USING LANDSAT IMAGERY TO IDENTIFY POTENTIAL OCELOT HABITAT IN TAMAULIPAS, MEXICO

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ABSTRACT

Within the United States (U.S.), the ocelot is an endangered species limited to southern Texas. Currently, the greatest problem for ocelot conservation is the lack of suitable habitat, which consists of dense woody cover. Techniques used to accurately identify ocelot habitat from remotely sensed imagery would aid ocelot conservation. In addition, successful management of ocelots within adjacent Mexico may be important in maintaining viable populations of ocelots within the U.S. The objectives of this study were to develop a cover map identifying ocelot habitat within a biological research area (Los Ebanos Ranch) in Tamaulipas, Mexico, and ground truth this cover map to measure its accuracy in identifying ocelot habitat. Using a LANDSAT ETM 7 image acquired in April 2000, we delineated supervised classification training sites based on known ocelot habitat defined as >75% woody cover using the ArcGIS 9 GIS software. Using the training sites delineated in ArcGIS 9, spectral signatures were developed for supervised classification within the ERDAS IMAGINE 8.7 software program producing a cover map identifying areas with >75% woody cover. We created random points within the cover map to measure its accuracy on the ground. The cover map was >85% successful in delineating ocelot habitat, thereby making it acceptable for land use classification. This technique could be used in studies to delineate cover types for other species, thereby providing biologists the ability to conduct habitat selection analysis, identify important conservation areas, and develop recovery strategies that link habitat patches.

INTRODUCTION

Within the U.S. the ocelot *Leopardus pardalis* is listed as endangered by the U.S. Fish and Wildlife Service (1982), with only two breeding populations occurring within southern Texas (Navarro-Lopez, 1985; Tewes and Everett, 1986) (Figure 1). Major threats affecting ocelots include loss of habitat, road-mortalities, and genetic isolation (Tewes and Everett, 1986; Tewes and Miller, 1987; Walker, 1997; Haines et al., 2005), with loss of habitat considered the greatest threat to ocelot conservation in the U.S. A population viability analysis (PVA) that evaluated recovery strategies for an ocelot population within the U.S. concluded that the most effective recovery scenario for ocelots was the protection and restoration of ocelot habitat (Haines et al. *In Press*). However, combinations of different recovery strategies (e.g., protecting and restoring ocelot habitat, construction of ocelot culverts, establishment of ocelot travel corridors, and translocation of ocelot into the U.S. from northern Mexico) was determined to be more effective at reducing ocelot probability of extinction in the U.S. over the next 100 years (Haines et al., *In Press*).

Translocation of individual ocelots from Mexico could benefit ocelots in the U.S by decreasing the potential for genetic inbreeding. Walker (1997) found that ocelots residing within Tamaulipas, Mexico had higher microsatellite heterozygosity when compared to the populations of ocelots residing in the U.S., suggesting that ocelots residing within the U.S. were more susceptible to genetic inbreeding than ocelots within Tamaulipas, Mexico. Potential results of genetic inbreeding include reduced adult survival, fecundity, disease resistance, and success in competition for mates (Miller and Lacy, 2003). Caso (1994) stated that dense woody cover was required for ocelot survival in Tamaulipas, Mexico, and that ranch managers and wildlife biologists need to protect dense woody areas to ensure ocelot conservation.

Tewes et al. (1999) successfully used SPOT satellite imagery (SPOT Image Corp., http://www.spot.com) with supervised classification to identify potential ocelot habitat in southern Texas. In addition, Tewes et al. (1999) stated that the use of remote sensing to identify potential ocelot habitat would greatly aid researchers in identifying ocelot habitat within a specific region. The objectives of this study were to (1) develop a habitat map identifying

potential ocelot habitat within a biological research area in Tamaulipas, Mexico using LANDSAT ETM 7 satellite imagery (EROS, Data Center, USGS, http://edcwww.cr.usgs.gov/webglis), and (2) conduct an accuracy assessment of the habitat map to justify its use for land classification.

