

PROJECT TITLE:

Analysis of Pesticides and Contaminants in Guano of Endangered Bats in Northeastern Oklahoma

PRINCIPLE INVESTIGATOR: Dr. Keith W. Martin, Ph.D. Assistant Professor of Biology

ABSTRACT:

Declines in bat populations in North America became apparent in the late 1960's, particularly in obligate cave-dwelling species of bats. Pesticide and contaminant toxicity has been implicated in the decline in a number of insectivorous bats in North America. Lethal pesticide poisoning has been reported in gray bats and Mexican Free-tailed bats and sublethal levels of agricultural pesticides have been documented gray bats and two additional sympatric species of bats. Endangered bat species in eastern Oklahoma forage exclusively on agricultural pests predisposing each to pesticide and contaminant toxicity. Ultimately, bioaccumulations may be high enough in bats to be of concern to higher trophic level predators such as falcons, hawks, and owls that regularly consume bats as prey. The intent of this study is to conduct a standard systematic sampling of guano of previously detected contaminants in selected caves inhabited by endangered species of bats in northeastern Oklahoma. Such sampling can contribute to establishing trends of exposures and serve as an indicator of terrestrial environmental quality.

INTRODUCTION:

About 18 of the 45 species of bats found in North America rely substantially on caves throughout the year, and 13 use caves year-round (McCracken, 1989). All North American bats listed as endangered or threatened by the U.S. Fish and Wildlife Service are cave-dwelling species or subspecies (McCracken, 1989; Harvey et al., 1999; Pierson, 1999). Two cave-dwelling species, the gray bat (*Myotis grisescens*) and Indiana Bat (*Myotis sodalis*), and one subspecies, the Ozark big-eared bat (*Corynorhinus townsendii ingens*), are of particular concern to recovery biologists in Oklahoma because each is federally listed as endangered (U.S. Fish and Wildlife Service 1982, 1984, 1995). Declines in bat populations in North America became apparent in the late 1960's, particularly in obligate cave-dwelling species of bats. Persistent or casual human disturbance at maternity caves and hibernacula has been implicated as a cause for the decline in population of most cave dwelling bats (Barbour and Davis 1969; Humphrey and Kunz 1976; Tuttle 1979; Amer. Soc. Mamm. 1992). Pesticide and contaminant toxicity has also been implicated in the decline in a number of insectivorous bats in North America (Mohr, 1972, Clark 1981), but not thoroughly studied. Pesticide poisoning has been reported in gray bats (Clark et al, 1978, 1993; Clawson and Clark, 1989) and Mexican Free-tailed bats (*Tadarida brasiliensis*). Sublethal levels of agricultural pesticides have been documented gray bats in Missouri

(Clark et al, 1983), and in two sympatric species, the northern long-eared bat (*Myotis septentrionalis*) and the big brown bat (*Eptesicus fuscus*).

Endangered bat species in northeastern Oklahoma forage exclusively on insects, particularly on moth species (Leslie and Clark, 2002). Contamination of prey species by persistent pesticides could lead to significant quantities being ingested by bats, with subsequent hazardous bioaccumulation. Bioaccumulation via food supplies could include other organic and elemental compounds as well (Martin, 1992). Ultimately, these accumulations may be high enough in bats to be of concern to higher trophic level predators such as falcons, hawks, and owls that regularly consume bats as prey (King et al, 2001).

Previous analysis of pesticides and contaminants in guano and carcasses from bats in northeastern Oklahoma detected the following substances:

