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Revisión bibliográfica actualizada del oso negro en México

Luis Antonio Juárez-Casillas^{1*} y Cora Varas²

Abstract

Black bears are widely distributed in North America; historically their range included most of northern Mexico. By the middle of the twentieth-century their distribution was reduced to about 20% and by 1994, black bears were classified as endangered. In recent years, however, there has been an increase in the number of black bears sightings in some of their historic distribution, suggesting that black bears in Mexico may be dispersing and recovering historical habitats. In spite of the fact that the black bear is one of the important mammals that inhabits Mexican territory, there is little knowledge concerning its life history. We present information about black bear presence in the Sierra Madre Occidental and Sierra Madre Oriental. Also, we present a review of available research results on habitat, diet and population density. We include a review of peer-reviewed publications, theses, and grey literature, some of which are available only in Spanish. Our goal is to present a country-wide overview to show where studies of black bears have been conducted, where there is need for further research, and to make the information available for researchers in and outside of Mexico.

Keywords: current distribution, historical review, *Ursus americanus*

Resumen

El oso negro se encuentra distribuido extensamente en Norteamérica; históricamente su distribución incluyó gran parte del norte de México. A mediados del siglo XX, su distribución se redujo aproximadamente al 20 % y para el año 1994, los osos negros fueron clasificados en peligro de extinción. En los últimos años, sin embargo, ha habido un aumento en el número de observaciones de osos negros en parte de su distribución histórica, lo que sugiere que los osos negros posiblemente se están dispersando y recuperando parte de su hábitat histórico. A pesar de que el oso negro es uno de los principales mamíferos que habita el territorio mexicano, hay poco conocimiento científico generado en lo que concierne a la historia de vida. Nosotros presentamos información sobre la presencia de oso negro en la Sierra Madre Occidental y la Sierra madre Oriental, organizado por estado. También presentamos la información investigación disponible sobre hábitat, dieta y densidad poblacional. Incluimos publicaciones de revistas científicas, tesis, y literatura gris que en algunos casos ha sido solo disponible en español. Nuestro objetivo es el presentar datos nacionales para demostrar donde se

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han conducidos estudios sobre el oso negro y en donde hay necesidad de investigación; además de presentar esta información para investigadores dentro y fuera de México.

Palabras clave: Distribución actual, revisión histórica, *Ursus americanus*

Introduction

The American black bear was once a species characterized by its extensive distribution throughout Mexico. The first report of the American black bear (*Ursus americanus*) in Mexico is credited to Elliot (1903) in Casas Grandes, Chihuahua. Three subspecies have been reported in Mexico (*U. a. machetes*, *U. a. eremicus* and *U. a. amblyceps*; Hall, 1981; Doan-Crider and Hellgren, 1996), though some authors consider that only the first two of these subspecies are actually distributed in Mexican territory (RamírezPulido *et al.* 1996). Historically black bears lived in the temperate forests of the Sierra Madre Oriental, Madre Occidental and adjacent mountains, within the states of Sonora, Chihuahua, Coahuila, Nuevo Leon, Tamaulipas, Durango, Zacatecas (Leopold 1959; Pelton *et al.* 1999), Nayarit (Baker and Greer 1962), Aguascalientes, Sinaloa, and San Luis Potosi (Hall 1981).

The distribution of black bears in Mexico has been reduced to 20% of its historical range as result of habitat destruction, and poaching (INE/SEMARNAP 1999). This forced Mexico to seek alternatives and implement actions to facilitate its conservation. In this process, only *U. a. eremicus*, distributed in the Sierra Madre Oriental was classified in 1986 as threatened and hunting was banned indefinitely. By 1994 its status was changed to endangered, except for the population in the Serranías del Burro in northern Coahuila, which is listed as Species of Special Concern (SEMARNAT 2010a). Currently, the complete distribution and status of the black bear in Mexico is unclear in some areas of its historical range. However, it has been reported that stable populations persist in Tamaulipas, Nuevo Leon, Coahuila, Chihuahua, and Sonora, with a few records in Chihuahua and Durango, with little information from Zacatecas and San Luis Potosi (Medellin *et al.* 2005; Moctezuma-Orozco and Doan-Crider 2005; Zepeda-Gonzales *et al.* 1997).

In spite of the fact that black bears in Mexico are considered endangered, they confront multiple threats. Increase of human population in bear territory as well as loss and fragmentation of habitat are among the most important (Pelton *et al.* 1999). Black bears are poached; mainly in areas where they are in direct contact with humans (Delgadillo-Villalobos 2011). These threats could be mitigated with education and management plans based on comprehensive scientific knowledge. However, scientific information about black bears in Mexico is scattered and incomplete to the point that even their widespread current distribution is unclear. Documents with up to date information are in the form of theses and unpublished documents such as reports, mostly written in Spanish. Our goal for this review is to present a summary of black bear research in terms of historical and current distribution in Mexico, to present the current knowledge of habitat requirements, diet and density estimations, and to offer the reader an updated picture of the current topics of black bear research in Mexico.

