U.S. Fish & Wildlife Service

South Texas Refuge Complex
Laguna Atascosa National Wildlife Refuge

Ocelot Survey in and around Laguna Atascosa National Wildlife Refuge

Mitch A. Sternberg[1] and Jody L. Mays[2]

ABSTRACT – From November 18, 2009 to February 15, 2010 we used paired camera traps to photograph ocelots in Laguna Atascosa National Wildlife Refuge and the surrounding area. Eleven adult ocelots (8 male, 3 female) and two kittens (estimated age <1 year) were photographed. One adult female and one adult male, previously unknown to this population, were documented, as well as an adult male that had not been documented since 2005. Program CAPTURE estimated 11±0.32 adult ocelots. The area sampled by the camera traps, including a buffer zone, was 125.7 km^2. Ocelot density was estimated to be 0.09 ocelots/km^2. Based on previous data on the abundance and distribution of ocelots and the results of the current study, we suggest there are vacant territories with suitable habitat on LANWR, providing further support for proposed efforts to translocate ocelots into LANWR. As part of a long-term ocelot recovery effort, the U.S. Fish and Wildlife Service continues to increase available habitat through acquisition and restoration while acting to minimize threats such as vehicle-caused mortalities.

Suggested Citation: *Sternberg, M.A. and J.L. Mays. 2011. Ocelot Survey in and around Laguna Atascosa National Wildlife Refuge. U.S. Fish and Wildlife Service, South Texas Refuge Complex, Alamo, Texas.*

The ocelot (*Leopardus pardalis*) ranges from northern Argentina to the southwestern USA and is listed as a species of Least Concern by the World Conservation Union (International Union of Concerned Scientists 2008). In the USA, ocelots occur in southern Texas and Arizona, and are listed as a federally-endangered species (U.S. Fish & Wildlife Service [USFWS] 1982). Primary factors in the USA contributing to their endangered status include habitat loss, habitat fragmentation, population isolation, loss of genetic diversity among Texas ocelots (Walker 1997, Janečka *et al.* 2008), and collisions with vehicles (Haines *et al.* 2005a).

Dense woodlands form the primary habitat for South Texas ocelots (Navarro-Lopez 1985, Tewes 1986, Laack 1991, Shindle & Tewes 1998), yet over 90% of dense woodlands in the area have been destroyed or significantly altered since the 1900's (Jahrsdoerfer & Leslie 1988, Tremblay *et al.* 2005). Habitat loss and fragmentation continues today due to urban expansion, conversion of large ranches to other uses,

[1]South Texas Refuge Complex, Mitch_Sternberg@fws.gov
[2] Laguna Atascosa National Wildlife Refuge, Jody_Mays@fws.gov

installation of new roads, expansion of existing roadway infrastructure, oil and gas exploration and production, wind energy production, and international bridges. The border region of southern Texas is one of the fastest growing areas in the USA (Strayhorn 2002). Ocelots moving between the fragmented habitats that remain are at risk of mortality as they cross roads and are limited by other barriers.

Collisions with vehicles are the leading documented mortality factor for ocelots in Texas (Haines *et al.* 2005a). Isolation of Texas ocelot populations resulting from habitat loss, habitat fragmentation, and road mortality is further exacerbated by infrastructure intended to curtail illegal border activities and to protect developments from the flooding of the Rio Grande.

Only 2 small ocelot populations are known to remain in Texas, including one on private lands in Willacy County and one in and around Laguna Atascosa National Wildlife Refuge (henceforth referred to as LANWR) in Cameron County. Results of a population viability analysis (Haines *et al.* 2005b) indicated that both Texas ocelot populations are at a high risk of becoming extinct within 50 years without significant human intervention. Translocation of ocelots into these populations from larger populations in Mexico or other suitable areas, in combination with reduction of roadway mortality, was recommended as an effective measure to reduce the immediate risk of extinction. In order to successfully accomplish such an action, information on the current size and status of these populations is needed.

