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Migratory linkages of Burrowing Owls on DoD installations and adjacent lands
Final report

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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. Some populations have declined and Burrowing Owls have been extirpated from areas on the western, northern, and eastern periphery of their breeding range. Because of these declines, Burrowing Owls are listed as a *Species of National Conservation Concern* in the United States (U.S. Fish and Wildlife Service 2008) and federally endangered in Canada. 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. Moreover, 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. Finally, Burrowing Owls are listed as a Bird of Conservation Concern by DoD Partners-in-Flight in 7 of the BCR regions where they occur (BCRs 9, 11, 16, 17, 32, 33, and 35) and by 83 of the 85 DoD installations in those BCRs.

However, population declines in Burrowing Owls do not appear to be ubiquitous; owls appear to be declining in some locations (and on some DoD installations) but not in other locations. Indeed, recent studies suggest that owls are decreasing in the northern periphery of their breeding range in North America, but appear to be stable or increasing in the desert regions of the southwestern U.S. and northwestern Mexico. Owls appear to be year-round residents in the southwestern U.S. and northwestern Mexico and population densities on many DoD installations in the region are much higher compared to the surrounding landscape (Ellis et al. 2004).

One possible explanation for the regional variation in population trends of Burrowing Owls is that they are becoming less migratory; owls which once migrated to northern breeding locations during the summer may have recently become year-round residents in the southwestern U.S. and northern Mexico. In other words, 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 the likely effectiveness of different management actions designed to increase local populations. Burrowing Owls breed and/or overwinter on dozens of DoD installations throughout the western U.S. and, hence, any changes in their status may affect the military mission.

Understanding why owls have declined in some locations but not in others requires a broad-scale comparative approach across their breeding range. Burrowing Owls are present on many DoD installations throughout the western U.S. and especially in the southwest; most (if not all) DoD installations located within suitable habitat in this region have (or once had) populations of breeding owls. Hence, DoD is vested in the persistence of this species and maintaining the DoD mission requires a better understanding as to why these birds are declining in some locations but not others.

Over the past 10 years, numerous DoD installations have requested and/or obtained funds to monitor and conduct studies of Burrowing Owls on their installation. Methods and protocols have varied greatly and there has been no coordination or synthesis among these independent efforts. This project conducted studies in a standardized way on bases throughout the western U.S. using a collaborative approach – not only among DoD installations, but also including partnerships with other agencies and organizations. In addition to identifying migratory linkages of Burrowing Owls throughout North America, we produced a series of documents describing standardized protocols so that DoD installations throughout the country can use identical methods (and hence produce comparable results) on any future Burrowing Owl monitoring or research efforts that occur on DoD lands.

The objectives of this project were:

1) Determine the linkages and connectivity of Burrowing Owl populations throughout North America.
2) Estimate the extent of changes in the breeding distribution of Burrowing Owls
3) Estimate the extent to which individual owls move among populations, both among DoD installations and between DoD installations and other lands.
4) Test the hypothesis that Burrowing Owls are redistributing their numbers by becoming less migratory.
5) Develop standardized protocols for coordinated efforts to monitor and study burrowing owls on DoD installations

We used stable isotope ratios from owl feathers, molecular genetics, and radio telemetry to identify linkages among DoD installations and lands managed by other state and federal partners and quantify land-use of migrating and wintering owls in the region. Because Burrowing Owls often nest in close proximity to airfields on DoD installations throughout the southwestern U.S., the telemetry component of this project also provides valuable information to the Bird Air Strike Hazard (BASH) program regarding the foraging areas used by burrowing owls, their migratory trajectories off the installation, and the frequency of owl-aircraft strikes.

METHODS

We located, trapped, and individually color-marked adult and juvenile Burrowing Owls at most of the DoD installations in the western U.S. that proved to have substantial aggregations of Burrowing Owls. We collected a feather from each of 3 feather tracts and we collected a blood sample from each bird (see Appendix 1 for details). We analyzed this enormous set of feather and blood samples to identify the latitude at which each feather was grown and to document the extent of connectivity among Burrowing Owls on DoD installations throughout the western U.S.