Material and Methods

We searched for peer-reviewed documents that contained information about black bears in Mexico by exploring the web of science. We also consulted Mexican and foreign scientific collections databases available on the Internet, such as the Global Biodiversity Information Facility, Global Biodiversity Information, and Arctos Multi-Institution-Multi-Collection Museum. We reviewed databases of Mexican University libraries where they have biological sciences in their curriculum (veterinary, agronomy, forest sciences, etc.). We obtained access to theses, dissertations and technical reports, and condensed information about black bear's historical and current presence. We summarized for each document, research goals, area of study and main results. Finally we contacted Governmental and Non-Governmental organizations (Secretaría del Medio Ambiente del Estado de Coahuila (SEMARNAC), Protección de la Fauna Mexicana A.C. (PROFAUNA), Procuraduría Federal de Protección al Ambiente (PROFEPA) and the Consejo Estatal de Flora y Fauna Silvestre de Nuevo León (CEFFSNL) to obtain up to date studies about black bear conservation and human-bear interactions.

We collected published sightings of black bears with geographic references, if there were more than one at the same location; we used only one sighting to avoid an overcrowded map. We then, exported the database to Geographic Information Systems (ArcView view. 3.2; ESRI 1999) to generate a map of spatial distribution of current records of black bears.

Results

We found 61 scientific published documents and 12 museum collection records between the years of 1899 to 2011. Thirty-eight citations were black bear studies, while the rest were mammal inventories, institutional reports, or other studies in which the presence *U. americanus* was mentioned. The main sources of information for this review are theses and dissertations that have not been published (23), and national or international peer-reviewed published research papers (23), followed by non-peer reviewed documents such as manuals, reports, and bulletins (6), books or book chapters (8), conferences abstracts and symposiums (2), Mexican scientific collections (4), international scientific collections (9), and online sources (1).

One hundred and eighteen localities reported black bear presence, 100 records show the current presence of black bears as shown in a distribution map (Fig. 1). Most localities were from four of the 14 Mexican states: Coahuila (52), Nuevo Leon (20), Chihuahua (10), and Sonora (6). Fewer records were found in Durango (3), Tamaulipas (2), Zacatecas (2), Jalisco (1), Nayarit (1), Queretaro (1), Guanajuato (1) and Hidalgo (1). Our data-base of black bear records obtained from scientific collections includes 65 records from six Mexican states (Appendix 1); Coahuila (28), Chihuahua (23), Sonora (7), Durango (2) Nuevo Leon (4) and Hidalgo (1). 54 records (83%) are from ten foreign collections, while 11 records (17%) are concentrated in four national collections CNMA (three, Colección Nacional de Mamíferos), UANL (four, Colección de Mamíferos de la Facultad de Ciencias Biológicas de la Universidad Autónoma de Nuevo León), CM-UAEH (one, Colección de Mamíferos del Centro de Investigaciones Biológicas de la Universidad Autónoma del Estado de Hidalgo) and the mammal collection at CIAD

(three, Centro de Educación Ambiental e Investigación en Alimentación y Desarrollo, AC, Unidad Guaymas).