- 1) Organochlorine Pesticides: Although use of many organochlorides (OC's) are presently banned, others are still used extensively. A study by Martin (1992) in northeastern Oklahoma detected 9 OC's in carcasses of gray bats; DDE, dieldrin, oxychlorane, heptachlor epoxide, trans-nonachlor, HCB, alpha-chlordane, and two derivatives of DDD. It is anticipated that since use of these pesticides is presently restricted, that incidence in samples should decrease over time and not pose a threat to endangered species of bats in northeastern Oklahoma.
- 2) Petroleum hydrocarbons: Feeding experiments involving oil in the diet of birds noted growth suppression, impaired avoidance behavior, liver hypertrophy, splenic atrophy, kidney degeneration, hyperphagia, and hemolytic anemia (Hall and Coon 1988). These conditions combined with other forms of physiologic stress could have serious consequences in wild populations, but studies of sublethal effects on bats has not been conducted to date.
- 3) Elemental Contaminants: Metal concentrations and bioaccumulation varies considerably among dietary specialists. Elemental contaminants tend to accumulate in specific organs and tissues of vertebrates. However, a sufficient mass of tissue from such organs is difficult to accomplish. Eight elements (As, Cd, Cr, Cu, Hg, Pb, Se, and Zn) were detected in guano from gray bats in northeastern Oklahoma by Martin (1992). The elements to most likely accumulate to toxic levels include arsenic, cadmium, lead, mercury, and selenium (King et al, 2001). It is not suspected that any of these metals will accumulate to toxic levels in samples of bats in northeastern Oklahoma.

The intent of this study is to contribute to the understanding of the degree to which bats are exposed to these previously detected contaminants, in selected caves inhabited by endangered species of bats in northeastern Oklahoma.

OBJECTIVES:

- 1) To gain a preliminary understanding of the degree to which bats are exposed to Organochloride Pesticides, Petroleum hydrocarbons, and elemental contaminants in selected caves inhabited by endangered species of bats in northeastern Oklahoma.
- 2) Compare residue and contaminant levels to initial observations collected in similar studies in 1981 and 1991. Periodic and systematic sampling of guano and tissue residues can establish trends of exposures of bat populations to pesticides and other trace elements and serve as an indicator of terrestrial environmental quality.
- 3) Employers in the environmental/ecological market consistently pursue applicants with experience in field techniques involving environmental quality monitoring. Methods conducted during this project will provide crucial field experience for students in Rogers State University's bachelor degree in Biology with an Environmental Conservation emphasis.

STUDY AREA AND METHODS

Our study will be conducted in Adair, Cherokee, Delaware, and Ottawa counties of northeastern Oklahoma in the western limit of the Boston Mountains of the Ozark Plateau. The Plateau covers about 103,000 km² (Huffman, 1959) in the central United States; elevations are 260–460 m above mean sea level. The area is dominated by outcrops of alternating layers of limestone and flint (= chert) and sandstone conducive to cave formation (Blair and Hubbell, 1938). It has been proposed that caves in these and other similar latitudes may have served as refugia from severe post-Pleistocene winters for *C. t. ingens* and other cave-dwelling species (Humphrey and Kunz, 1976).

Vegetation on mountain slopes is predominantly blackjack oak (*Quercus marilandica*), post oak (*Q. stellata*), black hickory (*Carya texana*), and winged elm (*Ulmus alata*). Coralberry (*Symphoricarpos orbiculatus*) and sassafras (*Sassafras varifolium*) comprised a sparse shrubby understory. Riparian areas occurred in lowlands and were dominated by silver maple (*Acer saccharium*), river birch (*Betula nigra*), American elm (*U. americana*), cottonwood (*Populus deltoides*), sycamore (*Plantanus occidentalis*), and various oak species. Sporadic openings of managed grasslands are used for various types of agricultural (Blair and Hubbell, 1938; Harvey *et al.*, 1981).

Guano samples will be collected in late summer and early fall 2003 from three caves, one each in Adair, Delaware, and Ottawa Counties, Oklahoma. Samples will be from gray bat colonies that have been in the study area for the entire summer, and just prior to their departure to hibernacula in Arkansas and Missouri. Guano will be collected using stainless steel utensils, stored in sterile glass containers, and packed in dry ice prior to shipment to a contracted analysis laboratory.

INSTITUTIONAL SUPPORT:

Transportation to complete appropriate field-work will be provided by institutional vehicles from Rogers State University. Associated transportation costs will be funded through project E-22-11, a research grant awarded to Rogers State University from the Oklahoma Department of Wildlife entitled *Cave Protection and Management for the Ozark Big-eared Bat and the Gray Bat in Oklahoma*. Additionally, all gear and equipment pertaining to spelunking will be provided by previously purchased supplies.