The project team was led by the 2 principal investigators: Dr. Courtney Conway from the U.S. Geological Survey and the University of Arizona (Tucson, Arizona), and Carol Finley from Kirtland Air Force Base (Kirtland AFB, New Mexico). Other key members of the team included Vicki Garcia from the University of Arizona in Tucson, AZ, Marianne Mershon from Envirological Services Inc. in Albuquerque, NM, 2 graduate students at the University of Arizona (Mark Ogonowski and Alberto Macias-Duarte), 2 senior biologists with Envirological Services (Kirsten McDonnell and Octavio Cruz), and 2 research biologists from the Canadian Wildlife Service (Dr. Geoffrey Holroyd and Dr. Troy Wellicome). All of these key team members had worked on Burrowing Owls for many years and provided team representation from a state university (Garcia, Ogonowski), U.S. government agency (Conway), Canadian government agency (Holroyd, Wellicome), Mexico (Macias-Duarte), the private sector (Mershon, McDonnell, Cruz), and DoD (Finley). The team also included natural resource managers and biologists from many DoD installations who actively participated in the project (e.g., Trish Griffin at White Sands Missile Range, Mead Klavetter at Pinon Canyon Maneuver Site, Robbie Knight at Dugway Proving Ground, and Carl Rudeen at Mountain Home Air Force Base).

Range-wide patterns in body size of burrowing owls

We weighed each owl, and measured the wing chord and metatarsal length of each adult in order to determine how Burrowing Owl morphological traits vary with latitude. We used Analysis of Covariance (ANCOVA) to analyze morphological traits of adult Burrowing Owls. The response variables were weight (g), left wing chord length (mm), and right metatarsal length (mm). Explanatory variables for each of the three analyses were latitude, date captured, and sex. We conducted similar analyses to examine body weight (response variable) of juvenile Burrowing Owls and examined latitude, age of juvenile when it was captured (days), and date captured as possible explanatory variables.

Estimating changes in burrowing owl distribution based on BBS data

We analyzed data from the North American Breeding Bird Survey (BBS) to quantify changes in the breeding distribution of burrowing owls over the past 40 years. Species distributions are notoriously difficult to define (Gaston 2003), but several analytical approaches have been suggested for delineating species' distributions based on presence-absence data (Fortin et al. 2005). We used an approach intended to model the breeding distribution of burrowing owls as a dynamic process that involved time without partitioning the dataset into discrete subsets of space and time. We used BBS data (USGS Patuxent Wildlife Research Center 2009) from 1967 to 2008 to fit a logistic regression model to predict the probability of burrowing owl presence as a function of longitude, latitude, and year. We modeled logit(p) to be a linear function of year and we modeled the spatial variation of the linear temporal trend in logit(p) by making the intercept (β_0) and the slope (β_1) a function of longitude and latitude. By following this procedure, we avoided partitioning the dataset into discrete subsets for each BBS route to obtain local estimates of temporal trends. Partitioning the data into subsets creates as many models as the number of BBS routes with burrowing owls (i.e., 588 BBS routes), each with 2 parameters (β_0 and β_1, and hence 1176 regression parameters total). Hence, our approach is a more parsimonious way to examine temporal changes in the breeding distribution of the burrowing owl. We also avoided the problem of complete or quasi-complete separation by BBS route (when a year t exists such us that only absences are recorded before t and only presences are recorded after t, or vice versa) in the maximum likelihood estimation procedure (Hosmer and Lemeshow 1999) which can lead to numerical errors. We used a double Fourier series to model for the spatially explicit intercept and slope of the equation and assumed that both parameters can be modeled as a sum of two-dimensional wavelets of different frequencies. Sampling effort has increased since the initial implementation of the BBS in the 1960s and may hinder our ability to accurately model the probability of burrowing owl's presence in space and time. The number of BBS routes surveyed (and hence the number of routes with ≥1 burrowing owl detection) has steadily increased since the initial implementation of the BBS in 1967, which creates an unbalanced sampling design in the year variable. Balanced designs reduce bias (i.e. regression coefficients shifting away from zero, Firth 1993) in maximum likelihood estimates for logistic regression in discrete variables (Dietrich 2005). Hence, we used simulations to determine if the increase in sampling effort inherent in BBS data biased our results and was exclusively responsible for the inferred spatio-temporal patterns in the probability of presence by the original dataset. We ran 10 simulations by randomly assigning a presence or absence value to each BBS route sampled through 1967-2008 using a Bernoulli distribution. We used the average yearly proportion of BBS routes with presence of burrowing owls estimated from our logistic regression analysis as the Bernoulli parameter.