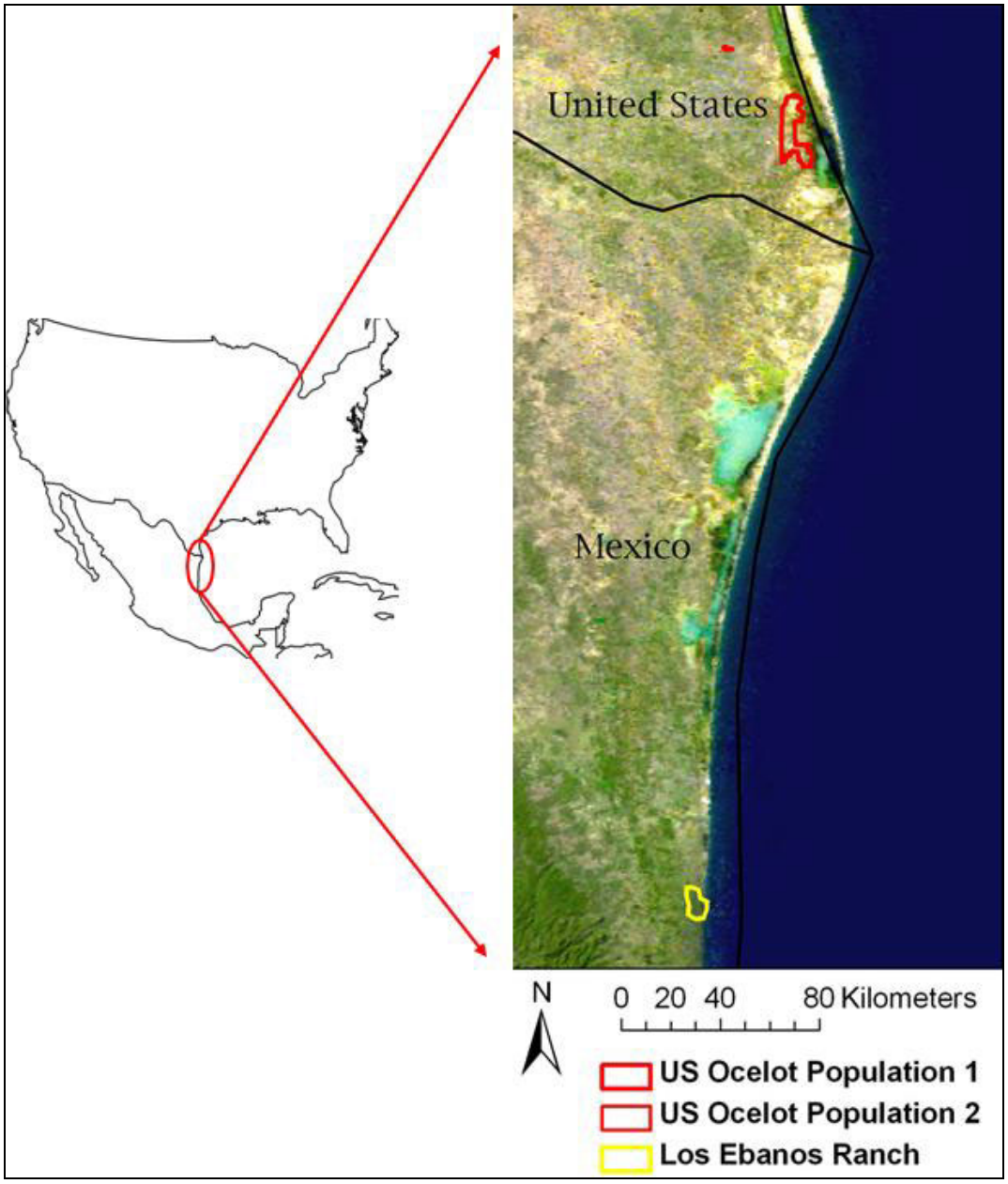

Figure 1. Locations of the 2 U.S. ocelot populations and the Los Ebanos Ranch in Tamualipas, Mexico.

METHODS

Study Area

The study area was located in Tamaulipas, Mexico, on a private cattle ranch used also as a biological research area (Los Ebanos Ranch) (Figure 1). The study area resides on flat topography of 0 to 30 m elevation (Detenal 1987) and consists of native vegetation classified as low tropical forest (Veracrucian), and ebony-grassland communities (Leopold 1959, González-Medranco 1972).

Ocelot Cover Map

The ocelot has been defined as a habitat specialist with spatial patterns strongly linked to ≥95% canopy cover (Navarro-Lopez, 1985; Tewes, 1986; Laack, 1991; Caso 1994, Horne, 1998; Harveson et al., 2004). However, Harveson et al. (2004) found that ocelots did not avoid areas with 75-95% canopy cover, but stated that ocelots avoided areas with <75% canopy cover. Furthermore, Tewes and Everett (1986) stated that 75-95% canopy cover was suboptimal whereas canopies with <75% cover were inadequate for ocelots. Thus, we developed a current ocelot cover map focusing on Los Ebanos Ranch to identify habitat with >75% canopy cover. This analysis was conducted by delineating spatial data based on an April 2000 LANDSAT ETM 7 satellite image of Tamaulipas, Mexico obtained from the Wildlife Technologies Laboratory at Texas A&M University-Kingsville (Figure 2). LANDSAT imagery was used to identify, digitize, and create shapefiles for areas with >75% woody cover and areas with <75% woody cover in the ArcGIS 9.0 software program (ESRI®, Inc. Redlands, Calif.).

