FACTORS OF OCELOT OCCUPANCY IN SOUTH TEXAS

A Dissertation

by

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FACTORS OF OCELOT OCCUPANCY AT DIFFERENT SPATIAL SCALES

IN SOUTH TEXAS

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ABSTRACT

Factors of Ocelot Occupancy in South Texas

(May 2020)

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The Rio Grande Delta and surrounding rangelands of South Texas have become one of the fastest urbanizing regions in the United States over the last 35 years. Coupled with rapid urbanization, this region is noted for productive agriculture and rangeland while retaining the distinction as a richly biodiverse region in Texas. Since the early twentieth century, the conversion of woody cover for agriculture and human development has become one of the main drivers of the decline of endangered ocelots (*Leopardus pardalis*), and the extirpation of jaguars (*Panthera onca*) and jaguarundi (*Puma yagouaroundi*) in South Texas. About 80% of the known breeding population of ocelots (*Leopardus pardalis*) in the United States occurs exclusively on private rangelands in northern Willacy and Kenedy counties in South Texas. These private ranches support several large contiguous undisturbed patches of thornshrub which is home to a diverse carnivore community that also includes bobcats (*Lynx rufus*) and coyotes *(Canis latrans*). Over the last 37 years, past studies have suggested ocelots in South Texas select for woody patches that contain extremely dense thornshrub (i.e., 95% canopy cover and 85% vertical cover) and require large patches of woody cover to survive. However, information on occupancy dynamics of ocelots over time relative to landscape- and site-level factors and interspecific competition has yet to be described in this region. Furthermore, I have yet to understand large-scale processes that have driven land cover change in the Rio Grande Delta and surrounding

rangelands since the late 1980s and project in the future until 2050. To address these broad questions, I initiated this four studies: 1) Quantified different rates of land cover change from 1987-2016 and used housing density scenarios to project changes in the amount and spatial distribution of woody cover until 2050 and its potential impact of wild felid habitat; 2) Assess colonization-extirpation dynamics of ocelot occupancy relative to site-level and landscape-level factors, and 3) Examine interspecific interactions and examine potential resource partitioning among coyotes, bobcats, and ocelots on the East Foundation's El Sauz Ranch from 2011 to 2018; 4) Quantify the predictive performance of using high-frequency GPS telemetry data to inform an ocelot species distribution model on private rangelands in northeastern Willacy and eastern Kenedy counties in South Texas.

From 1987 to 2016, woody cover increased from 3.9% along with patch density and edge density, while mean patch area, and Euclidean nearest neighbor decreased. Closer inspection revealed that woody encroachment of small patches (<1 ha) was the leading cause of woody cover increase by a magnitude of 4, with an observed significant skewness and kurtosis in the frequency distribution of patch size across years. By 2050, urbanization will be the dominant landscape type (39.9%) and at least 200 km^2 of woody cover may be lost.

From 2014-2017, 8 ocelots were captured on the East Foundation's El Sauz Ranch in Willacy and Kenedy counties, Texas. Two-hour fix rates have similar performance to 12 hr fix rates and might represent the optimal fix rates for researchers trying to obtain as much GPS data over longer periods as possible while avoiding serial autocorrelation. Probability of ocelot presence was greatest in mixed woody canopies which is important in determining ocelot presence on the Coastal Sand Plain of South Texas. This study shows that accounting for serial

autocorrelation among step lengths at different fix rates can enable researchers to use high-frequency GPS data within MaxEnt without potentially biasing occurrence data.

From 2011 to 2018, initial occurrence of ocelots was positively influenced by cooler temperatures in woody areas and similar humidity as compared to non-woody areas. Colonization-extinction dynamics were influenced by the spatial structure of woody land cover. Ocelots were more likely to colonize areas with a greater woody percentage and patch density, and farther Euclidean distance (<9 m). However, decreasing mean patch area and increasing shape index of woody cover positively influenced extirpation rates. I also found strong evidence of seasonal mutual coexistence among ocelots, bobcats, and coyotes and observed a species-specific seasonal trend in detection. Seasonal coexistence patterns were also explained by increasing distance from a high-speed roadway.

