

Conservation of Critically Endangered Lagomorphs: The Tehuantepec Jackrabbit (*Lepus flavigularis*) as an Example

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Introduction

The Tehuantepec jackrabbit (*Lepus flavigularis*) is a Mexican endemic lagomorph species that is critically endangered by habitat loss and fragmentation, over-hunting, small population size, and genetic isolation. As the most endangered among five species of jackrabbits in México and, in fact, one of the most endangered mammals in the world (Flux and Angermann 1990), the Tehuantepec jackrabbit is protected by the Mexican Official Norm on endangered wildlife and the IUCN Red List of Endangered Species (although jackrabbit habitat is not protected). The total species population size is probably less than 1,000 and divided into three isolated subpopulations that occur along the shores of Superior and Inferior Lagoons in the Isthmus of Tehuantepec, Oaxaca, México (Fig. 1). Conservation laws are not enforced and jackrabbits are hunted for sport or subsistence. In addition, jackrabbit habitat is used as cattle pasture and is deteriorated as the result of introduced exotic grasses, induced fires, agriculture, and human settlements.

Previous studies on Tehuantepec jackrabbits have included cerotype analysis, histology of ovaries and vagina, and phylogenetics (Lorenzo 1996; Portales 1996; Cervantes and Lorenzo 1997). More recently, surveys have showed that jackrabbits were found in well-conserved grassy plains and coastal dunes, but were not observed in agricultural lands, overgrazed grasslands, or continuous dense vegetation (Vargas 2000; Sántis 2002). In addition, Farías (2004) conducted radio-telemetry research ($n = 51$ individual jackrabbits) to specifically assess home range size and overlap to gain insight into the jackrabbit's social organization, habitat use to identify vegetation that should be target of conservation efforts, and cause-specific mortality factors that threaten survival of jackrabbits. One of the consequences of this work was the ability to better assess conservation needs of the species.

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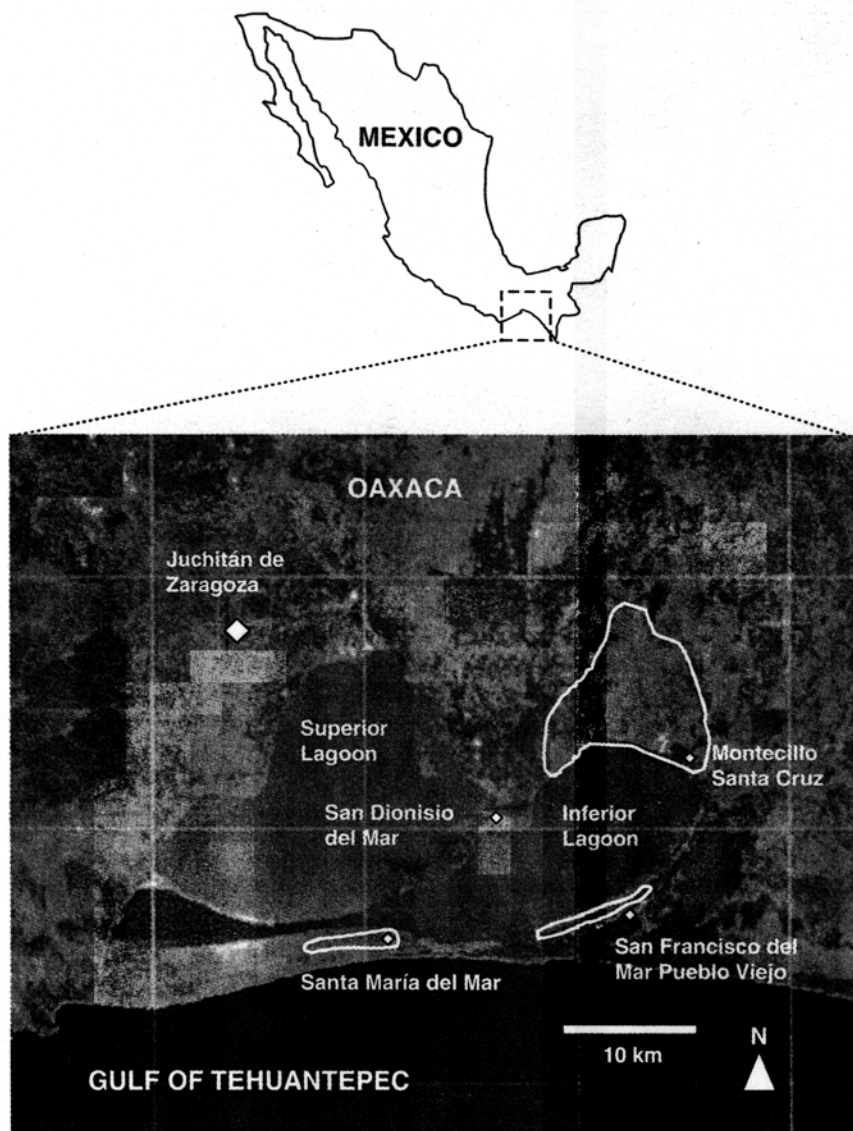