Connectivity among populations based on genetic markers

We extracted genomic DNA from blood samples using a Qiagen© DNeasy® Blood & Tissue Kit. We initially used microsatellite DNA primers previously developed (Korfanta et al. 2002), but we could consistently obtain PCR products for only two of these markers (BUOW7 and BUOW11). Moreover, all of the microsatellites developed by Korfanta et al. (2002) had low variability (and hence limited ability to distinguish among populations). Hence, we chose to develop a set of novel microsatellite markers for Burrowing Owls that were more variable. Therefore, we extracted further genomic DNA from blood samples using a Qiagen© DNeasy® Blood & Tissue Kit. The DNA was partially restricted with the enzyme RSAI (NEB) and fragments were ligated (using T4 DNA ligase) to double-stranded SNX-24 linkers (Glenn and Schable 2005). To create a whole genome PCR library, linker-ligated fragments were amplified by polymerase chain reaction (PCR) using an SNX-24 forward primer and high-fidelity DNA polymerase (Invitrogen). This library was hybridized to biotinylated microsatellite oligonucleotide probes $(GT)_{15}$, $(CT)_{15}$, and $(GATA)_{8}$. Hybridized fragments were captured on streptavidin-coated paramagnetic beads (Dynal). Microsatellite-enriched fragments were recovered by PCR and products were ligated and transformed using a TOPO TA cloning kit (Invitrogen). Approximately 276 colonies were amplified using M13 forward and reverse primers, with clones ranging from 500 to 1200 bp, as visualized on 1.5% agarose gels. Clones were sequenced using M13 primers on an ABI 3730xl genetic analyzer (PE Applied Biosystems) using BigDye Terminator. From clones with recognizable microsatellite sequences, we designed 45 primer pairs using Primer 3 software (Rozen and Skaletsky 2000). The designed primer pairs were double-checked for homodimers, hairpins, and heterodimers using Oligo Analyser software (Integrated DNA Technologies; http:// www.idtdna.com/analyser/Applications/OligoAnalyser). Of the initial 45 primer pairs designed, 13 loci amplified and had substantial variation among individuals (Macias-Duarte et al. 2010). We then assessed the variability of these loci in burrowing owls from DoD installations throughout the western U.S. and from Canadian and Mexican populations.

To test our predictions, we grouped the 36 study locations (Table 3) into 3 categories: agricultural areas in the southern portion of the species' range, areas in the northern portion of the species' range where migratory populations are declining, and all other study locations. Seven of our study locations were located in irrigated agricultural areas of northwestern Mexico and southern Arizona ('southern agricultural study locations' hereafter). These study locations were Casa Grande (CAG), Mexicali Valley (MEX), Caborca (CAB), Hermosillo (HER), Yaqui-Mayo Valley (YAQ), Rio Fuerte Valley (FUE), and Culiacan (CUL). Some population declines have been documented throughout the breeding range of the burrowing owl, but systematic regional declines have been most evident in Alberta, Saskatchewan, North Dakota, and South Dakota, where the species is close to extirpation (owls have been extirpated from Manitoba and British Columbia). Therefore, we only defined Alberta (ALB), Saskatchewan (SAK) and Grand River-Little Missouri National Grasslands (GRL) as northern study locations with declining migratory breeding populations ('northern study locations' hereafter).

We used MS Excel© macro GENALEX 3.6 (Peakall and Smouse 2006) to calculate standard descriptive statistics of genetic diversity of burrowing owls in our study locations, including observed heterozygosity, expected heterozygosity, and fixation index F. We also used program ARLEQUIN 3.1.1 (Excoffier 2006) to estimate the Weir and Cockerham's F_{ST} (θ, Weir and Cockerham 1984) for all populations.