The Cameron County ocelot population has been monitored regularly since 1982 (Haines *et al.* 2005a, USFWS unpubl. data). Using information on home range size and suitable habitat, the population was estimated in 1991 to include about 30 ocelots (Laack 1991). But more recent long-term monitoring has indicated a decrease in the population. By 2009, only 8 individuals were documented (USFWS unpubl. data) and the population was thought to include as few as 10 ocelots. As a result, a thorough, systematic survey to search for additional individuals and provide a scientific estimate of the size of the Cameron County ocelot population became a priority.

The focus of the current study was on the Cameron County ocelot population centered on LANWR. The study had three objectives: (1) search for previously-undocumented ocelots, (2) provide an accurate and current estimate of the size of the population, and (3) provide additional data to support the proposed translocation of ocelots into the population from Mexico or other suitable areas if approved.

Project Site

The study was conducted on and around LANWR in Cameron County, Texas (Fig. 1). Most areas of significant size in Cameron County with habitat conditions to support ocelots were included in this survey. Access to private land was granted by many conservation-minded private landowners and agencies. Two areas where ocelots occur or were documented within the past 10 years were not included in this study due to lack of access. Radio-telemetry data and digital photographs of ocelots in Cameron County from

1982 to 2009 were used in the selection of the survey sites to maximize the likelihood of documenting the majority of ocelots in Cameron County.

Methods

Capture-recapture sampling, as in this survey, is used to estimate the abundance of animals based upon a series of periods where animals are captured, marked in some way, released, and then recaptured after some time. Animals have been estimated using capture-recapture methods since the 1930's (White *et al.* 1982). Capture-recapture methods have been used extensively with remote camera-trapping to study felids since the 1990's (Karanth 1995, Karanth & Nichols 1998, Heilbrun *et al.* 2003, Kelly 2003, Trolle & Kéry 2003, Maffei *et al.* 2004, Silver *et al.* 2004, Maffei *et al.* 2005, Trolle & Kéry 2005, Weaver *et al.* 2005, Cuellar *et al.* 2006, Haines *et al.* 2006, Dillon & Kelly 2007, Dillon & Kelly 2008, Kelly *et al.* 2008). Ocelots can be identified to an individual based on a unique set of markings on the fur by comparing between photographs (Karanth 1995, Trolle & Kéry 2003). In this way, photographs of ocelots can be recognized as a capture or a recapture observation among different trapping periods, providing valuable information for estimating population size.

Paired camera traps were used to sample 49 sites (40 on LANWR, six on private land, two on the Arroyo Colorado Wildlife Management Unit of Texas Parks & Wildlife Department, and one on the Immigration and Customs Enforcement facility) from November 18, 2009 to February 15, 2010. Camera trap locations were chosen based on a 1km x 1km grid design (the equivalent area for the average home range of ocelots on LANWR [Laack 1991]). At each grid intersection, camera traps were placed in the nearest patch of suitable brush habitat. Thirty-seven sites were maintained with scent lure using techniques tested at several zoos and field sites including LANWR in 1999 (Weaver *et al.* 2005). The scent attracts ocelots as well as other felids long enough to ensure additional photographs, making identification more likely than from a trail-set camera. Twelve camera sites were at rain catchments.

Two remote camera systems were used: Cuddeback (models Excite™ and Expert™) and Reconyx RapidFire™ (model PC90). All cameras were set approximately 30cm above ground and were programmed to take photographs continuously. Delay times between photographs were minimized on all camera models (one minute for Cuddeback and one second for Reconyx). Cameras were set to high motion and heat sensitivity levels.

Whenever possible, at least one Reconyx camera was used at each camera site to increase the likelihood of capturing additional photographs since the Cuddeback cameras have a 1-minute long photograph interval. Cameras were set on either side of the expected approach to the scent lure or rain catchment in order to capture both profiles. Each camera site was visited for maintenance and regular downloads of photographs every 1-2 weeks and scent was reapplied if the mixture was not evident on the scent pad. Scent and visual attractants were removed from each site immediately at the end of the sampling session.

Individual ocelots were identified using unique, laterally asymmetric coat markings (Karanth 1995, Trolle and Kéry 2003). Photo-capture histories of individual ocelots were divided into 28-day periods. In an attempt to meet the assumption of a closed population estimate (Otis *et al.* 1978), all sites were sampled within 90 days of initiation of sampling at the first camera site. Ocelot photographs identified to an individual were placed in named folders to assist in identifications of photographed ocelots through time and among populations in Texas.

