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CONSERVATION ECOLOGY OF AN ISOLATED POPULATION OF BLACK BEARS IN THE BIG BEND ECOSYSTEM

Submitted by :

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ABSTRACT:

Black bears have recolonized Big Bend National Park in the past 10 years from adjacent habitat in Mexico. Reproduction occurs in the Chisos Mountains, and bear sightings and bear-human interactions have increased manifold in that period. Range expansion by the Big Bend bear population has considerable consequences for resource managers in Big Bend National Park, especially in the areas of bear-human interactions and waste management. Knowledge of bear distribution and range use can facilitate people management by allowing prediction and alleviation of potential bear-visitor incidents. Management needs extend to knowledge of the genetics of the bear population for conservation purposes. Genetic data from resident bears and bears in nearby Mexican populations can provide information regarding the genetic connectivity via interpopulation movement of the metapopulation of black bears in the Big Bend Ecosystem. These data also can assist in population viability analyses of the Big Bend population. This study proposes a twofold approach to black bear research in Big Bend National Park: to examine the relationship of bear range use to habitat types, geographic features and human activity areas in the Park; and to examine genetic relationships among individuals by molecular genetic

techniques. This study proposes to mark and sample all individuals in the recolonizing black bear population in the Chisos Mountains over a 3-year period. Ecological data will be used for direct management application to the prediction and amelioration of bear-human conflicts. Demographically, the black bear population in Big Bend National Park provides an interesting case study in conservation genetics and colonization. The role of Mexican bear populations in providing gene flow to Big Bend will be explored.

INTRODUCTION AND JUSTIFICATION

Historical evidence indicates that the black bear (*Ursus americanus*) was once common in the Chisos Mountains of the Big Bend Ecosystem (Bailey 1905). Between the establishment of Big Bend National Park in 1944 and 1988, however, bears were rarely sighted and were considered transients in the area. Females with young, a sign of a resident population, were sighted once in 1969 and 5 times in 1978.

Suitable habitat for black bear exists in the Chisos Mountains and other parts of the Big Bend area; and bear populations in the Sierra del Carmen and Serranias del Burro mountains in adjacent Mexico are apparently serving as reservoirs for bear reproduction and dispersal into Big Bend and trans-Pecos Texas (Doan-Crider and Hellgren 1996). Sightings increased from a 1955-1987 average of 3 annually to 21 in 1988, 70 in 1990 (LoBello 1989, LoBello and Taylor 1991), and >500 in 1993. Sightings have varied in 1994-1997, with 148 for the last reporting period of 1-1-97--8-31-97 (R. Skiles, National Park Service, in litt.). Photographic evidence of reproduction, in the form of a female with 3 cubs-of-the-year and a female with 2 yearlings (presumably the same female), were provided in 1989 and 1990, respectively. Females with

young have now been sighted every year from 1988 to 1997, and a minimum of 2, perhaps 3, breeding, adult females now occur in the Chisos Mountains.

Range expansion as the Chisos population grows has considerable consequences for resource managers in Big Bend National Park, especially in the areas of bear-human interactions and waste management. Knowledge of seasonal bear distribution and spatio-temporal range use can facilitate people management by allowing prediction of temporal and spatial patterns of bear-visitor incidents. These data can assist in prescriptions for conflict avoidance by allowing Big Bend managers to concentrate information and education efforts in zones of highly probable bear-human contact.

A previous report (Hellgren 1991) provided a few relevant conclusions and suggestions. Spatially, concentration of bear sign and sightings indicated areas of heavy bear use and, thus, potential bear-human interactions. Temporally, most bear sightings are made in the summer months, which is probably an interaction between bear habitat use and visitor distribution. Finally, the Basin area, by virtue of its concentration of public use and human foods, constitutes an attractant to bears and the most probable site of bear-human interactions.

Data are needed on habitat use and movement dynamics of black bears in Big Bend National Park to assist in the formulation of a Park black bear management plan; and to predict and alleviate potential bear-human problems. LeCount and Mollohan (1995) recommended that a comparative investigation of bear and human habitat use should be the first research priority in Big Bend NP. The Geographic Information System (GIS) now available at Big Bend National Park would be integral to this work, by permitting assessment of the relationship of bear range use to geographic features and heavy visitor use areas in the Park. Also needed are data on

population abundance and dynamics for use in modeling bear population changes over time, as bears recolonize this historical habitat.

Other research questions arise from the increased number of bear observations. For example, what will happen to the black bear population in the Chisos in the coming years? What is the genetic makeup of the current population and how will it change over time? Is gene flow among the black bear metapopulation (a series of populations linked by limited dispersal) in the Big Bend Ecosystem adequate to prevent inbreeding depression in Big Bend National Park? Nothing is known about genetic input to the resident population of black bears in Big Bend National Park, although it is assumed that Mexico is providing the source, at least for male bears (Doan-Crider and Hellgren 1996). Routes of dispersal for male bears are unknown, and therefore, the effects of future fragmentation on the bear population, especially from human development in the area (e.g., Terlingua, Study Butte), cannot be predicted. Molecular genetic techniques combined with present demographic information (reproductive and survival rates) will help address some of the above questions.