We computed actual differentiation *D* (Jost 2008) to test our prediction that gene flow between declining migratory populations in the north and populations in southern agricultural areas would disrupt an otherwise apparent isolation-by-distance relationship. We used the web-based platform GMSOD 1.2.5 (http://www.ngcrawford.com/django/jost/) to compute actual differentiation *D*. We used *D* as our measure of population-pairwise genetic differentiation because F_{ST} does not adequately measure genetic differentiation when within-population allelic diversity is high (Jost 2008). *D* ranges from 0 to 1, corresponding to complete similarity to complete differentiation. We performed a Mantel test (Mantel 1967) to test our assumption of the existence of an isolation-by-distance pattern (i.e., that the genetic differentiation between 2 populations is positively correlated to the geographic distance that separates those populations). If our hypothesis is true, we expected that pairwise comparisons between northern locations and southern agricultural locations would fall below the predicted Mantel regression line in the scatterplot of genetic *vs.* geographic distances.

We performed an Analysis of Molecular Variance *AMOVA* (Weir and Cockerham 1984) using *ARLEQUIN* 3.1.1 to test our prediction that all declining migratory populations in the north and all populations in agricultural areas in the south, pooled together, would be genetically differentiated from the remainder of the breeding populations within the species' range (pooled together). The *AMOVA* is analogous to a nested Analysis of Variance and uses a permutational approach to test the statistical significance of any given classification of study locations in explaining the overall genotypic variation. We performed 2 *AMOVA*s, one based on allele sizes (R_{ST}) and the other based on the number of different alleles (F_{ST}) (Michalakis and Excoffier 1996). The former measure assumes the stepwise mutation model (Ohta and Kimura 1973), which is appropriate for microsatellite loci. We used the *AMOVAs* to test for evidence of 2 distinct genetic groups: Group 1 with southern agricultural locations (CAG, CAB, CUL, FUE, HER, and YAQ) together with northern locations (ALB, SAK, and GRL), and Group 2 including all other locations. Our large sample size (1,560 individuals) may confer enough statistical power to reject the null hypothesis for any grouping of study locations. To explore this possibility, we conducted 7 additional AMOVAs using 2-group classifications by replacing northern study locations (ALB, SAK, and GRL) from Group 1 with other study locations and moving them to Group 2 (Table 4).

We conducted an assignment test as implemented by program *STRUCTURE* (Hubisz et al. 2009; Pritchard et al. 2000) to test our prediction that southern agricultural study locations will have more individual owls with probabilities of membership similar to those found in individuals from declining populations in the north compared to the non-agricultural study locations in the southern part of the species range. *STRUCTURE* 2.3.3 implements an algorithm suited to infer weak population structure (Hubisz et al. 2009). *STRUCTURE* estimates the posterior probability of the data (L(K)=Prob[*Data* |K]) given existence of K burrowing owl populations under Hardy-Weinberg equilibrium and estimates the posterior probability of membership of each individual owl to each of K populations. We used study locations as prior information to assist the inference of population structure (Hubisz et al. 2009) by setting LOCPRIOR=1 in *STRUCTURE*. We performed 10 runs for each K = 1, 2, … 10. Each run consisted of a burn-in period of 50,000 Markov Chain Monte Carlo repetitions followed by 50,000 repetitions to sample from the posterior distribution of *K*. We estimated L(*K*) for each *K* from correlated allele frequencies and an admixture model. This approach is superior when population differentiation is low at detecting subtle genetic structure compared to the use of uncorrelated allele frequencies and a non-admixture model (Falush et al. 2003). We used the outputs of the web-based platform STRUCTURE HARVESTER 0.56.3 (http://taylor0.biology.ucla.edu/struct_harvest/) to assess the number of inferred populations. *STRUCTURE HARVESTER* estimates the statistic Δ*K* at each value of *K*. Δ*K* performs better in detecting population genetic structure than L(*K*) (Evanno et al. 2005). Therefore actual number of populations is revealed by the value of *K* with the highest value of Δ*K*. We used program *CLUMPP* (Jakobsson and Rosenberg 2007) to calculate the posterior probabilities of membership of each individual owl to each of the *K* populations from our multiple runs in *STRUCTURE*.

