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Analysis of Variables Related to Corridor Use by Ocelots and Bobcats in South Texas

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By

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A Thesis presented to the Graduate Faculty of the College of Science, Mathematics, and Technology in Partial Fulfillment of the Requirements for the Degree of

Master of Science

In the Field of Biology

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ABSTRACT

Biologists estimate that less than 50 endangered ocelots (*Leopardus pardalis*) remain in the United States, restricted to two small populations in Cameron and Willacy Counties located in deep south Texas. Conversely, bobcats (*Lynx rufus*) are abundant in south Texas; however, two of the biggest threats to both species are vehicle collisions and habitat fragmentation. To mitigate these threats, the installation of wildlife crossings has been proposed to decrease the number of road mortalities, and wildlife corridors have been suggested as a useful tool for providing increased habitat connectivity. However, research on ocelot use of corridors and wildlife crossings in Texas is severely lacking. Due to overlap in daily activity, diet, and habitat, ocelots and bobcats may be exhibiting competition over resources where space to coexist without conflict is limited. This study used camera traps to document wildlife communities with a focus on ocelots and bobcats from October 2013 to October 2014 to test the following hypotheses: 1) Bobcat hourly activity will differ between locations where ocelots are present and absent. 2) Prey composition will be a significant indicator of felid presence. 3) Ocelot and bobcat presence will be correlated with differing plant species and levels of canopy cover. 4) Wildlife diversity indices will be similar within corridor types and will differ between corridor types. 5) Wildlife community composition and diversity indices will differ between proposed wildlife crossings and corridors not adjacent to Farm-to-Market Road (F.M.) 106. Cameras were placed within four structural habitat types: brush strip, resaca (oxbow lake) edge, drainage ditch, and brush patch. Structural habitat variables were surveyed to analyze habitat preferences of ocelots and bobcats in corridors. Fifty-eight species were identified at 52 cameras. Eight of the 16 known ocelots in the Cameron County population were surveyed. Bobcat hourly activity and prey frequency were different at cameras where ocelots were present and absent. Ocelots were associated with corridors (brush strip, resaca edge, drainage ditch) and not brush patches; high amounts of spiny hackberry, texas ebony, and goatbush; greater distance from F.M. 106; higher diversity of woody species >1m tall; and ground cover comprised of low amounts of grass, forbs, and bare ground, and high amounts of leaf litter, woody debris, and woody species <1m tall. Corridors differed from small, sparse brush patches in wildlife frequency and diversity, and brush strips had the greatest species richness and total number of individuals. Brush patches had a significantly lower number of individuals present when compared to corridors. Fifty percent of the known Cameron County ocelot population was observed using corridors, suggesting that functional corridors may be a valuable tool to promote connectivity of ocelot populations in Texas. Proposed wildlife crossing locations had lower diversity when compared to corridors not adjacent to F.M. 106. However, ocelots were recorded on both sides of F.M. 106, indicating that wildlife crossing structures under roadways should be effective in providing ocelots with a safe alternative to traversing over dangerous roadways.

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INTRODUCTION

Ecology of Ocelot and Bobcat

The ocelot (*Leopardus pardalis*) is a medium-sized spotted cat native to South, Central, and North America (USFWS 2010). In the United States, the ocelot historically inhabited the majority of the state of Texas, with its range reaching as far north as Arkansas and Louisiana (Navarro-Lopez 1985). Today, only two breeding populations of this critically endangered cat remain in the United States, spanning public and private lands in Cameron and Willacy counties of the Lower Rio Grande Valley (LRGV) in south Texas (Tewes and Everitt 1986, Caso et al. 2008). Ocelot populations were negatively impacted by poaching, the pet trade, and the fur trade in the 1960's and 1970's (Laack 1991). In the past three decades, ocelot populations in Texas have faced increased pressure due to road mortalities and habitat loss from agriculture and urbanization (Jahrsdoefer and Leslie 1988).

Ocelots are one of the top predators throughout the majority of their range. Their diet consists primarily of rodents and rabbits, though birds and lizards may also make up a portion their diet (Booth-Binczik et al. 2013). Ocelots in Texas thrive in Tamaulipan thornscrub, a thick, thorny, diverse composition of woody plants (Connolly 2009). These cats tend to inhabit areas with 75-95% canopy cover, but there is evidence that they spend time traveling through areas with less canopy cover (Harveson et al. 2004, Horne et al. 2009).

Biologists estimate that there are fewer than 50 ocelots remaining in the United States (Swarts 2015). One of the two populations, estimated at 14-25 individuals, is found in Cameron County on and around Laguna Atascosa National Wildlife Refuge (LANWR) (USFWS 2010). The second population is found in Willacy County, which borders Cameron County to the north. This population is found on private lands and tracts of the Lower Rio Grande Valley National Wildlife Refuge (LRGVNWR). The two populations seldom interact due to distance and severe habitat fragmentation (Korn 2013).

In Texas, ocelots require large areas of undisturbed thornscrub habitat. Estimated home range sizes range from 2.1-17.7 km^2 in Texas (Navarro-Lopez 1985, Tewes and Everitt 1986, Laack 1991). Increased development results in increased road connectivity between developments. This has proved to be a detrimental obstacle for ocelots in Texas to overcome. Of all known ocelot deaths in the United States, over 40% were caused by collisions with vehicles (Haines et al. 2005). Two ocelot mortalities from the Cameron County population were reported on State Highway 100 in Cameron County within a nine month period during this study (Maldonado 2014) and a third ocelot mortality from the Willacy County population was reported on State Highway 186 prior to completion of this study, which likely represents a loss of approximately 12.5% (2/16) of the Cameron County ocelot population (Swarts 2015). Lack of habitat connectivity has also led to reduced gene flow (Korn 2013). Presently, there is no evidence of a genetic depression affecting the health of ocelots, however if habitat fragmentation and other factors negatively influencing ocelot populations in Texas continue, the risk of genetic depression will increase (Janečka et al. 2011, Korn 2013).

The bobcat (*Lynx rufus*), another medium-size spotted cat, thrives in nearly all regions of the United States, including south Texas (Rolley 1987). However, due in part to their expansive range, bobcat road mortality rates are high across the United States, including south Texas, and may serve as an indicator species for risks to the smaller ocelot population (Hewitt et al. 1998, Tewes and Blanton 1998, Cain et al. 2003, Litvaitis and Tash 2008). Similar in size and appearance to the ocelot (6.6 kg for females; 10.9 kg for males), the bobcat (6.8 kg for females; 12.7 kg for males) also feeds primarily on rabbits and rodents, and may opportunistically take larger mammals as well (Rolley 1987, Tewes and Schmidly 1987, Horne et al. 2009, USFWS 2010). Estimates for bobcat home range size vary greatly from 0.6-201 km^2 (McCord and Cardoza 1982).

A notable morphological difference between species is tail length to body length ratio. Ocelot tail length is typically greater than ½ of the individual's total body length. Conversely, bobcat tail length is typically less than ½ of the individual's total body length (Horne et al. 2009). Bobcats often have less noticeable rosette markings than ocelots, as well as pointed, tufted ears rather than rounded ones (Figure 1) (Rolley 1987).

Ocelot and Bobcat Sympatry

Based on the competitive-exclusion theory, it is believed that two species cannot fill the exact same niche without leading one species to extinction (Gause 1934). It is unclear whether ocelots and bobcats have different niches with overlap or if they are exhibit niche partitioning. Haines *et al.* (2005) documented interspecific interaction with bobcats as a source of ocelot mortality. Thus, research on bobcat and ocelot interactions in shared space is warranted. Shoener (1974) suggested three types of partitioning that allow for coexistence of similar species: habitat, temporal, and food. In Texas, ocelots prefer dense thornscrub while bobcats, a habitat generalist species, prefer a variety of habitat types with intermediate canopy cover (Litvaitis et al. 1986, Rolley 1987, Jackson et al. 2005, Connolly 2009, Horne et al. 2009). Partitioning of habitat allows the two species with similar body size and prey preferences to coexist. However, an overlap in presence of these two felids may be observed within corridors due to fragmentation and restricted travel options. Ocelots are primarily nocturnal while bobcats are crepuscular. However, both species are not exclusively active at these times (Rolley 1987, Tewes and Hughes 2001). Additionally, there are documented differences in prey selection. Booth-Binczik *et al.* (2013) documented that the diet of both species is primarily composed of rodents and rabbits. Yet, the authors also indicated a large portion of ocelot diet was composed of birds, ocelots preyed upon a greater variety of species than bobcats, and ocelots selected medium-sized rodents while bobcats selected large rodents. These differences in activity, habitat, and prey selection may be allowing the two felids to partition resources in south Texas. However, these trends may not be observed in fragmented habitats and corridors, where space is limited. Additionally, the documentation of bobcat attacks on ocelots by Haines *et al.* (2005), combined with the assumption that both species use narrow corridors, increases the likelihood that there is interaction between ocelots and bobcats in corridors.

Habitat Fragmentation

Habitat loss, caused by an ever-expanding human footprint, is one of the leading cause of wildlife population decline (Fahrig 2003). A common effect of large-scale habitat loss is habitat fragmentation, which restricts many species to isolated sub-populations that can become increasingly vulnerable to genetic bottlenecks over time.