Fig. 1 Estimated extent of occurrence for three remnant populations of Tehuantepec jackrabbit (*Lepus flavigularis*) in Oaxaca, México, is indicated with white circled areas

Geographical Distribution

The former range of the Tehuantepec jackrabbit is not documented in detail, but the geographic distribution of *L. flavigularis* is entirely tropical and represents the southernmost limit of the genus in North America (Hall 1981). The species was named after its geographic range along the Mexican Pacific

coast on the Isthmus of Tehuantepec, from Salina Cruz in Oaxaca to Tonalá in Chiapas (Nelson 1909), an area of perhaps only 5,000 km². The present extent of occurrence was estimated to be about 520 km² for three remnant populations found (1) on the sand bar of Santa María del Mar, (2) on the sand bar of San Francisco del Mar Pueblo Viejo, and (3) in a tropical dry savanna between San Dionisio del Mar and Montecillo Santa Cruz (Fig. 1).

Farías (2004) studied Tehuantepec jackrabbits in a savanna 2 km northwest of Montecillo Santa Cruz, an area typical of jackrabbit habitat. Native vegetation in this area includes grassy plains dominated by grama (*Bouteloua* spp.) and paspalum (*Paspalum* spp.), open shrubbery dominated by nanche (*Byrsonima crassifolia*), and scattered trees dominated by morro (*Crescentia* spp.; Pérez-García et al. 2001). Local people practice subsistence fishing and hunting and raise free-ranging cattle, horses, sheep, and goats. Climate is tropical with mean annual temperature of 25°C, mean annual rainfall of 800 mm (García 1964), and marked seasons. Rains occur from May to October with an intra-estival drought in August, and rains stop from November to April with severe drought during late winter and early spring (Zizumbo and Colunga 1982). Native mammals associated with Tehuantepec jackrabbits are Eastern cottontails (*Sylvilagus floridanus*), Nine-banded armadillos (*Dasypus novemcinctus*), skunks (*Mephitis macroura*, *Conepatus leuconotus*), Southern opossums (*Didelphis marsupialis*), Mouse opossums (*Marmosa canescens*), Gray foxes (*Urocyon cinereoargenteus*), Northern raccoons (*Procyon lotor*), and Coyotes (*Canis latrans*). Gray foxes are potential native predators of Tehuantepec jackrabbits (Trapp and Hallberg 1975) and a Coyote was observed carrying a killed Tehuantepec jackrabbit during a survey (Enrique Martínez-Meyer, pers. comm.).

Conservation Ecology

Farías et al. (2006) found that average seasonal home ranges (95% fixed kernel) and core area sizes (50% fixed kernel with least-squares cross-validation) for adult jackrabbits were similar to annual ranges, did not vary much by season, and were similar for females (58 and 9 ha, respectively), and males (66 and 10 ha). Seasonally, adult jackrabbit ranges overlapped with at least one and up to ten individuals, with mean overlap index of 0.21 for 75 observed dyads over the four seasons of radio-tracking (Farías et al. 2006). Male-male overlap (0.08) was significantly less than female-female overlap (0.26) and female-male overlap (0.23).

Tehuantepec jackrabbits showed significant habitat selection for grassy plains with open shrubbery and scattered trees and avoided dense vegetation to establish home ranges (Farías 2004). Within home ranges, Tehuantepec jackrabbits favored grassy habitats with woody cover but underused grasslands without woody cover. Only 6% of available habitat was grassland without woody cover, but 30% of mortality sites from predated adults were found in this habitat type. In contrast, grassy plains with scattered trees (*Crescentia* spp.)

occupied 36% of available habitat and 20% of mortality sites from predated adults fell in this habitat type. Jackrabbits left their forms at dusk to forage throughout the night and at dawn returned to rest in their forms (Farías 2004). During dusk, night, and dawn, jackrabbits favored grassy habitats with scattered trees (*Crescentia* spp.) for foraging. During diurnal hours, jackrabbits favored nanche (*B. crassifolia*) shrubbery to rest.

