

# Impacts of an Expanded Highway on Ocelots and Bobcats in Southern Texas and Their Preferences for Highway Crossings

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## Abstract

Vehicle collisions are a significant cause of mortality for the endangered ocelot (*Leopardus pardalis*) in southern Texas. To minimize such impacts, the Texas Department of Transportation (TxDOT) has designed and modified culverts to facilitate ocelot road crossings near occupied or potentially occupied ocelot habitat. Culverts were recently modified in connection with a project expanding a section of U. S. Highway 281 in Live Oak County, Texas where potential ocelot habitat occurs. Our objectives were to assess the likelihood that an ocelot population exists in the area, determine the effects of the highway expansion on resident ocelots, and to assess the effectiveness of the highway crossing structures for free-ranging cats. To date, we have not documented ocelots in the study area; however, our trapping effort will continue for another 6 months. We have captured and radiocollared 7 bobcats (*Lynx rufus*) that will be used as surrogates for the similarly sized ocelot. We have documented radiocollared bobcats crossing the expanded section of the highway and that used the highway culverts for both daybeds and crossing structures. A roadkill survey has shown a large number of vehicle-related mortalities along the expanded section of highway, including one radiocollared bobcat. This project, which will be completed in 1999, will provide information necessary for TxDOT to evaluate the effects of roads on ocelots and bobcats and to determine if crossing structures are effective and which structural design is used most readily by a variety of wildlife species.

## Background

The ocelot (*Leopardus pardalis*) is a medium-sized (15-35 lb), neotropical cat that reaches the northern limits of its distribution in southern Texas. The ocelot is listed as endangered by the Convention on International Trade of Endangered Species, the United States Fish and Wildlife Service (USFWS), and the Texas Parks and Wildlife Department (TPWD). The primary threat to the persistence of the ocelot population in Texas is loss of habitat (Tewes and Everett 1986). Less than 1% of the southern Texas region supports the dense thornshrub vegetation type preferred by ocelots (Tewes and Everett 1986). Currently, the only documented reproducing populations of ocelots in the U.S. occur in the Lower Rio Grande Valley (LRGV) of southern Texas (Figure 1). However, fragmented tracts of the dense thornshrub vegetation type preferred by ocelots occur north of the LRGV. Ocelots have been photographed and sighted in counties north of the LRGV, although the reliability of these reports varies (Tewes and Everett 1986).

## Roadkill Impacts in Texas

Vehicular collisions are a significant cause of mortality for ocelots in southern Texas. From 1982-1996, twelve out of twenty-seven (44%) recorded ocelot mortalities were likely vehicle-related. Two roadkilled ocelots found in Kenedy County in 1990 and 1997 suggested other subpopulations might be discovered. Tewes and Müller (1987)

discussed the need to study impacts of highways on ocelot mortality and the utility of different highway crossing designs.

## Previous Projects to Reduce Road Mortality.

In the early 1990's, The Texas Department of Transportation (TxDOT), in coordination with USFWS and TPWD, modified 4 culverts to facilitate ocelot movement across improved roadways near Laguna Atascosa National Wildlife Refuge (LANWR) in Cameron County Texas. Previous vehicle-caused mortalities of ocelots in the area, the proximity of the project sites to the ocelot population at LANWR, and the presence of ocelot habitat adjacent to the project sites initiated this interagency coordination. These culverts were structurally modified to allow animals to traverse the culvert above the usual plane of high water. In addition to the structural modifications, thornshrub was allowed to revegetate the area immediately adjacent to the entrance and mowing was established on either side of the culvert. A fence was constructed at each entrance to funnel animals into the culvert.

Although an ocelot was documented using an unmodified culvert as a daybed near LANWR, ocelot use of the modified culverts has yet to be documented (Linda Laack, USFWS pers. comm.). In addition to limited monitoring on all the culverts, there are other possible reasons ocelots have not been documented using the modified culverts. First, although a culvert on Farm to Market (F.M.) road 510 (Figure 1) near Laguna Vista was placed along a natural corridor used by transient and resident ocelots, a large portion of dense thornshrub on one side of the road was cleared by a private landowner creating sub-optimal habitat for ocelots. Second, the chain-link fence erected along F.M. 510 near the culvert entrance was poorly maintained and did not extend an adequate distance on either side of the road. An adult male ocelot was later killed by a vehicle approximately ¼ mile from the culvert.

Ocelot use of a culvert on State Highway 100 (Figure 1) near Los Fresnos may not have been observed for the following reasons. First, the modified culvert was placed 50-70 m from the nearest dense thornshrub vegetation, thereby decreasing the likelihood that an ocelot would cross at that location. Second, the hog-wire fence installed at both culvert entrances did not extend to the nearest thornshrub vegetation, thereby further negating the desired effect of "funneling" cats to the culverts. These two examples of culvert modification illustrated the need for coordination between TxDOT, USFWS, and all other parties involved in future road expansions through areas of potential ocelot occupation.