Connectivity between habitat blocks and movement across the landscape are critical for gene flow and species survival.

The LRGV is comprised of the four southernmost counties in the state: Cameron, Hidalgo, Starr, and Willacy. Over 95% of the native vegetation in the LRGV of south Texas has been destroyed or altered in some way, primarily due to agriculture and urbanization (Jahrsdoefer and Leslie 1988). Heavy agriculture and clearing of large areas of woody vegetation began in the 1930's (USFWS 1980). According to the United States Census Bureau, as of 2010 an estimated 1,264,091 people reside in the LRGV (U.S. Census Bureau 2014), encompassing a large amount of the land area of the LRGV. Thus, a large portion of native vegetation no longer remains, leaving wildlife with increasingly limited resources and available habitat. Continued existence of the endangered ocelot in Texas is reliant upon restoration of habitat and connectivity between habitat blocks.

Corridors

A common result of habitat fragmentation is the well-known concept of "patch-corridor-matrix." This terminology implies that every point in the landscape is part of either a patch, a corridor, or the background matrix (Forman 1995). According to Beier *et al.* (2008), a corridor is defined as "a linear habitat, embedded in a dissimilar matrix that connects two or more larger blocks (patches) of habitat." Many studies have shown that corridors are an effective method to maintain connectivity between habitat blocks, leading to increased animal movement between blocks, increased gene flow, increased population sizes, and maintenance of biodiversity (Haddad et al. 2003).

In an extremely fragmented habitat, such as the LRGV, corridors may play a key role in maintaining populations of fragmentation-sensitive species (Beier and Noss 1998). Specifically, corridors have been suggested as a useful tool for restoration of ocelot populations in the LRGV by providing connectivity between the two segregated populations (Tewes et al. 1993, Tewes and Hughes 2001, Haines et al. 2006, USFWS 2010).

Tewes *et al.* (1993) documented ocelots using the following corridor types in the LRGV: "resaca, river, irrigation canal, irrigation drain, natural drainages, shore line, fence line, road, and other man-made corridors." In the study, resacas were the predominately used corridor type on and around LANWR. Additionally, ocelots of different social class, age, and sex used different corridor types for different activities (Tewes et al. 1993).

However, no published research could be found which quantifies ocelot use of corridors, compares ocelot and bobcat use of corridors, or defines structural and functional features of corridors used by ocelots in Texas. In light of continued development in the LRGV, there is a glaring need for tools which help define characteristics that are associated with ocelot or bobcat use of corridors, including prediction of felid presence based on a combination of structural features, vegetation communities, and wildlife communities.

Wildlife Crossings

One fifth of the land area of the United States is "directly affected ecologically by the system of public roads"(Forman 2000). Forman and Alexander (1998) estimate that one million vertebrates are killed on roads every day in the United States). The implementation of wildlife crossings (underpasses and overpasses) in North America has successfully provided many species of wildlife with an alternative to traversing dangerous roadways (Clevenger and Waltho 2003).

In the LRGV, only one of these crossings exists on State Highway 48 between Brownsville and Port Isabel in southeast Cameron County. However, Tewes and Hughes (2001) proposed the need for additional crossings on Farm-to-Market Road (F.M.) 106 due to its close proximity to the core ocelot population. In addition to providing ocelots and other wildlife an alternative to crossing roads, the construction of wildlife crossings is intended to improve driver safety as well (Nevada DOT n.d.).

F.M. 106 is located in Cameron County, Texas, and intersects LANWR, which includes a large portion of the documented habitat of ocelots in South Texas (Fig. 1). Nearly half of the radio-collared ocelots from the Cameron County population are known to have been located from 400 meters to 2.4 kilometers from F.M. 106 (USFWS 2010). The upcoming expansion of this road could bring potential risks to felids of South Texas, including increased vehicle usage and urbanization, and requires close scientific monitoring. The expansion includes widening the road as well as installation of seven wildlife crossing structures, some of which are at pre-existing culverts. Monitoring of these locations prior to construction is critical to properly assess the effects of the construction on wildlife in the area.

Use of Camera-traps in Research

Camera-traps are widely known as a useful, non-invasive tool for surveying wildlife. They are particularly effective in documenting elusive species such as the ocelot (Kelly 2008). Previous studies have utilized camera-traps to study ocelot home range, overlap, and density in Texas (Dillon and Kelly 2008) as well as bobcat abundance and individual identification (Heilbrun et al. 2003, 2006). Camera-traps are motion-triggered, which results in non-discriminatory data collection. This provides a more complete picture of wildlife activity at a given location, rather than activity of only a single species (Jiménez et al. 2010, Kays et al. 2010).

Objectives and Hypotheses

The objective of this study was to further an understanding of corridor use by felids in south Texas. Wildlife communities in corridors were quantified as predictors for felid presence or absence based on camera-trap observations. Ocelot and bobcat activity near F.M. 106 in south Texas was compared to activity in corridors not adjacent to F.M. 106 to provide a baseline data set prior to construction disturbance on F.M. 106. To meet these objectives, the following hypotheses were tested:

(1) Bobcat hourly activity will differ between locations where ocelots are present and absent.

(2) Prey composition will be a significant indicator of felid presence.

(3) Ocelot and bobcat presence will be correlated with differing plant species and levels of canopy cover.

(4) Wildlife diversity indices will be similar within corridor types and will differ between corridor types.

(5) Wildlife community composition and diversity indices will differ between proposed wildlife crossings and corridors not adjacent to public roads.

METHODS

Study Area

This study was conducted within and surrounding LANWR in Cameron County, Texas (Figure 2), ~20 km west of the Gulf of Mexico and 40 km north of the city of Brownsville. Nine locations proposed to receive wildlife crossing structures were located along F.M. 106, which bisects LANWR. Cameron County, Texas is primarily composed of agricultural land, ranch land, and urban development. However, LANWR is one of the few remaining areas in the county comprised of ecosystems such as coastal prairies, freshwater lakes, salt marshes, salt flats, and mature Tamaulipan thornscrub. The area surrounding LANWR is made up of a mosaic of land uses with a network of many thornscrub corridors.

Camera Placement Methods

Camera-trap stations were placed in four distinct habitat structure types within LANWR, surrounding private properties, and at proposed wildlife crossing locations on F.M. 106. Cameras not adjacent to F.M. 106 were used as reference locations for analysis of proposed wildlife crossing locations. ArcGIS 10 (ESRI ArcGIS 2011) satellite imagery (Cameron County, Texas 2013) was used during initial camera location selection to identify corridors and brush patches within the known range of the Cameron County ocelot population and to confirm connectivity to larger habitat blocks. Upon selection of possible camera locations, corridors and patches were visited to ensure the presence of thornscrub species, connectivity to large habitat patches, and accurate categorization of habitat structure type. Habitat structure types selected for camera-trap stations fell into one of four categories: 1) brush strip, 2) drainage ditch, 3) oxbow lake (hereafter, resaca) edge, or 4) brush patch. Brush strip was characterized as a narrow strip of continuous woody vegetation. Drainage ditch was characterized as a narrow strip of woody vegetation with intermittent water from rainfall and agricultural run-off in a central canal at a lower elevation than the woody vegetation. Resaca edge was characterized as woody vegetation parallel to a resaca with intermittent water from rainfall. Brush patch was characterized as a small area of sparse, non-linear woody vegetation and was included in the study as a comparison category. All patch locations were located at proposed wildlife crossing locations and adjacent to FM 106. Corridor width was measured at each camera (mean brush strip width: 23.75 m ± 3.82, mean drainage ditch width: 25.46 m ± 1.66, mean resaca edge width: 23.0 m ± 1.76) and brush patch maximum width and maximum length (mean maximum width: 193.6 m ± 39.79, mean maximum length: 414 m ± 51. 17) were measured using ArcGIS 10 (ESRI ArcGIS 2011) satellite imagery (Cameron County, Texas 2013). The number of cameras within each corridor or patch ranged from two to five, depending on habitat features and availability of suitable camera locations. Within corridors, cameras were placed with a minimum of one game trail within the field of view. At proposed wildlife crossing locations, cameras were placed where design specificity indicated that the crossing structure would be located, and additional cameras were placed along the linear area where proposed roadside fencing, extending from each side of the crossing structure parallel to the road, was to end.

Cameras were attached to t-posts and placed 40 cm above the ground. Minimum distance between any two cameras was 25 m with no overlap of field of view. Photos used in this study were a subsample of the larger dataset of photos collected to monitor the F.M. 106 project that was started by USFWS in March 2013. Photos used in this project were from cameras deployed and maintained expressly for this study from October 2013 to October 2014. Cameras were deployed for a minimum of three months and a maximum of 12 months depending on the location. A minimum of three cameras per habitat structure type were continuously functioning throughout the study period. Cameras were deployed for an average of 286 days, with a total of 14,911 camera-trap-nights

Automatic infra-red trail cameras were used in this study (Bushnell TrophyCam and Bushnell TrophyCamHD models 119537C and 119547C [Bushnell Corporation, KS, USA]). Cameras were visited to change batteries and memory cards every four to six weeks. Vegetation growth that limited the field of view of the cameras was trimmed as needed. No scent, bait, or attractant of any kind was used at the sites. Cameras were programmed to take a burst of two photos when triggered with a10-second interval between triggers. All camera models used infrared illuminators and no white flash was used for nighttime photos.