The ocelot population was estimated using CAPTURE (Otis *et al.* 1978, White *et al.* 1982, Rexstad & Burnham 1991). The density estimate was calculated by dividing the effective sampling area (calculated using ArcGIS) by the abundance estimate from CAPTURE (Silver *et al.* 2004). The effective sampling area was a buffer of 1km in diameter around each camera site.

Results

Sampling effort totaled 1410 camera trap nights. Eleven adult ocelots (eight males, three females) visited 14 camera sites 53 times. Of these adults, six males and two females were previously documented within the past three years during LANWR's ongoing long-term monitoring program. One adult male had not been documented since 2005. One adult female and one adult male had never been documented. One adult female was photographed with two kittens in February 2010 while her male offspring from a previous litter was roaming independently but using part of her home range.

Population closure was satisfied ($z = -1.58$, $P = 0.56$). The adult ocelot population was estimated by CAPTURE to consist of 11±0.32 (95% confidence interval of 11-11) (White *et al.* 1982). Capture probability was 0.55 per capture occasion; therefore we were confident in our ocelot population estimate (see Otis *et al.* 1978). The total effective area sampled was 125.7 km^2 (12,572 ha) and density based on results from CAPTURE was 0.09 ocelots/km^2 (equivalent to 1 ocelot/11.4 km^2). The Chao M_{th} model had the highest model selection value (second to the null model, M_0) which is consistent with unequal home range sizes of the sexes, and variability in home range overlap between the sexes and between adult and young adult ocelots of this population (Rexstad and Burnham 1991).

Discussion

Ocelots were only documented in the southern portions of LANWR. However, several ocelots were suspected of moving back and forth between one private property and these areas of LANWR. One male documented at camera sites on LANWR was tracked, using radio-telemetry techniques, making exploratory movements along the southern border of LANWR and into the wooded area at the Immigration and Customs Enforcement facility and beyond using the extensive network of ditches and resacas.

We recognize that the use of an attractant, such as scent or freshwater for drinking, may create a reward mechanism causing ocelots to visit, linger at, or return to these sites while the attractant is present. However, for a camera survey to be effective, an attractant that will successfully draw nearby ocelots into camera range is helpful. Previous camera studies conducted by USFWS in the Lower Rio Grande Valley have demonstrated that felids use the same trails repeatedly and may not visit trails nearby for extended periods unless an attractant is used (USFWS unpubl. data).

The current study and resulting population estimate builds on a long-term monitoring and research program conducted on and around LANWR by the USFWS and other researchers since 1982 (Haines *et al.* 2005a, USFWS unpubl. data). Between April 2007 and October 2009, monitoring efforts included 7916 camera-nights and 2333 live-trapping nights whereby eight ocelots (six males, two females) were documented. One of two identified females, known to be at least 13 years old, was found to have a large growth in her uterus and was determined to be non-reproductive. Biologists had concerns that if the only known reproductive female in the population died, the males might scatter in search of mates and the population could be lost. Therefore, a focused effort to survey for additional ocelots, particularly females, became a management priority and an objective of the current study. Fortunately, three additional adult ocelots were documented as well as 2 kittens as a result of the current study.

Previous estimates of the ocelot population on and around LANWR were indirect measures based on home range size of known individuals, the amount of suitable habitat, and indications or assumptions that the population was at carrying capacity (Laack 1991, Haines *et al.* 2005b). The current study was designed to provide a more direct, accurate, and scientific survey than had ever been conducted for this population. Such periodic population surveys can provide important information to managers about changes in abundance, distribution, or other parameters, and can allow for better evaluation of ocelot response to management and recovery actions, such as habitat restoration, installation of wildlife road crossings, and translocation efforts.