## U.S. Highway 281 Project

In 1993, due to safety concerns and increased truck traffic, construction began on U.S. Highway 281 to expand the highway from 2 to 4 lanes between towns Alice and George West, Live Oak County, Texas. The expansion, completed in May 1996, was a concern to USFWS because the sections of Jim Wells and Live Oak Counties through which U.S. 281 runs contain fragments of potentially occupied ocelot habitat. Although no reproducing ocelot populations are known to occur in the area, the combination of potential habitat, recent

credible sightings, and historic distribution provided cause for mitigation.

#### *Mitigation Projects/Techniques*

As part of their mitigation to minimize the impacts of the highway expansion on ocelots and their habitats, TxDOT and the Federal Highway Administration (FHWA) did the following: 1) minimized thornshrub clearing during construction and ensured that revegetated areas were protected from maintenance activities, 2) modified culverts to facilitate their use by cats crossing the highway, 3) funded a study involving an intensive trapping survey to document the presence of ocelots within a ten-mile radius of the project site, 4) funded a study that assesses cat preference for road crossing design, 5) monitored the use of the crossings by ocelots and other species, and 6) counted and identified roadkills along the project site.

During the highway expansion, 35 acres of dense thornshrub were impacted. To mitigate this loss, TxDOT purchased 56 acres of marginal thornshrub adjacent to the project site. Thornshrub was also allowed to revegetate beneath and at each side of four bridges along the expanded highway and strips of thornshrub, totaling approximately 7 miles, were not cleared from the median. Five culverts were modified during the highway expansion to facilitate cat movement across the highway (Table 1). Two of these culverts were modified with "catwalks", 18- x 12-inch concrete elevated walkways throughout the length of the culvert and along the wing walls that allow wildlife to cross through the culvert even when standing water was present. The installation of catwalks in two other culverts was unnecessary because of the presence of drainage slopes; however, the existing box culverts were widened and thornshrub was allowed to reestablish near the entrances.

#### *Caesar Kleberg Wildlife Research Institute Research Project*

In March 1997, the Caesar Kleberg Wildlife Research Institute was contracted to conduct a research project to meet the remaining mitigation criteria. The objectives of this study were to 1) survey the area within 10 miles of the U.S. Highway 281 expansion for ocelots with 5,000 trap nights, 2) determine ocelot and bobcat (*Lynx rufus*) habitat use, movements, and survival in areas surrounding the road expansion, 3) document felid use of highway crossing structures, and 4) determine the extent of vehicle caused mortality on the expanded section of U.S. 281 and relate this mortality to landscape features, season, and distance from wildlife crossings. Bobcats were used as a surrogate species in this study because many aspects of their ecology are similar to ocelots and bobcats are more abundant. The results of this project will provide information necessary for TxDOT to evaluate the effect of roads on ocelots and bobcats. Evaluation of the highway crossing structures will provide information necessary to determine if these structures are effective and which type of structures are used most readily by a variety of wildlife species.

#### **Study Area**

The Live Oak County study area (Figure 1) contains a mixture of thornshrub vegetation typical of the Rio Grande Plains and improved pasture of native and introduced grasses. Primary shrub species are mesquite (*Prosopis glandulosa*), desert yaupon (*Schaefferia cuneifolia*), cenizo (*Leucophyllum frutescens*), guajillo (*Acacia berlandieri*), blackbrush (*A. rigidula*), and lotebush (*Zizyphus obtusifolia*). Land use is primarily agricultural and dominated by cattle ranching, petroleum extraction, and hunting leases. The climate is hot and dry in the summer and mild in the winter. Average high temperature in July is 95 F and in January is 41 F. Annual rainfall is highly variable but averages 25 inches, with most precipitation in the spring and fall.

#### **Methods**

##### *Trapping and Telemetry*

Cats were captured using 20-30 wire box traps (42 x 15 x 20 in; Tomahawk Trap Co., Tomahawk, WI) with attached cages for live bait (domestic chickens). Traps were placed along trails within dense

thornshrub, particularly where felid sign (e.g., tracks, feces, or recent credible observations) occurred. Traps were placed in shaded areas and checked by 1030 hours each morning to reduce the risk of hyperthermia in captured animals. Captured cats were immobilized with ketamine hydrochloride (15 mg/kg) and xylazine hydrochloride (1 mg/kg). Individuals were ear-tattooed, aged, measured, and weighed. Cats were radio-collared with 110-gram transmitters containing mortality switches (Advanced Telemetry Systems, Isanti, MN). Cats were located 12-15 times/month at different times during a 24-hour period using a hand-held H-antenna to determine home range size, habitat use, movement patterns, and use of highway crossings on U.S. Hwy 281. Aerial telemetry was used when cats could not be located on the ground. Felids with home ranges adjacent to U.S. Hwy 281 were monitored daily during field seasons to determine frequencies and locations of highway crossings.

