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Migratory linkages of Burrowing Owls on DoD installations and adjacent lands: where do owls breeding on DoD installations in the southwestern U.S. spend the winter?

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April 2006

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Introduction

Burrowing Owls (*Athene cunicularia*) were once a common breeder in grasslands and deserts throughout the western U.S. and Canada. However, some populations have declined and Burrowing Owls have been extirpated from areas on the western, northern, and eastern periphery of their breeding range. Habitat loss and fragmentation due to agricultural or urban development and declines in populations of colonial burrowing mammals are thought to have contributed to these declines. The reduction of prairie in the United States is linked to decreasing Burrowing Owl populations, and fragmentation of nesting habitat may result in a decreased likelihood that unpaired owls will find mates (Sheffield 1997). However, the control of burrowing mammals such as prairie dogs and ground squirrels is thought to be the primary cause for the decline in Burrowing Owls (Desmond et al. 2000, Klute et al. 2003).

In response to these declines, Burrowing Owls are now federally endangered in Canada, and are listed by the USFWS as a Species of National Conservation Concern in the U.S. Burrowing Owls are also state endangered in Minnesota and Iowa, and are being considered or have been petitioned for state listing in California and Washington. Populations are thought to have declined in other states as well: Arizona, Colorado, Kansas, Nebraska, Nevada, New Mexico, and Utah (Klute et al. 2003). Hence, Burrowing Owls are listed as a high priority species in state Partners-in-Flight conservation plans. For example, the Partners-In-Flight plan for Arizona ranks Burrowing Owls 19th in conservation priority out of 177 terrestrial bird species wintering in the state. Similarly, Burrowing Owls are listed as a high responsibility species in the New Mexico Partners-in-Flight plan.

Despite the declines in some portions of their range, burrowing owls appear to be increasing in other areas. One possible explanation for this paradox is that Burrowing Owls are becoming less migratory; owls which once migrated to northern breeding locations during the summer are becoming year-round residents in the southwestern U.S. and northern Mexico. In other words, breeding owl populations might be redistributing rather than declining. If this hypothesis is correct, it has implications for the validity of current or future Burrowing Owl listing petitions and implications for the effectiveness of different conservation and management efforts. Recent field studies on Davis-Monthan Air Force Base (DMAFB) in southern Arizona suggest that many owls are year-round residents, and population densities on DMAFB are much higher compared to the surrounding landscape. Burrowing Owls have also been reported on many of the other DoD installations in the southwestern U.S. If Burrowing Owls are redistributing their numbers to the southwestern U.S. and northwestern Mexico, there exists the potential that this limited distribution will cause Burrowing Owl populations to be vulnerable to environmental stochasticity, disease, and other factors that threaten fragmented populations.

We will use stable isotopes of owl feathers, genetics from blood samples, and radio telemetry to quantify the importance of DoD lands to Burrowing Owl populations in the region, identify where owls breeding on DoD installations spend the winter, and quantify land-use of migrating and wintering owls in the region. We are working with DoD installations in the

southwestern U.S. that have records of Burrowing Owls to test this hypothesis and develop a coordinated, multi-agency program to help determine the extent to which Burrowing Owl populations are redistributing throughout North America.

Project Objectives:

- Locate Burrowing Owl nests on Department of Defense installations in the southwestern U.S.
- Determine the migratory linkages and connectivity of Burrowing Owl populations on DoD installations and adjacent lands in the southwestern U.S.
- Determine where Burrowing Owls nesting on DoD installations and adjacent lands spend the winter.
- Estimate the extent to which individual owls move among populations, both among DoD installations and between DoD installations and lands managed by other entities.
- Leverage Legacy funds to bring together a wide assortment of national and international partners to identify migratory linkages and prevent further population declines and listing efforts.

This work will provide a landscape level view of movements among Burrowing Owl populations which will allow conservation managers to direct their efforts appropriately. For example, reintroductions of Burrowing Owls into northern areas from which they have become extirpated will not succeed if those owls and their offspring fail to return after migration. Also, because Burrowing Owls tolerate human disturbance, their presence often overlaps with human activities such as construction, irrigation, and aircraft activity. Hence, Burrowing Owls are sometimes re-located or removed to wildlife centers. However, if some populations are isolated and likely to be distinct, re-location would be inappropriate. Moreover, periodic translocations may be detrimental to populations that rely primarily on local recruitment to maintain local population size. Conversely, if there is a high degree of connectivity among populations, removing or translocating owls will have less adverse effects on local and regional populations. Additionally, this study will provide insight into how the rapid land-use changes occurring in arid areas of the southwestern U.S. and northern Mexico are likely to influence distribution of species. This information is vital to supporting the military mission because it will help identify the management role of DoD for conserving Burrowing Owls nesting in the region, potentially help prevent further listing efforts for a species that is common on DoD installations, and provide information on risk and frequency of bird strike hazards by documenting foraging and migratory habits of a breeding bird common on DoD installations in the region. Additionally, several resource managers at DoD installations have expressed an interest in more active management of the Burrowing Owls that nest at their installation. Therefore, as we find Burrowing Owls on DoD lands, we will provide resource managers at each installation with the number and locations of nest burrows. We are also providing training to DoD personnel on Burrowing Owl field techniques.

This project includes 2 major components, the first of which is administered by USGS and the University of Arizona and focuses on collection of feather samples and blood samples from Burrowing Owls on Department of Defense lands in the southwestern U.S. for stable isotope and genetic analysis. The purpose of the stable isotope and genetic analyses is to determine the breeding and wintering location of each owl and the extent of population connectivity of Burrowing Owls on each DoD installation throughout the region. Dr. Courtney

Conway (USGS), and Vicki Garcia and Alberto Macias Duarte (University of Arizona) are coordinating this part of the project. The second component is administered by Kirtland Air Force Base and Envirological Services, Inc. in New Mexico, and focuses on identifying migratory corridors for Burrowing Owls leaving Kirtland AFB in the fall, determining areas in Mexico where Burrowing Owls winter, learning more about suitable winter habitat, finding and understanding the main threats to wintering Burrowing Owl populations, and determining areas lacking proper conditions for wintering owls. Dr. Carol Finley (Kirtland AFB) and Marianne Mershon (Envirological Services, Inc.) are coordinating this part of the project.

The two components are presented separately in this report. Section 1 (pages 4-14) focuses on the effort to collect feathers and blood from DoD installations throughout the southwestern U.S. for stable isotope and genetic analyses. Section 2 (pages 15-58) focuses on the effort to identify migratory corridors and wintering areas for Burrowing Owls in Mexico.

Section 1: Using stable isotope and genetic analyses to determine breeding and wintering locations and population connectivity in Burrowing Owls on DoD installations throughout the southwestern U.S.

Introduction

This portion of the project was initiated in the summer of 2005, and 2006 is the first breeding season in which we have made a large-scale effort to trap Burrowing Owls and collect feather samples at DoD installations throughout the region. This effort is currently underway, and we report our progress to date below.

Burrowing Owl Training Workshops

We have held 3 workshops in southern Arizona to train DoD personnel and DoD contractors on methods for how to safely capture, handle, band, and collect feathers from Burrowing Owls. The workshops were held 7-9 June 2005, 27-30 June 2005, and 13 April 2006. The workshops were attended by 11 participants from 4 DoD installations and 1 DoE installation (Fort Carson Army Base in CO, Kirtland Air Force Base in NM, Holloman Air Force Base in NM, White Sands Missile Range in NM, Nevada Test Site in NV). During the workshop, each participant received one-on-one instruction and ample hands-on practice on how to handle, band, and collect feathers from at least 4 owls (often more). Additionally, we trained participants to accurately record data from Burrowing Owl captures, to store feathers, and to construct Burrowing Owl traps. We provided workshop participants with Burrowing Owl traps and banding supplies to take back to their base. We also provided participants with a booklet containing standardized protocols for Burrowing Owl banding and data collection, datasheets for recording data from captured owls, and checklists of items to take in the field when trapping owls. At the end of the workshop, each participant was competent to trap owls independently. Additionally, we will be holding several on-site training workshops with interested DoD personnel at their own installations in 2006.

Banding Sub-permits

We helped some DoD personnel who participated in our training workshops to obtain their banding sub-permits from the USGS National Bird Banding Laboratory. We sponsored the applications of 5 DoD personnel from 3 installations who are now sub-permittees under the Master permit of C. Conway. These individuals will now be able to trap and band Burrowing Owls at their respective installations.

Participating DoD Installations and Other Cooperators

We have been in contact with colleagues from 31 different areas who have agreed to cooperate in the project, including personnel from 26 DoD installations (Table 1; Fig. 1). We have already trapped, banded, and sampled feathers from 15 of these installations (see below), and are planning on visiting the remaining locations this summer. We have obtained or applied for state and federal permits to trap owls and collect blood and feathers from owls for all of the states involved. We are also working with other cooperators outside of DoD who manage lands

adjacent to DoD installations (National Parks, National Wildlife Refuges, DoE lands, and other city, county, state, and federal agencies).

Burrowing Owl Trapping

We have trapped 1,031 Burrowing Owls and collected feathers from each owl following a standard protocol. Owls were individually marked using unique color bands to identify birds that have already been sampled. We obtained feather samples from the following 15 locations: Davis-Monthan Air Force Base in AZ, City of Tucson in AZ, Casa Grande Ruins National Monument in AZ, Marine Corps Air Station Yuma in AZ, Edwards Air Force Base in CA, Naval Base Coronado in CA, Seal Beach Naval Weapons Station in CA, Salton Sea National Wildlife Refuge in CA, scattered locations in southeastern CA, Kirtland Air Force Base in NM, Holloman Air Force Base in NM, White Sands Missile Range in NM, Fort Carson Army Base in CO, Rocky Mountain Arsenal in CO, and the Nevada Test Site in NV. We intend to collect additional feathers at many of these sites and to sample at additional DoD installations. We have hired and trained two experienced avian field technicians to travel to participating installations to trap and collect samples from Burrowing Owls during the 2006 breeding season. Below is a breakdown of owls trapped and from whom we collected feathers as of April 2006:

City of Tucson, AZ
74 samples: 56 juveniles, 18 adults (12 females, 6 males)

Casa Grande Ruins National Monument in AZ
326 samples: 244 juveniles, 82 adults (53 females, 29 males)

Davis-Monthan Air Force Base in AZ
242 samples: 199 juveniles, 43 adults (22 females, 21 males)

Marine Corps Air Station Yuma
7 samples: 0 juveniles, 7 adults (2 females, 5 males)

Edwards Air Force Base in CA
19 samples: 0 juveniles, 19 adults (8 females, 11 males)

Naval Base Coronado in CA
8 samples: 7 juveniles, 1 adult (female)

Seal Beach Naval Weapons Station in CA
5 samples: 2 juveniles, 3 adults (1 female, 2 males)

Salton Sea National Wildlife Refuge, CA
48 samples: 16 juveniles, 32 adults (30 females, 2 males)

Other locations in southeastern CA

38 samples: 21 juveniles, 17 adults (11 females, 6 males)

Kirtland Air Force Base in NM
78 samples: 62 juveniles, 16 adults (9 females, 7 males)

Holloman Air Force Base in NM
2 samples: 2 juveniles

White Sands Missile Range in NM
4 samples: 4 juveniles

Fort Carson Army Base in CO
2 samples: 2 juveniles

Rocky Mountain Arsenal in CO
156 samples: 115 juveniles, 41 adults (31 females, 10 males)

Nevada Test Site in NV
22 samples: 21 juveniles, 1 adult (female)

Preparation of feathers

All 1,031 feathers have been organized and stored in the Biological Sciences East Building at the University of Arizona.

Analysis of stable isotope ratios in sampled feathers

Stable isotope analysis of prepared feather samples will be conducted at the Stable Isotope Facility in the Department of Geosciences at the University of Arizona. We have met with the lab director and have discussed timing and logistics of feather analysis. Feather samples will be analyzed once we have collected ≥100 feather samples from each of 10 different locations.

Webpage

We have created a webpage (http://www.ag.arizona.edu/srnr/research/coop/azfwru/cjc/) to inform participants and other interested parties about the goals and status of the project. We are continually updating the webpage with reports, standardized protocols, datasheets, and a list of participating installations.

Literature Cited

Desmond, M. J., J. A. Savidge, and K. M. Eskridge. 2000. Correlations between burrowing owl and black-tailed prairie dog declines: A 7-year analysis. Journal of Wildlife Management **64**:1067-1075.

Klute, D. S., L. W. Ayers, M. T. Green, W. H. Howe, S. L. Jones, J. A. Shaffer, S. R. Sheffield, and T. S. Zimmerman. 2003. Status Assessment and Conservation Plan for the Western

Burrowing Owl in the United States. Biological Technical Publication FWS/BTP-R6001-2003, U.S. Department of Interior, Fish and Wildlife Service, Washington, D.C.

Sheffield, S. R. 1997. Current status, distribution, and conservation of the Burrowing Owl (*Speotyto cunicularia*) in Midwestern North America. Pages 399-407 *in* J. R. Duncan, D. H. Johnson, and T. H. Nicholls, editors. Biology and conservation of owls of the Northern Hemisphere, U.S.D.A. Forest Service, General Technical Report NC-190. North Central Forest Experiment Station, St. Paul, Minnesota.

Table 1. List of Participants in the DoD Legacy funded-project evaluating migratory linkages of Burrowing Owls in western North America.

State	Installation	Contact person	Status[1]
AZ	Barry M. Goldwater Air Force Range	Ron Pearce	2
AZ	Casa Grande National Monument	Mark Ogonowski	1
AZ	City of Tucson	Mark Ogonowski	1
AZ	Davis-Monthan AFB	Mark Ogonowski/Gwen Lisa	1
AZ	Yuma Marine Corps Air Station	Ron Pearce	1
AZ	Yuma Proving Ground	Randy English	2
CA	29 Palms	Rhys Evans	3
CA	Camp Pendleton	Jeff Kidd/Pete Bloom	2
CA	China Lake Naval Weapons Station	Jeff Kidd/Pete Bloom	2
CA	Edwards AFB	Mark Hagan, Robert Wood, Shannon Collis	1
CA	Fallbrook Naval Weapons Station	Jeff Kidd/Pete Bloom	2
CA	Fort Irwin	Brian Shomo	2
CA	March JARB	Chris Camacho	2
CA	Naval Air Facility El Centro	Jimmie Collins	2
CA	NAS Lemoore	John Crane	2
CA	Naval Air Station North Island	Tammy Conkle	1
CA	Naval Outlying Field, Imperial Beach	Tammy Conkle	2
CA	Salton Sea NWR	Chris Nadeau	1
CA	Seal Beach Naval Weapons Station	Bob Schallmann	1
CO	Buckley AFB	Floyd Hatch	2
CO	Fort Carson Army Base	Mead Klavetter	1
CO	Pinon Canyon Maneuver Site	Mead Klavetter	1
CO	Rocky Mountain Arsenal NWR	Noelle Ronan	1
CO	Schriever AFB	Melissa Trenchik	2
NM	Cannon AFB	Rick Crow	2
NM	Holloman AFB	Carol Finley	1
NM	Kirtland AFB	Carol Finley	1
NM	White Sands Missile Range	Trish Griffin	1
NM/TX	Fort Bliss Army Base	Brian Locke	2
NV	Nellis AFB	Bob Turner	2
NV	Nevada Test Site	Derek Hall	1

[1]status: 1=currently participating and collection of samples has begun, 2=have agreed to participate and will sample in 2006, 3=have owls but request for access was denied

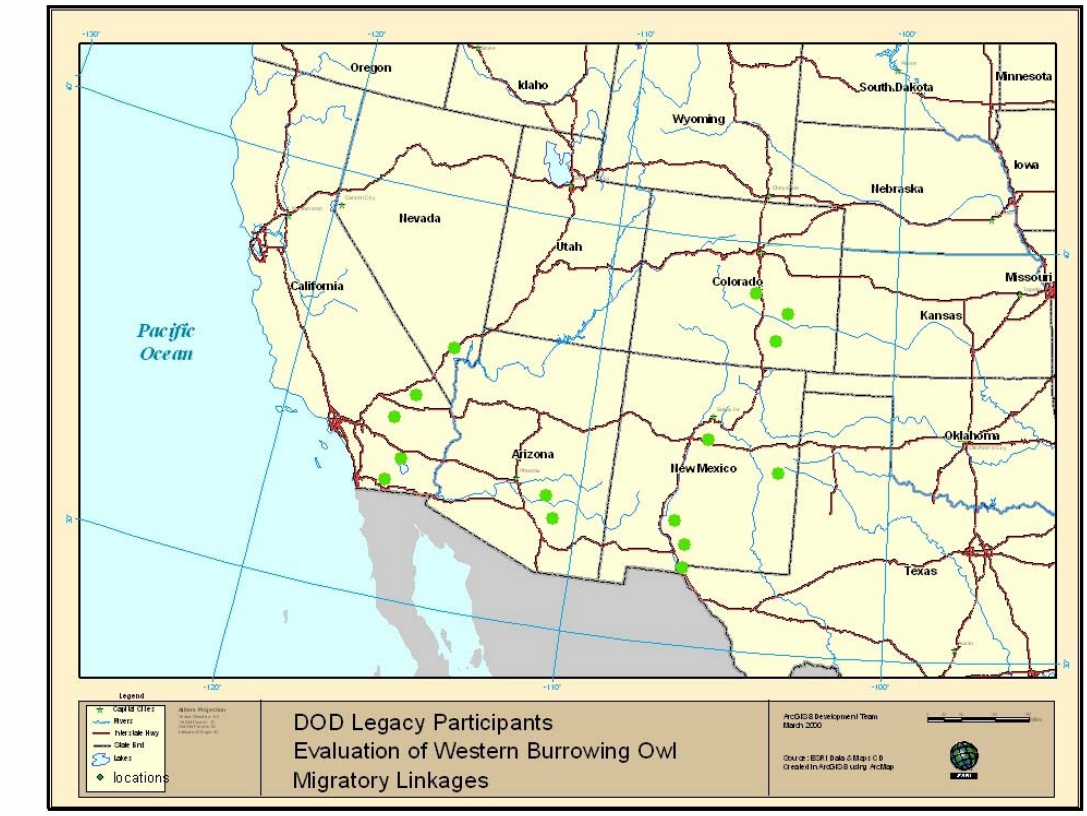


Figure 1. Location of sampling locations/participants in the DOD Legacy project on Burrowing Owl migratory linkages.