Haines *et al.* (2005b) recommended reduction of roadway mortality and translocation of ocelots from larger populations as the two most effective measures to reduce the immediate risk of extinction of ocelot populations in Texas. To reduce roadway mortality, the USFWS is working with the Texas Department of Transportation and other partners to identify high-risk areas and install wildlife road crossings. To initiate efforts to translocate ocelots into Texas populations, the Ocelot Recovery Team formed a Translocation Subcommittee in 2008 that created a plan outlining the justification, methods, and benefits for the translocation of ocelots from larger populations in Tamaulipas, Mexico to populations in Texas. Initial translocation efforts will be focused on the ocelot population on LANWR. The current study was conducted to provide additional information in support of proposed translocation of ocelots into the Cameron County population.

Previous long-term monitoring efforts have documented more than 15 ocelots on or near LANWR at one time (USFWS unpubl. data). Haines *et al.* (2005b) suggested the carrying capacity for the area in and around LANWR was 19 breeding adult ocelots. Based on their information and the results of the current study, we suggest that there may be vacant territories with suitable habitat on LANWR, providing further support for proposed efforts to translocate ocelots into LANWR.

Without translocation of ocelots from a genetically more diverse population, heterogeneity is likely to continue to decrease (Janečka *et al.* 2008). Decreased heterogeneity in a small, isolated population can result in increased susceptibility to disease and decreased fertility (Roelke *et al.* 1993, Lacy 1997). If such problems arise in the Cameron County ocelot population, they could ultimately lead to the loss of the population and the possible extinction of the ocelot in Texas.

Acknowledgements

We thank the landowners who share the landscape with ocelots and allowed us to survey their properties, and the many other partners who work with the USFWS to advance recovery of the ocelot in the USA and northern Mexico. Thanks to Sam Patton for information on ocelot observations and for access to the Arroyo Colorado Wildlife Management Area of the Texas Parks & Wildlife Department. We also thank Sarah Mendez, Bob Severson, Mary Ann Severson, Nova Mackentley, Chris Neri, Bruce Radabaugh, Veronica Grigalchik, Scott McKnight, and other USFWS staff, interns, and volunteers. Historic radio telemetry data was collected by Linda Laack, Bruce Radabaugh, Jody Mays, Caesar Kleberg Wildlife Research Institute, and numerous LANWR staff, interns, and volunteers. Comments from John Young and Grant Harris improved our manuscript.

References

Cuellar E.,Maffei L., Arispe R. & Noss A. 2006. Geoffroy's cats at the northern limit of their range: activity patterns and density estimates from camera trapping in Bolivian dry forests. Studies on Neotropical Fauna and Environment 41, 169–177.

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

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

Haines A.M., Tewes M.E. & Laack L.L. 2005a. Survival and Sources of Mortality in Ocelots. Journal of Wildlife Management 69, 255-263.

Haines A.M., Tewes M.E., Laack L.L., Grant W.E. & Young J.H. 2005b. Evaluating recovery strategies for an ocelot population in the United States. Biological Conservation 126, 512-522.

Haines A.M., Janečka J.E., Tewes M.E., Grassman L.I., Jr., & Morton P. 2006. The importance of private lands for ocelot *Leopardus pardalis* conservation in the United States. Oryx 40, 90-94.

Heilbrun R.D., Silvy N.J., Tewes M.E., & Peterson M.J. 2003. Using automatically triggered cameras to individually identify bobcats. Wildlife Society Bulletin 31:748-755.

International Union of Concerned Scientists. 2008. The IUCN Red List of Threatened Species: *Leopardus pardalis*. IUCN Red List Unit, Cambridge United Kingdom. http://www.iucnredlist.org/apps/redlist/details/11509/rangemap. Viewed 17 March 2011.

Jahrsdoerfer S.E. & Leslie D.M. 1988. Tamaulipan brushland of the Rio Grande Valley of south Texas: description, human impacts, and management options. U.S. Fish and Wildlife Service, Biological Report 88.

Janečka J.E., Tewes M.E., Laack L.L., Grassman L.I., Jr., Haines A.M., & Honeycutt R.L. 2008. Small effective population sizes of two remnant ocelot populations (*Leopardus pardalis albescens*) in the United States. Conservation Genetics 9:869-878.

Karanth K.U. 1995. Estimating tiger (*Panthera tigris*) populations from camera-trap data using capture-recapture models. Biological Conservation 71:333–338.