##### *Wildlife Crossing Use*

Nine Trailmaster active infrared monitoring units (Goodson & Associates, Lexena, KS) were used to document wildlife use of modified and unmodified culverts. Each Trailmaster unit is composed of an active infrared transmitter and receiver coupled with a digital counter and 35mm, automatic flash camera. Trailmaster units were set up at both entrances in 4 modified culverts and 3 unmodified culverts (Table 1). One Trailmaster unit was placed in the culvert opening in the median of a modified culvert. The monitoring units were rotated among the seven crossings in a biweekly pattern to ensure all crossings were monitored equally. Trailmaster units were placed in plastic security boxes to reduce theft and vandalism. Each box was mounted onto the culvert wall so the infrared beam emitted from the transmitter was approximately 8 inches above the ground. Interruption of the infrared beam triggered the camera to take a photograph and the Trailmaster receiver recorded the time and date of the interruption.

Track surveys began 1 July 1997 to monitor wildlife use of 4 bridges, 5 modified culverts, and 9 unmodified culverts. Culverts and bridges without a tracking surface had soil or Austin white lime spread on the culvert floor. All crossings were checked twice a week for tracks and the species, date, type of crossing, track condition, and presence or absence of standing water were recorded for each location. Any tracks found were erased using a garden rake.

##### *Roadkill Survey*

A roadkill survey was conducted along the 20-mile section of U.S. Highway 281 in the study area. Northbound and southbound lanes were driven 2 times/week and the date, location, and species of vertebrates killed were recorded. Sections of road right-of-ways that had limited visibility were searched by foot. To avoid recounting, carcasses were either removed from the road or marked with paint. Contact was maintained with TxDOT and local law enforcement agencies to ensure that wildlife accident reports were included in the survey.

#### **Results**

##### *Trapping and Telemetry*

From May through November 1997, 15,000 acres were surveyed for 3,133 trap-nights. Seven bobcats were captured and fitted with radio collars. No ocelots were captured. Non-target species captured and released included coyote (*Canis latrans*), nine-banded armadillo (*Dasypus novemcinctus*), and raccoon (*Procyon lotor*). Preliminary data collection has not yielded enough information to accurately document habitat use, movement patterns, or home range estimates. However, anecdotal observations have provided some indication of felid use of culverts and areas near the expanded highway. One male bobcat was documented using unmodified culverts as bedding sites on 29 July 1997 at 1323 hours and on 2 September 1997 at approximately 1430 hours. This bobcat may have used culverts to escape the high daytime temperatures that often exceeded 100° F during the summer months (June-August). The surrounding vegetation at both culverts was predominately tall grass with thornshrub habitat on the private lands adjacent to the highway. This bobcat was killed by a vehicle on

U.S. Hwy 281 on 25 September 1997 at approximately 2322 hours. Minutes prior to the mortality, this cat was located in a patch of thornshrub vegetation in the median of the highway.

#### Wildlife Crossing Survey

As of December 1997, 880 different track sets had been detected using track surveys in all crossing types combined. Because of their similar size and shape, we could not differentiate between bobcat and ocelot tracks; therefore, we classified them as "bobcat/ocelot". Bobcats/ocelot tracks accounted for 103 of the 880 track sets. The mean number of felid tracks per crossing structure was 10.0 at bridges followed by modified and unmodified culverts with 6.8 and 3.3 track sets, respectively (Figure 2). Tracking conditions were variable at each crossing and the number and species detected often depended on the condition of the tracking surface. Unusually high rainfall also caused problems during the survey period by washing tracking surfaces from the culverts and flooding the underpasses of bridges frequently submerging the track surface.

Raccoon tracks were the most frequently noticed tracks at all crossing types. Some crossings may have created an environment suitable for raccoon prey items, such as amphibians and insects. Raccoon, bobcat/ocelot, and armadillo tracks were observed on the catwalks in two of the modified culverts. When water was present, bobcats/ocelots appeared to use the catwalks to travel through the culverts. Bobcat/ocelot tracks were observed crossing muddy areas and even shallow pools of standing water in culverts without elevated catwalks.