Habitat Analysis Methods

Ground cover composition, canopy cover, and woody plant species frequency were analyzed within a six-meter radius around each camera. A tape measure was used to ensure consistent sampling areas. Ground cover percentages were visually estimated to the nearest 5% in five different categories: (1) bare ground, (2) leaf litter and woody debris, (3) grasses, (4) forbs, and (5) woody species less than one meter tall.

Canopy cover was measured using a densitometer at one meter above the ground (Shindle and Tewes 1998, Simpson et al. 2010). Five canopy cover measurements were taken at each camera: one measurement directly above the camera and one measurement three meters from the camera in each cardinal direction. These five measurements were summed and averaged to determine mean canopy cover for each camera. Woody plant species greater than one meter tall (Simpson et al. 2010) were identified using *Plants of Deep South Texas* (Richardson and King 2011) and were counted to obtain frequencies of each species.

Photo-processing

Upon field collection, all photos were sorted and identified to the lowest taxonomic rank possible and by number of individuals present (Harris et al. 2010). Rodents were considered one group due to image quality and possible species identification errors, with the exception of the Mexican Ground Squirrel (*Spermophilus mexicanus*), due to its distinct physical appearance. Birds were identified by species using *The Sibley Guide to Birds* (Sibley 1961). Ocelots were individually identified using a guide created by LANWR that includes photos of individual ocelot from multiple angles (unpublished data). Bobcats could not be individually identified due to their abundance and lack of an identification database.

Photos of one species taken within 15 minutes were considered to be one "event" or "camera visit" to avoid overestimation of animal presence while ensuring that all individual ocelot camera visits were represented. Photos without wildlife present were not included in the analysis (Harris et al. 2010). Photos were renamed using the freeware program ReNamer (ReNamer 2013). This program changed file names to reflect the date and time that the photo was taken. The program DataOrganize was used to organize files to allow data to be seamlessly converted into a usable spreadsheet format for statistical analysis. DataAnalyze was used to produce a descriptive analysis of camera data (Harris et al. 2010).

Statistical Methods

All data from camera-trap sites was standardized to 100 trap-nights (Dillon and Kelly 2007). Capture frequency by species was the number of photos of a given species per 100 trap-nights. Data of capture frequency by species were log(x+1) transformed to account for the influence of very abundant species. Statistical significance was determined at $P < 0.05$ for all tests used in this study. All statistical analyses were performed using the SPSS® statistical package (Version 22.0), the PRIMER-E software (Version 6.1.16), and Microsoft Excel (2010 Edition).

Ocelot and Bobcat Sympatry

Hourly activity of ocelots, bobcats at locations where ocelots were present, and bobcats at locations where ocelots were absent were displayed visually using Microsoft Excel graphs to identify differences in hourly activity rates.

To determine if prey presence was a good indicator of felid presence, a Similarity of Percentages Test (SIMPER) was applied to wildlife frequency data at all cameras. A t-test assuming unequal variances was performed to compare canopy cover at sites with and without ocelots. Additionally, a SIMPER was applied to habitat data at all cameras.

A SIMPER was also applied to woody vegetation data at all cameras to identify the woody vegetation species which were the greatest contributors to differences between locations with and without ocelots.

Camera sites

Cameras were analyzed for grouping by individual corridor or brush patch and individually using non-parametric multidimensional scaling (MDS) plots of a Bray-Curtis resemblance matrix (Clarke and Gorley 2006).

A BEST test (Clarke and Gorley 2006) was run to identify factors which best explain variance in wildlife frequency between cameras. Diversity indices (species richness and total number of individuals) (Clarke and Gorley 2006) were calculated by PRIMER-E for each camera and analyzed for grouping by corridor. A SIMPER was applied to determine which species contributed to similarities and dissimilarities between corridor types. An Analysis of Similarity (ANOSIM) was used to determine similarity indices between corridor types. Additionally, a one-way Analysis of Variance (ANOVA) was performed on wildlife diversity indices between corridor types. A Tukey's HSD post-hoc test was performed to identify which corridor types differ from others.

Proposed Wildlife Crossing Sites

An MDS plot was applied to a Bray-Curtis resemblance matrix to visualize differences in frequencies at cameras based on whether the camera was located at a wildlife crossing location or in a corridor not adjacent to a public road (reference corridor). A BEST test was run to identify the habitat factors which best explain variance in wildlife frequencies at cameras, based on a Bray-Curtis resemblance matrix.

A t-test assuming unequal variances was performed to test significant differences between diversity indices at wildlife crossing locations and reference corridors. The Benjamini and Hochberg procedure was applied where multiple t-tests were used and a false discovery rate of 0.05 was applied to determine B-H corrected *P*-values (Benjamini and Hochberg 1995).

RESULTS

Camera-traps

Fifty-seven species and two groups (i.e. bird and rodent) were observed (Appendix 1, 2) by 52 individual cameras. The number of images used for analysis was 29,077. Eight out of a possible 16 known ocelots (Swarts 2015) were documented during the study. Of these, six were male and two were female. Two of the eight ocelots were killed by vehicles prior to completion of the study (Swarts 2015). MDS plots of wildlife community by camera showed that cameras did not cluster together by camera group (Fig. 3). Therefore, further analyses treated cameras as individual locations. Initial analysis concluded that no bird species surveyed (Appendix 1) were significant in any of the analyses below. Thus, birds were subsequently considered as one group for all further analyses.

Ocelot and Bobcat Sympatry

Hourly activity of bobcats at locations where ocelots were present (BO^+) was found to be different than hourly activity of bobcats at locations where ocelots were absent (BO^-) in the morning hours. A peak in bobcat activity at BO^+ locations was observed in the late morning (i.e. 07:00 to 09:00), immediately following a steep drop in ocelot hourly activity (Fig. 4). Frequency of activity of bobcats at BO^- locations during daytime hours, when bobcats are typically less active, was higher than at BO^+ locations (Fig. 4).

Rodents, birds, and rabbits, in descending order, were the top contributors of all wildlife to dissimilarity between locations where ocelots were present and absent (SIMPER) (Table 1, Fig. 5). Additionally, prey frequency trended higher at BO^+ locations (Table 1, Fig. 5). All cameras had a mean canopy cover of 61.89% (Fig. 6) and canopy cover was not significantly different at BO^+ and BO^- locations (T statistic = -0.258, *P*= 0.398). A SIMPER indicated that canopy cover ranked lowest out of all habitat variables (Appendix 2), and contributed the least to habitat differences between BO^+ and BO^- locations. Variables that had that greatest contribution to differences between BO^+ and BO^- locations were the amount of ground cover comprised of forbs (avg. squared distance= 2.23), distance to the nearest public road (avg. squared distance= 2.03), and the amount of ground cover comprised of woody species <1m tall (avg. squared distance= 1.96) (Table 2). Woody species that had the greatest contribution to variance between locations were spiny hackberry (*Celtis pallida*) and Texas ebony (*Chloroleucon ebano)* (SIMPER) (Table 3). Goatbush (*Castela erecta*) was the greatest contributor to similarity between BO^+ locations.

Corridor Comparison

Diversity indices were similar within corridor types, with brush strip corridors having the highest similarity between cameras (SIMPER) (Table 4). Community composition of wildlife was significantly different at brush patch cameras. Brush strips, resaca edges, and drainage ditches were not significantly different from each other (ANOSIM Global R= 0.194, significance level of sample statistic= 0.03, 9999 permutations) (Table 4).

All diversity indices were significantly different between habitat structure types (Species richness: $F = 5.255$, $P = 0.003$; Total individuals: $F = 9.080$, $P = 0.000$). A Tukey's HSD post-hoc test identified differences between specific corridor types as follows. Species richness at brush strip cameras was significantly different from all other habitat structure types (brush patch $P = 0.002$, resaca edge $P = 0.024$, drainage ditch $P = 0.019$). Total number of individuals at patch cameras was significantly different from all other corridor types (resaca edge $P = 0.001$, brush strip $P = 0.000$, drainage ditch $P = 0.007$) (Fig. 7).

Wildlife Crossings

Whether a camera was placed at a proposed wildlife crossing or at a reference corridor explained the largest amount of variance between wildlife communities at cameras, followed by habitat structure type and amount of ground cover comprised of woody species less than <1m (BEST test). Additionally, wildlife crossing locations and reference corridor locations were visually separated in an MDS plot of similarity of wildlife frequency (Fig. 8).

Reference corridor cameras had significantly higher mean values than wildlife crossing cameras for species richness (11.897 ± 0.410 and 10.611 ± 0.472 respectively, $P = 0.01$), total individuals (26.327 ± 1.345 and 18.301 ± 1.705, $P = 0.0001$), and Pielou's evenness (0.929 ± 0.005 and 0.902 ± 0.009, $P = 0.006$).