Karanth K.U. & Nichols J.D. 1998. Estimation of tiger densities in India using photographic captures and recaptures. Ecology 79:2852–2862.

Kelly M.J. 2003. Jaguar monitoring in the Chiquibul Forest, Belize. Caribbean Geography 13:19–32.

Kelly M.J, Noss A.J., DiBitetti M.S., Maffei L., Arispe R., Paviolo A., De Angelo C.D., & DiBlanco Y.E. 2008. Estimating puma densities from camera trapping across three study sites: Bolivia, Argentina, Belize. Journal of Mammalogy 89:408–415.

Laack L.L. 1991. Ecology of the ocelot (*Felis pardalis*) in south Texas. M.S. thesis, Texas A&I University, Kingsville, Texas.

Lacy R.C. 1997. Importance of Genetic Variation to the Viability of Mammalian PopulationsImportance of Genetic Variation to the Viability of Mammalian Populations. Journal of Mamalogy 78:320-335.

Maffei L., Cuellar E., & Noss A.J. 2004. One thousand jaguars (*Panthera onca*) in Boliva's Chaco? Camera trapping in the Kaa-Iya National Park. Journal of Zoology 262: 295–304.

Maffei L., Noss A.J., Cuellar E., & Rumiz D.I. 2005. Ocelot (*Felis pardalis*) population densities, activity, and ranging behaviour in the dry forests of eastern Bolivia: data from camera trapping. Journal of Tropical Ecology 21:1–6.

Navarro-Lopez D. 1985. Status and distribution of the ocelot in South Texas. Unpublished M.S. thesis, Texas A&I University, Kingsville, Texas.

Otis D.L., Burnham K.P., White G.C. & Anderson D.R. 1978. Statistical inference from capture data on closed populations. Wildlife Monographs, 62, 1–135.

Rexstad E. & Burnham K.P. 1992. User's Guide for Interactive Program CAPTURE. Colorado State University, Fort Collins, Colorado.

Roelke M.E., Martenson J.S. & O'Brien S.J. 1993. The consequences of demographic reduction and genetic depletion in the endangered Florida panther. Current Biology 3:340-350.

Shindle D.B., & Tewes M.E. 1998. Woody species composition of habitats used by ocelots (*Leopardus pardalis*) in the Tamaulipan Biotic Province. The Southwestern Naturalist 43:273-279.

Silver S.C., Ostro L.E.T., Marsh L.K., Maffei L., Noss A.J., Kelly M.J., Wallace R.B., Gomez H., & Ayala G. 2004. The use of camera traps for estimating jaguar Panthera onca abundance and density using capture-recapture analysis. Oryx 38:148–154.

Strayhorn C.K. 2002. Window on state government: The south Texas border region. http://www.window.state.tx.us/ecodata/regional/stxborder/outlook.html. Viewed 2/16/2011.

Tewes M.E. 1986. Ecological and behavioral correlates of ocelot spatial patterns. Unpublished Ph.D. dissertation, University of Idaho, Moscow, Idaho.

Tremblay T.A., White W.A., & Raney J.A. 2005. Native woodland loss during the mid 1900s in Cameron County, Texas. Southwestern Naturalist 50:479-519.

Trolle M. & Kéry M. 2003. Estimation of ocelot density in the Pantanal using capture-recapture analysis of camera-trapping data. Journal of Mammology 84:607-614.

Trolle M. & Kéry M. 2005. Camera-trap study of ocelots and other secretive mammals in the northern Pantanal. Mammalia 69:3–4.

United States Fish & Wildlife Service. 1982. Endangered and threatened wildlife and plants; endangered status for U.S. population of the ocelot. Federal Register 47, 31670-31672.

Walker C.W. 1997. Patterns of genetic variation in ocelot (*Leopardus pardalis*) populations for south Texas and northern Mexico. Ph.D. Thesis, Texas A&M University and Texas A&M University-Kingsville, College Station and Kingsville, Texas.

Weaver J.L., Wood P., Paetkau D. & Laack L.L. 2005. Use of scented hair snares to detect ocelots. Wildlife Society Bulletin 33:1384-1319

White G.C., Anderson D.R., Burnham K.P. & Otis D.L. 1982. Capture-recapture and Removal Methods for Sampling Closed Populations. Los Alamos National Laboratory, Los Alamos, New Mexico.