Appendix 1. Protocol for collecting feather samples from Burrowing Owls.

Feather collection protocol for burrowing owls

The purpose of collecting feathers is to determine the amount of exchange between populations. This will ultimately help test our hypothesis that burrowing owls that formerly migrated between Mexico and Canada/northern U.S. are altering their migratory habit and becoming year-round residents in low-elevation areas throughout the southwest.

We need feather samples from both adults and juvenile owls; feathers from juveniles will allow us to identify the local isotope "signature" from each location, and then we will be able to use the signatures from each area to determine where the feather from each adult was grown (and hence where it spent the previous breeding season). The more samples we get from each location, the better able we will be to determine the origin of each individual adult owl.

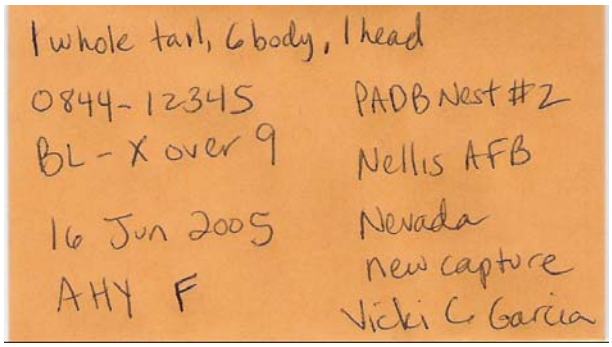
For juveniles: collect 3 body feathers from the breast and 3 body feathers from the back. Use one hand to stabilize (hold down) the skin around the feathers. Use the other hand to pinch 3 feathers at the base of the feather between your thumb and index finger and pull slowly and firmly until the feathers come out.

For adults: collect 3 body feathers from the breast and 3 body feathers from the back, 1 full tail feather (3rd from right), and ≥1 feather from the head. If you are holding the owl in your lap with the owl's belly facing up and the owl's feet pointing toward you, spread the tail and with one hand, and with the other hand place your thumb and index finger on either side of the third tail feather in from the furthest left (third rectrix on the bird's right side). Once you have the tail feather with one hand, use the other hand to stabilize (hold down) the skin around the feather. Then pull the feather at the base where it inserts into the skin. Pull slowly and firmly until the feather comes out of the skin. Then collect at 3 body feathers from the breast, 3 from the back, and at least one from the head. For each of these, pinch the base of the feather(s) and pull firmly and slowly while stabilizing the skin around the feathers with the other hand.

For recaptures of previously banded adult owls: If the owl was banded in a prior year, **collect the third tail feather on the right and body feathers from 3 different areas as described above.** These are important feathers because they allow us to verify the validity of the stable isotope results. If the owl was banded earlier the same year and a feather sample was already taken, look to see whether the owl has started to regrow the collected feather and record the growth status of the far-right tail feather (ie, "~65% regrown").

Put the feather(s) in a feather envelope (e.g., Columbian #3 Coin Envelopes, 2½" x 4¼", Mfr# CO545, Office Depot Item # 348-177) and label the outside of the envelope with the following information:

and type of each feather (adults: # partial tail, # whole tail, # body feathers, # head feathers; juvies: # of body feathers)
USFWS Band #:
ACRAFT Band #:
Date:
Age (HY, AHY, or "unknown age"):
Sex (M, F, M?, F?, or "unknown sex"):
Nest identification #:
Location/study site:
State:
Recapture or New Capture:
Collector's full name:



Feather Storage: Store bags with feathers in a refrigerator if possible. If a refrigerator is not available, store feathers in a cool, dry location until ready to send shipment. Contact Courtney Conway at the address below when ready to send collected feathers:

Dr. Courtney J. Conway
USGS Arizona Coop. Fish & Wildlife Research Unit
104 Biological Sciences East
University of Arizona
Tucson, AZ 85721
ph: 520-626-8535
FAX: 520-621-8801
Email: cconway@Ag.Arizona.Edu

Appendix 2. Reduced Burrowing Owl banding datasheet.

Burrowing Owl Banding Data Sheet

Codes: How Sexed: BP=Brood Patch; PL=Plumage (Females: darker, bars extend far down sides; Males: lighter, bars ending further up sides); Brood Patch?: 0=none; P=yes, but not vascularized; V=vascularized; W=Wrinkly/Scaly; R=Receding/new feather growth.

Note: When dealing with recaps please record all the columns that are in CAPS (Nest ID, Burrow caught at, Date, Obs, bands on both Right and Left Legs (USFWS and Acraft bands), Bird-bag Weight and Bag Weight (for Adults), Sex, How Sexed, and Juvie Age Range).

FOR ACRAFTS, WRITE OUT "OVER", "BAR" and "VBAR" – do not abbreviate or use slashes.

Site: _____ **Year**:_____

NEST ID	BURROW CAUGHT AT	UTMS OF BURROW CAUGHT AT	DATE	OBS	LEFT LEG	RIGHT LEG	RE-CAP?	BIRD&BAG WT (g)	BAG WT (g)	SEX (M, F, J)	HOW SEXED	Brood Patch?	Adult Left wing (mm)	Adult Right Wing (mm)	Adult Left Meta-tarsus (mm)	Adult Right Meta-tarsus (mm)	JUVIE AGE RANGE	# WHOLE TAIL FEATHERS	# PARTIAL TAIL FEATHERS	# BODY FEATHERS	# HEAD FEATHERS	Wing Pics?	Blood Taken?	Comments

Section 2: Collaborative Efforts to Determine Wintering Grounds and Habitat Quality for Burrowing Owls (*Athene cunicularia)* in México

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ABSTRACT

Most specialists agree that winter habitat could be a cause for the decline of the Burrowing Owl (*Athene cunicularia*). This was the first year of a five-year project aimed at examining this hypothesis, funded by Kirtland Air Force Base and by Legacy funding from the Department of Defense. The main objectives of the project were to determine areas in México where Burrowing Owls winter, learn more about suitable winter habitat, find and understand the main threats to wintering Burrowing Owl populations, and also to determine areas lacking proper conditions for wintering owls. Envirological Services, Inc. coordinated a network of Mexican biologists to collaborate on this initiative.

Envirological Services conducted three exploratory trips to México during the late fall and winter of 2005 to identify Burrowing Owl territories and habitat quality, and to meet with Mexican collaborators. We visited 21 states of northeast, northwest, west coast, and central México, covering more than 12,000 kilometers (7,500 miles) of potential habitat, and located 105 wintering Burrowing Owls.

Throughout México, surveys by Mexican biologists were conducted using standardized protocol during the winter of 2005/2006. Surveys were carried out in 13 states of México; Nuevo León, Coahuila, Chihuahua, Sinaloa, Durango, Zacatecas, San Luis Potosí, Aguascalientes, Jalisco, Estado de México, Puebla, Veracruz, and Oaxaca. While conducting transects, data was recorded on type of vegetation, percentage of coverage, density of burrows, and presence/absence of owls. UTM's were taken during transects as well as for every owl located. As a result, 31,514.31 hectares (77,873.55 acres) were surveyed. Collaborators in México located 230 Burrowing Owls on winter territories.

Threats to owls in México include habitat loss due to advancement of agriculture and housing settlements; pesticide use in agricultural fields contaminating Burrowing Owls prey and habitat; illegal poaching of Burrowing Owls, driven by cultural and religious practices and the pet trade; and lack of law enforcement of all of the above by the Mexican government.

The information gained from this study, as well as future data gathered by both collaborators and Envirological Services, will continue to be compiled furthering our insight into the decline of the Burrowing Owl in North America. For the winter of 2006, owls from Kirtland Air Force Base will be outfitted with radio transmitters and attempts will be made to locate them on their winter grounds by low flying aircraft. The results from this years' study will be used to help optimize the flight effort in 2006.

INTRODUCTION

The Burrowing Owl (*Athene cunicularia*) is federally listed by the United States Fish and Wildlife Service as a Species of National Conservation Concern (USFWS 2003). In New Mexico they are listed as a high responsibility species by New Mexico Partners in Flight (NMPIF 2003). Declines in Burrowing Owl populations are documented throughout the West, including studies conducted in New Mexico (Arrowood et al. 2001, Holroyd et al. 2001, Murphy et al. 2001). On Kirtland Air Force Base the population of owls increased slightly in 2005, but since monitoring efforts began in 1998, an overall decrease has been documented.

Several proposed mechanisms may be involved in this decline, including high predation rates, habitat loss, the decrease in burrowing mammals, drought, rearrangement of the population, and alterations in their migration and over-winter habitats. Although winter habitats are often cited as a possible cause for the decline of the Burrowing Owl, not much is known

about where these owls are spending their winter. This is the first year of a five-year study attempting to locate wintering grounds of the owls that breed in New Mexico.

During the winter of 2005-2006, 21 states of central & northern México were surveyed to determine habitat condition and presence of owls. For the winter of 2006, owls from Kirtland Air Force Base will be outfitted with radio transmitters and attempts will be made to locate them in México by low flying aircraft and by receivers on the ground.

The primary objective of this study was to determine areas where Burrowing Owls winter in México. By learning more about suitable winter habitat, as well as knowing areas lacking proper conditions for the owls, our flight coverage and intensity in 2006 will be optimized.

A network of Mexican collaborators was established to carry out a series of observations in several regions of the central and northern parts of México. This group of professionals gathered specific information on the habitat structure and quality, as well as recording owl sightings.

STUDY AREA

México is a country with much diversity in landscape. Coastal plains extend along the entire east and west coasts. Agriculture and Tropical Deciduous Forest characterize these lowlands as well as Tamaulipan Brushland on the northeast coast and Sonoran Desert on the northwest coast. The lowlands rise sharply to the mountains of the Sierra Madre Occidental in the West and the Sierra Madre Oriental in the East. These ranges run north to south with the highest peaks reaching heights of 3700 meters (above 12,000 feet). Between these two mountain ranges, there is the high plateau of México. This is a vast high elevation desert plateau in the center of the country that extends through central and northern México. To the south of the plateau, running east to west across the central part of the country, there is the Trans-Mexican volcanic belt which joins with the two south ends of the mountain ranges. This volcanic belt contains the highest peaks in México (and three of the top ten peaks in North America) reaching heights of 5636 meters (18,491 feet).

México is comprised of a wide variety of habitat types. The north and northwest coast is primarily desert, which is prime habitat for Burrowing Owls. The Chihuahuan Desert is found in the high plateau bordered by the two mountain ranges and with its southern border extending into Zacatecas, Aguascalientes and San Luis Potosí states. The elevation of the Chihuahuan Desert ranges from 600 meters to 1675 meters (1970 feet to 5500 feet). Because much of this desert is located at higher elevations, summers are quite hot with winter temperatures cold. The average annual temperature ranges from 14° Celsius to 23° Celsius. The dominant shrubs of the Chihuahuan Desert include creosote bush (*Larrea tridentate*) and tarbush (*Flourensia cernua*). Characteristic succulents include yuccas (*Yucca elata, Yucca torreyi*), agaves (*Agave sp*.), and a variety of small to medium sized cacti. Common grass species include black gramma (*Bouteloua eriopoda)* and tobosa grass (*Hilaria mutica).* Other plant species include bear-grass (*Nolina sp*.), sotol (*Dasylirion sp*.), candelilla (*Euphorbia antisyphilitica*), ocotillo (*Fouquieria spendens)*, and prickly pear (*Opuntia sp*.).

The ecoregion of the Chuihuahuan Desert is comprised of the following three regions:

- Trans Pecos Chihuahuan (Desierto de Transpecos) covers the northwest of Coahuila, northeast of Chihuahua, west Texas, and southeast New Mexico.
- Mapimian Chihuahuan Desert (Desierto o Bolsón de Mapimí) is located in the northeast of Durango, southeast of Chihuahua, and central and west of Coahuila states.

▪ Saladan Chihuahuan Desert (Desierto o Bolsón del Salado), or what is also considered south of the Chihuahuan Desert, is comprised of northeast Jalisco, northeast Aguascalientes, east and north of Zacatecas, central and east Durango, south of Coahuila, southwest Nuevo León, southwest Tamaulipas, and central and north San Luis Potosí (MacMahon 1998).

Throughout the entire Chihuahuan Desert, grasslands with scattered bushes and short trees and cacti dominate the landscape. Some of the main grass species are: slender grama (*Bouteloua repens*), blue grama (*Bouteloua gracilis*), black speargrass (*Heteropogon contortus*), salt grass (*Distichlis spicata*), and plains lovegrass (*Eragrostis intermedia*). These grasslands are distributed mostly in the Mapimí Chihuahuan Desert and with a higher density in the Saladan Chihuahuan Desert at the south end of the plateau.

The Sonora Desert in México is found in the state of Sonora and down the Baja California peninsula. Mild winters and bi-seasonal rainfall patterns are characteristic of this region. Dominant vegetation found in the Sonora Desert includes creosote bush (*Larrea tridentate)*, bursage (*Ambrosia sp*.), palo verde (*Cercidium microphyllum*), and cactus species including saguaro (*Carnegiea gigantea)*, barrel (*Ferocactus wislizeni*), prickly pear and cholla *(Opuntia sp.*), senita (*Lophocereus schottii)*, and organ pipe (*Stenocereus thurberi*).

Both the Sonoran and Chihuahuan Deserts gradually merge into Thornscrub to the south. This is an intermediate between the desert and Tropical Forest biomes. Thornscrub is dominated by drought deciduous trees and shrubs. The Chihuahuan Desert also merges into Tamaulipan Brushland to the east, which is dense and woody but also thorny and semi-arid. The lowland Thornscrub and Tamaulipan Brushland then merge into the Tropical Deciduous Forest that lines the east and west coasts of southern México. Although these last habitat types are not ideal for Burrowing Owls, cattle grazing and agriculture have produced clearings which may offer flat open spaces for Burrowing Owls.

For the practical purpose of this study, México has been divided into four different regions as follows:

NE México

This area is comprised of the states of Coahuila, Nuevo León, northern San Luis Potosí and the northeast portion of Zacatecas. The habitat ranges from Saladan Chihuahuan Desert to Tamaulipan Brushland, with moderate to high agricultural activity.

NW México

This area includes the states on the east side of the Sierra Madre Occidental; Chihuahua, Durango, Aguascalientes, the remaining portion of Zacatecas, the llanos of southeast Nayarit, and northern Jalisco. This region presents many similarities to the region of NE México, but NW México has more naturally vegetated areas. Mapimian Chihuahuan Desert is found in the North, becoming Saladan Chihuahuan Desert prairie in the central and southern part of this region, also called llanos, which is altered by seasonal agriculture, mainly black beans and corn.

NW Coastal México

The lowlands of Sonora and Sinaloa comprise this region. Sonoran Desert is the dominant ecoregion in the northern portion and lowland Tropical Deciduous Forest is dominant towards the south. This region is being heavily developed for agricultural and industrial activity, with the northern portion of Sinaloa state the most modified area.

Central México

This area includes the states of Guanajuato, northern Michoacan, Queretaro, Estado de México, Hidalgo, Puebla, the highlands of Veracruz, and the central valley of Oaxaca. This region is characterized by a series of valleys surrounded by mountain ranges, and in the llanos of Queretaro, Guanajuato, and northwest Hidalgo, grasslands are mixed with patchy desert vegetation and seasonal agriculture.