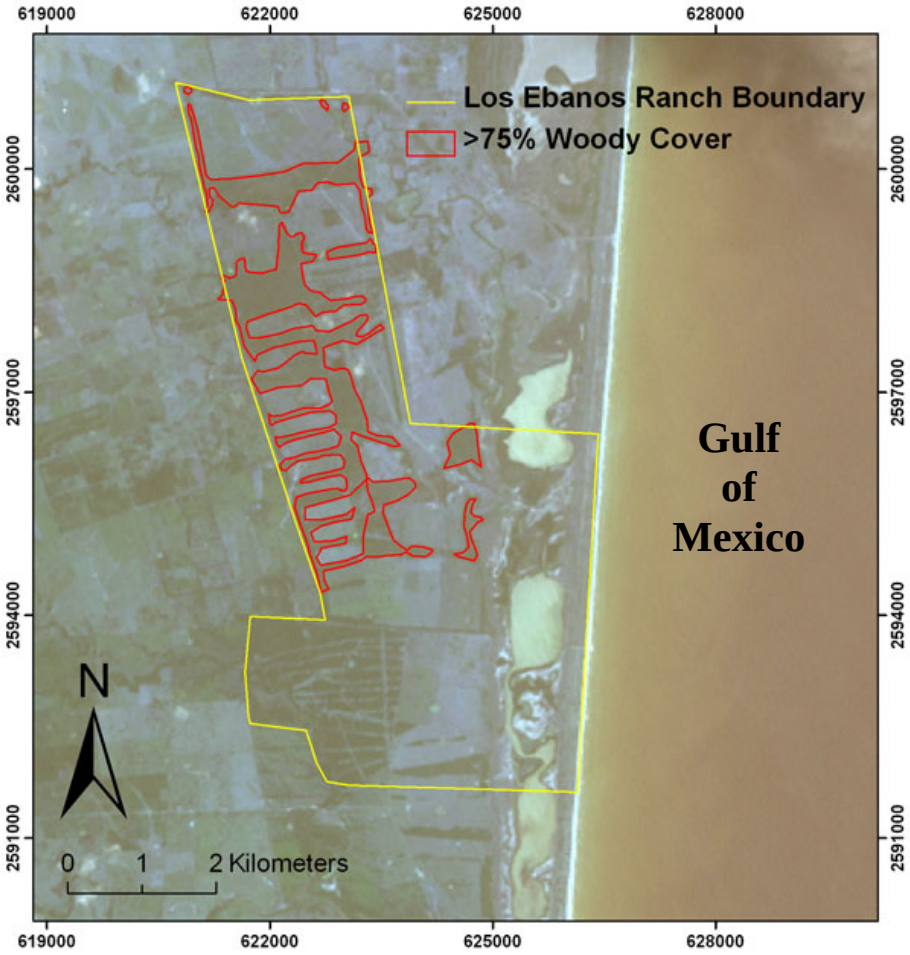

Figure 2. April 2000 LANDSAT image of the Los Ebanos Ranch in Tamualipas, Mexico with areas of >75% woody cover used as training sites for supervised classification.

Shapefiles of cover layers served as training sites to develop spectra-reflective signatures that were used in a supervised classification using the ERDAS IMAGINE 8.7 software program (ERDAS®, Inc. Atlanta, Georgia). We used the supervised classification to identify areas of >75% woody cover where field verification (i.e., accuracy assessment) could be achieved on the Los Ebanos Ranch. Based on this analysis we identified areas of potential ocelot habitat.

Accuracy Assessment

An accuracy assessment of the supervised classification was conducted using the accuracy assessment tool in the ERDAS IMAGINE 8.7 program. The accuracy assessment tool created random points (reference points) within areas of >75% woody cover classification. We used >50 reference points as suggested by Congalton (1991). By downloading these random points into a GARMIN global positioning system unit (GARMIN® International Inc., Olathe, Kansas), we conducted a ground survey in the Los Ebanos Ranch to find and ground truth reference points. The minimum level of accuracy acceptable for land use and land cover classification is 85% (Anderson et al., 1976).

RESULTS

We were able verify 146 reference points on the Los Ebanos Ranch to conduct the accuracy assessment (Figure 3). The cover map identified areas of closed cover (>75% woody cover) with 86% accuracy (Figure 3). Because the results of the accuracy assessments were >85% for the cover map, the habitat map was acceptable to identify potential ocelot habitat (Anderson et al., 1976).