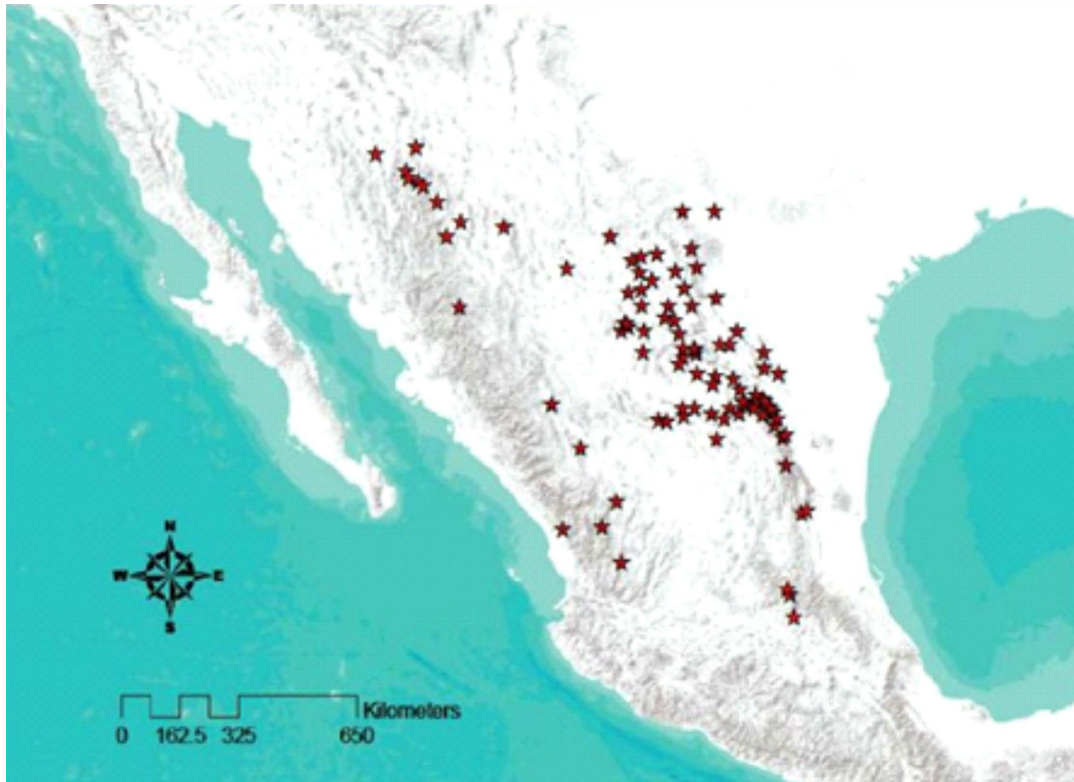


Figure 1. Historical and current published black bear presence sites in Mexico, taken from grey and published documents used in this paper. Stars represent Universal Transverse Mercator (UTM) geographic coordinate system locations as indicated in original documents.

Status of Mexican black bear

Sonora. There are records of black bears in the mountains of the state of Sonora, Sierra San Luis (Sierra-Corona *et al.* 2005; Varas *et al.* 2006), Sierra Los Ajos (Varas *et al.* 2010; Lara-Díaz 2010), Sierra La Madera, Sierra del Tigre and Sierra San Diego (Lara-Díaz 2010). In the Vertebrate Collection of the Centro de Investigación en Alimentación y Desarrollo, A.C., Guaymas Unit (ICAS-00-0076), there are black bear skulls from the Sierra de Huachinera (CIAD-210801-1, -2 and -3; Gallo *et al.* 2008).

Chihuahua. There are historical records of black bears in the Sierra Madre Occidental (Anderson 1972), which includes the northern, central, and eastern portions of the state (Leopold 1959). During the 1970s, the Dirección General de Vida Silvestre (DGVS) confirmed the presence of black bears in isolated areas in Janos, Casas Grandes, Buena Ventura, Namiquipa, Bachíniva, Riva Palacio, Chihuahua, Cuauhtémoc, Guerrero, Gómez Farías and Madera municipalities, in the northern part of the state (DGVS 1977). Pacheco *et al.* (2000), confirmed the presence of black bears in the region of Janos-Casas Grandes, northwest of the Sierra Madre Occidental (Moctezuma-Orozco and Doan-Crider 2005). Verdugo-Valenzuela (2005) reported the presence of black bear tracks in the Sierra El Pajarito. Sánchez-Mateo *et al.* (2007) stated the presence of black bears in Santuario Madera, Madera City. Also Moreno-Arzate (2008) reported black bear presence in Sierra del Nido. Accordingly Calderón-Domínguez (2009) confirmed the presence of black bears throughout most of the Sierra Madre Occidental, from Janos

County in northwest Chihuahua to the sub-tropical forests of Sierra Tarahumara; Sierra del Nido (from Riva Palacio County to Sierra del Pajarito); Sierra de Las Tunas; and desert mountains. The Instituto Nacional de Ecología (INE/SEMARNAP 1997) mentions the presence of very small populations of black bears in the Sierras Hechiceros and Rica in Cañón de Santa Elena.

Sinaloa. Allen (1906) reported the only record of the genus *Ursus* in the state, and reported that Batty in 1904 purchased a bear skin from a hunter at the municipality of Escuinapa located in the south of the state; however, it was not determined whether it was from a grizzly bear (*Ursus arctos*) or American black bear (*U. americanus*). Armstrong *et al.* (1972) reported this specimen as *U. americanus* based on geographic location but the skull is being kept at the American Museum of Natural History (AMNH-24908) and labeled as *U. arctos* (Solano-Arenas 2012).

Durango. Information regarding the presence of black bears is uncertain for the state of Durango. There are however, reports of random isolated sightings. The first report of black bear (Allen 1904) was a skull from the municipality of Río Ocampo, bordering the state of Chihuahua. Leopold (1959) reported black bears in a location 50 kilometers south of the city of Durango, and in the Mezquital Indian Reservation in southern Durango. Baker and Greer (1962) reported that the black bear was uncommon in Durango and it was found only in very remote parts of the Sierra Madre Occidental, mostly in the Municipality of Mezquital. J. I. Servin (from the Universidad Autónoma Metropolitana unit Xochimilco) in 2004 reported two direct observations in Sierra de la Candela, Tepehuanes, and in 2005 near Canoas, Sierra del Mezquital (Delfín-Alfonso *et al.* 2011).