DISCUSSION

Ocelot and Bobcat Sympatry

Select habitat variables, vegetation composition, prey composition, and bobcat hourly activity differed between locations where ocelots were present (BO^+) and where ocelots were absent (BO^-). Canopy cover did not significantly differ between BO^+ and BO^- locations, but mean canopy cover (61.89%) was lower than typically observed in areas described as core ocelot habitat by Harveson *et al.* (2004), Connolly (2009), and Horne *et al.* (2009). This may be attributed to the overall lower quality of habitat found in the corridors surveyed, which was also observed by Tewes *et al.* (1993). A corridor is a temporary passageway, rather than an area of core habitat, which may explain the use of corridors with lower canopy cover (Tewes et al. 1993). These results suggest that ocelots will use corridors with less than ideal amounts of canopy cover. Of 16 known ocelots in the study area, eight were surveyed traveling through corridors during this study, meaning that a minimum of 50% of known ocelots in the Cameron County population during this study used corridors. Although no ocelots were observed in patches during the study, USFWS captured a male ocelot using one of the patches near FM 106 on April 18, 2013 (M. Sternberg, pers. comm.)

Ocelot presence in corridors was associated with the following habitat variables: greater distance from a public road; greater diversity of woody species present; and ground cover comprised of less grass, bare ground, and forbs, and greater amounts of leaf litter (Table 2). These findings are consistent with previous studies that suggest ocelots prefer a ground cover layer with minimal bare ground and grass, and high amounts of leaf litter; and high diversity of woody species (Connolly 2009).

Ocelot use of corridors was also associated with higher amounts of spiny hackberry, Texas ebony, and goatbush, and lower amounts of colima (Table 3). Shindle & Tewes (1998) found spiny hackberry to be the most common woody species among locations surveyed at LANWR. In the current study, goatbush frequency was most similar among BO^+ locations, suggesting that it may be equally indicative of ocelot corridor use as the above combination of woody species. Prey (bird, rabbit, rodent) frequencies were all higher at BO^+ locations than BO^- locations, suggesting that ocelots are closely linked to higher frequency or availability of prey (Korn 2013).

In general, bobcat hourly activity at BO^+ locations (Fig. 4) was consistent with activity estimates from a study that compared activity patterns from multiple studies throughout their range, and was most similar to a study conducted in the Chihuahuan Desert, Mexico (Elizalde-Arellano et al. 2012). However, possible effects of ocelot presence on bobcats were observed in the morning hours. Bobcat hourly activity at BO^- locations was notably different than general activity estimates from previous studies (Elizalde-Arellano et al. 2012). This may be due to the overall lower habitat quality of BO^- locations, which could result in lower prey abundance and additional time required for hunting. Due to the generalist nature of bobcats (Rolley 1987) and their abundance in the study area, analyzing hourly activity of ocelots at cameras where bobcats were absent, in order to identify effects of bobcat presence on ocelots, was not possible.

Corridors

As predicted, brush patches were significantly different from all corridor types, which is likely attributed to their non-linear structure (Forman 1995). Diversity indices were significantly higher at brush strip cameras than all other categories. However, this may be indicative of the structure of each corridor type. A single brush strip allows wildlife one relatively narrow passageway, whereas drainage ditches and resaca edges are composed of two corridors, one on either side of the ditch or resaca, which allow wildlife two options for travel to the same place. The findings of this study suggest that type of corridor (i.e. resaca edge, drainage ditch, brush strip) is not as important as had been previously hypothesized for wildlife activity and diversity. However, corridors had greater wildlife activity and diversity than small brush patches, suggesting that a wider range of wildlife utilize corridors than small brush patches. Additionally, no ocelots were documented in these small brush patches, which is indicative of the importance of corridors for ocelot conservation.

Proposed Wildlife Crossing Locations

Wildlife activity levels and diversity indices were significantly different between wildlife crossing cameras and reference corridor cameras as hypothesized. Lower levels of activity and lower diversity indices were observed closer to F.M. 106. This may suggest road avoidance, but could also be indicative of lower quality habitat closer to public roads (Forman and Alexander 1998, Forman 2000, van der Ree et al. 2011). Habitat close to roads is subjected to edge effects, which can be associated with lower quality habitat and differing vegetation composition and abundance than the interior of a corridor or patch (Forman and Godron 1981). These differences in activity levels and diversity indices should be considered when monitoring and evaluating use of wildlife crossings in post-construction stages of this or similar projects.

Though wildlife activity was concentrated away from F.M. 106, high activity levels near F.M. 106 were observed, suggesting that wildlife is abundant throughout the study area and wildlife crossings are imperative to maintaining connectivity of habitat for south Texas wildlife. During this study, two of the ocelots surveyed were killed by vehicles. These mortalities reaffirm the pressing need for wildlife crossings in areas near ocelot populations in Texas to help reduce vehicle mortalities. The findings of this study suggest that functional corridors are essential features of the landscape used by ocelots, and when combined with properly installed wildlife crossings, may provide an invaluable avenue for continued existence of the endangered ocelot in the United States.

LITERATURE CITED

Beier, P., and R. F. Noss. 1998. Do habitat corridors provide connectivity? Conservation Biology 12:1241–1252.

Benjamini, Y., and Y. Hochberg. 1995. Controlling the false discovery rate: a practical and powerful approach to multiple testing. Journal of the Royal Statistical Society 289–300. Stat Methodol.

Booth-Binczik, S. D., R. D. Bradley, C. W. Thompson, L. C. Bender, J. W. Huntley, J. A. Harvey, L. L. Laack, and J. L. Mays. 2013. Food habits of ocelots and potential for competition with bobcats in southern Texas. The Southwestern Naturalist 58:403–410.

Cain, A. T., V. R. Tuovila, D. G. Hewitt, and M. E. Tewes. 2003. Effects of a highway and mitigation projects on bobcats in Southern Texas. Biological Conservation 114:189–197.

Cameron County, Texas. 2013. Texas Natural Resource Information Services.

Caso, A., C. Lopez-Gonzalez, E. Payan, E. Eizirik, T. de Oliveira, R. Carrera, M. Kelly, and C. Valderrama. 2008. Leopardus pardalis. IUCN Red List of threatened species. Version 2010.4. IUCN. <http://www.iucnredlist.org>.

Clarke, K. R., and R. Gorley. 2006. PRIMER v6: User Manual/Tutorial. PRIMER-E, Plymouth.

Clevenger, A. P., and N. Waltho. 2003. Long-term, year-round monitoring of wildlife crossing structures and the importance of temporal and spatial variability in performance studies. Road Ecology Center. <http://escholarship.org/uc/item/3g69z4mn.pdf>. Accessed 8 Jul 2014.

Connolly, A. R. 2009. Defining habitat for the recovery of ocelots (Leopardus pardalis) in the United States. Texas State University-San Marcos. <https://digital.library.txstate.edu/handle/10877/3130>. Accessed 8 Jul 2014.

Dillon, A., and M. J. Kelly. 2007. Ocelot Leopardus pardalis in Belize: the impact of trap spacing and distance moved on density estimates. Oryx 41:469–477.

Dillon, A., and M. J. Kelly. 2008. Ocelot home range, overlap and density: comparing radio telemetry with camera trapping. Journal of Zoology 275:391–398.

Elizalde-Arellano, C., J. C. López-Vidal, L. Hernández, J. W. Laundré, F. A. Cervantes, and M. Alonso-Spilsbury. 2012. Home range size and activity patterns of bobcats (Lynx rufus) in the southern part of their range in the Chihuahuan Desert, Mexico. The American Midland Naturalist 168:247–264.

ESRI ArcGIS. 2011. Environmental Systems Research Institute, Redlands, CA.

Fahrig, L. 2003. Effects of habitat fragmentation on biodiversity. Annual Review of Ecology, Evolution, and Systematics 34:487–515.

Forman, R. T., and L. E. Alexander. 1998. Roads and their major ecological effects. Annual Review of Ecology, Evolution, and Systematics 29:207.

Forman, R. T., and M. Godron. 1981. Patches and structural components for a landscape ecology. BioScience 31:733–740.

Forman, R. T. 1995. Some general principles of landscape and regional ecology. Landscape Ecology 10:133–142.

Forman, R. T. 2000. Estimate of the area affected ecologically by the road system in the United States. Conservation Biology 14:31–35.

Gause, G. F. 1934. The struggle for existence. Hafner, New York.

Haddad, N. M., D. R. Bowne, A. Cunningham, B. J. Danielson, D. J. Levey, S. Sargent, and T. Spira. 2003. Corridor use by diverse taxa. Ecology 84:609–615.

Haines, A. M., M. E. Tewes, L. L. Laack, J. S. Horne, and J. H. Young. 2006. A habitat-based population viability analysis for ocelots (Leopardus pardalis) in the United States. Biological Conservation 132:424–436.

Haines, A. M., M. E. Tewes, and L. L. Laack. 2005. Survival and sources of mortality in ocelots. Journal of Wildlife Management 69:255–263.

