that bats regularly use south-, southwest- and east-facing bat boxes, but rarely use boxes that face north. As for the appearance of artificial wooden roosts, Horncastle reports that plywood designs stained lighter than their host trees have received just as much use by bats as boxes painted to match

trees. Chambers agrees that bats don't seem to favor camouflaged bat boxes, but she continues to paint them in order to discourage vandalism by people. Both researchers have been placing artificial roosts more than 7 feet off the ground, and they suggest placing artificial roosts 7-50 feet above the ground for best results.

Additional Management and Conservation Considerations

Bats are sometimes overlooked in conservation planning efforts because they are difficult to observe and study. For example, it may be hard to determine a species' overall geographic range because many species are patchily distributed due to specialized habitat requirements (although see Hinman and Snow 2003 for species range maps in Arizona). In addition, seasonal distributions of many bat species differ greatly throughout the year, and we know very little about the seasonal habitat shifts of most North American bat species. To offset this lack of knowledge, conservation strategies should include both summer and winter habitat, and should incorporate diverse features that support the multiple roost requirements of many forest bat species.

Prior to any forest restoration effort, consider hiring a bat expert or a university student interested in studying bats to survey bat populations in your locale. Such surveys can provide valuable information that will inform your restoration and/or conservation decisions.

On the Web

Arizona Game and Fish Bat Conservation and Management
www.gf.state.az.us/w_c/bat_conservation.shtml
Bat Conservation International
www.batcon.org/home/default.asp
U.S. Fish and Wildlife Service bat information
www.fws.gov/endangered/bats/links.htm
Bat Conservation and Management
www.batmanagement.com
Organization for Bat Conservation
www.batconservation.org

Sources for Artificial Roosts

Wesco Enterprises
3235 Monier Circle #1,
Rancho Cordova, CA 95742
(916) 635-1270

Bat Conservation and Management
www.batmanagement.com/Ordering/batboxes/housemanual.pdf

References

Arizona Game and Fish Department. 1996. Mammal Diversity Review Notes.

Bernardos, D.A. 2001. Use of ponderosa pine-Gambel oak forests by bats in northern Arizona. Master's thesis. School of Forestry, Northern Arizona University, Flagstaff.

Bernardos, D.A., C.L. Chambers, and M.L. Rabe. 2004. Selection of Gambel oak roosts by southwestern myotis in ponderosa pine-dominated forests, northern Arizona. *Journal of Wildlife Management* 68(3):595-601.

Centers for Disease Control and Prevention. 2002. Rabies: Epidemeology. http://www.cdc.gov/ncidod/dvrd/rabies/Epidemiology/Epidemiology.htm.

Chambers, C.L., V. Alm, M.S. Siders and M.J. Rabe. 2002. Use of artificial roosts by forest-dwelling bats in northern Arizona. *Wildlife Society Bulletin* 30(4):1085-1091.

Cockburn, E.L. 1960. Order Chiroptera: Bats. Pp. 31-66 *in* The recent mammals of Arizona: Their taxonomy and distribution. Tucson: University of Arizona Press.

Herder, M. 2000. Managing deadwood for bat habitat. *Resource Notes* No. 17. National Applied Resources Science Center.

Herder, M. and J.G. Jackson. 1999. Characteristics of ponderosa pine snags selected as roosts by long-legged Myotis bats, *Myotis volans. In* Proceedings of the ecology and management of dead wood in western forests. November 2-3, 1999 Reno, Nevada.

Hinman, K.E. and T.K. Snow, eds. 2003. Arizona bat conservation strategic plan. Technical Report 213. Nongame and Endangered Wildlife Program, Arizona Game and Fish Department. http://www.gf.state.az.us/pdfs/w_c/bat/NGTR%20213%20-%20Arizona%20Bat%20Conservation%20Strategic%20Plan.pdf.

Kunz, T.H., and E.D. Pierson. 1994. Bats of the world: An introduction. Pp. 1-46 *in* R.W. Nowak, Walker's bats of the world. Baltimore: Johns Hopkins University Press.

Nagorsen, D.W. and R.M. Brigham. 1993. *Bats of British Columbia.* Vancouver: University of British Columbia Press.

Rabe, M.J., T.E. Morrell, H. Green, J.C. Devos, and C.R. Miller. 1998. Characteristics of ponderosa pine snag roosts used by reproductive bats in northern Arizona. *Journal of Wildlife Management* 62(2):612-621.

Tuttle, S.R., C.L. Chambers, and T.C. Theimer. 2006. Potential effects of livestock water-trough modifications on bats in northern Arizona. *Wildlife Society Bulletin* 34(3):602-608.

Bats and Rabies

Given that wildlife biologists are only now beginning to understand the ecology of bats, it's no wonder that the general public harbors various misconceptions about these animals. One such misunderstanding is that all bats are rabid. In fact, only a very small percentage (0.1-0.5%) of the wild bat population is infected with rabies (Nagorsen and Brigham 1993), and the Centers for Disease Control and Prevention (2002) attributes only 1.3 deaths per year to rabid bats. This is not to downplay the serious nature of rabies, which is a potentially fatal viral disease that affects the nervous systems of humans and other mammals, but the chances of someone dying from a rabid bat are extremely low when compared to deaths from other carriers of rabies (especially dogs and cats).

Of course, people working in forests or other outdoor environments may encounter bats on a more regular basis than the general public. They should keep the following in mind about bats and bat-related diseases:

- Never handle any bats unless you are wearing leather gloves.
- Have yourself vaccinated, as needed, for protection against rabid animals.
- Seek immediate medical help if you are bitten and have not been vaccinated; try and capture the rabid bat and send it to a laboratory for rabies testing.
- Bats normally bite only in self defense; aggressive behavior is rare even in rabid bats.
- Provide educational materials about bats to visitors to natural areas; emphasize that visitors should not handle or touch any wild animals they might find, including bats.
- Bats do not transmit the West Nile Virus even though they eat mosquitoes that do spread the disease.
- Histoplasmosis, an airborne fungal disease related to bats and bat guano, is relatively rare in the arid climate of northern Arizona.

For more information about bats and rabies consult the following web sites:
Bat Conservation International
http://www.batcon.org/home/index.asp?idPage=91&idSubPage=62
Centers for Disease Control and Prevention
http://www.cdc.gov/ncidod/dvrd/rabies/bats_&_rabies/bats&.htm

Arizona myotis

Bats Found in Northern Arizona Forests

Forest obligates
Silver-haired bat (*Lasionycteris noctivagans*)
Western red bat (*Lasiurus blossevillii*)
Hoary bat (*Lasiurus cinereus*)

Forest common
Big brown bat (*Eptesicus fuscus*)
Southwestern myotis (*Myotis auriculus*)
California myotis (*Myotis californicus*)
Western small-footed myotis (*Myotis ciliolabrum*)
Long-eared myotis (*Myotis evotis*)
Arizona myotis (*Myotis occultus*)
Fringed myotis (*Myotis thysanodes*)
Long-legged myotis (*Myotis volans*)
Yuma myotis (*Myotis yumanensis*)

Forest occasional
Pallid bat (*Antrozous pallidus pallidus*)
Townsend's big-eared bat (*Corynorhinus townsendii*)
Spotted bat (*Euderma maculatum*)
Greater western mastiff (*Eumops perotis californicus*)
Allen's lappet-browed bat (*Idionycteris phyllotis*)
Big free-tailed bat (*Nyctinomops macrotis*)
Western pipistrelle (*Pipistrellus hesperus*)
Mexican free-tail bat (*Tadarida brasiliensis mexicana*)

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For more information about forest restoration,
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