Nayarit- Jalisco. Leopold (1959) reported black bears spotted by locals in Río Bolaños Basin between Nayarit and Jalisco; however, the exact locations of the records are uncertain. Baker and Greer (1962) published the only report of a possible population in northern Nayarit. Delfín-Alfonso *et al.* (2011) reported that in 2007 L. Vidal Melendez photographed a black bear about 4 km west of El Taiste near Huajicori, Nayarit.

Zacatecas. It has been reported that the black bears in Zacatecas are distributed in the Municipalities of Concepción del Oro and Jiménez del Teul (Matson and Baker 1986).

Tamaulipas. Records of black bears in the state are scarce. Vargas-Contreras and Hernandez-Huerta (2001) documented the presence of black bears in the Biosphere Reserve El Cielo. Goodwin (1954) reported black bear presence in the town of Agua Linda in the Biosphere Reserve El Cielo. Medellín *et al.* (2005) validated this information; he noted that there is a reproductively active population of black bears in central Tamaulipas (Medellín *et al.* 2005).

Nuevo Leon. In the early 1980's, black bear presence was reported in very low densities in 52 study areas, (11 municipalities: Allende, Aramberri, Iturbide, Linares, Morelos, Monterrey, Rayones, Santa Catarina, Villa Juárez, Villa de Santiago and Zaragoza). As part of the study, ten black bears were observed and/or captured; two skins and four skulls were collected (Carrillo-Orozco 1981; Moreno-Valdez 1987).

In recent years, black bear numbers have increased in Nuevo Leon and direct sightings are becoming common in the state. Zepeda-González *et al.* (1997) reported that between 1988 and 1992 black bear sighting, as well as the number of tracks, scats and claw marks increased near the town of San Josecito, in southern Nuevo Leon. There is a black bear population in the Sierra de Picachos, in the north-central region of the state (Jiménez-Guzmán 1981; Jiménez-Guzmán *et al.* 1999; Juárez-Casillas 2006).

Salgado-De Los Santos *et al.* (2005) confirmed the presence of 28 black bears in the Sierra "Gomas and Milpillan" (Cuenca Palo Blanco), municipality of Salinas Victoria, Nuevo Leon. Between April and August 2005, the authors obtained photographic records from motion sensors. A total of 28 black bears were identified from the 208 photographs and they found a large number of scats, tracks, and marks on trees.

In 2007, the Consejo Estatal de Flora y Fauna Silvestre de Nuevo León, A. C. (CEFFSNL) and the Parques y Vida Silvestre de Nuevo León (PVSNL, Nuevo Leon Wildlife Park), landowners and holders of 54 Management Units for the Conservation and Sustainable Use of Wildlife (UMAS), participated in a Management Program: Conservation and Sustainable Use of Wildlife Cuenca Palo Blanco. They gathered information to understand the current status of black bears in the northwest of Nuevo Leon, and to determine their distribution, home range, density, dynamics and population structure. The work is in progress and its results have not been published (CEFFSNL 2005).

Coahuila. Baker (1956) reported that black bears were distributed in most mountainous areas in the north of the state of Coahuila. He also pointed out that bears were more common in remote areas with low human density and low hunting pressure. For example, sightings of bears were common in Sierra Madera del Carmen, Sierra del Pino, Sierra de Guadalupe, and Sierra de San Marcos. Medellín *et al.* (2005) and Doan-Crider and Hellgren (1996) indicated that reproductively active populations were present in northern Coahuila. This may show that bears may be increasing their territory because, earlier Baker (1956) reported bears in low densities in some areas in the north of the state and concluded that bears may have disappeared in some northern areas, such as Sierra de los Hechiceros. This low density in some areas in the north of the state was corroborated by Contreras-Balderas *et al.* (2007) who reported no black bear sightings in Sierra de San Marcos also in the north of the state.

Since December 2005, the Environment Ministry of Coahuila (SEMARNAC, unpublished) has been collecting geographically referenced information regarding sightings of black bears in the entire state. The sighting showed that black bears are close to the towns, for instance, in the city of Saltillo, Coahuila bear sighting was common; a possible cause is a severe drought in the region in last decade. The Environment Ministry (SEMARNAT) has deployed personnel to capture black bears and move them to areas where they do not disturb people or their livestock.

San Luis Potosi. In San Luis Potosi, occasional sightings have been reported, however Dalquest (1953) failed to obtain confirmation of black bears in the state, but pointed out that local newspapers reported the killing of few bears in an area close to Matehuala. Therefore, it is unknown if stable populations exist. It is possible that bears observed and/or killed in the state could have been individuals wandering from Nuevo Leon and/or Tamaulipas.

Queretaro. In September 2009, the SEMARNAT confirmed the presence of black bears in the Barranca Pinal de Amoles, state of Queretaro (Newspaper Mensajero de la Sierra Gorda 2009).