METHODS

Envirological Services surveys

Envirological Services (ES) staff took three exploratory trips to México to identify Burrowing Owl territories and habitat quality. During these trips, ES staff traveled to areas that historically host populations of wintering Burrowing Owls as well as areas with suitable habitat for Burrowing Owls.

Areas were surveyed by driving through suitable habitats searching for owls. Data on density of burrows, prey availability, and signs of use were collected. Once an owl was located, description of the habitat, digital photographs, and the Universal Transverse Mercator (UTM) were taken.

An additional goal was to meet with Mexican collaborators. Prior to the trips to México, contacts were made with local ornithologists already working with Burrowing Owl populations in México, as well as with other biologists interested in this research initiative. Links were made by presenting the project to the Mexican ornithological community to expand the search for possible collaborators. Throughout our travels in México, we met with all collaborators to discuss the scope of the project. In order to make the quality of the information collected consistent, ES provided collaborators with standardized protocol for surveys.

Mexican collaborative survey effort

Each of our collaborators conducted two-day surveys in mid-November, 2005, mid-December, 2005, and mid-January, 2006. When possible, surveys were conducted during the first four hours after sunrise and the last three hours before sunset when conditions were optimal for detection of owls. To maximize time spent in the field by collaborators, surveys were also conducted mid-day if weather conditions were suitable. Surveys were discontinued at any part of the day if winds exceeded 20 km/hr (12mph) or temperatures reached above 30°C (86°F) when owls would likely be inside their burrows (Conway and Simon 2003).

Three different field techniques were implemented to gather information on wintering owls. Linear transects by car were conducted. The survey start time, end time, and temperature was recorded. Observers took UTM coordinates at the start points and scanned the terrain in 360 degrees for two to three minutes in order to locate owls. The observers continued on by car stopping every 500 to 750 meters. At each stop they repeated the observation protocol. At each stop UTM's were recorded as well as lateral distance scanned, usually 100 to 200 meters on each side of the linear transect depending on the relief and vegetation (Bibby 1992). Additional data collected included type of vegetation, percentage of coverage, density of burrows (using a scale of low, medium, and high density), and presence/absence of owls (Table 1). The UTM of the end points for each transect was also recorded. Car transects were the primary survey method to maximize time and coverage of the terrain.

Walking transects were also conducted. These transects were implemented in areas with limited access for vehicles but suitable habitat for owls. UTM's were again taken at the start and end point of the survey and at each stop, every 500 to 750 meters, along the transect. Lateral distance surveyed, habitat type and percentage of coverage, density of burrows, presence/absence of owls, start and end time, and temperature were also recorded.

Table 1. Summary of data collected, explanation, and examples, taken by collaborators in México, winter of 2005 to 2006.

DATA COLLECTED	**EXPLANATION AND EXAMPLE**
Name	Full name of the observers: example Octavio Cruz
Date	In this format DD/mmm/YY: example 11/nov/05
Start and finish time	In 24 hour format: example 1610 – 1935
Start and finish UTM	In NAD 83 format
UTM at each observation point	In NAD 83 format
TRANSECT Number	For car transects use the prefix TA and a sequential number: example TA-1, TA-2, TA-3 For transects on foot use the prefix TP and a sequential number: example TP-1, TP-2, TP-3
Average Lateral Distance	The area of coverage on each side of the linear transect, record in meters: example 200 m
Temperature (Temp ^{o}C)	Temperature at the start of the survey, record in Celcius: example 15^{o} C
Habitat	Describe each habitat type with two or three words and the percentage of coverage by each type at the beginning of the survey, end, and at each point along the transect: example grassland 60% and cornfield 40%, or scrubland 30% barren ground 70%
BUOW	The number of Burrowing Owls seen at the specific point or stop along the transect.
Right Leg	This is very important data. If the owl is banded, note whether there is a USFWS band or color band, if there is an ACRAFT band, note the color and the alphanumeric code: example black/USFWS, red/dark green, or black ACRAFT A over S
Left Leg	This is very important data. If the owl is banded, note whether there is a USFWS band or color band, if there is an ACRAFT band, note the color and the alphanumeric code: example black/USFWS, red/dark green, or black ACRAFT A over S
Density of burrows	Describe if the presence of burrows is low, moderate, or high.
Notes and comments	Any data that may be considered important, such as a brief description of the weather conditions, presence of threats for BUOW like hunters or predators, or species associated to the BUOW.

Isolated sightings of owls were also recorded. This method was included to document specific points where owls were observed at times other than during formal survey transects. Also this allowed collaborators to include observations made by other colleagues. Our

collaborators would follow-up reports they received by visiting those sites and collecting the same data on date, time, temperature, UTM of the location, habitat and its percentages, and burrow density.

Bands

Both collaborators and ES staff searched for bands on every owl observed. Collaborators were provided with detailed descriptions and a series of photographs of different types of bands used on Burrowing Owls, including aluminum Fish and Wildlife Service bands, plastic color bands, and aluminum ACRAFT bands. Collaborators were provided information on the different colors of bands used by researchers, and how to read the alphanumeric codes on ACRAFT bands. Explanations were provided to collaborators regarding difficulties reading bands, i.e. bands get dirty and fade due to sunlight over time, and the amount of light and distance affects an observer's ability to read bands accurately. Techniques on how to approach owls correctly in order to read their bands were also described.

If a banded owl was observed, collaborators were instructed to take as much time as necessary to clearly read the color combination, and to discontinue the survey until band type and colors were determined. UTM's of the location would be taken as well as photographs if possible. Collaborators were directed to call ES subsequent to discovery of a banded owl.

Feather collection and diet analysis

When possible, feathers were collected for stable isotope analysis, a component of research that will be completed by a United States institution involved in the Legacy funding. Whenever owls were found, observers approached and searched the burrow area for feathers. Feathers were collected using tweezers or pliers and placed in a paper envelope. Each envelope was identified with the location description, UTM, and date of collection. Once feathers were collected and properly tagged, they were stored under refrigeration. Also, whenever a pellet was found at burrow entrance, it was checked for its contents to determine prey species if possible.

Materials and equipment

A variety of types of field equipment (such as binoculars, GPS, cameras, and spotting scopes) were used to conduct surveys. All collaborators recorded and reported the type of equipment used.

RESULTS

Envirological Services surveys

The first trip to México by ES staff occurred from August 15 to October 2, 2005. The focal region of this trip was central and southern México. Texcoco Valley in Estado de México, the Central Valley in Oaxaca state, the state of Guanajuato, Amozoc and Tehuacan Valleys in Puebla state, and the highlands of Veracruz state were visited.

On the second trip, central, northwestern and northeastern México were surveyed from October 17 to November 8, 2005. Texcoco Valley in Estado de México was revisited, and the states of Aguascalientes, San Luis Potosí, Zacatecas, Durango, Nuevo León, and Mapimí Reserve in Durango and Chihuahua states were visited.

The third trip was conducted from December 11 through the 21st, and December 29, 2005. The areas of concentration on this trip were northern México, the west coast, and west to

south central México. Chihuahua, Sonora, Sinaloa, Nayarit, Guadalajara, Jalisco, Toluca (in Estado de México), and Llanos de El Carmen in Puebla and Tlaxcala were visited.

ES staff surveyed key areas for wintering Burrowing Owls in 21 states of northeast, northwest, west coast, and central México; covering more than 12,000 kilometers (7,500 miles) of potential habitat, including desert and coastal grasslands, dunes, barren ground, scrubland, salt-grass, agave plantations, a variety of agriculture fields, grasslands with mesquite and sweet acacia trees, and ponds, rivers and canals w/riparian vegetation. A total of 105 owls were observed (Table 2).

Table 2. Summary of number of Burrowing Owls observed by Envirological Services staff in México, winter of 2005 to 2006.

Region	State	Number of Days Surveying in Area	Number of Burrowing Owls
NW México	Durango	4	7
NW México	Aguascalientes	1	1
NE México	Nuevo León	3	54
NW Coastal	Sonora	2	5
NW Coastal	Sinaloa	2	9
Central	Estado de México	3	8
Central	Puebla/Tlaxcala	1	21

Mexican collaborative survey effort

The Mexican collaborators surveyed 31,514.31 hectares (77,873.55 acres) by transects, resulting in 204 owls (Table 3). These 204 owls were located in 159 distinct wintering grounds throughout the northwest, northeast, northwest coast, and central parts of the country (Table 4). Owls were observed singularly, in pairs, and in clusters of three, four, and six, averaging 0.78 owls per point where owls were observed (Table 4).

Table 3. Summary of number of Burrowing Owls observed by collaborators in México, winter of 2005 to 2006.

Region	State	Number of Days Surveying in Area	Number of Burrowing Owls
NW México	Durango	10	17
NW México	Aguascalientes	8	23
NW México	Jalisco	6	6
NE and NW	Zacatecas	6	24
NE México	San Luis Potosí	6	55
NE México	Coahuila	7	33
NW Coastal	Sinaloa	4	18
Central	Estado de México	7	50
Central	Veracruz	4	3
Central	Puebla/Oaxaca	6	1

Table 4. Summary of different amounts of owls observed by collaborators at each transect point, the number of records of each of these amounts, and the total number of owls observed in México, winter of 2005 to 2006.

Amount of owls observed at each transect point	Number of records of each of these amounts of owls	Total number of owls
6	1	6
4	3	12
3	1	3
2	29	58
1	125	125

Collaborators produced 319.25 hours of observation (Table 5) and 1,351.09 kilometers of transects were conducted. While not conducting formal surveys, 26 more owls were registered by other contacts in México, resulting in a total of 230 Burrowing Owls.

The collaborators conducted formal surveys in 13 states of México (Nuevo León, Coahuila, Chihuahua, Sinaloa, Durango, Zacatecas, San Luis Potosí, Aguascalientes, Jalisco, Estado de México, Puebla, Veracruz, and Oaxaca) with an elevation range of 100 to 2900 meters (300 to 8600 feet). Habitats surveyed included agricultural land (alfalfa, corn, wheat, prickly pear plantations, vineyards, poli-plantations, and undetermined agricultural land), scrubland, barren ground, ponds and wetlands, suburban areas, forests (mesquite, sweet acacia, and pine), living fences of yuccas, agave, and prickly pear, malpais, riparian forest, and grassland.

Combining the Burrowing Owls located by ES and by Mexican collaborators, 335 owls were located during the winter of 2005 to 2006.

Table 5. Summary of the observation effort, showing the total observation hours per state and per region in México, winter of 2005 to 2006.

State / hrs of observation	State / hrs of observation	State / hrs of observation
Coahuila 100.36hours	Zacatecas 58.26	Veracruz - Puebla 22.11
	Durango 16.79	
San Luis Potosi 32.87 hours	Aguascalientes 18.41	Estado de México 30.04
	Jalisco 40.41	
NE total 133.23	**NW total 133.87**	**Central total 52.15**

NW México

Regional research contributors: Victoria Bailey, Isaias Cedillo-Martinez, Marco Antonio Cortes-Chamorro, Octavio Cruz-Carretero, Vicente Garcia, Alfredo Garza-Herrera, Sergio Raúl Gutiérrez-Reyes, Ernesto Herrera-de-la-Cerda, Marcelo Márquez-Olivas, Octavio Martinez-Castañeda, Kirsten McDonnell, Salvador Martín Medina-Torres, Alfredo Sanchez-Alvarado, Francisco Sanchez-Alvarado, Luis A. Tarango-Arámbula, Araceli Valverde-Castañeda.

Within the Transpecos Desert, the Janos Valley in the northwest portion of Chihuahua hosts a widespread black-tailed prairie dog colony (*Cynomys ludovicianus*) and many breeding Burrowing Owls. Many of the small colonies are located on land referred to as *ejido*; land that is shared among the local residents where they are permitted to use the land for purposes such as agriculture or livestock grazing. Other colonies are on private lands. In both of these situations, the future for the owl is uncertain. NGO Pronatura Noreste recently purchased Rancho el Uno, 18,500 hectares of prime llanos habitat that is now a private reserve that could make it possible for some colonies to remain intact.

No owls were observed in Janos Valley, but the habitat was of a high quality with a high burrow density. Although many owls breed in this area, it appears not many spend the winter here. Jennifer McNicoll (former New Mexico State University graduate student) studied the breeding Burrowing Owl colonies in this area. She found most of the owls in the colonies she studied were gone in the winter (personal communication).

The biosphere reserve of Bolson de Mapimí covers 320,000 hectares in the northeast region of Durango and extends into a small portion of southern Chihuahua. Part of this area is also ejido. There are three species of ground squirrels found in the Mapimí region: Mexican ground squirrel (*Spermophilus mexicanus)*, spotted ground squirrel (*Spermophilus spilosoma*), and rock squirrel (*Spermophilus variegates)*. Owls are associated with ground squirrels and in this region they are also associated with a desert tortoise called the Mexican bolson tortoise *(Gopherus flavomarginatus)* that is endemic and endangered. Burrowing Owls can use the tortoise burrows, which are large, badger-sized burrows. These burrows have a mound, are quite long with a curvature, and sometimes have more than one entrance.

Although the desert plants of this area (mostly creosote bush and ocotillo) range from two to four feet tall, there is also plenty of barren ground in both open patches and in between the clusters of vegetation. In the north end of the reserve there were many burrows clustered together in the banks of soil that border the road and railroad tracks. These burrows were made by the same species of ground squirrel as in central México, the rock squirrel. We also observed kangaroo rat (*Dipodomys sp*.) burrows that were utilized by Burrowing Owls.

Biologists report that owls are found here only in the winter; although some ranchers say there are owls here year-round. There were many burrows with evidence of owl use (feathers and whitewash), but some of these signs could have been quite old. Clusters of burrows were observed with heavy whitewash on all surrounding burrows, which may suggest owl families, but the whitewash may have just been from consecutive winter usage. Since this is an area with low precipitation, it is difficult to know, as the soil type and amount of rainfall may not easily wash this away.

The eastern portion of Aguascalientes and the southeast and northern portion of Zacatecas contain a large expansion of prairies with very short sparse vegetation in the winter. There are over 200 reservoirs that hold water during the dry season (October though June) for agriculture and cattle. This availability of water seems to have a positive impact on wildlife since they are the only sources of water during the dry season. Burrow density is low in the prairie flats, but the ridges surrounding small reservoirs have a high density of burrows.

In NW México, 78 owls (49 unbanded and 29 unknown) were located.

NE México

Regional research contributors: Victoria Bailey, Miguel Angel Cruz, Octavio Cruz-Carretero, José Ignacio González-Rojas, Miguel Angel Hernandez, Armando Jiménez-Camacho, Kirsten McDonnell, Gabriel Ruiz-Ayma.

Prime owl habitat was found in a series of four reserves in NE México (La Soledad, La Trinidad, Hediondilla and El Salero) that host large prairie dog colonies. Burrows here are found by the thousands and the proximity to agricultural fields makes the area prime potential wintering grounds. Many more small patches of prairie dog colonies are also found around the areas outside of these reserves.

In this large region, the ornithology department of the Universidad Autonoma de Nuevo León, in conjunction with Pronatura Noreste, is working with Burrowing Owl populations in

prairie dog colonies. There are many protected prairie dog colonies of various sizes found in this region. La Soledad is the largest prairie dog town in the world (17,000 hectares). Collaborators have extrapolated data obtained from transects and statistical programs that calculate an estimated 1000 owls residing in La Soledad in the winter.

The prairie dog species found here is the Mexican prairie dog (*Cynomys mexicanus).* They are endangered and endemic to the Potosi Valley between Coahuila, Nuevo León and San Luis Potosí states (Figure 1). The Mexican prairie dog at one time was also found in Zacatecas, but they have been officially extirpated due to habitat loss (SEMARNAT). This species evolved from black-tailed prairie dogs (*Cynomys ludovicianus*).

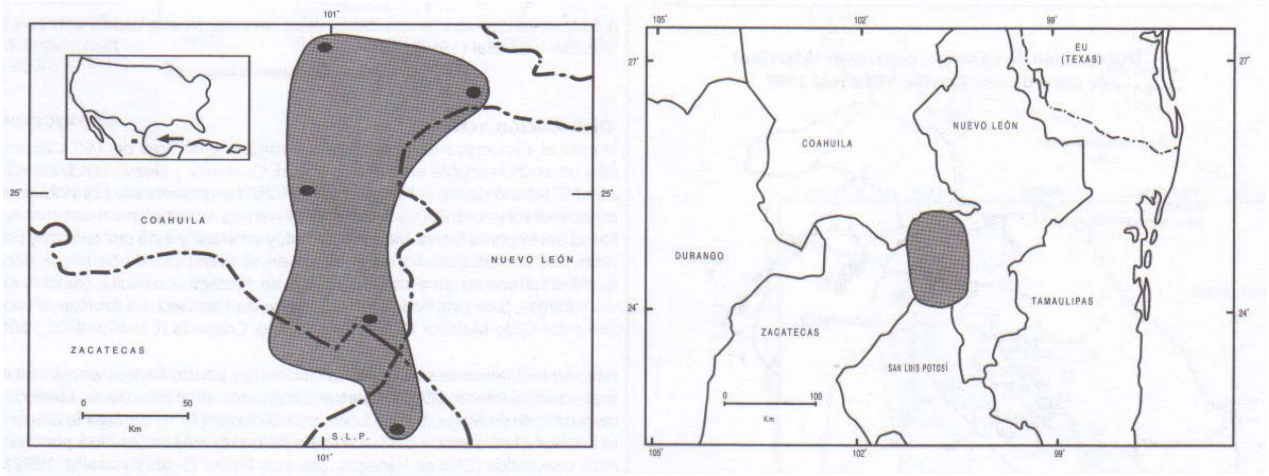

Figure 1. Range Map of Mexican prairie dog, México (SEMARNAT).