Trailmaster camera surveys began 18 September 1997, after all security boxes had been mounted in each culvert. Sixty-three photographs of 8 wildlife species had been taken by 9 November 1997. Raccoon, bobcat, and opossum were the most frequently photographed animals with totals of 29, 14, and 9, respectively. Other species photographed included 1 armadillo, 1 coyote, 3 feral house cats, 3 javelina, and 3 cotton rats. Trailmaster photos indicated raccoons were most active from 2300 to 0500 hours whereas bobcats were photographed most often from 1100 to 1500 hours (Figure 3). The highest activity period among all animals photographed occurred from 2300 to 0500 hours (Figure 4). Occasionally, units were tripped as a result of heavy rainfall, moving vegetation, or rodents chewing on the camera cables attached to the receiver.

#### Roadkill Survey

From May through November 1997, 915 mortalities were recorded. Of these, one was a male bobcat hit on U.S. Highway 281 on 25 September 1997. The most frequently recorded mammals were from the Order Rodentia (Table 2). Other mortalities included many species of birds, such as yellow-billed cuckoos (*Coccyzus americanus*), scissor-tailed flycatchers (*Tyrannus forficatus*), barn owls (*Tyto alba*), and golden-fronted woodpeckers (*Melanerpes aurifrons*). Snakes and other reptiles have also been recorded.

#### Discussion

This paper describes preliminary results of a study to assess the impact of a highway expansion on ocelots, one of the rarest carnivores in the United States. One of the primary objectives of the project was to assess the probability that an ocelot population exists in the study area. Despite unconfirmed sightings and the presence of adequate habitat, we have not documented ocelots in the study area; however, our trapping effort will continue for an additional 6 months.

Ocelots, like all rare carnivores, may be particularly susceptible to the negative impacts of highways because of their low population size and low reproductive rates which magnify the effects of highway mortality (Ruediger 1996). To minimize such impacts, culverts and bridges have been designed and managed in different areas of south Texas to facilitate ocelot road crossings. Because of only limited monitoring, the effectiveness of these structures is unknown. Thus, another objective of our study was to assess the use of crossing structures by wildlife in the study area. Crossing structures built for

wildlife in other areas were often designed to present a clear view of habitat on the far side of the crossing (Foster and Humphrey 1995). Whereas few of the culverts in our study area afforded such a view, bobcats and other wildlife entered the culverts anyway. Another difference between crossing structures in other areas and our study area is the use of fencing to prevent wildlife access to the road except where crossing structures were present (Foster and Humphrey 1995). Fencing was not part of the crossing structures in our study and although we do not know the effect of fencing, we have evidence that wildlife will enter culverts without it.

The crossing structures were designed to help free-ranging cats cross the road with little danger of being hit by a vehicle. We have documented 1 vehicle-related bobcat mortality, a bobcat that had been seen using a culvert as a day bed. Our radio telemetry data show that cats are crossing the highway; however, we only have limited evidence that cats are using the culverts for this purpose. The frequency of bobcats moving into the culverts at midday and observations of cats bedded in these culverts at midday suggest that the culverts may also be used as resting sites during the heat of the summer. In contrast to our initial findings, most bobcat movements through underpasses in Florida occurred between dusk and dawn and these cats often moved through an underpass several times in a night (Foster and Humphrey 1995).

The roadkill survey has shown a large number of animals being killed on the road. We will use these data in a GIS setting to determine the distribution of these roadkills in relation to landscape features, season, and crossing structures.

#### Acknowledgments

Cooperative funding was provided by the FHWA and the TxDOT. We appreciate the support provided by the Caesar Kleberg Wildlife Research Institute, the TxDOT, Texas Parks and Wildlife Department, and the USFWS. We sincerely thank the private landowners whose participation made this project possible. A special thanks is extended to David Potter (TxDOT) for his assistance with the implementation of this project. David Dunlap (TxDOT), William Hood (TxDOT), and David Potter reviewed and provided helpful suggestions on this report.