Guanajuato. V. Ildefonso A. (Director of the Biosphere Reserve Sierra Gorda, Guanajuato), stated that it is very likely that bears pass through the Sierra de Guanajuato between the communities of Toro and El Platanal because it forms a natural corridor in the Sótano del Barro in the municipality of Arroyo Seco, Queretaro where there have been sightings, tracks and damage to cornfields (V. Ildefonso A, per. Com.).

Hidalgo. In 2005 the skeleton of an adult black bear was found in La Joya near the town of El Aguaje de Cerro Prieto in the Municipality of Misión, in the northern part of the state. The remains of this bear are housed in the Laboratorio de Ecología de Poblaciones del Centro de Investigaciones Biológicas, Universidad Autónoma del Estado de Hidalgo (CM-335; Rojas-Martínez and Juárez-Casillas in press).

Current habitat, diet, density and conflicts.

Habitat Research. Most of the information about black bears in Mexico is from the Sierra Madre Oriental, states of Coahuila and Nuevo Leon. For instance, Carrera-López and Canales-Gutiérrez (1985) developed a classification of habitat quality for black bear in these two states. It consisted of five categories such as the presence and abundance of food, such as oaks (*Quercus* sp.), the presence of surface water sources, the presence or absence of agriculture, human population density, and the presence or absence of high mountains. The results based on their analysis showed that the northern regions of Coahuila and Nuevo Leon have the best conditions for the survival of black bears in the Sierra Madre Oriental.

Juárez-Casillas (2004) evaluated the diversity of mammals in the Ecological Park Chipinque, A. C., in the limits of the city of Monterrey in Nuevo Leon and observed an adult black bear in el Pinar. Within the park, the greatest amount of bear tracks and signs appeared to be in areas that ranged from 1080 to 1526 m in altitude, in isolated forested areas where visitors are not allowed and thus without anthropogenic disturbance (Abrazo del Oso, Pinar and in Pico Lobos). Tracks have also been reported in oak and mixed oak-pine forest with low human activity (e.g., La Deslavada, El Empalme and Las Moras). In the Sierra Madre Occidental, studies have focused mainly on habitat use. For instance Sáyago-Vázquez (2003) and Sierra-Corona *et al.* (2005) evaluated habitat selection of black bears in the Mountain range of Sierra San Luis, Sonora. They combined scats, footprints, and photographic information gathered for two years (during the dry, rainy and post-rainy seasons) to determine vegetation type use. Sáyago-Vázquez (2004) reported 910 black bear sightings (730 for 2002 and 180 for 2003). In 2003 bears used mostly oak-pine forest, pine forest with second growth, and grassland compared with 2002 seasons, and with less use of open low chaparral forest than in 2002. Also, in 2003, during the dry season, bears showed an increased use of pine oak forest, pine forest with second growth, and grassland compared to 2002. For the rainy season there was significant increase in the use of pine forest; they also used open low forest, chaparral and pine-oak with second growth.

Verdugo-Valenzuela (2005), studied black bear habitat characteristics in the Sierra Pajarito, located northwest of the city of Chihuahua, in the Municipality of Buenaventura in Santa Mónica. The authors explored 17 sites for black bear presence. Eight sites had scats; for these sites four habitat variables, exposure, slope, altitude and vegetation type were analyzed using multivariate techniques. Altitude and vegetation type were the best variables to explain the presence of a bear ($P < 0.05$).

Moreno-Arzate (2008), found that the vegetation type and the slope are the most important variables that influence the presence of the black bears in San Luis and in the Sierra del Nido. Open forests are the most commonly used habitat. Other environmental variables such as vegetation, altitude and orientation also can have an effect on where black bears were found. However, no variation was found in habitat use in the Sierra San Luis where three stations were sampled (spring, summer and autumn). Environmental variables were not highly correlated with habitat use during the time of study.

Diet. In Mexican black bears, between 80 % and 97 % of the total food ingested is plant. The amount of plants ingested depends on the time of the year and the geographic locality. Only a small portion of their diet (3% to 20%) consists of animals, principally insects, such as ants and beetles. Also, black bears consume carrion across habitat quality (Carrillo-Orozco 1981; Moreno-Valdez 1987; Niño-Ramírez 1989; Doan-Crider 1995; Tavizon-García 1998; Herrera-González 1999; Delgadillo-Villalobos 2001; Silva-Hurtado 2004; Loaiza-López 2005; Juárez-Casillas 2006; Moreno-Arzate 2008; López-González *et al.* 2009; Nava-Castillo 2011).