Annual survival rates for adult Tehuantepec jackrabbits were 0.51 for females ($n = 13$) and 0.36 for males ($n = 12$), and averaged 0.43 (Farías 2004). Adult females survived better during dry season (1.00, $n = 13$) when compared to wet season (0.53, $n = 13$), but adult males did not (0.61 $n = 11$ vs. 0.59, $n = 12$). Juvenile survival was low, and males survived better than females during wet (0.48, $n = 6$ vs. 0.15, $n = 12$) and dry (0.35, $n = 10$ vs. 0.06, $n = 14$) seasons. Predation was responsible for 67% of adult and 94% of juvenile mortalities (Farías 2004). Human-induced fires caused 20% of adult mortalities, and poaching accounted for 13% of adult and 6% of juvenile deaths.

Discussion

Home range and overlap analysis indicates that differences in spatial behavior may exist between females and males of Tehuantepec jackrabbit (Powell 2000; Farías 2004) and that there is a real need for long-term ecological research. Apparently, Tehuantepec jackrabbits have non-territorial social organization and polygamous mating behavior (Flux 1981; Farías 2004), and establish their home ranges in selected habitats.

Preservation of flora diversity and structure of native vegetation in jackrabbit habitat is urgently needed for conservation of Tehuantepec jackrabbits (Farías 2004). Grassy plains with open shrubbery and scattered trees provide jackrabbits with places to rest and feed, and allow predator detection and attack evasion (Lechleitner 1958). Introduction of exotic grasses and induced fires are activities related to cattle raising that deteriorate jackrabbit habitat (Pérez-García et al. 2001) and may threaten survival of Tehuantepec jackrabbit populations.

Predation was the main mortality cause for radio-tracked Tehuantepec jackrabbits, and juvenile survival was low due to predation (Farías 2004). Juvenile jackrabbits are more vulnerable to predation than adults (Rohner and Krebs 1996), and jackrabbits too young to outrun predators rely on concealment as behavior to avoid being detected (Aanes and Andersen 1996). Induced fires turn jackrabbit habitat into bare areas where jackrabbits may be completely exposed to predators (Farías 2004). Coyotes and Gray foxes, native predators of jackrabbits, may be favored in human-altered and deteriorated habitats (Trapp and Hallberg 1975). Research targeted to identify mortality caused by specific predators, and studies on predator densities are needed for development of potential predator management plans.

Unfortunately, functional programs on predator control and designation of protected natural areas for conservation of Tehuantepec jackrabbits may take several years. However, management strategies to reduce jackrabbit mortalities due to human activities may be developed in the short term if local people integrate into conservation efforts. Adult deaths by fires and poaching added to high predation rates on juveniles threaten survival of Tehuantepec jackrabbit populations (Fariás 2004). Until predator control is implemented, poaching and induced fires are human activities that should be controlled.

Educational programs need to be implemented and aimed to facilitate acceptance and involvement of local people into wildlife conservation in their homelands. Cattle raising activities could be oriented for wildlife conservation through active participation of local people. For example, cattle-enclosures discourage non-local hunters from entering jackrabbit habitat because hunters do not trespass cow corrals to avoid confrontation with local ranchers. Cattle densities in jackrabbit habitat could be gradually reduced to a minimum that would guarantee poaching inhibition, and induced-fires could be eradicated.

Strategies should allow local people to gradually abandon cattle-raising activities and instead benefit from wildlife conservation activities. For example, local people that protect jackrabbit habitat could benefit from exclusive use of food, building materials, and fuel in protected land. Until the designation of a natural protected area for Tehuantepec jackrabbits is achieved, jackrabbit habitat could be protected by government agencies and non-government organizations that would pay rent or rights of land use. Nevertheless, economic resources should benefit local communities.

Tehuantepec jackrabbits face continuous habitat loss and fragmentation, small population size with isolated subpopulations, high predation rates, and low juvenile survival. Ecology research on demographic parameters should continue for monitoring of birth ratios, age structure, age- and sex-specific reproduction and survival rates, and specific-predator mortality rates. Estimates of age of first reproduction, pregnancy rates, litter size, and number of litters produced per female per year could be obtained through captive or semi-captive breeding of Tehuantepec jackrabbits. Robust estimates of demographic parameters are needed to develop models on population dynamics of Tehuantepec jackrabbit for conservation efforts.

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