Owls are found in the Potosi and Tokio Valleys year-round and some may be residents although it is believed the population increases in the winter. Owls were observed calling at dusk (coo coo), and collaborators from this area state that Burrowing Owls call all winter at dusk and at dawn. In NE México, 142 owls (106 unbanded and 36 unknown) were located.

NW Coastal México

Regional research contributors: Octavio Cruz-Carretero, Hugo Manuel Espinoza-Flores, Marco Antonio González-Bernal, Cecilia del Rocio Hernandez-Celis, Alberto Macias-Duarte, Kirsten McDonnell.

ES staff visited this region of México for a shorter period of time. Nevertheless, collaborators have recorded high densities of breeding owls in this area with fewer owls found in the winter. In Sonora and Sinaloa many areas with a high density of burrows and high signs of use were observed. Although ES did observe some wintering owls, they were not found in similar concentrations as described by our collaborators here in the summer. Local people interviewed also described that Burrowing Owls are more commonly observed in the summer than in the winter. Burrow density is high almost everywhere within this area.

The region of south Sonora and northern Sinaloa (also commonly known as the Fuerte River Valley) has experienced drastic changes in recent years. Large tracts of natural habitat have been transformed into agricultural fields that utilize mechanized processing of crops. This intense agricultural activity coupled with the associated socioeconomic activities, such as the

pesticide and fertilizer industry and moving and shipping equipment, have transformed this area into a major producer of vegetables for all of México and for the United States.

The common use of pesticides that we observed here was unlike what we found throughout the rest of México. These are highly mechanized agricultural operations, where all the products are processed in factories and then exported internationally or nationally consumed. In other regions of México, production is small-scale and vegetables are consumed locally.

In NW Coastal México, 32 owls (one dead, 10 unbanded, and 22 unknown) were found.

Central México

Regional research contributors: Sergio Humberto Aguilar-Rodríguez, Gabriel Alva-Santana, Victoria Bailey, Agustin Cigarroa-Dávila, Octavio Cruz-Carretero, Adelina Margarita Fuentes-Romero, Pedro Roberto García-Galán, Manuel Grosselet, Marcelo Márquez-Olivas, Kirsten McDonnell, Ricardo Padilla-Borja.

Most of the sites visited revealed some degree of suitability as wintering grounds for Burrowing Owls. Burrowing mammals seemed to be less plentiful than in the other regions of México. The presence of limestone substrates appeared to be a beneficial factor for burrow availability. The rain and running water creates a number of holes along the sides of the banks. This substrate was found at Mitla in Oaxaca, Tehuacan Valley in Puebla, Valencianita in Guanajuato, and Perote in Veracruz. Soils with high clay content and high moisture levels were found to be too soft and therefore not appropriate for burrowing animals. This type of soil was observed in the salt flats of Texcoco, the south end of Tehuacan Valley, Guanajuato City, and the flooding flats of Perote and El Carmen in Veracruz and Tlaxcala, respectively. Groundwater level close to the surface also affects owls in the Texcoco Valley and the Perote area, as the water level is too high to burrow. Consequently, many areas in the valleys of south central México were unsuitable for burrowing animals and therefore, Burrowing Owls.

Burrowing Owls are closely associated to ground squirrels of the genus *Spermophilus* in this part of México. In Perote, Burrowing Owls are associated with a species of ground squirrel (*Spermophils perotensis*) that is endemic and endangered. This species is declining severely, although the causes are still uncertain. In Perote, volcanic lava substrate is mixed with agricultural lands. There are records of owls in this region; in fact there are records of adults and juveniles suggesting the possibility of breeding owls, although none were documented during our surveys.

Texcoco is a city east of México City, located in the state of México. Burrowing Owl observations began in areas around Texcoco in 1993 and 1994; however the first time our collaborators discovered breeding pairs was in 2000. Since then, they have discovered that owl presence varies from area to area. In some areas owls were observed year-round; in other areas, winter only; and yet in others, year-round with a population increase in the winter. About 100 pairs of Burrowing Owls breed in the whole Texcoco area, and the number is increasing every year (Margarita Fuentes, Marcelo Marquez, personal communication).

In Texcoco there is a saline lake of 1,000 hectares and a dried-up lakebed of 9,000 hectares that surrounds it. This lake and the dry surroundings (a total of 10,000 hectares) is a waterfowl reserve that is enclosed and protected. It is managed by the National Water Commission. Some of the areas have only recently dried, creating more available habitat for owls on the reserve. Breeding pairs have arrived to these areas as recently as one year ago. Crab claws mixed with insects were found in the pellets of some owls here. The protected habitat and food sources seem to be favorable circumstances for breeding, wintering, or year-round owls.

Artificial burrows entrances (only about one and a half feet long) made of thick corrugated PVC were installed here in the past to enhance the habitat for owls. In November 2005, more artificial burrows were installed using construction recommendations provided by ES and collaborators from Texcoco. External parasites have been observed on Burrowing Owls in this area by our collaborators. Perhaps this is due to higher humidity and warmer temperatures, as well as the presence of livestock (mainly sheep, goats, and cattle) and in some cases denser vegetation.

Another location in Texcoco where Burrowing Owls are seen is in an extensive area that was set aside for a future airport for México City. Due to social confrontations with the government for this land, the construction of the airport has been abandoned for the time being, and Burrowing Owls are using the fields. People are not allowed access to this area, so researchers observe owls on the perimeter but do not know the number of owls using the land. Unfortunately, illegitimate housing settlements are being established inside the area and encroaching upon the owl habitat. Adjacent to this field there are pastures and agricultural fields where post-graduate researchers from the Colegio de Postgraduados Campus Montecillo, conduct their agricultural related field work. These are fields with grass 75 cm high (two feet) in some places, although most of it is below 30 cm (one foot) in height. Owls are using the burrows in spite of the tall grass. The burrows are formed by cracks created by water.

The southeast area of the Texcoco Valley is quite poor, and human poverty affects owls directly. Illegal trapping and selling of owls for the pet trade also occurs here, as well as in Jalisco, and at El Huizache in San Luis Potosí. Poachers trap mostly nestlings and obtain $100 pesos (approximately $10) per owl. The intermediary can sell these birds in local markets and even some pet stores for prices ranging from $300 to $1500 pesos (approximately $30 to $150 dollars). People have been observed in the fields around Texcoco with shovels, digging for owls in their burrows. Also, domestic dogs have been seen excavating occupied burrows and in some cases dogs have killed both adults and nestlings. There have also been records of people in this area harvesting Burrowing Owls for food. There are some breeding owls in the southern portion of Texcoco, but the population increases in the winter.

On the west side of the state of México is Llanos de Tlachaloya near Toluca city. This is an area of high elevation with rolling grassland prairies adjacent to agricultural areas and much urbanization. Here the owls are using sewage boxes, dirt banks, and dirt ditches. Owls are seen here at 2900 meters (9500 feet) of elevation, but only in winter. There have been no reports of humans disturbing the owls in this region.

In Llanos de El Carmen a winter colony was discovered in 2003. This area is in a valley that is located for the most part in eastern Puebla extending into Tlaxcala. The soil is sandy with a high content of caustic salt and clay. When wet it is sticky and when dry it is hard. Mountains surround the valley and water drains into the center, so during the rainy season (June to October) the center of the valley is flooded and the rest is very muddy. This valley has an elevation change of 50 to 75 meters from the foothills to the center; the topography is relatively flat except for some differences in the ground height, causing 1 meter (2 or 3 feet) steps or drops. At these steps, banks are created between the upper and lower ground. Also mounds of ground retained by the vegetation (mostly prickly pears, hedgehog cactus, and small bushes) can be seen breaching the terrain. All burrows were found exclusively in these steps or mounds. There is a high density of owls even though suitable burrow structures are limited. During the winter surveys, Burrowing Owls were heard calling (coo coo) at dusk.

In Central México, 83 owls were located (50 unbanded and 33 unknown).

Diet analysis

The following is a brief description about the variety of prey items observed during ES surveys and reported by collaborators at their areas of observation.

In northern México, including NW Coastal México, Mapimí in the Northwest, and Potosí Valley in Northeast, owls seemed to be consuming a similar diet to owls in New Mexico. The majority of the pellets collected contained grasshoppers, beetles, and moths.

Pellets found from Texcoco owls had additional prey items. Sowbugs and crab claws were found, perhaps due to the proximity of cattle, much moisture in the ground, and the presence of the lake. Our collaborators report breeding owls preying on House Sparrows (*Passer domesticus*). This introduced sparrow species is associated with urban and suburban areas, often roosting in trees in abundance. The owls seem to be taking advantage of this during the night.

In Llanos de El Carmen of south central México, owls were preying almost entirely on rodents (most likely mice). A half eaten Mourning Dove (*Zenaida macroura*) was also found in an occupied burrow entrance. Owls in México seem to utilize a wide variety of food sources, showing the flexibility owls possess when it comes to prey species.

Bands

Of the 309 Burrowing Owls located during surveys by ES and collaborators, 213 could be identified as unbanded. 96 owls remained unknown for various reasons such as vegetation height, light and distance, or owls going underground into their burrows. No banded owls were observed during this project.

DISCUSSION

The main focus of these surveys was to obtain a network of sites across México that hold Burrowing Owl habitat.

NW México

West México is a vast region with a combination of good prairie habitat, agriculture, and water reservoirs. Burrowing Owls are not found in clusters here, as they are in prairie dog colonies, rather they are dispersed throughout the surroundings. This makes locating owls more challenging, although signs such as burrow availability and food resources suggest that this area is suitable for wintering owls. This will be one of the key areas designated for flying in search of radio-tagged owls in 2006.

NE México

The expansion of agriculture into protected areas that hold prime habitat for Burrowing Owls is a large problem in this region. Ten years ago the road that connects Monterrey City to México City was made into a large two-lane highway. This road goes through Burrowing Owl and prairie dog habitat, as well as natural reserves, and many fledglings are killed every summer on this and surrounding roads. Along with the construction of a highway like this comes increased access to the area, more development, and significant amounts of land being converted to agriculture. In fact, agricultural efforts are replacing prime habitat at an alarming rate.

One plot of several hectares of prairie dog colonies that our collaborators took us to see had been very recently plowed and was being prepared for planting. Our collaborators were surprised by the quick transition and explained to us that most likely many prairie dogs were

buried in the process. Prairie dogs have decreased by 30% here in just the past three years, and have decreased by 80% since studies began (Pronatura Noreste, internal information). This occurrence is probably repeated in this region with the influx of people, and this translates to habitat loss for many grassland species, in this case prairie dogs, and probably Burrowing Owls as well. To make matters worse, we learned this area we visited actually is a "reserve" but obviously not managed as such or protected. It is private property and being developed as the landowner decides. This was not considered an atypical occurrence in this area.

Because La Soledad is a larger reserve and has less impact from agriculture, it contains more species of concern, such as the Mountain Plover (*Charadruis montanus*), and an extremely large prairie dog colony. Because of its size and species present, more emphasis has been placed on protecting it than other reserves in the area. Nevertheless this land is ejido and privately owned. So legally it is protected, but in actuality, as the prior example demonstrates, private landowners have the right to do as they please to their land. Pronatura Noreste has been placed in charge of La Soledad's conservation plan and management. As part of their mission, they promote environmental education and awareness, but the fate of this natural resource still lies in the future. As the community grows, hopefully more members of it will begin to see the impact on this valuable natural resource, and safeguards for wildlife and their habitat will factor into the future outcome before it is too late.

NW Coastal México

Historically, the west coastal plain was scrubland and coastal grasslands. In recent years, most of this landscape has been transformed for use by industrialized agriculture. Owl habitat was enhanced with the construction of irrigation and drainage ditches, which created long banks where ground squirrels and other animals build burrows; the availability of burrows is certainly high. While owls are found here in the winter, we theorize that many of the breeding residents may migrate to other winter grounds, rather than stay here year-round.

Heavy pesticide use in this region poses a threat. Sinaloa is the largest vegetable producer of México. Tomato, cucumbers, peppers, eggplant, squash, asparagus, and onion are produced as well as corn, sugar cane, and other grains. The United States relies on this region of México for many of its winter vegetable imports. Pesticides, fertilizers, and agricultural machinery are associated with such large-scale operations. All of these "agricultural advancements" may have a direct negative impact on Burrowing Owls' physical condition. Another direct impact may be caused by poisoned pellets that are being spread in very large quantities in the agriculture fields to control the Arizona cotton rat (*Sigmodon arizonae*). This grassland rat is a problem pest of sugar cane fields. More research will be needed to determine the extent of this potential impact.

The habitat structure and the food sources as observed by ES were suitable for owls to overwinter here. Because of topography, the owls found here in the winter may include migrants that fly south from states like California, Arizona, Nevada, and Oregon. South and east of Tucson, Arizona the Sierra Madre Occidental rises and runs south creating a natural barrier between New Mexico and Sinaloa. Because of this mountain barrier, we theorize New Mexican owls may not be found in the northwest coast of México in winter.

Central México

Around México City to the east, north and west, the suburban areas are intercalated with agriculture, natural desert, and prairie patches containing both natural and introduced grasses.

This offers a wide variety of opportunities for the Burrowing Owls. In the east, Texcoco Lake and its surrounding vast flat areas that reach Hidalgo state (both protected and non-protected), represents an alternative for the Burrowing Owls and in fact (according to our collaborators) the breeding population of the area has been growing year after year (Margarita Fuentes, Marcelo Marquez, personal communication). ES has received notice of two new colonies in this area, northeast of México City, since this initiative started.

Unlike agricultural practices found in other parts of México, farms in south central México are mostly pesticide-free and worked using traditional methods of cultivation and harvesting. The difference is probably due to size (smaller farms) and economics; however this, of course, will benefit the owls. Their diets will consist of toxin-free insects and rodents and the absence of heavy machinery near their territories will reduce stress. Here seasonal crops are mostly corn and grains. However, blue agaves for tequila are also commonly planted in the fields. Agaves take seven years until the time of harvest. This lifecycle ensures that habitat will not vary drastically within that time-frame. Also, green agaves are planted around the edge of the seasonal crop fields to act as natural fences, and many burrows are found around the base of these living fences. This is another advantage for the Burrowing Owl.

In south central México along the volcanic belt, there are several isolated high elevation valleys between the mountains that may host wintering populations of Burrowing Owls, like that observed in Llanos del Carmen. In the areas between Puebla, Tlaxcala, and Veracruz most of the flats are poor in vegetation but rich in saline soils. This seems to reduce agricultural activity and enhance Burrowing Owl presence. Although local residents exploit this caustic salt source to produce cleaning and bleaching products, this activity is entirely handcrafted and non-industrialized. In Llanos de El Carmen, all burrows were exclusively in this type of terrain (isolated high elevation valley with saline soil). This area had the some of the highest concentrations of owls, even though suitable habitat structure was reduced and very localized. It would be interesting to determine if other valleys with the same characteristics could be hosting wintering owls.

The most southern areas of the Central México region had suitable habitat but low records of owls. The Tehuacan area of Puebla produced only one record of a Burrowing Owl from this survey, and the central valley of Oaxaca produced none. These areas may represent the southern boundary of their distribution range.

The Trans-Mexican volcanic belt may represent a natural barrier for the owls. These mountains are very high, and they form the southern border of the distribution of ground squirrels (Alondra Castro-Campillo, personal communication). There are 10 species of ground squirrels (genus *Spermophilus*) found in México, but only two species may be found south of the volcanic belt, distributed along the Balsas River and in the Sierra Madre del Sur in Oaxaca ((Alondra Castro-Campillo, personal communication). The lack of burrowing mammals may be a primary reason Burrowing Owls are rarely found south of this region. Burrowing Owls are shown south of here on range maps. Our collaborators provided us with a non-confirmed sighting in a cattle field in the Isthmus of Tehuantepec. There are also confirmed reports of owls in the coastal plain of Veracruz.