Harris, G., R. Thompson, J. L. Childs, and J. G. Sanderson. 2010. Automatic storage and analysis of camera trap data. Bulletin of the Ecological Society of America 91:352–360.

Harveson, P. M., M. E. Tewes, G. L. Anderson, and L. L. Laack. 2004. Habitat use by ocelots in south Texas: implications for restoration. Wildlife Society Bulletin 32:948–954.

Heilbrun, R. D., N. J. Silvy, M. J. Peterson, and M. E. Tewes. 2006. Estimating bobcat abundance using automatically triggered cameras. Wildlife Society Bulletin 34:69–73.

Heilbrun, R. D., N. J. Silvy, M. E. Tewes, and M. J. Peterson. 2003. Using automatically triggered cameras to individually identify bobcats. Wildlife Society Bulletin 748–755.

Hewitt, D. G., A. Cain, V. Tuovila, D. B. Shindle, and M. E. Tewes. 1998. Impacts of an expanded highway on ocelots and bobcats in southern Texas and their preferences for highway crossings. International Conference on Wildlife Ecology and Transportation. <http://trid.trb.org/view.aspx?id=639944>. Accessed 8 Jul 2014.

Horne, J. S., A. M. Haines, M. E. Tewes, and L. L. Laack. 2009. Habitat partitioning by sympatric ocelots and bobcats: implications for recovery of ocelots in southern Texas. The Southwestern Naturalist 54:119–126.

Jackson, V. L., L. L. Laack, and E. G. Zimmerman. 2005. Landscape metrics associated with habitat use by ocelots in south Texas. Journal of Wildlife Management 69:733–738.

Jahrsdoefer, S. E., and D. M. Leslie. 1988. Tamaulipan brushland of the lower rio grande valley of south Texas: description, human impacts, and management options. Biological Report, United States Fish and Wildlife Service.

Janečka, J. E., M. E. Tewes, L. L. Laack, A. Caso, L. I. Grassman Jr, A. M. Haines, D. B. Shindle, B. W. Davis, W. J. Murphy, and R. L. Honeycutt. 2011. Reduced genetic diversity and isolation of remnant ocelot populations occupying a severely fragmented landscape in southern Texas: Reduced genetic diversity and isolation of US ocelot. Animal Conservation 14:608–619.

Jiménez, C. F., H. Quintana, V. Pacheco, D. Melton, J. Torrealva, and G. Tello. 2010. Camera trap survey of medium and large mammals in a montane rainforest of northern Peru. Revista Peruana de Biología 17:191–196.

Kays, R., S. Tilak, B. Kranstauber, P. A. Jansen, C. Carbone, M. J. Rowcliffe, T. Fountain, J. Eggert, and Z. He. 2010. Monitoring wild animal communities with

arrays of motion sensitive camera traps. arXiv preprint arXiv:1009.5718. <http://arxiv.org/abs/1009.5718>. Accessed 8 Jul 2014.
Kelly, M. J. 2008. Design, evaluate, refine: camera trap studies for elusive species. Animal Conservation 11:182–184.
Korn, J. M. 2013. Genetic pedigree and prey dynamics of ocelot and fine-scale movement patterns of bobcat in south Texas. Texas A&M University-Kingsville. <http://gradworks.umi.com/36/06/3606818.html>. Accessed 6 Sep 2014.
Laack, L. L. 1991. Ecology of the ocelot (Felis pardalis) in south texas. Texas A & I University.
Litvaitis, J. A., J. A. Sherburne, and J. A. Bissonette. 1986. Bobcat habitat use and home range size in relation to prey density. The Journal of Wildlife Management 110–117.
Litvaitis, J. A., and J. P. Tash. 2008. An approach toward understanding wildlife-vehicle collisions. Environmental Management 42:688–697.
Maldonado, D. E. 2014. Rare ocelot found dead on highway. The Brownsville Herald17 July 2014; section Local. Brownsville, Texas.
McCord, C. M., and J. E. Cardoza. 1982. Bobcat and lynx. Pages 728–766 *in*. Wild Mammals of North America.
Navarro-Lopez, D. 1985. Status and distribution of the ocelot (Felis pardalis) in south Texas. Texas A & I University.
Nevada DOT. n.d. Wildlife Crossing Brochure. Nevada Department of Transportation.
Van der Ree, R., J. A. Jaeger, E. A. van der Grift, and A. P. Clevenger. 2011. Effects of roads and traffic on wildlife populations and landscape function: road ecology is moving toward larger scales. Ecology and Society 16:48–48.
ReNamer. 2013. WebAttack, Inc. <http://www.snapfiles.com/downloads/denrenamer/dldenrenamer.html>.
Richardson, A., and K. King. 2011. Plants of Deep South Texas: A Field Guide to the Woody and Flowering Species. Texas A&M University Press.
Rolley, R. E. 1987. Bobcat. Pages 671–681 *in*. Wild Furbearer Management and Conservation in North America. Ontario Ministry of Natural Resources, Toronto, Canada.
Shindle, D. B., and M. E. Tewes. 1998. Woody species composition of habitats used by ocelots (Leopardus pardalis) in the Tamaulipan Biotic Province. The Southwestern Naturalist 273–279.
Sibley, D. A. 1961. The Sibley Guide to Birds. First edition. The National Audubon Society.
Simpson, R., C. Smith, C. Wolf, and W. Director. 2010. Defining areas of potential ocelot habitat. <http://www.urbanwildlife2011.org/business/grants/wildlife/section_6/projects/mammals/e108_final_report.pdf>. Accessed 8 Jul 2014.
Swarts, H. 2015. Personal communication.
Tewes, M. E., and D. R. Blanton. 1998. Potential impacts of international bridges on ocelots and jaguarundis along the Rio Grande wildlife corridor.
Tewes, M. E., and D. D. Everitt. 1986. Status and distribution of the endangered ocelot and jaguarundi in Texas. Pages 147–158 *in*. Cats of the World: Biology,

Conservation, and Management. National Wildlife Federation, Washington, D.C., USA.

Tewes, M. E., and R. W. Hughes. 2001. Ocelot management and conservation along transportation corridors in southern Texas. Road Ecology Center. <http://escholarship.org/uc/item/6mc7x9mx.pdf>. Accessed 8 Jul 2014.

Tewes, M. E., L. L. Laack, and A. Caso. 1993. Corridor management for ocelots in the southern United States and northern Mexico. International Wildlife Management Congress 10.8:444–446.

Tewes, M. E., and D. J. Schmidly. 1987. The neotropical felids: jaguar, ocelot, margay, and jaguarundi. Pages 697–712 *in*. Wild Furbearer Management and Conservation in North America. Ministry of Natural Resources, Ontario, Canada.

U.S. Census Bureau. 2014. Annual estimates of the resident population by sex, race, and hispanic origin for the united states, states, and counties: April 1, 2010 to July 1, 2013. U.S. Census Bureau, Population Division.

USFWS. 1980. Department of the Interior Habitat Preservation Plan- preservation of areas of important fish and wildlife habitat: Cameron, Hidalgo, Starr, and Willacy counties, Texas. U.S. Fish and Wildlife Service, Region 2, Albuquerque, NM.

USFWS. 2010. Draft ocelot (Leopardus pardalis) Recovery Plan, First Revision. U.S. Fish and Wildlife Service, Southwest Region, Albuquerque, New Mexico.

TABLES

Table 1. Similarity of Percentages (SIMPER) of prey frequency at cameras with presence or absence of ocelots in Cameron County, Texas, between October 2013 and October 2014.

Wildlife	**Mean Frequency** ***BO^-***	**Mean Frequency** ***BO^+***	**Average Dissimilarity Between Groups**	**Contributing %**
Rodent	50.64 ± 13.35	63.31 ± 20.94	4.79	11.39
Bird	27.66 ± 5.64	64.19 ± 21.33	4.03	9.58
Rabbit	47.22 ± 12.24	79.15 ± 22.25	3.64	8.64

Table 2. Similarity of Percentages (SIMPER) of habitat variables within a 6 m radius of cameras with presence or absence of ocelots in Cameron County, Texas, between October 2013 and October 2014.

Habitat Variable	**Mean Value** ***BO^-***	**Mean Value** ***BO^+***	**Average Squared Distance**
Ground cover: forbs	6.13% ± 1.33	5.83% ± 2.30	2.23
Distance to F.M. 106	0.80 km ± 0.18	1.06 km ± 0.22	2.03
Ground cover: woody species < 1 m tall	10.16% ± 2.08	13.06% ± 2.46	1.96
Ground cover: grass	15.81% ± 3.26	8.33% ± 2.39	1.93
Ground cover: bare	22.58% ± 3.58	18.89% ± 3.63	1.81
Ground cover: leaf litter and woody debris	45.32% ± 4.91	53.89% ± 6.14	1.64
Total number of woody species (> 1 m tall)	4.32 ± 0.32	4.44 ± 0.44	1.35
Average canopy cover	62.72% ± 3.94	61.67% ± 5.99	1.26

Table 3. Similarity of Percentages (SIMPER) of woody species frequency within a 6 m radius of cameras with presence or absence of ocelots in Cameron County, Texas, between October 2013 and October 2014.