These results have important ecological implications for wild felid populations and planning ocelot recovery in the rangelands and adjacent Rio Grande Delta of South Texas. By 2050, urbanization will be the dominant cover type in the region and the largest tracts of woody cover will only occur in private lands in northeastern Willacy and eastern Kenedy counties. In these private lands, as woody patch density increases, these patches will coalesce over time and form larger woody aggregates, which will promote ocelot occurrence, colonization, and persistence. Brush management needs to be strategic as patch area and shape index are a limiting factor to promote ocelot persistence on private rangelands. Furthermore, the co-occurrence study indicates mutual coexistence among ocelots, bobcats, and coyotes, but we were unable to find clear evidence of resource partitioning, which may indicate the niches of these species may be too discrete for interspecific competition. Further research may provide a better understanding of the ecological mechanisms that facilitate coexistence within this community. As road networks

in the region expand over the next few decades, large private working ranches will remain the key to ocelot recovery into the future.

DEDICATION

This dissertation is dedicated to two people who affected my journey to complete this Ph.D. First, my late grandfather, Ernest Capalbo; Thank you for showing me the birds at Long Beach Island. Second, my late friend and colleague Alec Ritzell. Thank you for showing me the true meaning of life—your enthusiasm, fight, and determination to achieve greatness despite everything life throws your way showed that there is much more to life than worrying about research or authoring a dissertation.

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CHAPTER I

LANDCOVER TRENDS IN SOUTH TEXAS 1987-2050: IMPLICATIONS FOR WILD FELIDS

Deforestation and degradation of native vegetation for agricultural land use and urbanization have had profound global effects on wildlife (Sanderson et al. 2002, McKinney 2008). The human footprint on the natural landscape is unprecedented with >40% of the land surface affected by agriculture (i.e., crops and livestock) (Sanderson et al. 2002, Foley et al. 2005, Seto et al. 2011). The global extent of urban lands increased by 58,000 km^2 from 1970 to 2000, with the largest area of change occurring within North America (Seto et al. 2011). Today, >3 billion people live in urbanized areas worldwide, with mid-century projections expected to surpass 4 billion (Gehrt 2010, United Nations 2014). As habitat fragmentation and degradation rates increase, the ability of certain wildlife species to survive or disperse into new areas will be affected (Zemanova et al. 2017).

In North America, the rate of urbanization and habitat fragmentation is currently outpacing the rate of land preservation and the human population growth rate (Gehrt 2010). As habitats become fragmented, generalist carnivores such as coyotes (*Canis latrans*), raccoons (*Procyon lotor*), and red foxes (*Vulpes vulpes*) can exploit rapidly changing areas (Gehrt 2010, Lombardi et al. 2017). However, carnivores that have specialized habitat requirements such as ocelot (*Leopardus pardalis*) and Canada lynx (*Lynx canadensis*) (Janečka et al. 2011, 2016; Squires et al. 2013) and large home ranges (e.g., mountain lion [*Puma concolor*] and jaguar [*Panthera onca*]; Crooks 2002; Beier et al. 2010, Olsoy et al. 2016) which puts them often most

Chapters I, II, III, and IV were formatted in the style of Ecology and Evolution

at risk. In southern California, increasing urban development, increased traffic volumes, and increased road construction has been linked to genetic isolation and lack of gene flow in mountain lion populations (Ernest et al. 2014, Riley et al. 2014). Further, persistence and connectivity among jaguar populations have been severely limited due to deforestation caused by agriculture, human development, and rangeland conversion (Olsoy et al. 2016, Mora 2017, Zemanova et al. 2017).

In the early 1900s, five felid species were known to occupy the Rio Grande Delta and adjacent rangelands in South Texas: ocelot, bobcat (*Lynx rufus*), jaguar, mountain lion and jaguarundi (*Puma yagouaroundi*) (Schmidly and Bradley 2016). Today, bobcats are the most abundant felid and mountain lions are rare in many parts of South Texas (Horne et al. 2009, Hernandez-Santin et al. 2012, Schmidly and Bradley 2016). Ocelots, now endangered, remain in two small isolated populations (<80 individuals) in Kenedy, Willacy, and Cameron counties in South Texas (Janečka et al. 2016, Leslie 2016).