Diet studies in Mexico have shown that food items in black bear diet are similar across habitats. The principal food items found in spring and at the beginning of summer are herbaceous plants and acorns (*Quercus* sp.). In summer the plants that predominate are the fruits of sotol (*Dasylirion* sp.), yucca (*Yucca* sp.), acorns, junipers (*Juniperus* sp.), tunas (*Opuntia* sp.), and manzanita (*Arctostaphylos* sp.). During autumn, the principal food source is still acorns and manzanita (Carrillo-Orozco, 1981; Moreno-Valdez 1987; Niño-Ramírez 1989; Doan-Crider 1995; Tavizon-García 1998; Herrera-González 1999; Delgadillo-Villalobos 2001; SilvaHurtado 2004; Loaiza-López 2005; Juárez-Casillas 2006; Moreno-Arzate 2008; López-González *et al.* 2009; Nava-Castillo 2011).

It is important to mention that when the eating habits of black bears are analyzed in the Sierra de San Luis, Sonora remains of scorpions (*Diplocentrus peloncillensis*) were found in seven scat samples, which represents the first record of scorpions in bear diet in Mexico. Although scorpions are not a major component in black bear diet, bears seem to eat scorpions on a regular basis and this is not limited to a single black bear or family unit but is relatively common in the population in Sonora (López-González *et al.* 2009).

Migration. The use of genetic tools to evaluate the present situation of the black bear in Mexico has increased in the past 15 years. Molecular markers have made it possible to demonstrate movement between some populations of Mexico and the United States.

For instance, in Texas black bears were extirpated in the 1940s, but by the 1980s, black bears were seen in Big Bend National Park, the Davis Mountains, and in the east of Texas. Genetic studies showed that Texas individuals have migrated from Serranias del Burro in the north of Coahuila. They also showed that the inhospitable Chihuahuan

Desert was not a geographic barrier for black bears (Onorato *et al.* 2004). Another study showed that black bears in Arizona, black bears in the Sierra Madre Occidental, and bears in the border region between Mexico-Arizona share mitochondrial DNA haplotypes and microsatellite allele frequencies, which indicates that there has been historical, and ongoing gene flow between black bear populations in the United States and Mexico (Varas *et al.* 2006).

Density. Carrera-López and Canales-Gutiérrez (1985), determined the density of black bears in the states of Nuevo Leon and Coahuila. They used availability of habitat, information offered by locals and hunters, evidence of damages caused by bears to agriculture or cattle, marks on the vegetation, presence of dry and fresh scat samples, tracks on the transects, tracks in baited sampling sites, and direct observations of the bears. The authors grouped bears into five categories (1 = lowest density and 5 = highest). In most of the state of Coahuila, the density was classified as level two, which means that the area has vegetation consistent with good quality black bear habitat. Bear tracks (fresh and dry excrement) and other signs of bears were present in the area, along with signs of bear damage in ranches and farmlands in the region. The highest density was found in the Sierras de la Encantada, Santa Rosa, Maderas del Carmen. In Serranias del Burro in the north of the state, black bear density was classified as level four, which means, there were fresh tracks and recent direct observation of black bears. For most of Nuevo Leon, black bear density was lower (level one). Similarly, Mijangos-Araujo (2009), examined the population size of bears in Nuevo Leon, in the Municipalidad de Lampazos de Naranjo. They used three highly variable microsatellite markers, and the sex determination region (amelogenin gene). Microsatellite analysis showed high heterozygosity (70%) and a density of at least 1 bear/ km².

Doan-Crider (2003) explored black bear's habitat use in the foothills of the Burro Mountains, in the northern part of the state of Coahuila. She examined the availability of digestible energy between the years 1998 to 2001, and also, measured the reproduction, survival, and density of black bear populations in the area. Similarly she estimated the production of main food sources. Food was analyzed to quantify the content of digestible energy. Results showed a density of 0.56 bears/km² using a modified Lincoln-Petersen model and 0.84 bears/ km² during 1998 and 2001 using a modified mark-recapture method. Burro Mountains' density estimations are the highest published density for black bears in North America (Doan-Crider, 2003).

Sierra-Corona *et al.* (2005) examined black bears in the Sierra San Luis in the state of Sonora. They collected and analyzed 134 photographs (96 in 2002 and 30 in 2003) that resulted in a density estimate of 6.9 individuals/100 km², with a minimum density during the wet season of 2.64 individual/100 km², and an intermediate density during the dry season (6 individual/100 km²). They found the highest density during the dry season (8.91 individual/100 km²) in 2002, and in 2003, they found that the overall density was lower, 4.15 individuals/100 km², with no recorded individuals during the dry season. However, Varas *et al.* (2010) using non-invasive scat collection and molecular markers found a lower density of 0.22 bears/ km² to 0.38 bears/ km² in the Pinito Ranch located in the same region of Sierra San Luis, Sonora.

Threats and Conflicts. Among the main threats facing the black bear in Mexico, habitat destruction and poaching are important when considering black bear long-term survival. Black bears move through non-habitat, such as deforested areas, farms, ranches or towns in their paths to woodlands. Low population numbers can potentially have a large effect because bears have a long life expectancy and a low reproductive potential (Martínez-Castilleja, 1992).