Woody Species	**Mean Frequency *BO*$^{-}$**	**Mean frequency *BO*$^{+}$**	**Contribution %**
Spiny Hackberry	2.29 ± 0.51	2.61 ± 0.59	12.65
Ebony	1.07 ± 0.31	1.39 ± 0.38	11.64
Colima	1.19 ± 0.31	0.72 ± 0.30	9.24
Goatbush	0.29 ± 0.12	1.24 ± 1.17	8.01

Table 4. Similarity of Percentages (SIMPER) of wildlife diversity between habitat structure types (brush patch, brush strip, drainage ditch, resaca edge) and an Analysis of Similarity (ANOSIM) of wildlife frequency scaled to 100 camera-trap nights between habitat structure types at cameras in Cameron County, Texas, between October 2013 and October 2014.

Habitat Structure Type Combination	**SIMPER Average Dissimilarity**	**ANOSIM Statistic**	**ANOSIM significance level %**
Patch vs. Strip	26.17	0.425	0.3
Patch vs. Drainage	20.54	0.358	0.1
Patch vs. Resaca	21.60	0.546	0.1
Strip vs. Drainage	13.73	-0.063	75
Strip vs. Resaca	12.28	-0.069	73
Drainage vs. Resaca	12.85	0.032	23.3

FIGURES

Figure 1. Morphological differences between ocelot (left) and bobcat (right) in Cameron County, Texas. (Left photo courtesy of USFWS).

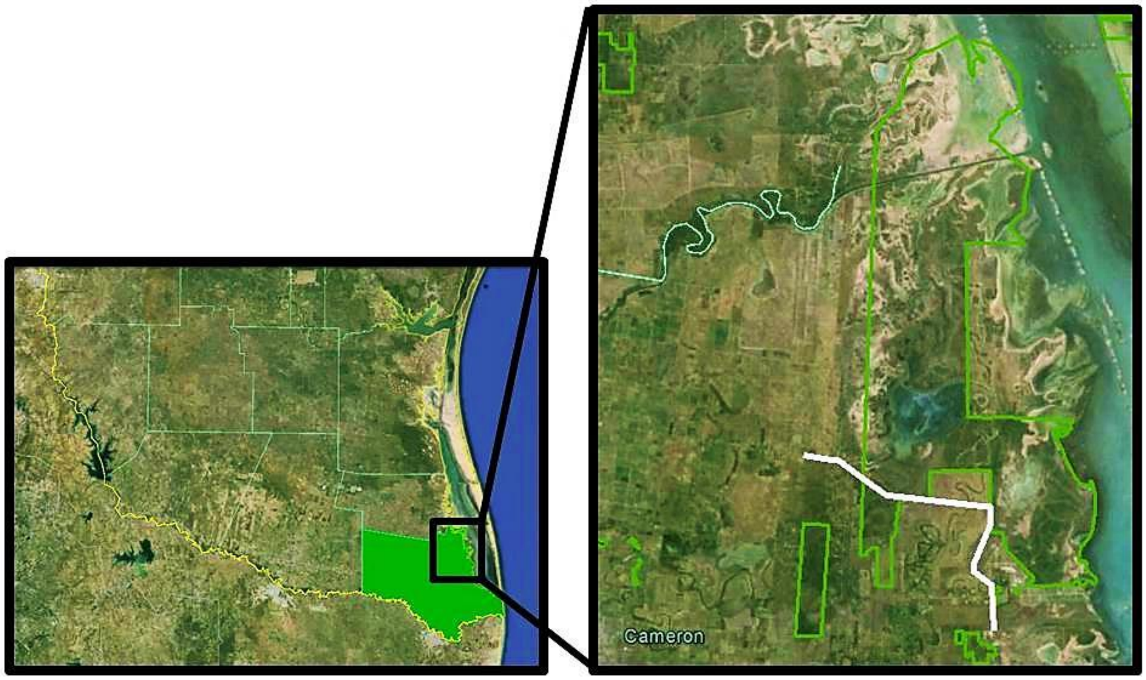

Figure 2. Study area including all reference sites (landowners where some reference sites were set-up signed a waiver to allow access to the property with the express caveat that the location of those cameras would not be publicized) located within and around Laguna Atascosa National Wildlife Refuge (boundary in green) and Farm-to-Market Road 106 (white line) in northeast Cameron County, Texas.

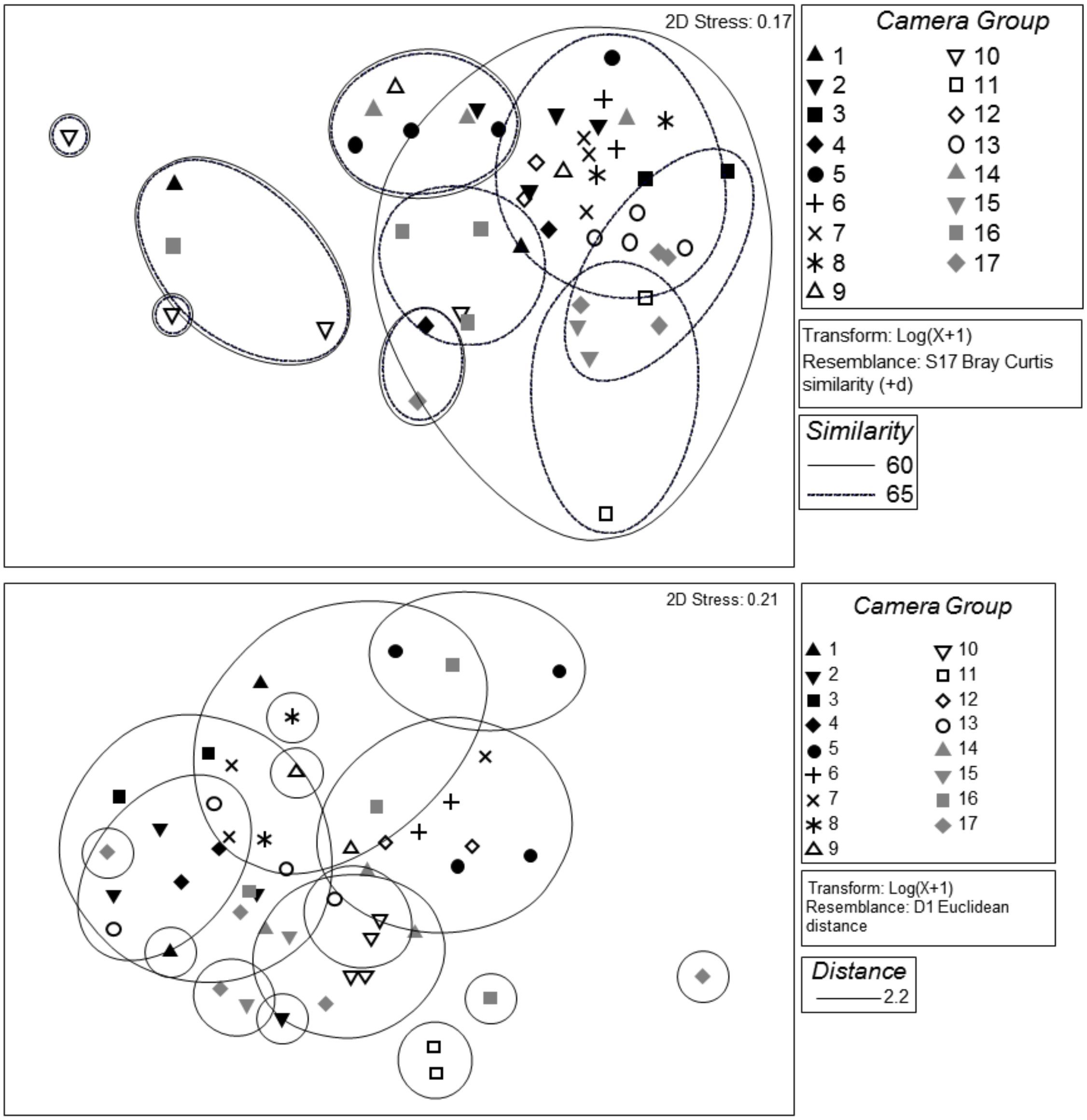

Figure 3. Multi-dimensional Scaling (MDS) plot of wildlife frequency similarity (top) and woody vegetation frequency similarity (bottom) between cameras. Symbols represent camera groups within individual corridors and patches. Clusters represent similarity at 60% and 65% for wildlife (top) and a Euclidian distance of 2.2 for vegetation (bottom).