#### References Cited

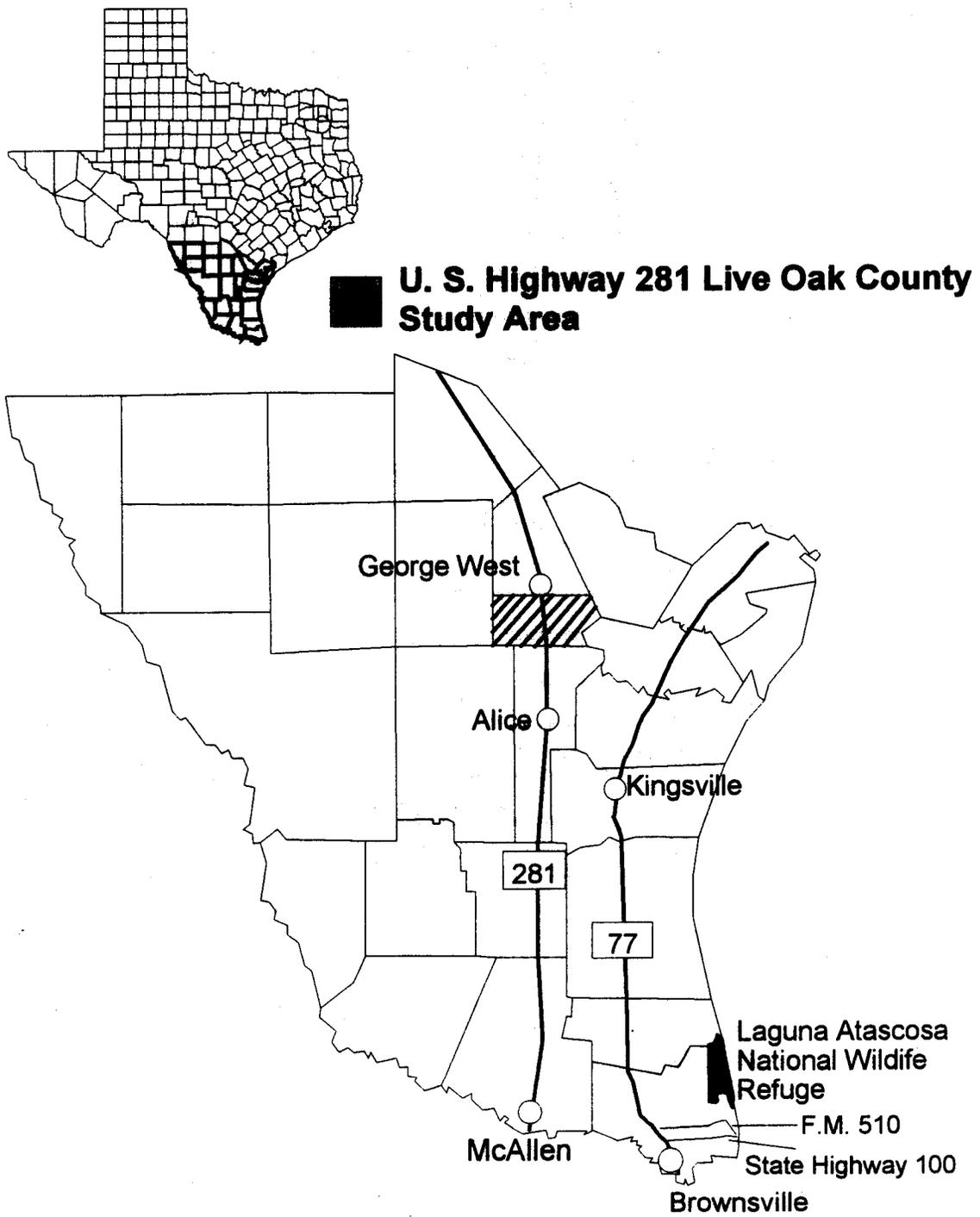
- Foster, M. L., and S. R. Humphrey. 1995. Use of highway underpasses by Florida panthers and other wildlife. *Wildlife Society Bulletin* 23:95-100.
- Ruediger, B. 1996. The relationship between rare carnivores and highways. In Evink, G. L., P. Garrett, D. Zeigler, and J. Berry. 1996. Trends in addressing transportation related wildlife mortality: Proceedings of the transportation related wildlife mortality seminar. Florida Department of Transportation, Tallahassee, FL.
- Tewes, M. E., and D. D. Everett. 1986. Status and distribution of the endangered ocelot and jaguarundi in Texas. Pages 147-158 in S. D. Miller and D. D. Everett, eds., *Cats of the world: biology, conservation, and management*. National Wildlife Federation, Washington D. C.
- Tewes, M. E. and S. D. Miller. 1987. Future research for the endangered ocelot population in the United States. Pages 164-166 in R. R. Odum, K. A. Riddleberger, and J. C. Ozier, eds., *Proceedings of the 3<sup>rd</sup> Southeastern Nongame and Endangered Wildlife Symposium*, Georgia Department of Natural Resources, Athens, Georgia.