According to literature (Howell 1995), Burrowing Owls range attitudinally from near sea level to 2000 meters. In this study, Burrowing Owls were both observed at sea level in San Isidro, Veracruz and up to 2900 meters in Toluca, Estado de México.

Burrow and food availability

In undisturbed habitat, owls are closely related to ground squirrels of the genus *Spermophilus* in México. Mexican prairie dogs, black-tailed prairie dogs, kangaroo rats, desert tortoises, moles and rabbit burrows are also used, as well as physical depressions, cracks, and crevices in the ground. In urban and suburban areas, drainage pipes and sewage enclosures are used.

A good food source as well as the availability of burrows or similar structures can be deciding factors for Burrowing Owls when choosing wintering grounds. Observations revealed that besides grasshoppers, beetles, and moths, owls also feed on sowbugs, small crabs, and roosting sparrows. In some regions they exclusively preyed on small rodents. This demonstrates just how opportunistic and adaptive owls can be concerning their diet.

Conservation issues, lack of education, and law enforcement

Burrowing Owls in México are faced with many of the same threats that they face in the United States, such as habitat loss. For some threats often found in the United States, the same threat may be documented far less in México. In México, pesticide use is cost prohibitive in many areas, thus reducing usage nationwide. Pesticide use is still a large problem in México because the type of pesticide used as well as the amount used is not regulated, therefore farmers may be using the most harmful agrochemicals in their fields. Regulations are placed on crops for export to the United States, as many of these crops in Sinaloa are designated, especially in winter. But regulations are not enforced in the fields, they are enforced by testing crops when they cross the border into the United States, and only a small percentage of these imports are tested. Farmers may therefore be using more toxic organophosphates that are more rapidly degraded, so they do not show up when crossing the border. Some pesticides are still used in México that are now banned from use in the United States. The pesticide problem is intensified on lands closer to the U.S. border and reaching to the West where factory farms are located. This is not the case in other areas of México, since pesticide prices are too expensive for local small farm owners.

But Burrowing Owls in México do face some new threats, such as the pet trade. People are harvesting owls because there is a demand for them. This is illegal but rarely enforced. This lifestyle choice is a result of poverty, and the people harvesting the owls are barely making money. In addition, owls are being consumed due to the impoverished conditions (in this case a mere 130 to 160 grams Burrowing Owl, but also any of the more than 50 species of birds used as alternate food sources in some parts of México (Cruz 1999, Cruz and Barr 1999)). Clearly these are not optimal dietary choices. Also, cultural and religious beliefs contribute to the demise of the Burrowing Owl, other raptors, and many other species of wildlife. This includes killing of many species of birds and animals for body parts to sell. None of this is justifiable; education may help control this abusive situation, but much more is needed to solve this problem and that of the pet trade that are fueled by poverty.

In México, the process of declaring an area of land as a reserve, or a protected area, has some flaws. First, an area is proposed as an important area in need of protection by an institution, such as an NGO, academia, etc. The institution goes to the National Commission for Natural Protected Areas branch of the government and describes the reasons for protection. The government may agree, and the area is then declared as a reserve. This is usually the end of the process. The government does not buy the land, or necessarily enforce what happens on it, or even necessarily inform the land owners as to the status change. Educational factors or

reasoning are not even relayed to the landowners in most cases. In some situations, the government gives authority to an institution (Pronatura Noreste, for the example at La Soledad) to do environmental education and management, but the institution does not have any legal control. In some areas of high importance (such as with flamingoes at Ria Lagartos and Ria Celestun in the Yucatan Peninsula), the government does enforce protection against disturbance. But the Burrowing Owl in México is not a species of concern (NOM-059-ECOL-2001). The Mexican prairie dog is, and that is why the reserves in the northeast region were initially established. Yet, in the minds of the general public, the prairie dog is another rodent similar to a rat or a squirrel, and concern for their endangered status is very limited.

Another hazard for owls is irresponsible falconers using their trained birds of prey to hunt Burrowing Owls. Harris Hawks are commonly owned and poorly trained by the inexperienced falconer with little sense of overall conservation needs. ES established contact with some falconry clubs in México, and according to responsible falconers, the take of Burrowing Owls is common in Jalisco, Veracruz and Estado de México. Falconry is regulated in México, but as we have seen with the pet trade, enforcement is weak and therefore ineffective.

According to ES observations and interviews with local people in some parts of México, the Burrowing Owl is thought to be harmful. Assumptions are made and many believe the owls kill the mammals in order to take over the burrow. This negative connotation would easily be changed with education. Burrowing Owls could be considered a positive influence in the environment because they eat pest species like insects and mice.

Through this national initiative, awareness was heightened within the biologist and bird specialist community in México about Burrowing Owl conservation issues. Our collaborators are more mindful regarding Burrowing Owl conservation as a result of this project. In México, Burrowing Owls are not listed as endangered or threatened; therefore many people are not aware of their status in other parts of North America. The magnitude of this five year study has already allowed us the opportunity to reach many people in many areas. Of course the biologists and ornithologists readily grasp the challenge and embrace the possibility to have an impact on their own natural resources. They have contributed immensely since the inception. The awareness extends beyond our collaborators into their communities, both scientific and within the general public due to their commitment. Our collaborators are also extremely interested in promoting conservation education in their regions.

Future plans of Envirological Services

- Attach radio transmitters to Burrowing Owls during the 2006 breeding season on Kirtland Air Force Base, and then attempt to locate the tagged owls on their winter grounds in México by airplane in fall 2006.
- Develop a GIS to be used during overflights in 2006.
- Create educational materials to be distributed in the main wintering areas of México.
- Continue to identify Burrowing Owl wintering grounds through this collaborative monitoring effort throughout México.

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Appendix A. Locations of Burrowing Owls observed by Envirological Services staff by region, state, location, and UTM, and whether the owl was banded or if this was unknown, in México, winter of 2005 to 2006.

Region	State	Location	Bands	Zone	Easting	Northing
NE	Nuevo León	San Rafael area	Unbanded	14R	339352	2768044
NE	Nuevo León	San Rafael area	Unbanded	14R	339352	2768044
NE	Nuevo León	San Rafael area	Unbanded	14R	339352	2768044
NE	Nuevo León	San Rafael area	Unbanded	14R	339352	2768044
NE	Nuevo León	La Soledad	Unknown	14R	325091	2755584
NE	Nuevo León	La Soledad	Unbanded	14R	327875	2744581
NE	Nuevo León	La Soledad	Unbanded	14R	330644	2741509
NE	Nuevo León	La Soledad	Unbanded	14R	330644	2741509
NE	Nuevo León	La Soledad	Unbanded	14R	330644	2741509
NE	Nuevo León	La Soledad	Unbanded	14R	330644	2741509
NE	Nuevo León	La Soledad	Unknown	14R	330644	2741509
NE	Nuevo León	La Soledad	Unknown	14R	330644	2741509
NE	Nuevo León	La Soledad	Unknown	14R	330644	2741509
NE	Nuevo León	La Soledad	Unbanded	14R	326470	2748264
NE	Nuevo León	La Soledad	Unbanded	14R	326439	2748468
NE	Nuevo León	La Soledad	Unknown	14R	326082	2749649
NE	Nuevo León	San Rafael area	Unbanded	14R	343052	2768374
NE	Nuevo León	San Rafael area	Unbanded	14R	343213	2768540
NE	Nuevo León	San Rafael area	Unknown	14R	343213	2768540
NE	Nuevo León	San Rafael area	Unknown	14R	332007	2766628
NE	Nuevo León	San Rafael area	Unknown	14R	332007	2766628
NE	Nuevo León	San Rafael area	Unknown	14R	332007	2766628
NE	Nuevo León	San Rafael area	Unknown	14R	332007	2766628
NE	Nuevo León	San Rafael area	Unknown	14R	332007	2766628
NE	Nuevo León	San Rafael area	Unknown	14R	332007	2766628
NE	Nuevo León	On road to Hediondilla	Unbanded	14R	329944	2766011
NE	Nuevo León	On road to Hediondilla	Unknown	14R	329944	2766011
NE	Nuevo León	On road to Hediondilla	Unbanded	14R	329227	2767115
NE	Nuevo León	On road to Hediondilla	Unbanded	14R	329227	2767115
NE	Nuevo León	On road to Hediondilla	Unbanded	14R	328911	2767495
NE	Nuevo León	On road to Hediondilla	Unbanded	14R	328911	2767495
NE	Nuevo León	On road to Hediondilla	Unbanded	14R	328911	2767495
NE	Nuevo León	On road to Hediondilla	Unbanded	14R	328911	2767495
NE	Nuevo León	On road to Hediondilla	Unbanded	14R	328911	2767495
NE	Nuevo León	On road to Hediondilla	Unbanded	14R	328911	2767495
NE	Nuevo León	On road to Hediondilla	Unknown	14R	328911	2767495
NE	Nuevo León	On road to Hediondilla	Unbanded	14R	328911	2767495
NE	Nuevo León	On road to Hediondilla	Unknown	14R	328911	2767495
NE	Nuevo León	On road to Hediondilla	Unknown	14R	328410	2768443
NE	Nuevo León	On road to Hediondilla	Unknown	14R	327434	2769898

Region	State	Location	Bands	Zone	Easting	Northing
NE	Nuevo León	On road to Hediondilla	Unknown	14R	327434	2769898
NE	Nuevo León	On road to Hediondilla	Unknown	14R	327434	2769898
NE	Nuevo León	On road to Hediondilla	Unknown	14R	327434	2769898
NE	Nuevo León	On road to Hediondilla	Unknown	14R	327434	2769898
NE	Nuevo León	On road to Hediondilla	Unknown	14R	327434	2769898
NE	Nuevo León	On road to Hediondilla	Unknown	14R	327434	2769898
NE	Nuevo León	La Trinidad	Unbanded	14R	356963	2753986
NE	Nuevo León	La Trinidad	Unbanded	14R	356444	2754629
NE	Nuevo León	La Trinidad	Unknown	14R	356444	2754629
NE	Nuevo León	On road to El Salero	Unbanded	14R	370911	2707758
NE	Nuevo León	On road to El Salero	Unbanded	14R	370911	2707758
NE	Nuevo León	On road to El Salero	Unbanded	14R	370911	2707758
NE	Nuevo León	El Salero	Unknown	14R	371268	2706675
NE	Nuevo León	El Salero	Unknown	14R	370100	2705632
NW	Aguascalientes	Aguascalientes	Unbanded	13Q	803773	2416688
NW	Durango	Bolson de Mapimí	Unbanded	13R	621434	2961521
NW	Chihuahua	Bolson de Mapimí	Unbanded	13R	600624	2973565
NW	Chihuahua	Bolson de Mapimí	Unbanded	13R	573587	2961446
NW	Chihuahua	Bolson de Mapimí	Unbanded	13R	572755	2961129
NW	Durango	Bolson de Mapimí	Unknown	13R	615734	2943957
NW	Durango	Bolson de Mapimí	Unbanded	13R	603498	2940085
NW	Durango	Bolson de Mapimí	Unbanded	13R	604051	2936581
NWCoastal	Sonora	Costa de Hermosillo	dead/no	12R	448448	3189766
NWCoastal	Sonora	Costa de Hermosillo	Unknown	12R	448448	3189766
NWCoastal	Sonora	Costa de Hermosillo	Unknown	12R	448448	3189766
NWCoastal	Sonora	Costa de Hermosillo	Unbanded	12R	445735	3169030
NWCoastal	Sonora	Costa de Hermosillo	Unbanded	12R	445735	3169030
NWCoastal	Sonora	Costa de Hermosillo	Unbanded	12R	445735	3169030
NWCoastal	Sonora	Valle de Yaqui	Unbanded	12R	586297	3042214
NWCoastal	Sonora	Valle de Yaqui	Unbanded	12R	585181	3039877
NWCoastal	Sonora	Valle de Yaqui	Unknown	12R	585181	3039877
NWCoastal	Sinaloa	Valle del Rio Fuerte	Unbanded	12R	708897	2870599
NWCoastal	Sinaloa	Valle del Rio Fuerte	Unbanded	12R	708897	2870599
NWCoastal	Sinaloa	Valle del Rio Fuerte	Unknown	12R	708897	2870599
NWCoastal	Sinaloa	Valle del Rio Fuerte	Unbanded	12R	709662	2860586
NWCoastal	Sinaloa	Valle del Rio Fuerte	Unbanded	12R	709662	2860586
Central	Estado de México	NE Texcoco	Unbanded	14Q	500601	2155238
Central	Estado de México	NE Texcoco	Unbanded	14Q	500601	2155238
Central	Estado de México	NE Texcoco	Unbanded	14Q	500704	2159770
Central	Estado de México	NE Texcoco	Unknown	14Q	500488	2162980
Central	Estado de México	SE Texcoco	Unbanded	14Q	507928	2150435
Central	Estado de México	SE Texcoco	Unknown	14Q	507928	2150435
Central	Estado de México	SE Texcoco	Unknown	14Q	507928	2150435
Central	Estado de México	SE Texcoco	Unknown	14Q	507928	2150435

Region	State	Location	Bands	Zone	Easting	Northing
Central	Puebla	Llanos de El Carmen	Unbanded	14Q	647116	2130510
Central	Puebla	Llanos de El Carmen	Unknown	14Q	647116	2130510
Central	Puebla	Llanos de El Carmen	Unknown	14Q	647116	2130510
Central	Puebla	Llanos de El Carmen	Unknown	14Q	646412	2129873
Central	Puebla	Llanos de El Carmen	Unknown	14Q	646412	2129873
Central	Puebla	Llanos de El Carmen	Unbanded	14Q	644409	2128797
Central	Puebla	Llanos de El Carmen	Unknown	14Q	644409	2128797
Central	Puebla	Llanos de El Carmen	Unbanded	14Q	645818	2129740
Central	Puebla	Llanos de El Carmen	Unbanded	14Q	650068	2134258
Central	Puebla	Llanos de El Carmen	Unknown	14Q	650068	2134258
Central	Puebla	Llanos de El Carmen	Unknown	14Q	647685	2130668
Central	Puebla	Llanos de El Carmen	Unbanded	14Q	647144	2130579
Central	Puebla	Llanos de El Carmen	Unknown	14Q	646010	2127917
Central	Puebla	Llanos de El Carmen	Unknown	14Q	646390	2129846
Central	Puebla	Llanos de El Carmen	Unknown	14Q	646390	2129846
Central	Puebla	Llanos de El Carmen	Unkown	14Q	647833	2131218
Central	Puebla	Llanos de El Carmen	Unkown	14Q	647833	2131218
Central	Puebla	Llanos de El Carmen	Unkown	14Q	647833	2131218
Central	Puebla	Llanos de El Carmen	Unkown	14Q	647833	2131218
Central	Puebla	Llanos de El Carmen	Unkown	14Q	648660	2133438
Central	Puebla	Llanos de El Carmen	Unkown	14Q	648660	2133438

Appendix B. Survey data sheets used by collaborators in México, winter of 2005 to 2006.

Hoja de registro número 1 (transectos en auto)

Nombre	Fecha	Hora de inicio	Hora de finalización	UTM inicio	UTM finalización

TRANSECTO	
Distancia lateral	
Temp ^{o}C	

	UTM	**Hábitat**	**Densidad de huecos**	**BUOW**	**Pata der.**	**Pata izq.**
parada inicial						
recorrido						
segunda parada						
recorrido						
tercera parada						
recorrido						
cuarta parada						
recorrido						
quinta parada						
recorrido						
sexta parada						
recorrido						
séptima parada						
recorrido						
octava parada						
recorrido						
novena parada						
recorrido						
décima parada						

Lanius ludovicianus	

Notas y comentarios:

Hoja de registro número 2 (transectos a pie)

Nombre	Fecha	Hora de inicio	Hora de finalización	UTM inicio	UTM finalización

TRANSECTO	
Distancia lateral	
Temp ºC	

Recorrido de ida	**UTM**	**Hábitat**	**Densidad de huecos**	**BUOW**	**Pata der.**	**Pata izq.**
Inicio del recorrido						
Primer punto						
Segundo punto						
Tercer punto						
Final del recorrido						
Recorrido de ida	**UTM**	**Hábitat**	**Densidad de huecos**	**BUOW**	**Pata der.**	**Pata izq.**
Inicio del recorrido						
Primer punto						
Segundo punto						
Tercer punto						
Final del recorrido						

Lanius ludovicianus	

Notas y comentarios:

Hoja de registro número 3 (registros por avistamiento).

Nombre

	BUOW	Hábitat	Densidad de huecos	Pata der.	Pata izq.	UTM	Fecha	Hora	L. ludovicianus
1									
2									
3									
4									
5									
6									
7									
8									
9									
10									

Notas y comentarios:

Hoja de registro número 4 (registro de colecta de plumas).