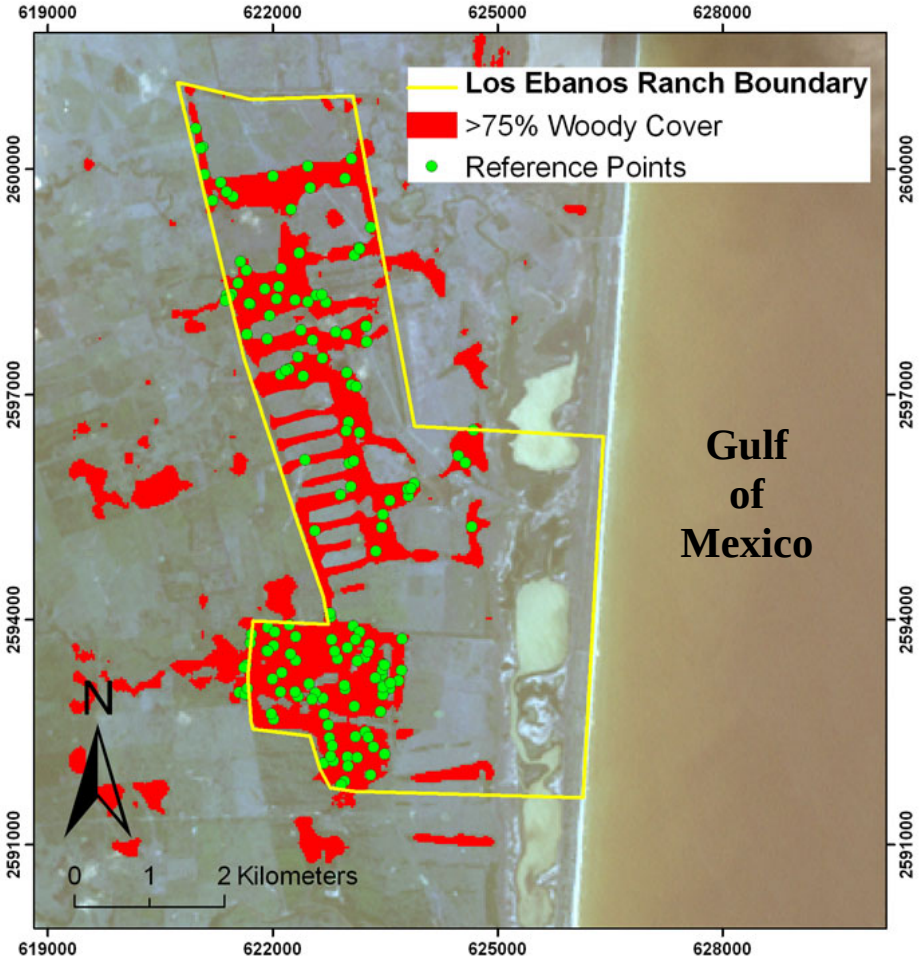

Figure 3. Cover map of the Los Ebanos Ranch in Tamualipas, Mexico identifying areas with >75% woody cover.

DISCUSSION

Tewes et al. (1999) listed several advantages of using remote sensing to identify potential ocelot habitat based on SPOT satellite imagery: (1) large tracts of land can be analyzed, (2) the process is non-destructive to the physical area, (3) verified ground-truthed data of a small area can be applied to provide a supervised signature for larger areas, (4) computers can be queried on the numbers of core areas composed of a specific vegetative cover, and (5) areas of interest can be quickly analyzed using known signature sets. The results of this research show that these benefits also apply when using LANDSAT ETM 7 satellite imagery with supervised signatures for ocelot cover. Within Texas, there are two benefits to using LANDSAT imagery over SPOT imagery. First, the area covered by LANDSAT imagery (34,000 km^2) is significantly larger than the area covered by SPOT imagery (3,600 km^2). Second, within Texas, multiple LANDSAT images covering the state can be obtained at no cost within the Texas Synergy website (www.synergyx.tacc.utexas.edu). Thus, LANDSAT imagery may be more preferred than SPOT imagery in Texas.

The same methods used in this study could easily be applied to studies that delineate cover types for other species, thus giving biologists the ability to conduct habitat selection analysis, identify important conservation areas, and develop recovery strategies to link habitat patches. In addition, Haines et al. (*In Press*) recommended the development of a more accurate and current habitat map of southern Texas that could be used to provide a better determination of available ocelot habitat. Demographic data provided by Haines et al. (*In Press*) could be linked to habitat data created for southern Texas using the same methods presented in this manuscript. The results would be a habitat-based population viability analysis (PVA) of ocelots that could be used to evaluate the effectiveness of ocelot recovery strategies within the U.S. based on spatially-realistic landscape data.

The methods described in this manuscript allow researchers to identify areas likely to contain ocelot habitat. However, areas that have been identified as potential ocelot habitat still need to be surveyed to confirm ocelot presence. Even if ocelots do not reside within identified habitat patches, these areas may still be used as sites for potential ocelot relocation, translocation, or corridor connection with other habitat patches that contain ocelots.

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