**Table 1**  
**Description of crossing structures on U.S. Highway 281 study site.**  
**Live Oak County, Texas**

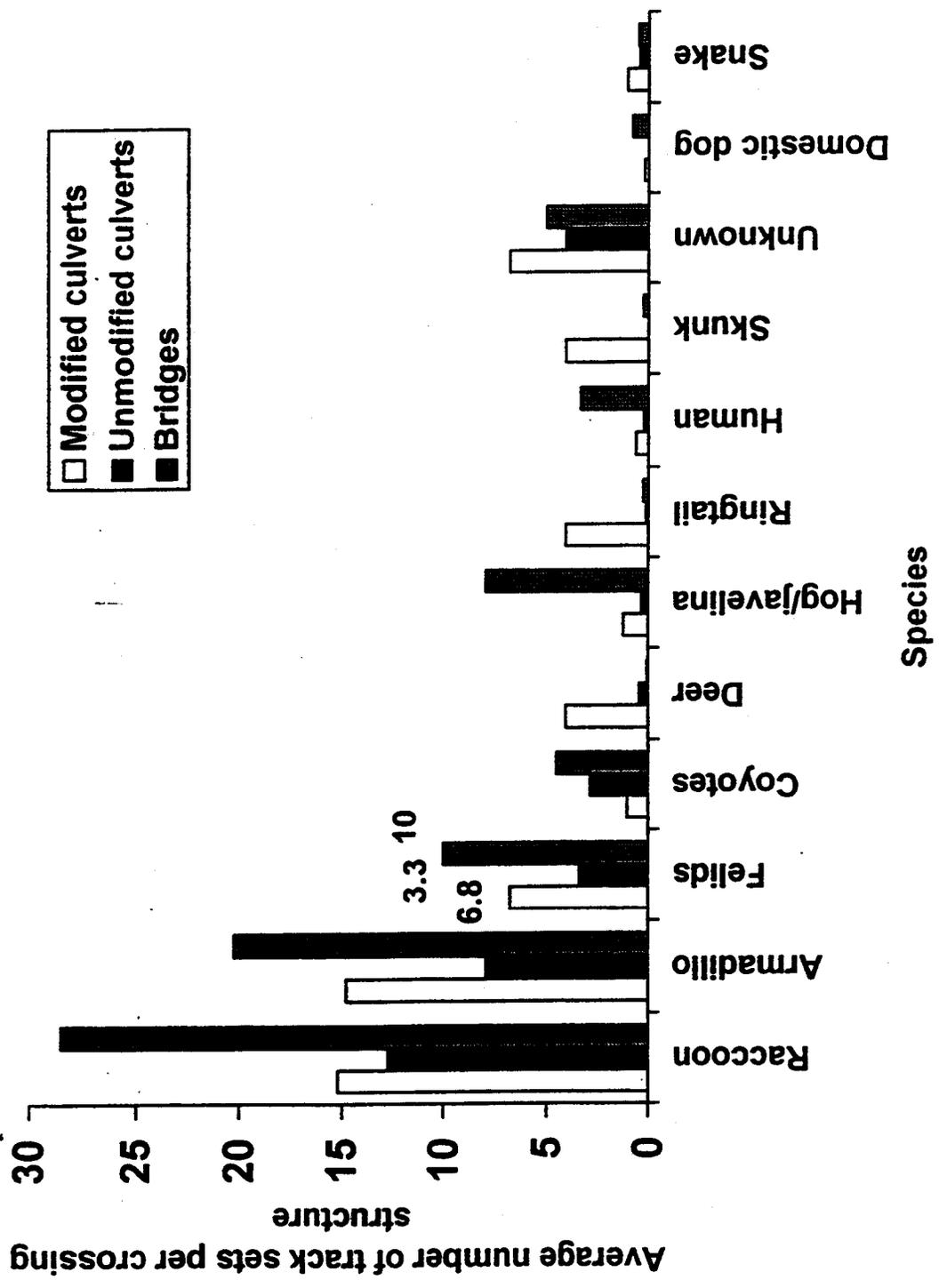
Crossing Type	Description
Bridges (n = 4)	Mean bridge span is 325 ft. Vegetation grows under bridges and provides screening cover for wildlife. All bridges in study area extend over natural water drainages which may be natural travel corridors for wildlife species.
Unmodified Culverts (n = 9)	Vary in size from 3 x 3 ft to 10 x 12 ft. All culverts have drainage structures ( drop inlets in the median with a steel grate covering). Culverts were designed and placed to handle runoff. Adjacent habitat is variable.
Modified Culverts (n = 5)	Designed and modified to encourage use by ocelots and other wildlife. These culverts may have any one of the following modifications: catwalks, barrier fencing, adjacent dense thornshrub, over-sized drop inlets, and openings in the median. Culverts with open medians are not continuous tunnels and vegetation may be may growing in the opens.
Culvert 1688	Dimensions 6 ft. x 6 ft. Catwalk present in this culvert.
Culvert 1716	Dimensions 3 ft. x 5 ft. Open median with barrier fencing to deter wildlife from exiting the median and crossing the road. No catwalk present.
Culvert 1854	Dimensions 10 ft. x 10 ft. 5 box culverts side by side with an open median and barrier fencing. Culvert was built over a natural drainage and may serve as a livestock crossing.
Culvert 2125	Dimensions 3 ft. x 5 ft. No additional modifications other than the adjacent dense thornshrub.
Culvert 2153	Dimensions 5 ft. x 6 ft. Catwalk present