Nombre

Sobre	No. plumas colectadas	BUOW	Hábitat	Densidad de huecos	UTM	Fecha	Hora

Notas y comentarios:

Hoja de registro número 5 (materiales y equipo)

Nombre

Equipo	**1er observador**	**2º observador**
Binoculares		
Telescopio		
GPS		
Brújula		
Cámara fotográfica		
Vehículo		
Otro		
Otro		
Otro		
Otro		

Hoja de registro número 7 (relación del kilometraje recorrido)

Nombre	Fechas	Vehículo (modelo, año)	Kilometraje de inicio	Kilometraje de finalización

Día 1

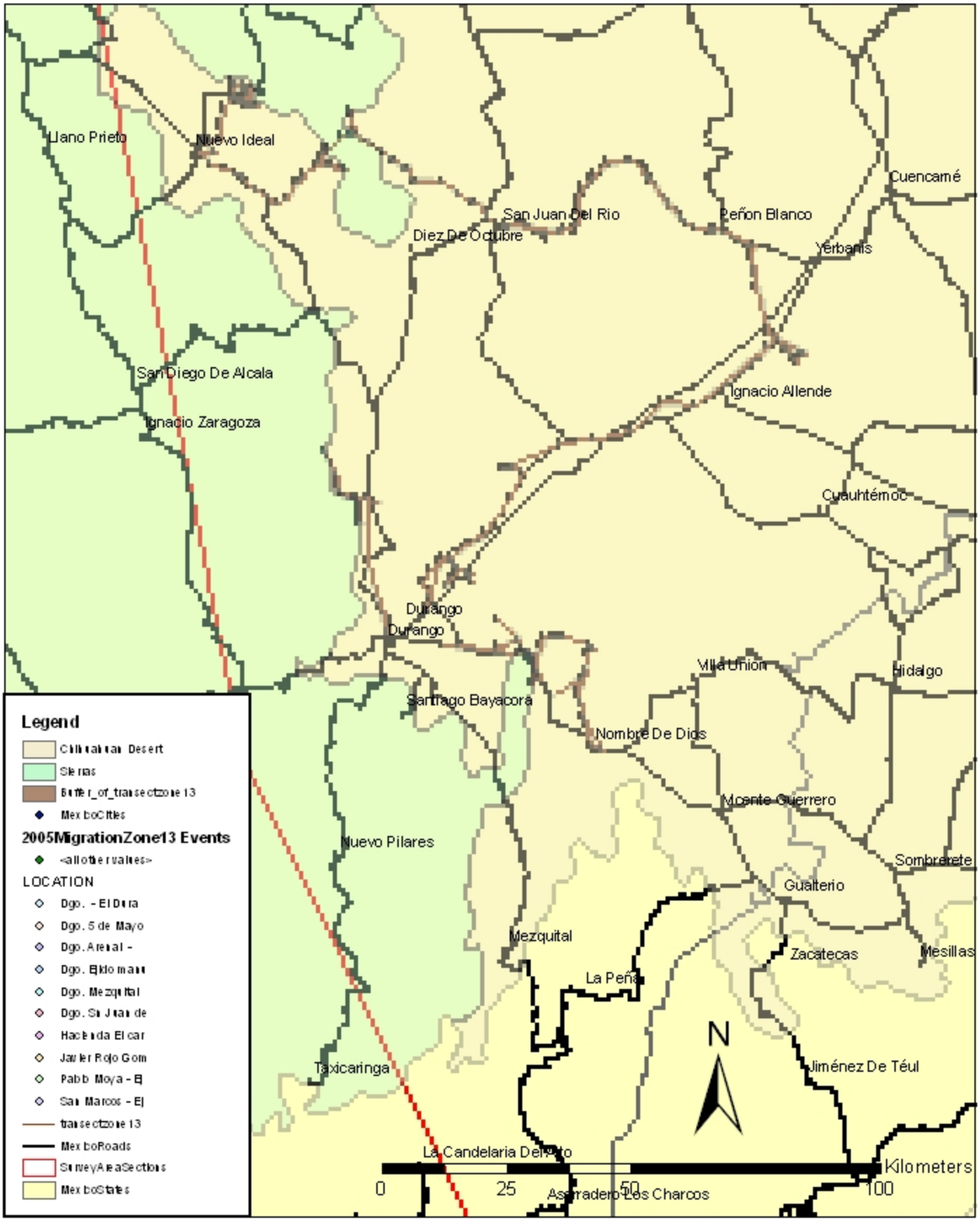
Salida	Llegada	Kilómetros recorridos	Gasolina $	Número de nota

Día 2

Salida	Llegada	Kilómetros recorridos	Gasolina $	Número de nota

2005-2006 Mexico Winter Burrowing Owl Locations Observed by Envirological Services Staff and Collaborators.

2005 BUOW Surveyed Sites in Central Durango



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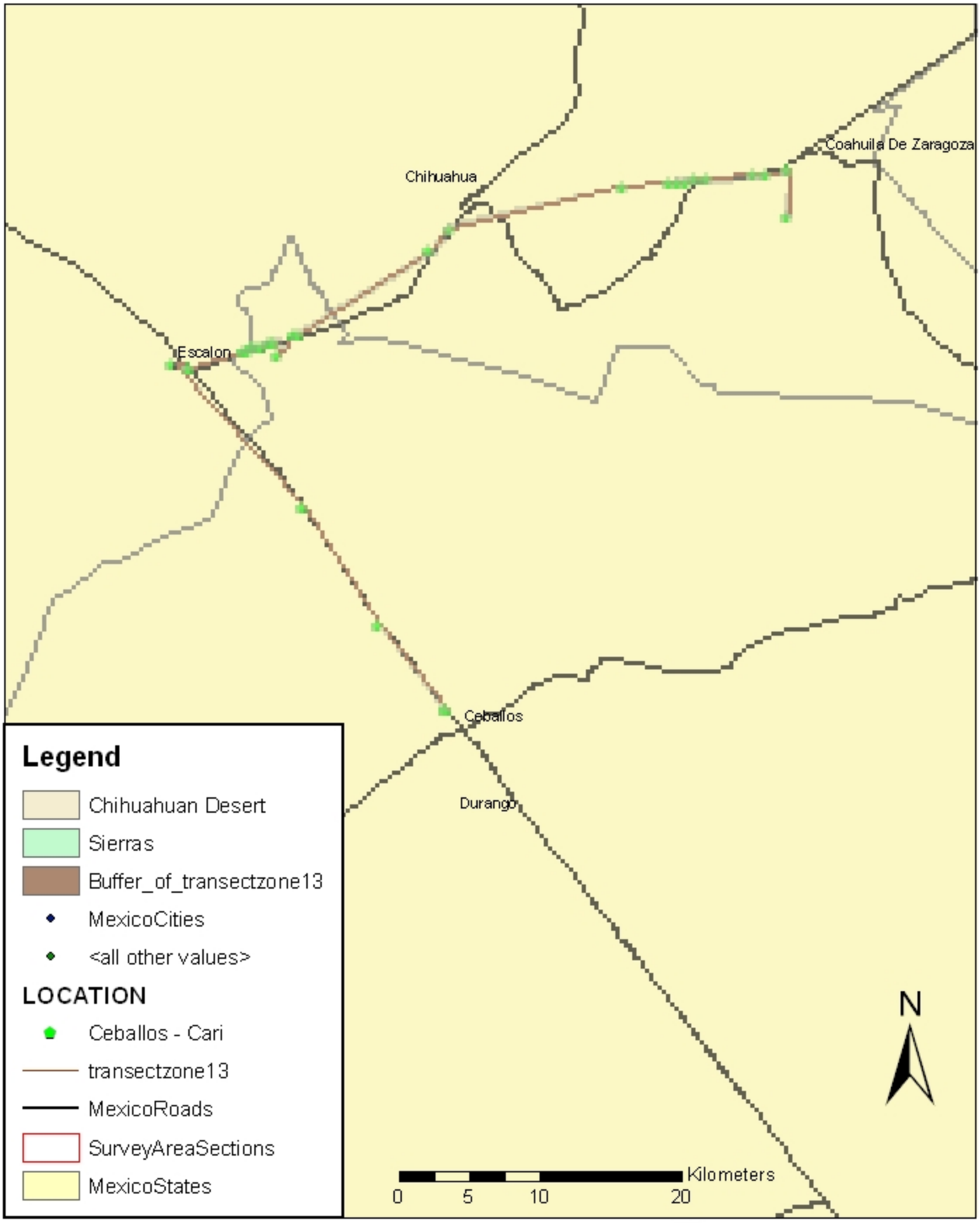
2005 BUOW Surveyed Sites in Northern Durango



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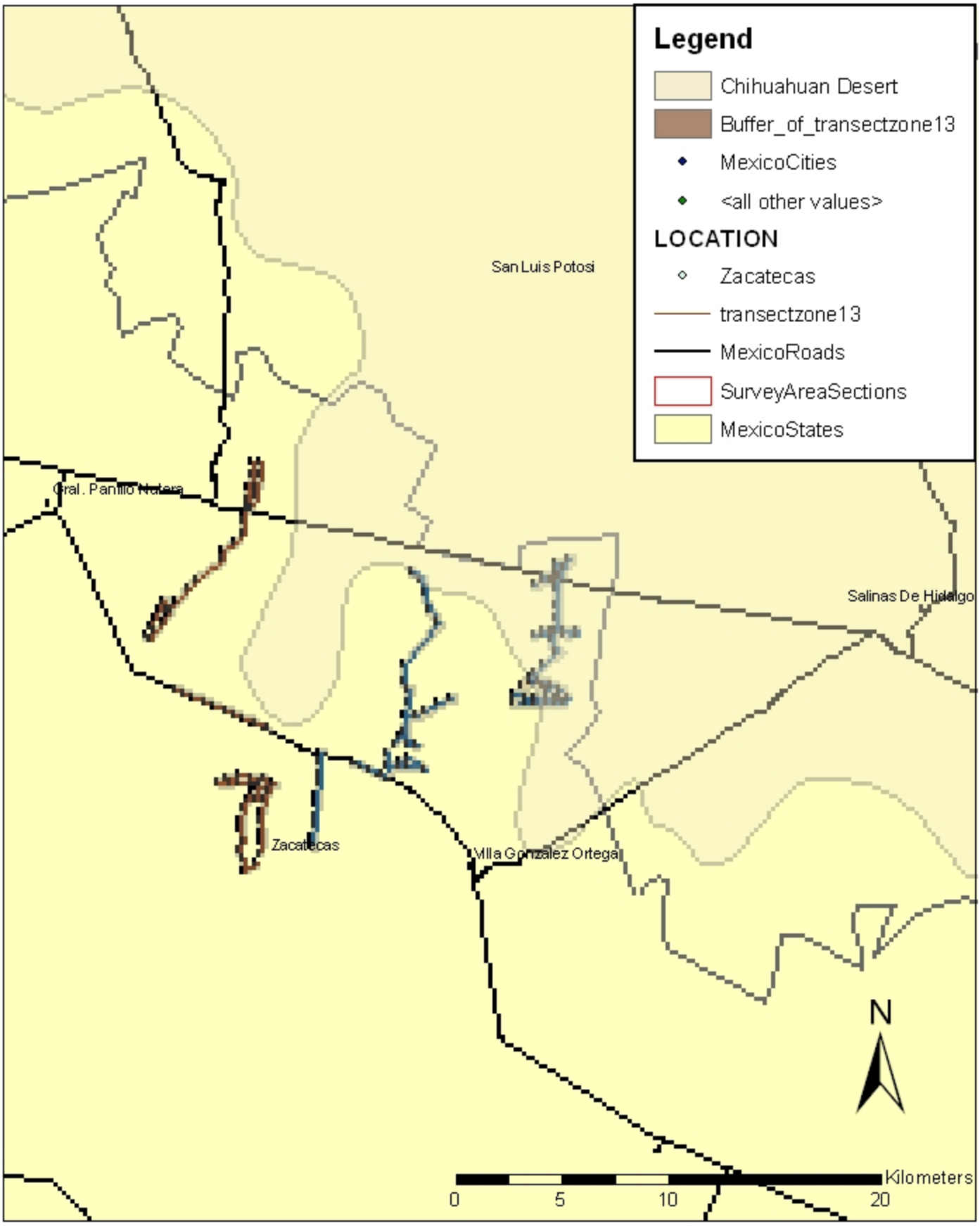
2005 BUOW Surveyed Sites Southeast Zacatecas



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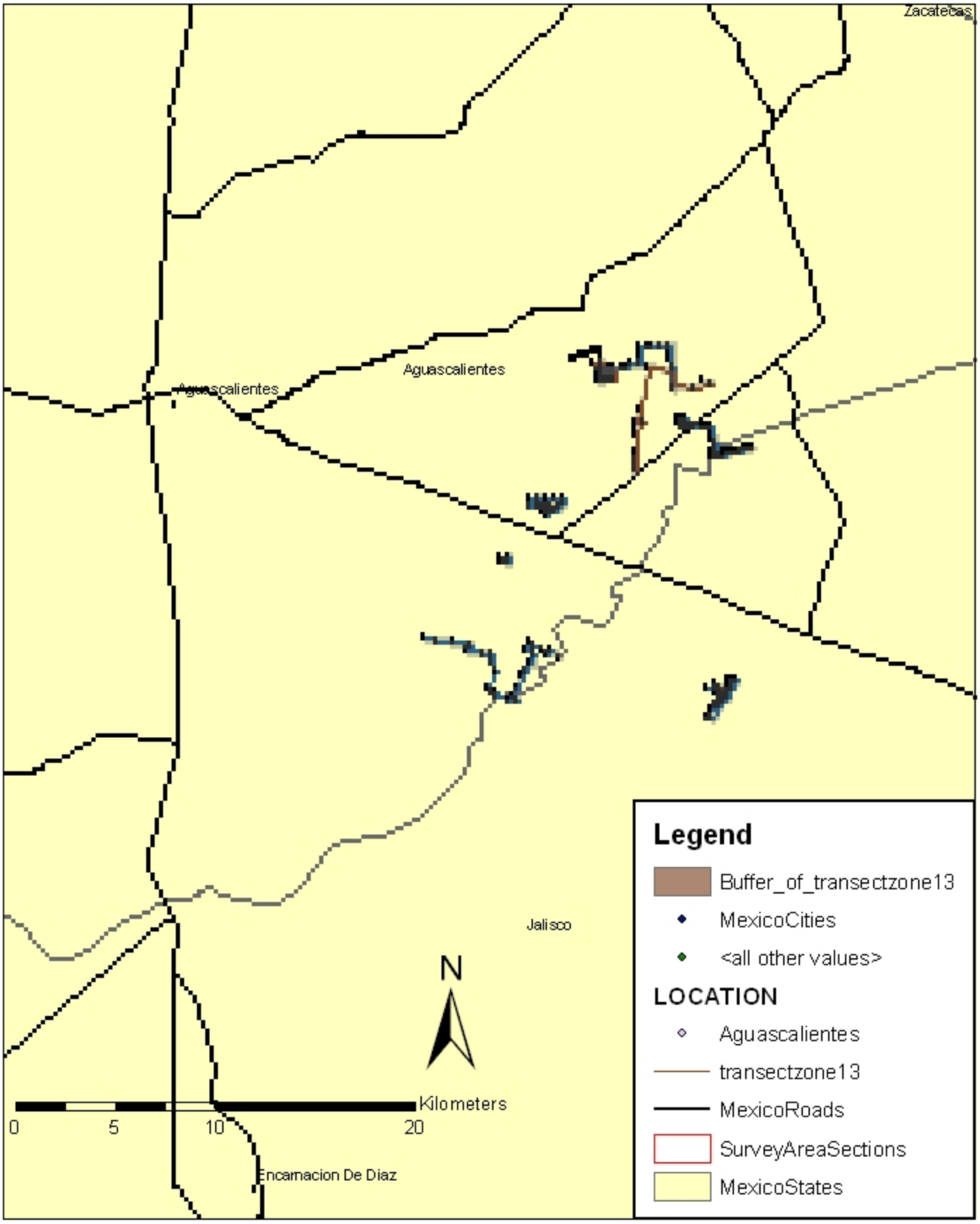
2005 BUOW Surveyed Sites Eastern Aguascalientes