Recently, Avise (1995) discussed the relevance of mitochondrial DNA polymorphisms to demography and conservation of species that exhibit limited female dispersal and strong matrilineal population structure, such as black bears. As discussed by Avise (1995) and Moritz (1994), because of maternal inheritance of the mitochondrial genome, such results should be interpreted in light of nuclear genetic variation before any specific management plan is implemented. Nuclear and mitochondrial markers provide complementary information relative to overall levels of gene flow, movements of males, and whether all female offspring in a group (different age classes) are the product of the same male. Such issues have direct impact on

management decisions concerning bears in western Texas, where 2 subspecies (*U. a. eremicus* and *U. a. amblyceps*), several disjunct mountain ranges, and increased bear activity occur. The protected, isolated status of black bears in Big Bend National Park allows for a unique opportunity to examine questions of genetics and conservation of small populations simultaneously with the direct management implications of human-bear interactions.

The Chisos Mountains are roughly 35 km from the nearest bear population (and suitable habitat) in the Sierra del Carmen of northern Coahuila. Thus, although the Chisos are well within the range of a dispersing male, it is not surprising that it took 40+ years for a resident female to return to the Chisos. Females rarely disperse from their natal, or birth, range (Rogers 1987, Elowe and Dodge 1989, Schwartz and Franzmann 1992). Avise (1995) stated that populations of species with limited female dispersal that are compromised or extirpated by human or natural causes will unlikely recover or re-establish in a short timeframe.

As the Chisos population grows, it is predicted, based on theories of black bear social behavior (Rogers 1987), that females will be closely related, adult resident males will be unrelated, and subadult males will be either closely related to residents (predispersal) or unrelated (transients). If predictions are true, it indicates that immigration is occurring, which is a positive indicator for the viability of the Big Bend population. If not, other options (e.g., augmentation) may need to be considered relative to long-term viability of the population.

Molecular genetic analysis of nuclear and mitochondrial genes will be used to examine the above scenario. Packer et al. (1991) used DNA fingerprinting to demonstrate the kinship structure of lion prides. They used DNA band sharing among known kin to estimate degree of

relatedness between individuals of unknown parentage. A similar analysis will be used to monitor the genetic structure of the Big Bend bear population.

Concurrent studies in Mexico and by the Texas Parks and Wildlife Department provide a unique opportunity for interagency cooperation and synergistic data-gathering. Samples from 2-4 different populations in the Serranias del Burro, 80 km southeast of the Park (Doan-Crider and Hellgren 1996), the Sierra del Carmen (D. L. Doan-Crider, Texas A&M University-Kingsville, personal communication), and perhaps the Sierra del Nido in Chihuahua (D. L. Doan-Crider, Texas A&M University-Kingsville, personal communication) will be available to study the phylogeographic structure of populations of black bears in the region. Data from these populations, when compared to black bear genetics throughout North America (Wooding and Ward 1998), will permit evaluation of gene flow within the overall metapopulation.

OBJECTIVES:

1. To address management concern about the viability of the small population of black bears in Big Bend National Park by describing intrapopulation and interpopulation genetic structure of the population using molecular genetic techniques.
2. To describe landscape use, home range, and dispersal dynamics of black bears in the Chisos Mountains
3. To compare bear range use to visitor use and human-related landscape features

MATERIALS AND METHODS

The study will be conducted in Big Bend National Park, which comprises over 320,000 ha of northern Chihuahuan Desert located in west Texas on the Mexican border. Wauer (1971)

recognized 6 habitat associations in the Park: arroyo-mesquite (*Prosopis* spp.)-Acacia (*Acacia* spp.); lechuguilla (*Agave lecheguilla*)-creosote (*Larrea divaricata*)-cactus; sotol (*Dasylirion leiphyllum*)-grass; deciduous woodland; pinyon (*Pinus* spp.)-juniper (*Juniperus* spp.)-oak (*Quercus* spp.) woodland; and cypress (*Cupressus* spp.)-pine-oak. Woodland/brush associations described by Plumb (1987) include pinyon-talus, forest meadow, pinyon-oak-juniper, pinyon-juniper-grass, oak-ponderosa pine-cypress, mixed oak, oak scrub, and mixed scrub and are equivalent to the 3 woodland types described by Wauer (1971) above. These associations represent 68.6 km² of available habitat (Hellgren 1993).

Black bears (as many as 30, though likely fewer) will be captured with barrel traps (a barrel with a padded, sliding door activated by movement of a lever that holds bait) to ensure visitor and bear safety; or leghold snares if conditions permit. Telazol (A.H. Robins Company, Richmond, VA 23220), a combination of tiletamine hydrochloride and zolazepam hydrochloride, will be used at a dosage rate of 4.8 mg/kg to immobilize bears (Doan-Crider and Hellgren 1996). Drugs will be administered by jabstick or blow-gun dart syringe. The first premolar will be extracted for aging by cementum annuli analysis (Willey 1974). All captured bears will be implanted with a PIT (passive integrator transponder) tag for permanent but visually nonintrusive identification. All female bears and selected male bears will be equipped with a radiotransmitter containing a mortality switch.