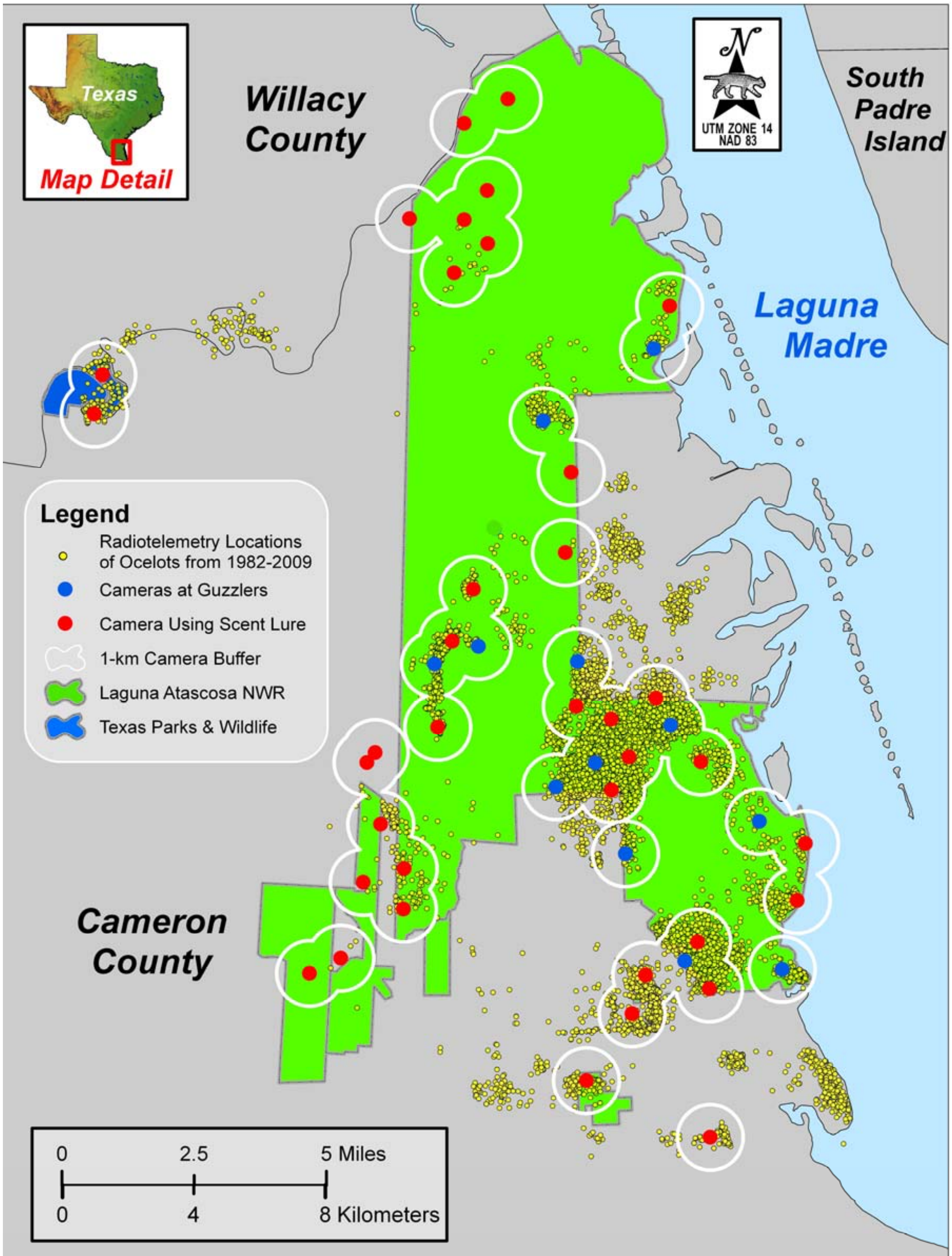

Fig. 1. Study area for the ocelot population survey conducted on and around Laguna Atascosa National Wildlife Refuge, Cameron County, Texas, from November 18, 2009 to February 15, 2010.