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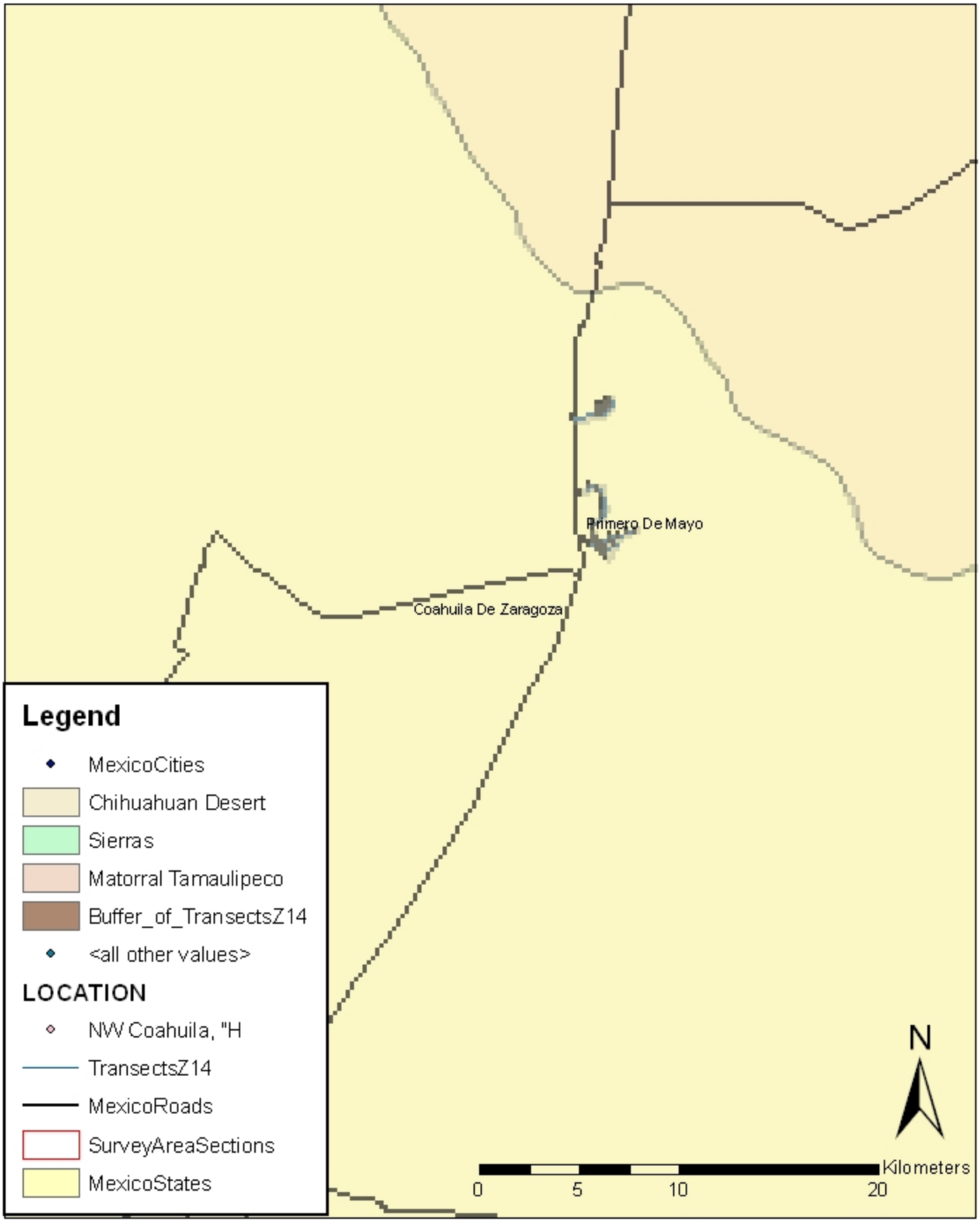
2005 BUOW Surveyed Sites in Northern Coahuila



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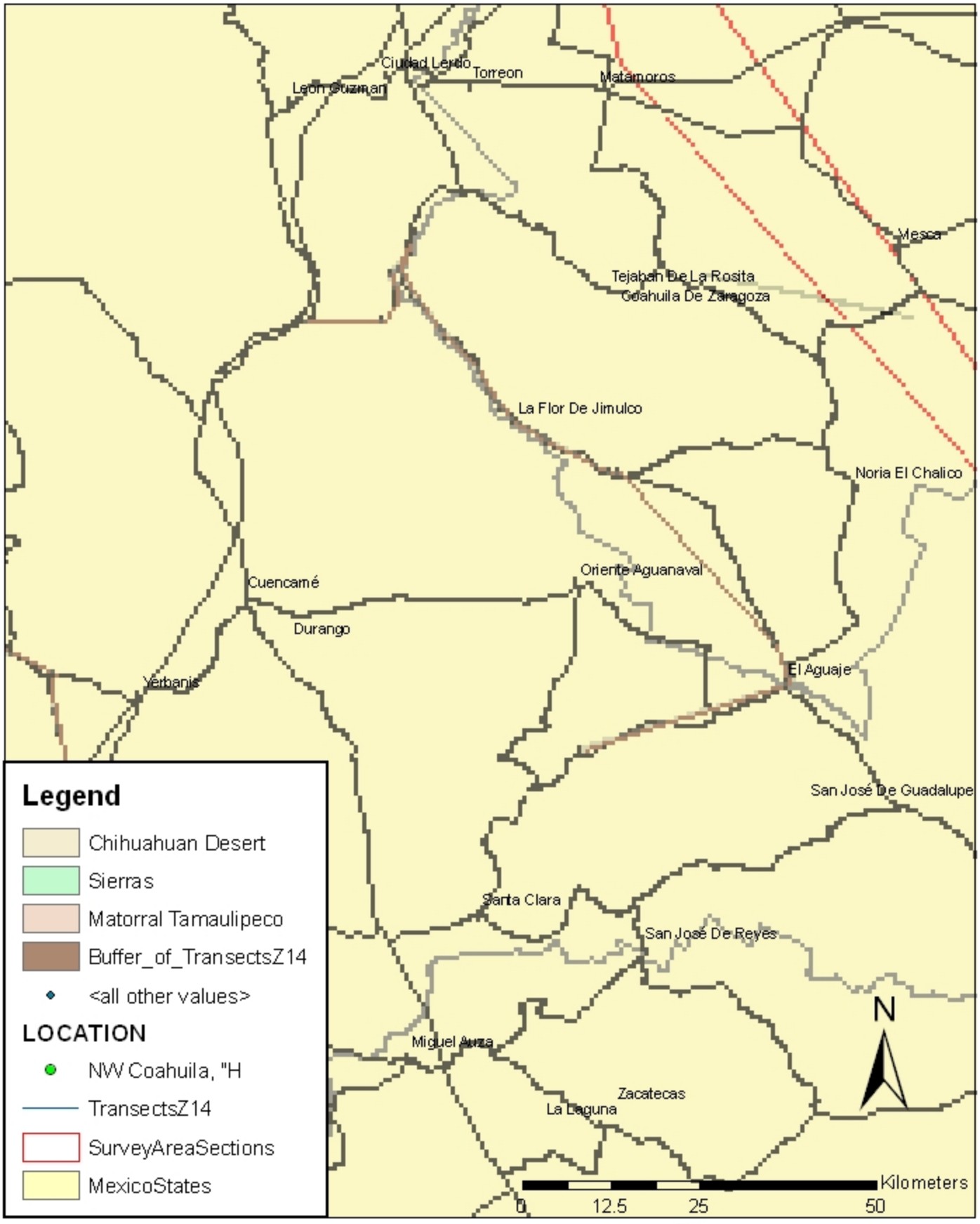
2005 BUOW Surveyed Sites in Northwest Coahuila



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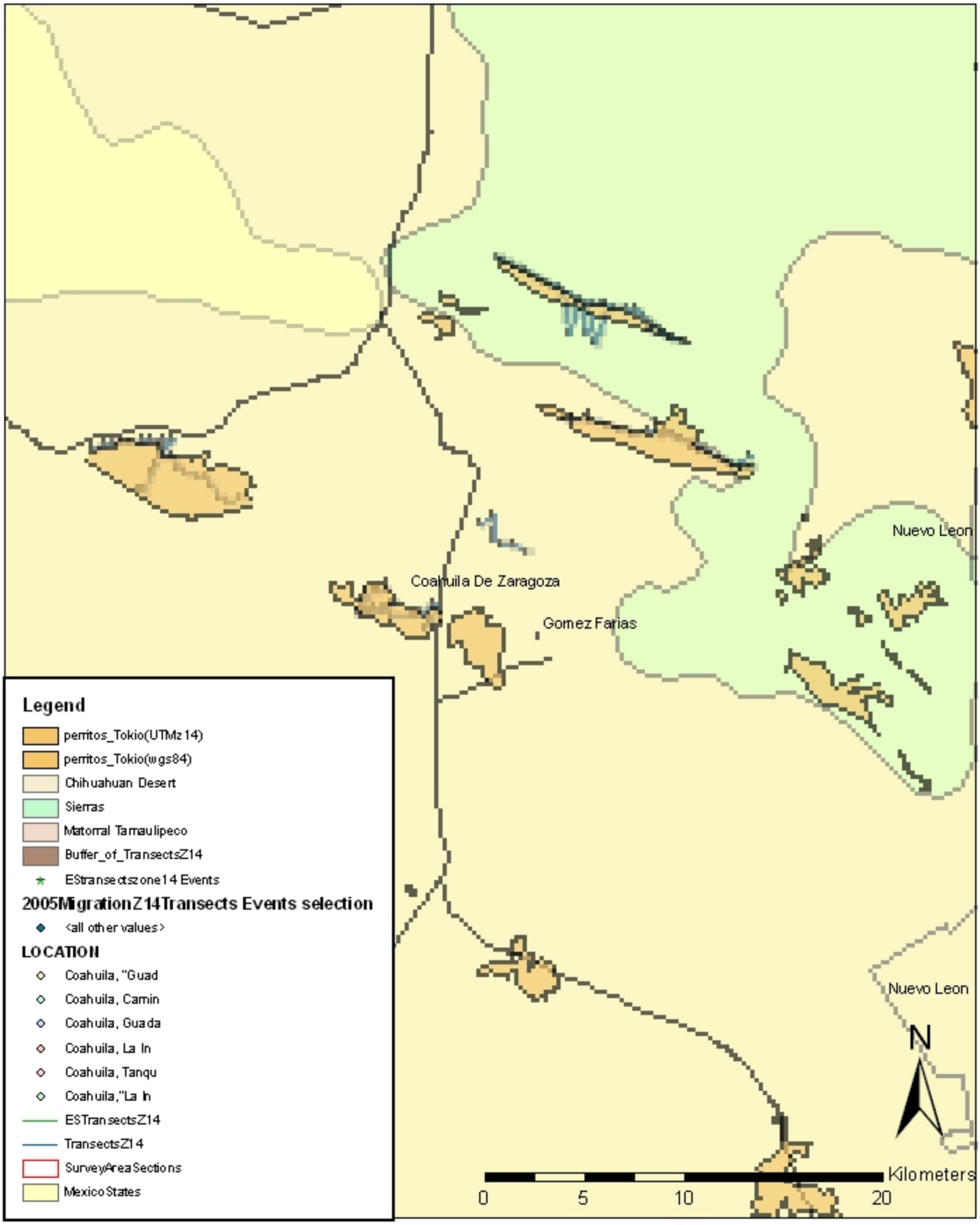
2005 BUOW Surveyed Sites in Southern Coahuila



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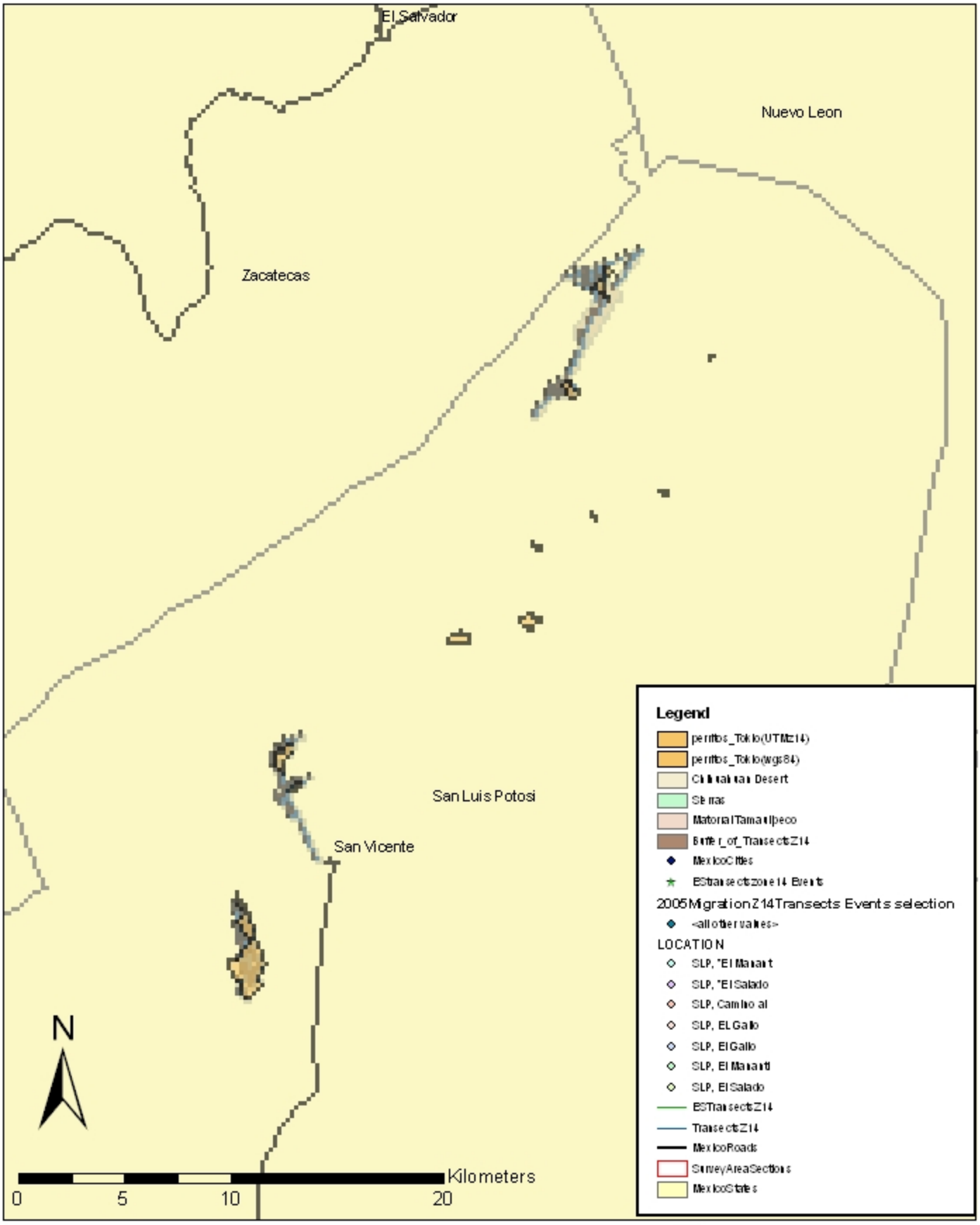
2005 BUOW Surveyed Sites in Northern San Luis Potosi



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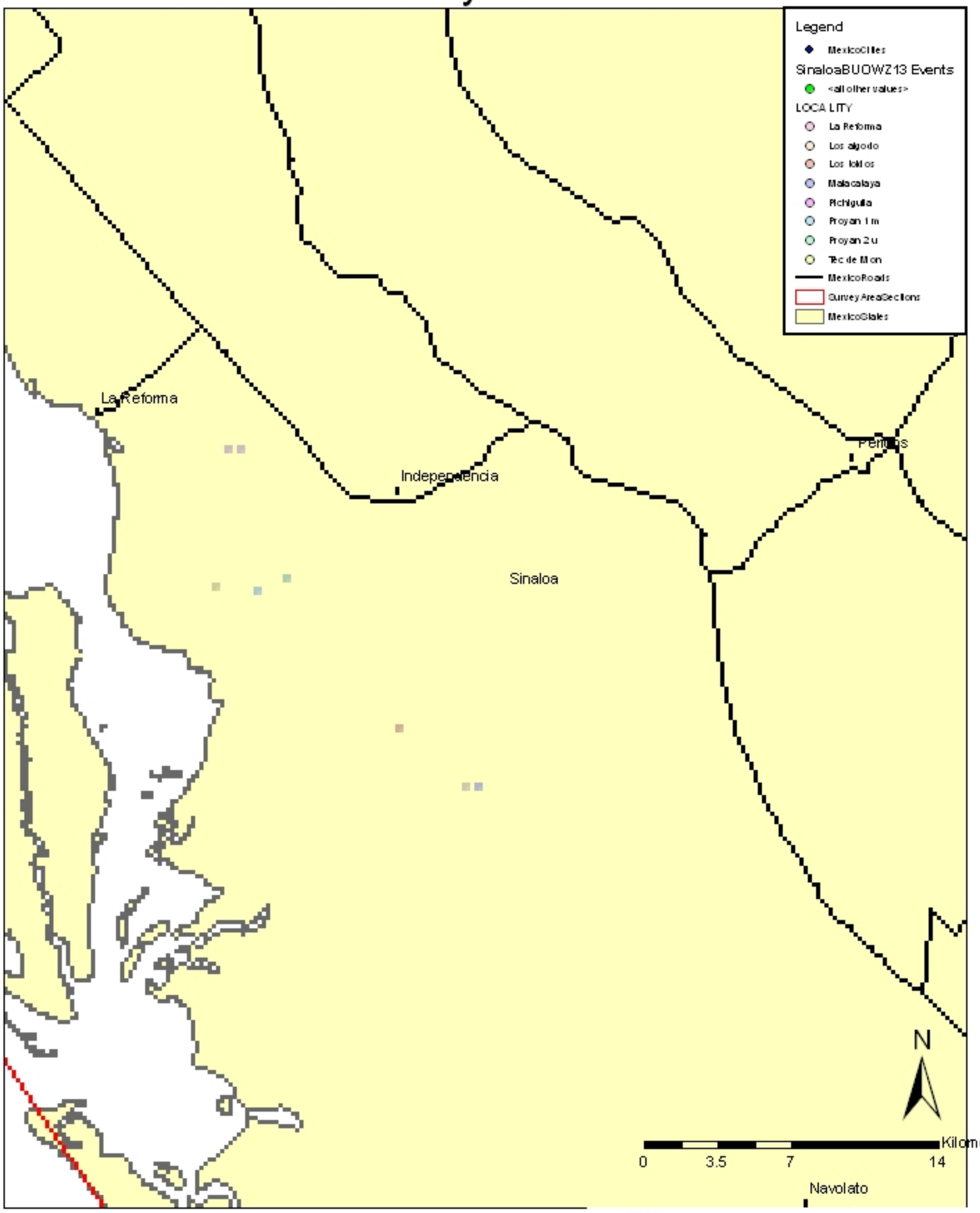
2005 BUOW Surveyed Sites in Sinaloa