**Table 2**  
**Mammal mortalities found on the 20-mile stretch of U.S. Highway 281 in**  
**Live Oak County, Texas, May-November 1997.**

Common Name	Scientific Name	Frequency
Rodent	<i>Rodentia sp.</i>	340
Rabbit	<i>Lepus or Sylvilagus spp.</i>	79
Nine-banded armadillo	<i>Dasypus novemcinctus</i>	45
Raccoon	<i>Procyon lotor</i>	26
Coyote	<i>Canis latrans</i>	16
Domestic dog	<i>Canis familiaris</i>	4
Domestic cat	<i>Felis domestica</i>	4
Striped skunk	<i>Mephitis mephitis</i>	3
Opossum	<i>Didelphis marsupialis</i>	3
Badger	<i>Taxidea taxus</i>	1
Bobcat	<i>Lynx rufus</i>	1
Domestic goat	<i>Capra hircus</i>	1
Whitetail deer	<i>Odocoileus virginianus</i>	1
Gray fox	<i>Urocyon cinereoargenteus</i>	1



**Figure 1.**  
**Location of the U.S. Highway 281 study site.**



**Figure 2.**  
 Average number track sets by species relative to type of crossing structure on U.S. Highway 281,  
 Live Oak County, Texas  
 1 July 1997 - 1 December 1997.