Connectivity and linkages based on stable isotope ratios of feathers

We obtained the isotope ratios of hydrogen (δD), carbon (δ^{13}C), and nitrogen (δ^{15}N) from nestling feathers to determine the multi-isotope signature at each sampling location (i.e., each DoD installation or non-DoD sampling location). This information was supplemented with multi-isotope signatures from owls at locations across North America that have already been sampled by our many project partners. With these data, we mapped the local multi-isotope signature throughout the Burrowing Owl breeding range in North America. This map allowed us to estimate the previous breeding location of each adult owl (or the hatching location of first-year breeders) and the extent of population connectivity of Burrowing Owls throughout their breeding range due to regional variation in isotope ratios. For example, δD varies in a very predictable latitudinal pattern and also correlates with amount of precipitation in the local area; δ^{13}C varies among plant communities based on the composition of C_2, C_3 and CAM plant species; and δ^{15}N allows discrimination between artificial and natural sources of nitrogen, such as agricultural areas and natural plant communities (Hobson 1999). These isotope signatures are incorporated into a bird's feathers when the bird undergoes a feather molt. Birds typically molt their flight feathers (wing and tail) once per year immediately after breeding (on the breeding grounds). Stable isotope ratios in a feather are fixed once the feather is fully grown, so we can examine a flight feather of a breeding owl to determine where it spent the previous summer.

To obtain the isotope signatures, we washed all feathers in a 2:1 chloroform/methanol solution to remove surface oils (Wassenaar 2008). We rinsed and submerged all feathers for an hour in the chloroform/methanol solution. We then removed the feathers from the solution and let them dry for one hour at room temperature in a fume hood. We cut the distal end of a rectrix for after-hatching-year (AHY) burrowing owls, and the distal end of a breast and/or a back feather for nestlings (HY). We sent our feather samples for analyses by continuous-flow isotope-ratio mass-spectrometry to the Environmental Isotope Laboratory at the University of Arizona.

We collected feathers from young and adult burrowing owls during the breeding seasons of 2004-2009 at 36 study locations throughout the species' breeding range. We defined populations in Alberta (ALB) and Saskatchewan (SAK) as declining migratory populations on the northern edge of the species' breeding distribution based on survey data in those locations (Sauer et al. 2008). We defined populations in Casa Grande (CAG), Salton Sea National Wildlife Refuge (SSW), Mexicali Valley (MEX), Caborca Valley (CAB), Hermosillo (HER), Yaqui-

Mayo Valley (YAQ), Rio Fuerte Valley (FUE), and Culiacan Valley (CUL) as southern resident populations within irrigated agricultural areas. We pulled breast, back, and head feathers from nestlings that were >10 days-old, and we pulled the third right rectrix from adult burrowing owls. We did not use natal down feathers from nestlings in our study, which may have the isotope signature of the mother's diet during spring migration (Duxbury et al. 2003). We performed bird handling, feather collection, and the import and export of feathers through international boundaries under the compliance of Canadian, Mexican, and U.S. regulations.

We initially used a chloroform:methanol solution for cleaning feathers in 45.6% of our samples to remove oils from feathers. We subsequently changed our cleaning protocol to a two-step cleaning procedure that included both a detergent solution and chloroform:methanol solution after a paper was published by Paritte and Kelly (2009). We processed all our samples in the Environmental Stable Isotope Laboratory at the University of Arizona. We used a Finnegan MAT TC/EA connected to Finnegan Delta Plus mass spectrometer through a Finnegan MAT CONFOLO III Interface to measure δ^2H in feather samples. Our analytical precision for δ^2H based on the repeated analysis of a benzoic acid lab standard was better than 1.8‰. We used sheep wool and swan feather trace standards to calculate non-exchangeable δ^2H in owl feather samples. We equilibrated samples and tracer standards with ambient water vapor in the laboratory for at least 4 days. After equilibration, we dried samples to eliminate the effects of adsorbed water. We included tracer standards with each batch of owl feather samples analyzed to monitor the effects of lab water vapor on measured δ^2H values. We used the δ^2H value of the tracer standards to calculate the δ^2H value of the exchangeable hydrogen in owl feather samples. We then calculated the value of non-exchangeable hydrogen in owl feather samples using a mass balance equation based on the proportion of exchangeable hydrogen and their total δ^2H value. We used a percentage of exchangeable hydrogen of 9.0% (based on estimates from swan feather tracer standards) and an arbitrary fractionation factor of α =1.12. We measured δ^{13}C and δ^{15}N on a continuous-flow gas-ratio mass spectrometer (Finnigan Delta PlusXL). We combusted samples in an elemental analyzer (Costech) coupled to the mass spectrometer. Standardization was based on acetanalide for elemental concentration, NBS-22 and USGS-24 for δ^{13}C, and IAEA-N-1 and IAEA-N-2 for δ^{15}N. Precision based on repeated internal standards was better than 0.08‰ for δ^{13}C and better than 0.2‰ for δ^{15}N. Values of δ^2H, δ^{13}C, and δ^{15}N (in parts per mil, ‰) are computed for the Vienna Standard Mean Ocean Water standard, PeeDee Belemite standard, and atmospheric N_2, respectively. Precision for δ^2H, δ^{13}C, and δ^{15}N based on replicate subsamples from the same feather were ±4.78‰ (1,263 feathers), ±2.89‰ (222 feathers), and ±0.32‰ (222 feathers), respectively, measured as the square root of the mean square error from an analysis of variance with feather sample (for δ^2H ,δ^{13}C, and δ^{15}N) and date of measurement (for δ^2H) as fixed effects. We included date of measurement in our estimates of precision for δ^2H (and not for δ^{13}C and δ^{15}N) to account for variability in δ^2H measurements caused by the uncontrolled exchange of ^{2}H atoms between ambient water (vapor) and the keratin in our feather samples (Wassenaar and Hobson 2003). The magnitude of this interchange can vary from date to date with temporal changes of δ^2H in ambient water and humidity, and can considerably affect measurements of δ^2H in feather samples.