Blood samples will be collected by femoral venipuncture in Vacutainer tubes as soon as possible following immobilization. Each sample will consist of at least 2 10-mL tubes without anticoagulant for serum analyses (Hellgren et al. 1989) and 1 7-mL tube containing EDTA coagulant for genetic analysis. Samples will be centrifuged, serum harvested, and samples stored

at -20 C for later analysis. Tubes containing EDTA will also be centrifuged, the white blood cells pipetted into a storage tube, and the storage tube frozen. Blood and ear tissue (collected using a eartag punch) will be used for microsatellite analysis of genetic variation (Paetkau and Strobeck 1994). Samples from Big Bend will be supplemented with samples collected in northern Coahuila, Mexico (Doan-Crider and Hellgren 1996; D. L. Doan-Crider, Texas A&M University-Kingsville, personal communication) from 2-4 populations. These populations could include the Rancho Rincon in the Serranias del Burro (Doan-Crider and Hellgren 1996), 2 populations in the Sierra del Carmen (the east side of the range and the Maderas del Carmen), and possibly the Sierra del Nido in Chihuahua. *B. ...*

Blood and ear tissue (collected using a eartag punch) will be used for genetic analyses. DNA will be isolated primarily following the technique of Longmire et al. (1991). Two independent genetic markers (mitochondrial and nuclear loci) will be utilized to evaluate genetic structure and gene flow within and among populations. An approximately 3,000 bp portion of the mitochondrial D loop, spanning the control region, ND6, and cytochrome b gene and several transfer RNAs will be amplified using universal primers. This piece of DNA will be subjected to restriction digestion with several restriction endonucleases to examine mtDNA relationships. Additionally, we will amplify a small portion of the most variable region of the control region and these amplified products will be examined for nucleotide variation through dideoxy fingerprinting (Sanger et al. 1992). Because the mitochondrial genome is maternally inherited, the DNA sequence of this marker should be identical among mothers and offspring, whereas unrelated males will possess DNA sequence variation not detected in the family group. We also will examine nuclear gene-flow among all individuals through microsatellite analysis. Primers

for microsatellite loci are currently available to amplify orthologous loci in the populations of black bears we propose to examine (Paetkau and Strobeck 1994). All methods for examining genetic variation and methods for data analysis (genetic structure, gene flow, and levels of relatedness) are currently performed in the laboratory of Dr. R. A. Van Den Bussche at Oklahoma State University on a routine basis and should present no technical difficulties.

Vital signs (heart rate, respiration, and temperature) of anesthetized bears will be monitored during the handling process. Anesthetization at the above dose level usually lasts 45-90 minutes. At the conclusion of sampling procedures, bears will be placed in the shade with a cloth covering their eyes. If vital signs are stable and normal (Hellgren et al. 1988), then handling personnel will vacate the area to permit the bear to recover. Personnel will return to the site after 4-12 hours to ensure that the bear has left the area (verified by radiotracking).

Relocations of radioed bears will be made weekly by ground or aerial telemetry. Location estimates of radioed bears will be assigned UTM coordinates. Home ranges will be determined by the convex polygon and harmonic mean methods and data analyzed by TELEM software (Coleman and Jones 1938). All location data will be in a form that is compatible for Geographic Information System (GIS) use by Park scientists.

Habitat use will be determined by merging UTM coordinates of bear radiolocations with the digitized data contained within the vegetation type map for Big Bend National Park (Plumb 1987). Preference or avoidance of individual habitats will be determined by the method of Neu et al. (1974) using Chi-square analysis and Bonferroni Z-statistics to control the experimentwise error probability at 0.05. If habitats are used proportionately more or less ($P < 0.05$) than available, they will be considered preferred or avoided, respectively.

Data also will be analyzed to examine relationships among bear range use and human-related landscape features, such as roads (paved, gravel), trails, campgrounds, water tanks, and waste management sites. The distribution of distances of bear relocations to human features will be compared (using Chi-square and Bonferroni Z-statistics) to a similar distribution of random points to assess the effect of human activity on bear distribution.

Range overlap and spatial use of resident bears will be examined. It is predicted that % range overlap will be greater for kin than for nonkin. It is also predicted that available habitat will be filled by encroachment, rather than by female immigration or dispersal from within the Chisos Mountains (Porter et al. 1991).

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SCHEDULE:

Jun-Aug 1998	Hire Ph.D. student with Ok. Coop Unit, visit study area, finalize study plan
Sep -Dec 1998	Initial trapping and blood/tissue sampling
Jan-May 1999	Ph.D. student writes dissertation proposal, takes classes
Jun-Dec 1999	Hire technician for summer, Ph.D. student and technician into field, trapping and monitoring
Jan-May 2000	Ph.D. student on campus, trips to study area
Jun-Dec 2000	Hire technician for summer, Ph.D. student into field, trapping and monitoring
Jan-May 2001	Ph.D. student on campus, trips to study area
Jun-Dec 2001	Monitoring
Jan-May 2002	Write Dissertation, graduate