PROJECT ITINERARY:

August-September 2003: Guano Collection and shipping to analysis laboratory
January-February 2004: Anticipated receipt of laboratory contaminant report
Spring 2004 Report findings to research committee, Rogers State University

LITERATURE CITED:

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PROPOSED BUDGET:

The total budget reflects outside contributions from a grant entitled *Cave Protection and Management for the Ozark Big-eared Bat and the Gray Bat in Oklahoma*. The grant is funded by the U.S. Fish and Wildlife Service (\$20,000 annually) and the Oklahoma Department of Wildlife Conservation. Primary objectives for the project are to develop and coordinate management efforts at caves that are inhabited by endangered species of bats in eastern Oklahoma.

Outside Contributions: Oklahoma Department of Wildlife Conservation Project E-22-11

- Personnel Services: Dr. K.W. Martin \$625.00
- Materials: Spelunking Supplies \$300.00
- Transportation Expenses: \$102.00
- Total Outside Funding Contribution \$1027.00

Rogers State University: Laboratory Analysis (Laboratory and Environmental Testing, Inc. 3501 Berrywood Dr., Columbia, Mo. 65201)

- Organochlorides (OC) Scan: \$340.00 x 3 \$1020.00
- Aromatic Hydrocarbon (PAH) Scan: \$465.00 x 3 \$1395.00
- Metals Scan: \$168.00 x 3 \$504.00
- Sterile Glass Containers: \$108.95
- Stainless Steel Scoopula \$11.96

Organized Faculty Research Grant Request: \$3039.91

Personal Vita
for
Dr. Keith W. Martin

Education: Graduated from Claremore High School in Claremore, Oklahoma, in 1978; received a Bachelors in Science degree in Biology-Education from Northeastern State University in Tahlequah, Oklahoma, in May 1986; received Masters of Science degree in Biology-Higher Education from Northeastern State University in Tahlequah, Oklahoma, in 1991; completed requirements for the Doctor of Philosophy degree with a major in Wildlife and Fisheries Ecology at Oklahoma State University in December 2001.

Experience: Biology Instructor for Owasso Public Schools in Owasso, Oklahoma, from 1986-1990. Instructor of Biology at Rogers State University, Claremore, Oklahoma, 1990-2000 and Assistant Professor of Biology at Rogers State University, Claremore, Oklahoma, 2001.

Professional Memberships: American Society of Mammalogists, Oklahoma Academy of Sciences, Oklahoma Ornithological Society (President 2002-2002), The Wildlife Society, Southwestern Association of Naturalists.

Research/Grants:

Principle Investigator for Project E-22 (1993-present) of the Oklahoma Department of Wildlife entitled *Cave Protection and Management for the Ozark Big-eared Bat and the Gray Bat in Oklahoma*. The grant is funded by the U.S. Fish and Wildlife Service (\$10,000-\$18,000 annually) and the Oklahoma Department of Wildlife Conservation. Primary objectives for the project are to develop and coordinate management efforts at caves that are inhabited by endangered species of bats in eastern Oklahoma.

Principle Investigator for an Organized Research Grant funded by Rogers State University 2000-2001 entitled *Effects of Internal Gating Structures on Cave Microclimates and Management Implications for Endangered Species of Bats*. The grant totaled \$3,500.00 and was completed in December 2001.

Publications:

Comparative Numbers of Gray Bats (*Myotis grisescens*) at Four Maternity Caves in Northeastern Oklahoma in 1981 and 1991. Proceedings of the Oklahoma Academy of Sciences 73:35-37. (1993)

Internal Cave Gating as a Means of Protecting Cave-Dwelling Bat Populations in Eastern Oklahoma. Proceedings of the Oklahoma Academy of Sciences 80:133-138. (2000)

Internal Cave Gating for Protection of Colonies of the Endangered Gray Bat (*Myotis grisescens*). Acta Chropterologica, 5:143-150. (2003)