They are considered a danger to farms and ranches; for example the Biosphere Reserve El Cielo, in the state of Tamaulipas, conducted a study using radio collars and photographs and showed that about 40% of the loss of corn crops was due to black bears (Carvajal-Villareal *et al.* 2007). There is a similar situation with apple farms. In the Municipality of Arteaga, Coahuila, there are about six thousand hectares in apple production, and bears destroy a great quantity of fruit-bearing trees. The bigger farms have chosen to use air cannons that are activated at certain time intervals creating a strong racket to scare bears. They also have an electrical fence around the farm; however, bears get used to the canons, and after a while they go back to eat the fruit. On smaller, family owned farms, farmers do not have the resources to avoid the assaults of bears, the crop gets lost, and the farmers kill bears. Also, in spite of the fact that black bears eat mostly plants, bears are considered responsible for the deaths of goats and cattle in the north of Mexico.

Martínez-Muñoz (2001) devised a project to evaluate the carrying capacity for the black bear in 261.943 acres of the Maderas del Carmen mountain range, Coahuila, from June 1998 to July 1999. This project was part of an extensive study that included researchers from the Caesar Kleberg Wildlife Research Institute. Its goals were to evaluate the sociological conflicts between black bears and ranchers in Madera del Carmen, Coahuila. Results revealed that the mean carrying capacity was 0.96 bears/100 acres. The interviews of 71 farmers indicated that 26% of ranchers reported bears were harmless, while 32% reported that black bears do damages such as the destruction of water hoses (mostly occurring during dry months *i.e.*, June, July and occasionally in May). Forty two percent reported black bears as an important cattle predator. Nevertheless, while reports of depredation by black bears were high; there was no evidence of depredation of cattle in the scats, even during the months of greater food shortage (summer).

Finally, Delgadillo-Villalobos (2001) analyzed 290 scat samples in Maderas del Carmen. They determined that black bears in the study area displayed an opportunistic eating behavior. A high percentage of their diets was composed of plant items and in smaller proportion animal items. Acorns and juniper were the most important components during summer, autumn and winter.

Discussion

It has been documented that black bear range in Mexico has decreased in at least 80% of their historical distribution (SEMARNAT, 2002). Black bears occurred in 11 states (Sonora, Chihuahua, Coahuila, Nuevo Leon, Tamaulipas, Durango, Zacatecas, Nayarit, Aguascalientes, Sinaloa, and San Luis Potosi). The literature mentions that their current distribution is only in Sonora, Chihuahua, Coahuila, Nuevo León and Tamaulipas; and there are unconfirmed sightings in other areas farther south such as Zacatecas and San Luis Potosi (Delgadillo-Villalobos, 2011). Even though their distribution has been reduced, it seems that black bears may be increasing in numbers in some states. For

example, there seems to be an increase of black bear sightings in Coahuila, Nuevo Leon, and northwestern of Chihuahua (SEMARNAC, Calderón-Domínguez, 2009).

Presence of black bears has also been confirmed in places where bears were considered gone by the early 80's; for example, in Sierra Gorda in Queretaro (Newspaper Messenger of Sierra Gorda, 2009; V. Ildelfonso A. Director of the Biosphere Reserve, Sierra Gorda, Guanajuato). There are also current reports of black bears in places where they were never reported before, for example in northern Hidalgo (Rojas-Martínez, personal communication; Fig. 1). This is the first record for the state and it is the most southern area in the distribution. The sighting could have been of a dispersing bear from the state of Queretaro.

It is difficult to know if sightings of black bears in an area mean an established population. In many cases published black bear records do not have information about the age or sex of the individuals, which in turn does not help to understand if the individual is part of a population, or a juvenile male in the process of dispersal. It is important to have studies to determine the status of black bear populations in areas where there have been sightings by locals, such as the states of Nayarit, Jalisco, Durango, San Luis Potosi, and Zacatecas. These sightings may suggest that the black bears in Mexico are dispersing and recolonizing historical habitats. The localities with the highest number of sightings are: Sierra de San Luis, Sonora (Sierra Madre Occidental) where black bear's maximum overall density reported is 4.15 individuals/100 km² (Sierra-Corona *et al.* 2005) and Serranías del Burro (Coahuila, Sierra Madre Oriental) with a reported density of 0.84 bears/km² (Doan-Crider 2003).

At present, there are numerous governmental and non-governmental institutions that are working to protect black bears in Mexico. These organizations have different mandates and regulations. Therefore they work independently from each other and in some cases the results of their research are not shared or published. It is important to include theses, dissertations, manuals, reports, etc. as sources of scientific knowledge, especially in areas where peer reviewed literature is limited. These documents can be useful to find collaborators and avoid duplication of effort.