Ocelots, bobcats, and mountain lions in Texas are dependent on large patches of woody cover (Jackson et al. 2005, Horne et al. 2009, Hernandez-Santin et al. 2012). Bobcats are generalists, occurring in mixed forests, thornshrub, riparian corridors and floodplains, coastal prairies, pastures, and developed areas (Horne et al. 2009, Lombardi et al. 2017, Young et al. 2019a). Although ocelots have been observed in a wide range of ecosystems (Sunquist and Sunquist 2017), they prefer large patches (mean patch area = 9.2 ha) of dense woody vegetation communities with 95% vertical cover and 85% horizontal canopy cover in South Texas (Jackson et al. 2005, Horne et al. 2009). However, unlike bobcats and mountain lions, ocelots are not commonly observed near urban areas in South Texas (Jackson et al. 2005) potentially due to lack of natural corridors.

The Rio Grande Delta region, including the cities of Harlingen, Brownsville, and McAllen, are among the most rapidly growing urban centers in the United States (Leslie 2016). Historically, increases in row-crop agriculture, livestock production, and urbanization spurred the removal of native woody vegetation, which has transformed the Rio Grande Delta into the third-most productive croplands in the United States (Leslie 2016). Collins (1984) estimated 95% of native vegetation was lost during the early to mid-twentieth century in the Lower Rio Grande Valley. Tremblay et al. (2005) estimated Cameron County lost 91% of native woodlands from 1930-1983. However, no region-wide assessment of woody cover has been conducted since the mid-1980s.

Conversion of natural land cover (e.g. native rangelands) to cropland and pasture has been linked to losses in genetic diversity and population declines for ocelots across their northern geographic range (Janečka et al. 2011, Leslie 2016, Mora 2017). Rapid expansions of road networks are leading to increases in road mortality of wildlife, especially felids in South Texas (Haines et al. 2005, 2006, Leslie 2016). To help address these issues, conservation organizations, academic institutions, federal and state agencies, and private landowners often work together to identify drivers of habitat loss and to preserve habitat in certain areas where it will assist populations and increase gene flow (Squires et al. 2013, Olsoy et al. 2016, Leslie 2016, Zemanova et al. 2017).

Assessing potential land cover trends over the past 30 years will contribute to our understanding of the large-scale processes that have driven land cover change in the Rio Grande Delta and surrounding rangelands since the late 1980s. Long-term availability of LANDSAT imagery (Wulder et al. 2008) combined with housing density projections (EPA 2017) enables an estimate of past, present and future land cover change and future land cover change and their

potential impact on felid population in these areas. These results will provide biologists and decision-makers baseline to develop landscape-level strategies to address habitat requirements for wild felids in Texas, as well as a wide variety of other species (e.g. raccoons, coyotes, and nilgai [*Boselaphus tragocamelus*]). Therefore, the specific goals of this research are to:

1) Perform a land use land cover analysis to assess the extent and change of woody cover in the Rio Grande Delta and surrounding rangelands of Texas from 1987 to 2016.
2) Quantify the spatial and temporal distribution of woody cover to determine the extent of potential fragmentation that has occurred since 1987.
3) Predict future trends in land cover change from 2020 to 2050 based on housing density projection models and discuss its potential effects on native felid populations.

METHODS

Study Area

This study was focused in the Rio Grande Delta and surrounding rangelands of South Texas (i.e., southern Kenedy, Willacy, Cameron, southeastern Brooks, and eastern Hidalgo counties) (10,065 km^2) (Figure 1.1). Major land cover types included low-high density urban development, open space, open water, barren land, pasture, crops, woody, and emergent herbaceous wetlands, thornshrub and live oak [*Quercus virginiana* Mill] forests (US Geological Survey 2011). This region occurs within the Laguna Madre Barrier Islands and Coastal Marshes, Coastal Sand Plain, and the Lower Rio Grande Valley ecoregions (Bailey and Cushwa 1981), which has a semi-arid subtropical climate (10° C to 36° C) (Leslie 2016). Mean annual precipitation in eastern South Texas is 837 mm, with lesser amounts in the winter than the summer and greater amounts near the coast (Norwine and Kuruvilla 2007).