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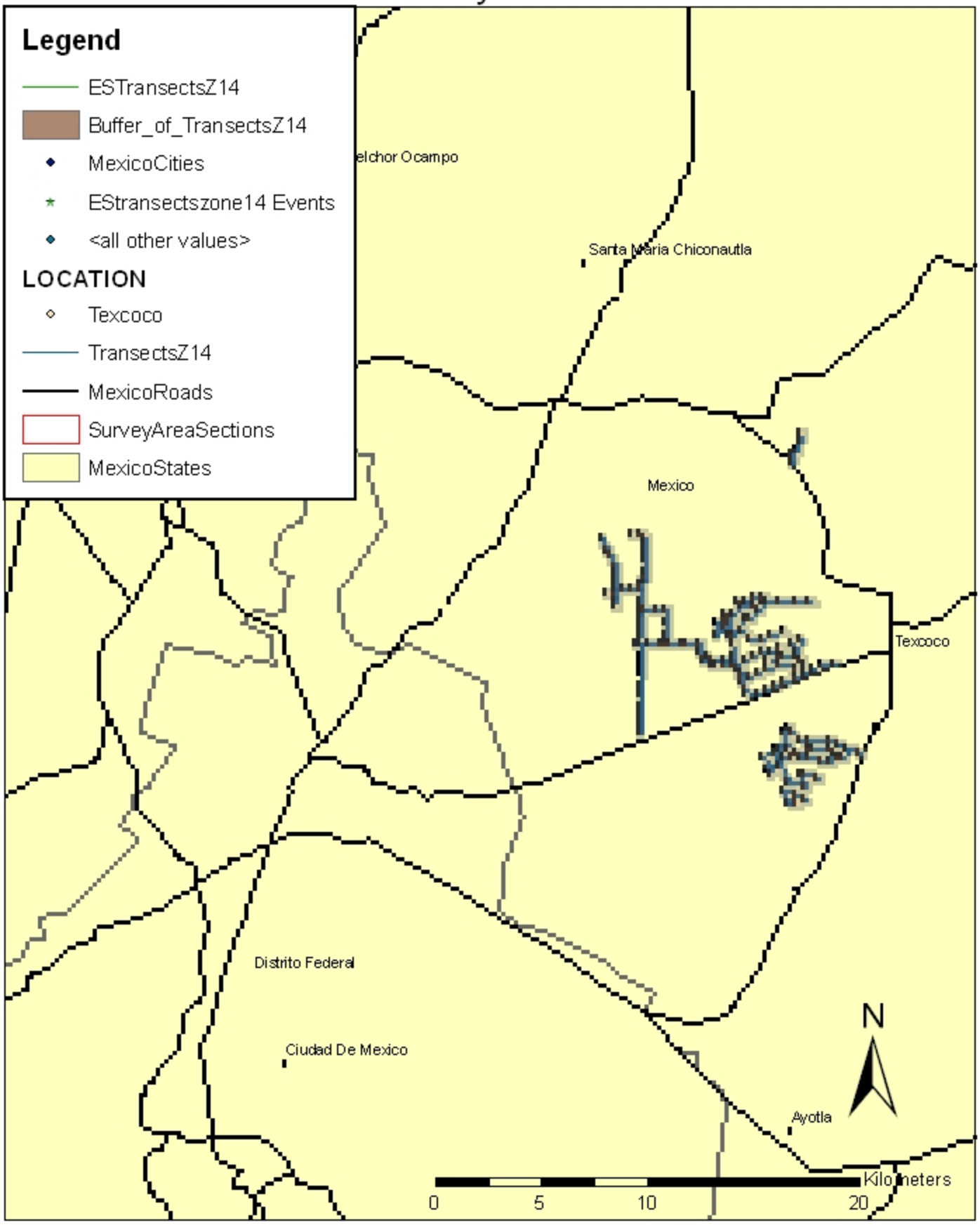
2005 BUOW Surveyed Sites in Texcoco



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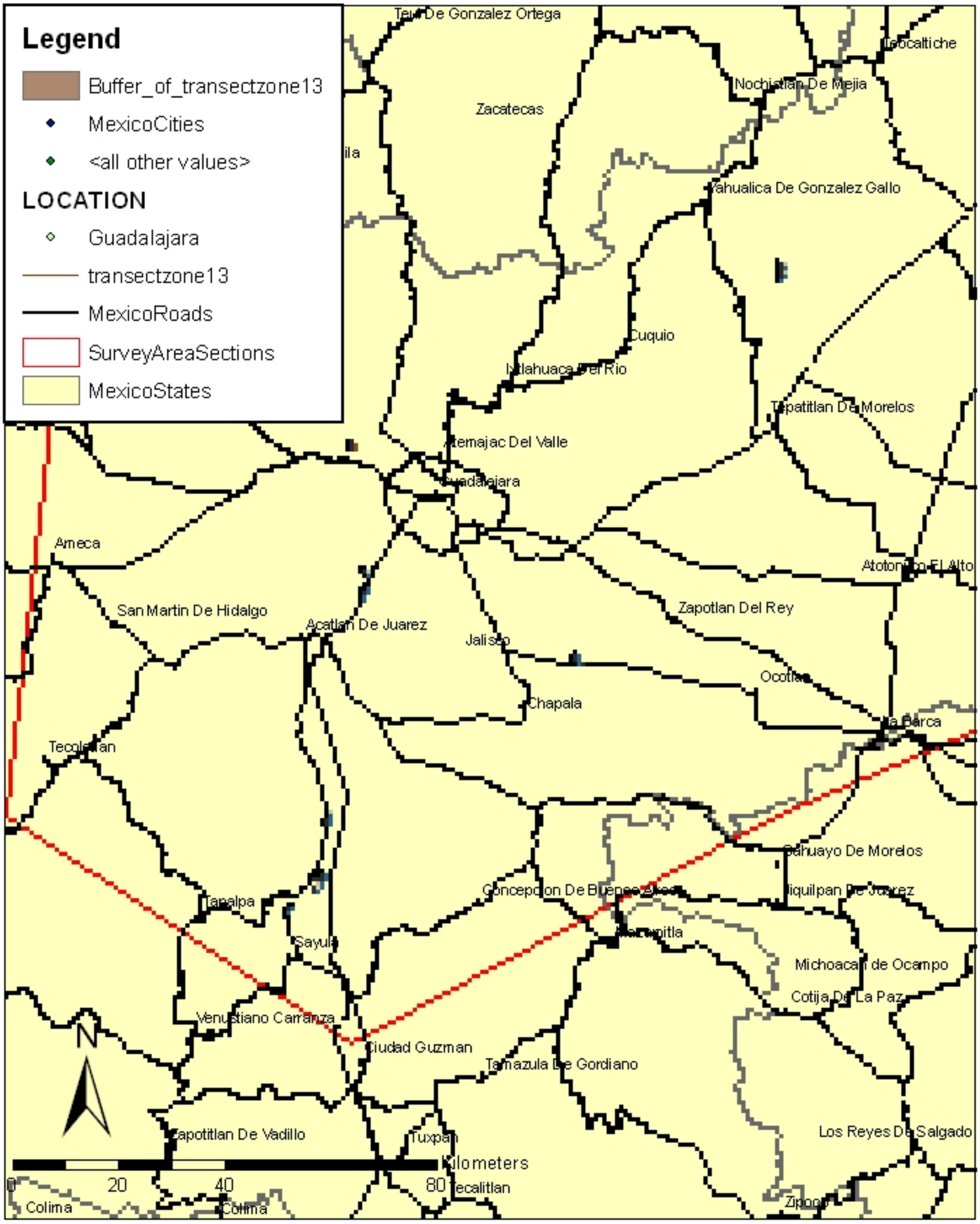
2005 BUOW Surveyed Sites in Jalisco



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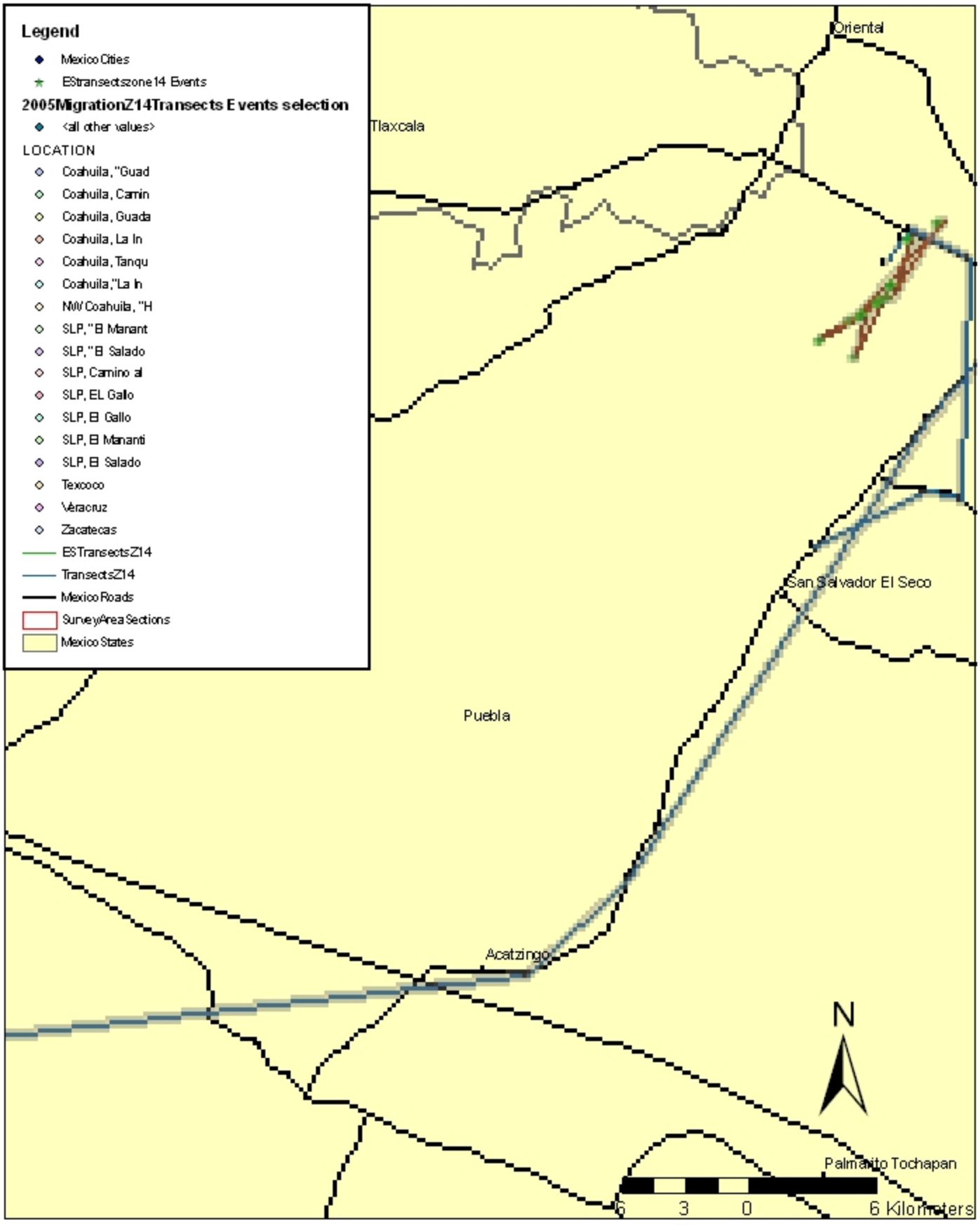
2005 BUOW Surveyed Sites in Puebla/Tlaxcala



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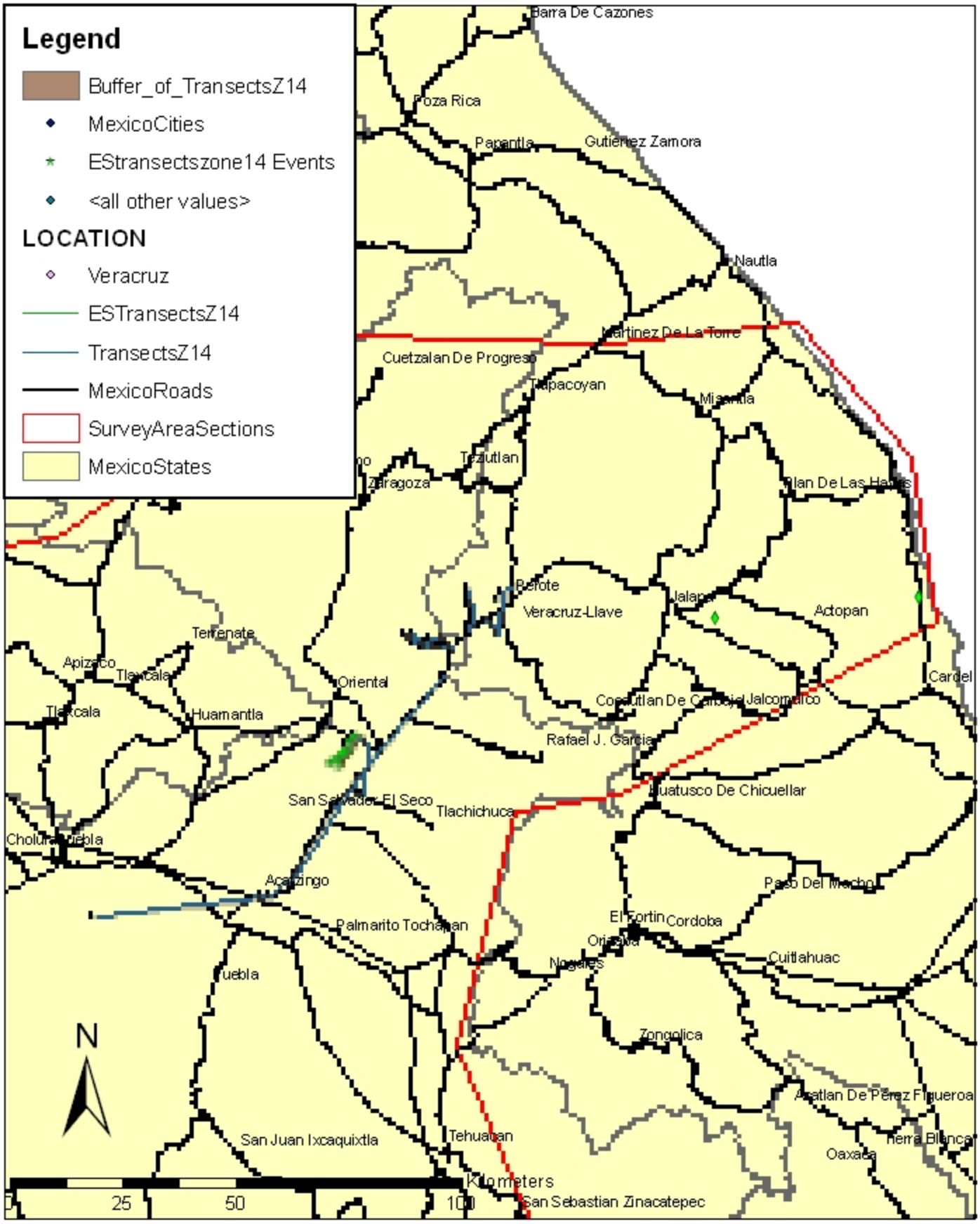
2005 BUOW Surveyed Sites in Veracruz-Puebla



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