Scientific collections are also important in the study and conservation of biological diversity (Chalmers 1992). Collections document the distribution of the target species, and are the base of taxonomic, ecological, and conservation status (Ramirez 2006).

However, there are only few black bear specimens (eight) housed in four Mexican scientific collections, thus demonstrating the need for more black bear studies in Mexico and reaffirming the importance of scientific. The distribution maps of black bears presented by Leopold (1959), Hall (1981), and Medellín (2005) used in most published documents are not precise and need to be updated. The published literature shows that current knowledge of the black bears in Mexico is localized to few states, for example, in the northern part of Sonora, and from Coahuila and Nuevo Leon (Doan-Crider and Hellgren, 1996; Sierra-Corona *et al.* 2005, Medellín *et al.* 2005, Onorato *et al.* 2007). There is little information from other parts of Mexico. Different aspects of black bear biology have been studied in these three states, accentuating the patchiness of black bear studies with a concentration of knowledge in a few areas and lack of information in others.

Black bear research in Mexico has mostly focused on detecting their current presence, followed by studies in distribution and then diet. More recently studies have

an ecological perspective, which includes conservation of populations, population density and population genetics. Research is needed to understand ecological factors that affect the survival of black bears in Mexico. There is urgent need for more research on distribution in Mexico, and a better understanding of the life history features and the genetic characteristics of local populations, as well as habitat requirements, food habits, and the demarcation and distribution of Mexican subspecies. It is also important to understand the views of local communities towards bears. If we understand the current situation and the reasons why black bear populations have diminished in the past, we can make science based management decisions for the long-term survival of black bears in Mexico.

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Appendix 1

Scientific collections, locality and catalogue number of *Ursus americanus* specimens from the Sierra Madre Occidental. Data obtained from the Information Facility and the Arctos Multi-Institution-Multi-Collection-Museum Database.

Data source	Locality	Catalogue #
*Harvard University-Museum of Comparative Zoology	-Colonia García, Chihuahua	MCZ -10502
*The Academy of Natural Sciences of Philadelphia-Mammalogy Collection	-Colonia García, Chihuahua	ANSP -6881, 6882, 6883
*American Museum of Natural History (AMNH)-Vertebrate Zoology Collection	-Colonia García, Chihuahua	M -15867
	-Ocampo River, Durango	M -21592
*Field Museum Natural History-Mammals Collections	-Casas Grandes, Chihuahua	FMNH -19012, 19064, 89904
	-Colonia García, Chihuahua	USNM -117100, 98321, 98322, 98325, 98326, 98329, 99338, 99665, 132195
*National Museum of Natural History (NMNH), Smithsonian Institution-Vertebrate Zoology Mammals Collections	-San Luis Mountain, Chihuahua	USNM -177661, 177662, 177663, 177664
	-Sierra Encarnación, Chihuahua	USNM -79571
	-San Luis Mountain, Sonora	USNM -177662, 177663, 177665, 203206
*Michigan State University Museum (MSUM)	-Súchil, Durango	MR -871
*Colección Nacional de Mamíferos, Instituto de Biología, UNAM	-Casas Grandes, Chihuahua	CNMA -1244
*Centro de Investigación en Alimentación y Desarrollo, A. C. Guaymas-Colección de Vertebrados	- Sierra de Huachinera, Sonora	CIAD -210801-1, 210801-2, 210801-3

Appendix 2

Scientific collections, locality and catalogue number of *Ursus americanus* specimens from the Sierra Madre Oriental.

Data source	Locality	Catalogue #
*Field Museum Natural History-Mammals Collections	-San Antonio del Jaral, Coahuila	FMNH -18151, 18152
*National Museum of Natural History (NMNH), Smithsonian Institution-Vertebrate Zoology Mammals Collections	-Maderas del Carmen, Coahuila -Sierra Guadalupe, Coahuila -Sierra Santa Rosa, Coahuila -Muzquiz, Coahuila	USNM -262695 USNM -116952 USNM -159369 USNM -157840, 158247, 159254, 159258
*Texas Cooperative Wildlife Collection - (TCWC), Vertebrate Collections	-Agua salada, Coahuila	TCWC -9466
*University of Kansas Biodiversity Institute (KU), Mammal Collection	-Hacienda la Mariposa, Coahuila -Las Margaritas, Coahuila -Saltillo, Coahuila -Maderas del Carmen, Coahuila	KUM -57087, 57088, 57089, 57090 KUM -56517, 56518, 56519, 56520, 57091, 57818, 57819 KUM -35706 KUM -35704, 35705, 54822, 57819
*Colección Nacional de Mamíferos, Instituto de Biología, UNAM	-Huachichil, Arteaga, Coahuila -Zaragoza, Coahuila	CNMA -44523 CNMA -26377
*Mamíferos de Nuevo León, México (UANL)	-Rayones, Nuevo Leon -Santiago, Nuevo Leon	UANL - 2694 UANL -3422, 4029, 4030