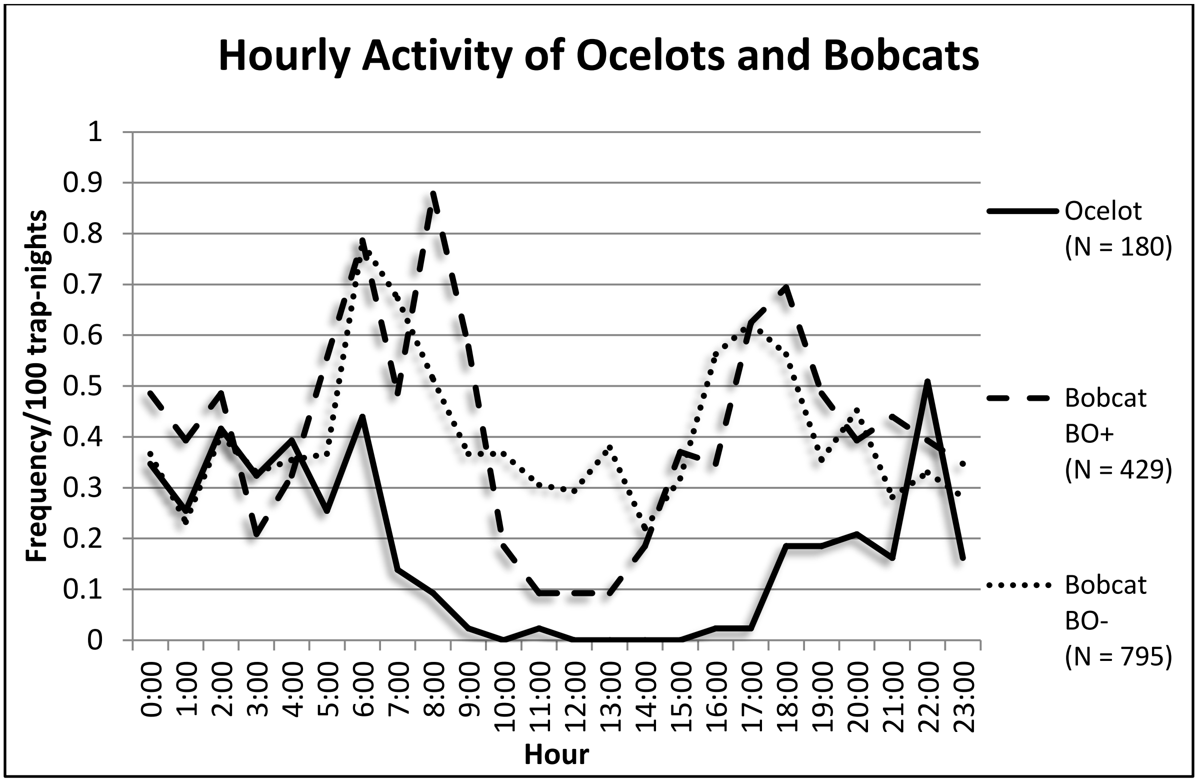

Figure 4. Frequency of hourly activity scaled to 100 trap-nights of ocelots and bobcats at all cameras with presence or absence of ocelots in Cameron County, Texas, between October 2013 and October 2014. N is equal to the number of independent visits by ocelots and bobcats.

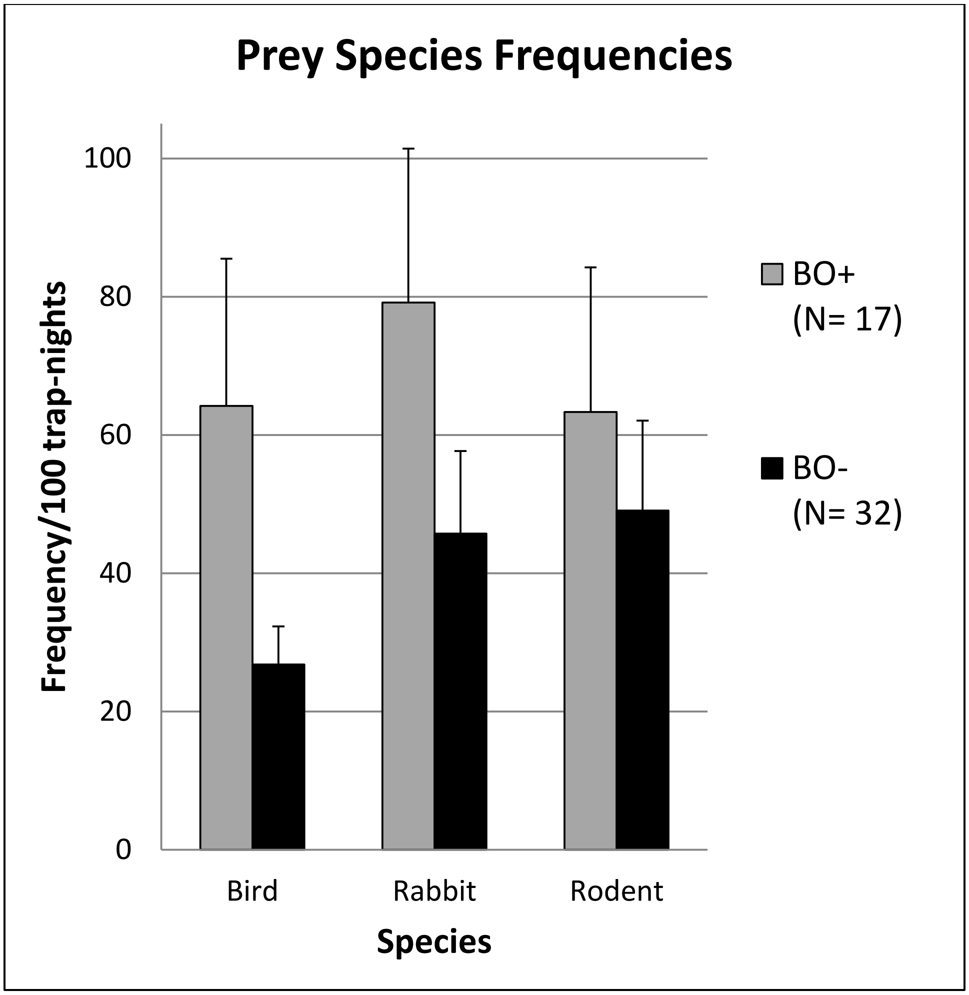

Figure 5. Frequencies of prey scaled to 100 trap-nights at cameras with presence or absence of ocelots in Cameron County, Texas, between October 2013 and October 2014. Bars represent standard error. N is equal to the number of cameras.

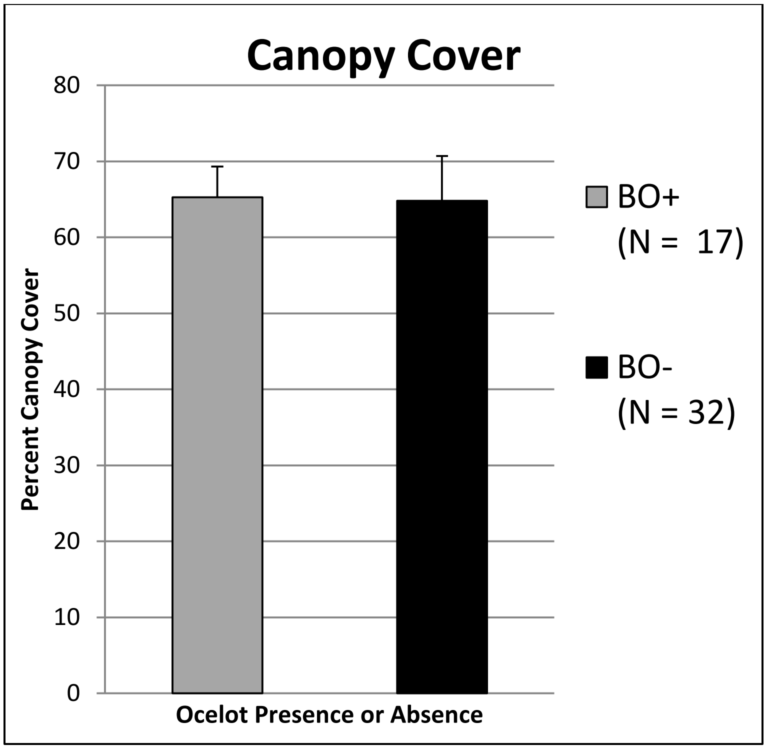

Figure 6. Mean canopy cover percentages at cameras with ocelots present or absent in Cameron County, Texas, between October 2013 and October 2014. Bars represent standard error. N is equal to the number of cameras.

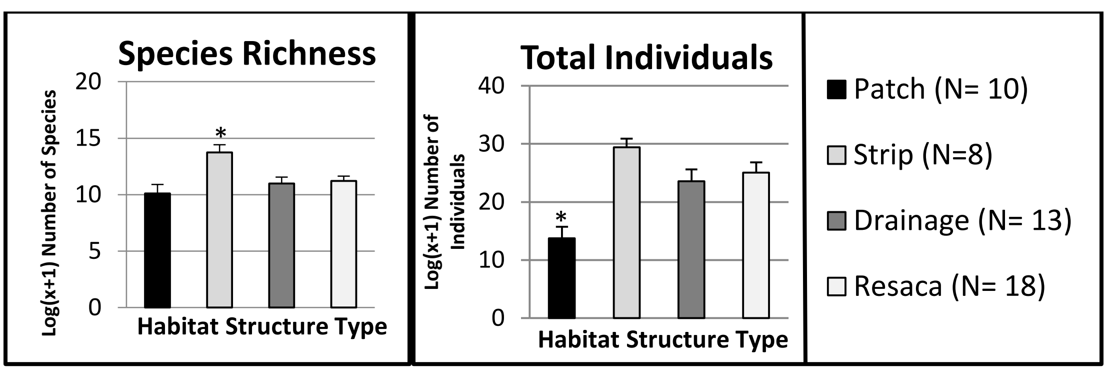

Figure 7. Diversity indices of wildlife by habitat structure type at cameras in Cameron County, Texas, between October 2013 and October 2014. Bars represent standard error. N is equal to the number of cameras. * Significant at 0.05.