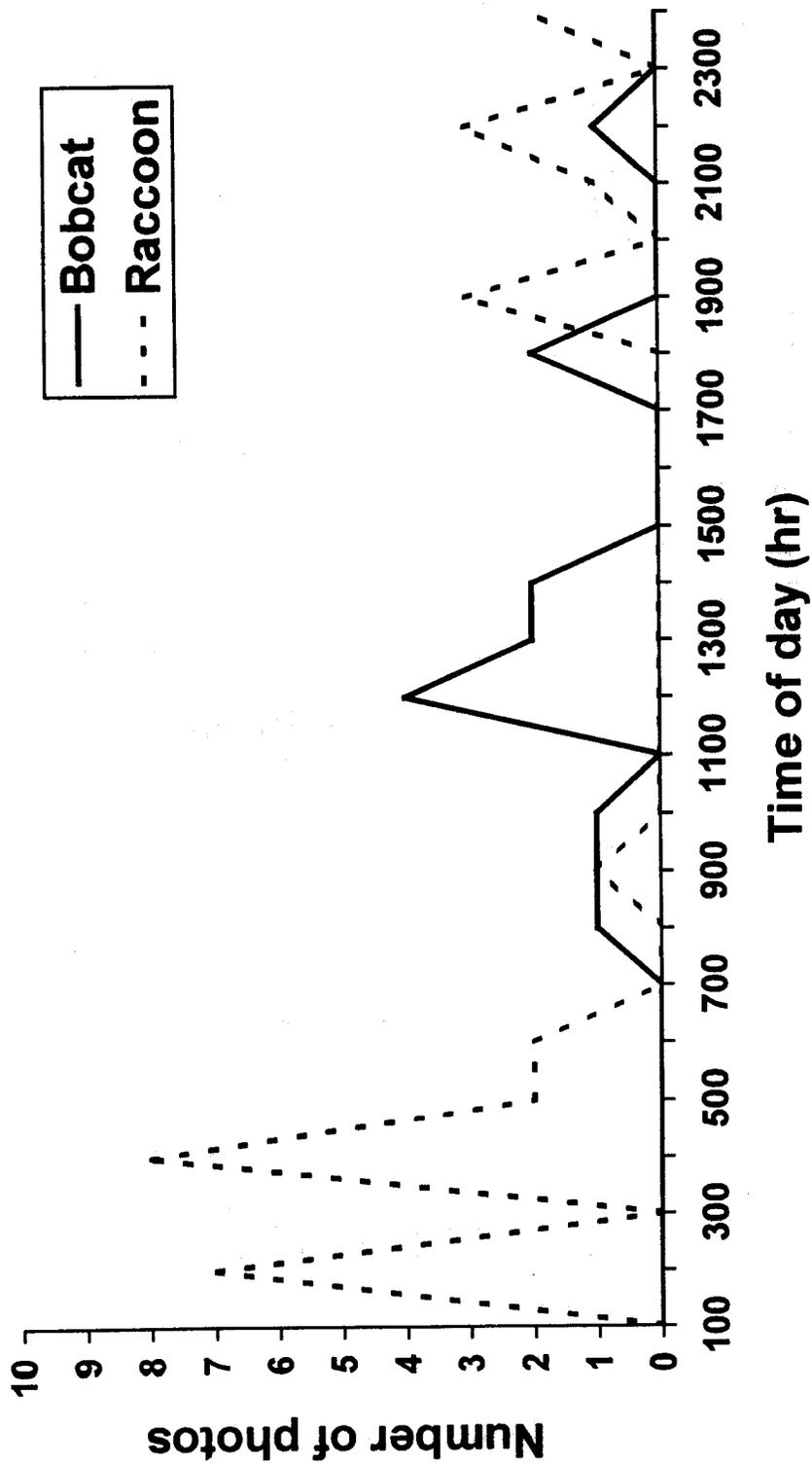
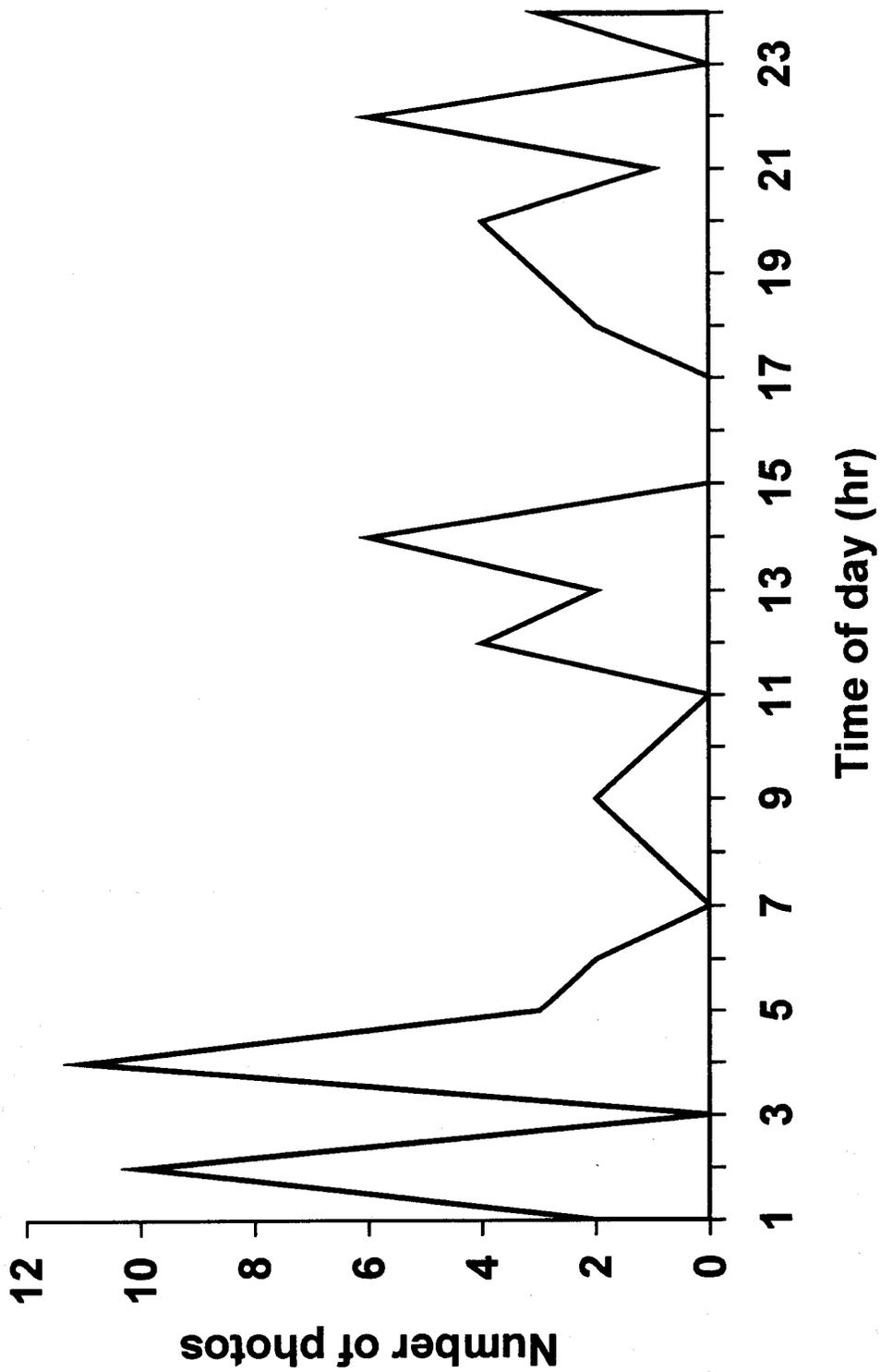


Figure 3  
 Number of remote camera photographs taken of bobcats (*Lynx rufus*) and raccoons (*Procyon lotor*) within culverts on U.S. Highway 281, Live Oak County, Texas  
 18 September - 9 November 1997.



**Figure 4.**  
**Number of remote camera photographs taken of all species within culverts on U.S. Highway 281 Live Oak County Texas**  
**18 September - 9 November 1997.**