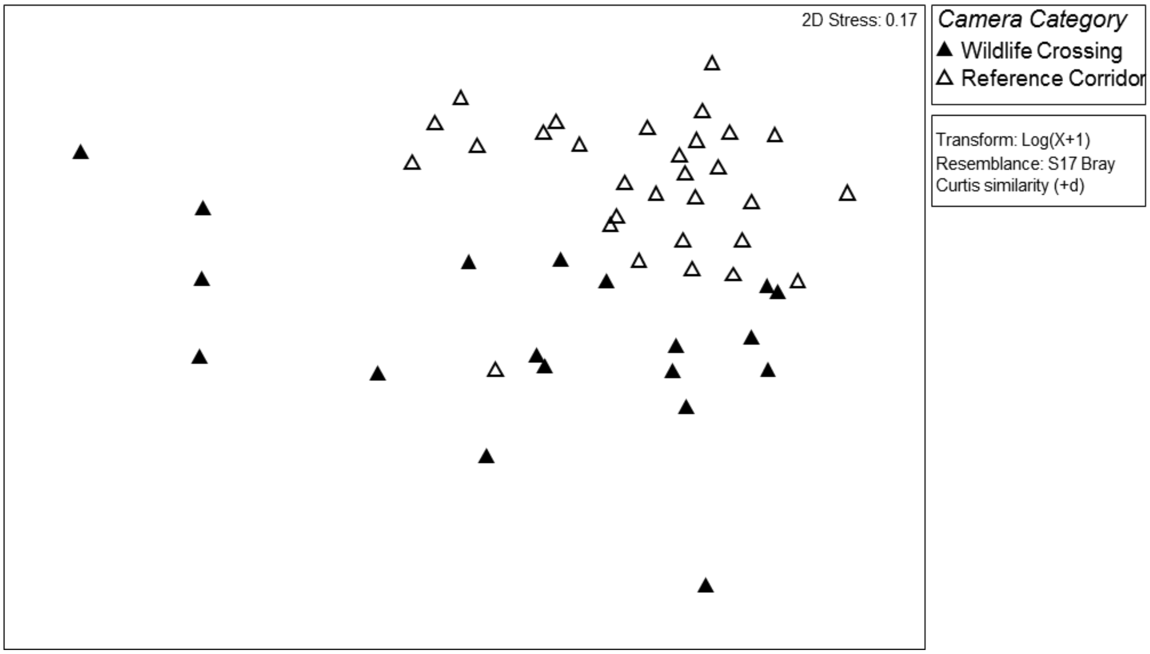

Figure 8. Multi-dimensional Scaling (MDS) plot of frequency similarity of wildlife between cameras. Symbols represent two camera categories: wildlife crossing or reference corridor.

APPENDICES

Appendix 1. Bird species photographed by cameras in Cameron County, Texas, between October 2013 and October 2014 and listed alphabetically by common name.

Appendix 2. Habitat variables surveyed at cameras in Cameron County, Texas, between October 2013- October 2014.

Appendix 3. Woody vegetation species surveyed at cameras in Cameron County, Texas, between October 2013- October 2014.

Appendix 4. Wildlife surveyed at cameras in Cameron County, Texas, between October 2013- October 2014.

Appendix 1. Bird species photographed by cameras in Cameron County, Texas, between October 2013 and October 2014 and listed alphabetically by common name.

Bird species (common)	**Bird species (scientific)**
American Kestrel	*Falco sparverius*
Black-bellied whistling duck	*Dendrocygna autumnalis*
Bronzed Cowbird	*Molothrus aeneus*
Burrowing Owl	*Athene cunicularia*
Common Pauraque	*Nyctidromus albicollis*
Cooper's Hawk	*Accipeter cooperii*
Great-tailed Grackle	*Quiscalus mexicanus*
Gray Catbird	*Dumetella carolinensis*
Great Egret	*Ardea alba*
Green Heron	*Butorides virescens*
Green Jay	*Cyanocorax yncas*
Groove-billed Ani	*Crotophaga sulcirostris*
Harris's Hawk	*Parabuteo unicinctus*
Hermit Thrush	*Catharus guttatus*
Hooded Warbler	*Wilsonia citrina*
Kentucky Warbler	*Oporornis formosus*
Golden-fronted Woodpecker	*Melanerpes aurifrons*
Greater Roadrunner	*Geococcyx californianus*
Great Kiskadee	*Pitangus sulphuratus*
Ladder-backed Woodpecker	*Picoides scalaris*
Little Blue Heron	*Egretta caeruleas*
Long-billed Thrasher	*Toxostoma longirostre*
Louisiana Waterthrush	*Seiurus motacilla*
Northern Bobwhite	*Colinus virginianus*
Northern Cardinal	*Cardinalis cardinalis*
Northern Mockingbird	*Mimus polyglottos*
Mourning Dove	*Zenaida macroura*
Olive Sparrow	*Arremonops rufivirgatus*
Plain Chachalaca	*Ortalis vetula*

Bird species (common)	Bird species (scientific)
Red-winged Blackbird	*Agelaius phoeniceus*
Wild Turkey	*Meleagris gallopavo*
Turkey Vulture	*Cathartes aura*
White-tipped Dove	*Leptotila verreauxi*
White-winged Dove	*Zenaida asiatica*
Yellow-billed Cuckoo	*Coccyzus americanus*
Yellow-breasted Chat	*Icteria virens*

Appendix 2. Habitat variables surveyed at cameras in Cameron County, Texas, between October 2013 and October 2014.

Habitat Variables	
Habitat structure type	Ground cover: bare ground
Wildlife crossing vs. reference corridor	Ground cover: forbs
Average canopy cover	Ground cover: grass
Distance to nearest public road (km)	Ground cover: leaf litter and woody debris
Total number of woody species >1m tall	Ground cover: woody species < 1m tall

Appendix 3. Woody vegetation species surveyed at cameras in Cameron County, Texas, between October 2013 and October 2014 listed alphabetically by common name.

Woody species (common)	**Woody species (scientific)**
Anacua	*Ehretia anacua*
Barbed-wire Cactus	*Acanthocereus tetragonus*
Berlandier's Fiddlewood	*Citharexylum berlandieri*
Berlandier's Wolfberry	*Lycium berlandieri*
Brasil	*Condalia hookeri*
Cenizo (Texas Purple Sage)	*Leucophyllum frutescens*
Colima	*Zanthoxylum fagara*
Coyotillo	*Karwinskia humboldtiana*
Desert Yaupon	*Schaefferia cuneifolia*
Guayacan	*Guaiacum angustifolium*
Honey Mesquite	*Prosopis glandulosa*
Huisache	*Acacia farnesiana*
Leatherleaf (Guttapercha)	*Maytenus phyllanthoides*
Lotebush	*Ziziphus obtusifolia*
Narrow Leaf Elbow Bush	*Ferstiera angustifolia*
Retama	*Parkinsonia aculeate*
Sea Oxe-eye	*Borrichia frutescens*
Snake Eyes	*Phaulothamnus spinescens*
Spanish Dagger (Palma Pita)	*Yucca treculeana*
Spiny Hackberry (Granjeno)	*Celtis pallida*
Spring Mistflower (Blue Boneset)	*Tamaulipa azurea*
Tenaza	*Havardia pallens*
Tepeguaje	*Leucaena pulverulenta*
Texas Ebony	*Chloroleucon ebano*
Texas Lantana (Calico Bush)	*Lantana urticoides*
Texas Prickly Pear Cactus	*Opuntia engelmannii*

Appendix 4. Wildlife surveyed at cameras in Cameron County, Texas, between October 2013 and October 2014 listed alphabetically by common name.

Wildlife species (common)	**Wildlife species (scientific)**
Birds	See appendix 1
Black-tailed jackrabbit	*Lepus californicus*
Bobcat	*Lynx rufus*
Collared peccary	*Peccary tajucu*
Coyote	*Canis latrans*
Eastern cottontail rabbit	*Sylvilagus floridanus*
Feral hog	*Sus scrofa*
Long-tailed weasel	*Mustela frenata*
Mexican ground squirrel	*Spermophilus mexicanus*
Nilgai	*Boselaphus trgocamelus*
Nine-banded armadillo	*Dasypus novemcinctus*
Ocelot (Northern spp.)	*Leopardus pardalis albescens*
Raccoon	*Procyon lotor*
Rodents	*n/a*
Striped skunk	*Mephitis mephitis*
Texas indigo snake	*Drymarchon melanurus erebennus*
Texas tortoise	*Gopherus berlandieri*
Virginia opossum	*Didelphis virginiana*
White-tailed deer	*Odocoileus virginianus*