Variability of δ^2H measurements on the same feather among laboratories (Smith et al. 2009) and across time within the same laboratory (Lott and Smith 2006) create challenges for using deuterium to track animal movements. We attempted to address these sources of measurement error by measuring δ^2H twice in almost all feather samples in the same laboratory (within 2 different batches analyzed $\bar{x} = 30$ days apart, range = 0–479 days). We replicated samples within and among dates of analysis. We used a generalized linear mixed model (Bolker et al. 2008) in the *R* package *NLME* to generate δ^2H for individual owls (fixed effect) accounting for date of measurement (random effect).

First, we assumed that adult burrowing owls with stable isotope signatures outside of the 95th-percentile ellipses defined by nestling signatures were not in the location the previous breeding season. The purpose of this approach was not to predict the origin of owls classified as migrant, but rather to estimate the proportion of adults in each population that was immigrant. We used package *ellipse* in program *R* (R Development Core Team 2009) to generate and plot the 95th-percentile ellipses from a bivariate normal distribution for δ^{13}C or δ^{15}N. Second, we used a local regression analysis (LOESS, Cleveland et al. 1992) for spatial interpolation to build base maps of δ^2H, δ^{13}C, and δ^{15}N across North America based on the stable isotope signatures of nestling feathers. ^{2}H base maps for feathers are available for other bird species for portions of our study area (Lott and Smith 2006, Hobson et al. 2009). The use of δ^{13}C and δ^{15}N base maps to track animal movements remains largely unexplored (Bowen and West 2008). Therefore, feather base maps for δ^{13}C and δ^{15}N are not currently available, although surrogate base maps exists for ^{15}C in terrestrial vegetation (Suits et al. 2005) and ^{15}N for soil-plant interface (Amundson et al. 2003). We decided to build our own base maps specific to burrowing owl feathers given: 1) the lack of information regarding interspecific variation in fractionation processes, and 2) our exhaustive sampling of nestling feathers throughout the species' breeding range (we typically caught juveniles while attempting to catch adults). We wrote our own script in program *R* to conduct geographic assignment of individuals with known isotopic signature and unknown origin. We created a 100×100 grid of points for the region encompassed by our study populations, with 0.23°×0.31° grid cells. We trimmed this grid by a maximum convex polygon with vertices defined by our study populations to avoid assignment of adult owls to locations out of our range of inference. We then used the command *predict.loess* to predict δ^2H, δ^{13}C, and δ^{15}N values for each location in the final grid based on the *R* object generated with command *loess* on nestling data. We computed the standardized Euclid distance from the isotopic signature of the *i*-th adult burrowing owl (i = 1, 2, … , 894) to the isotopic signature predicted by the three base maps at each point on the geographic grid (j = 1, 2, … , 5129).

We assigned each adult burrowing owl to the location on our grid that had the most similar stable isotope signature to that of the adult owl (i.e., the location that resulted in the lowest Euclidian distance; *d*). In situations where >1 location had similar *d* values, we assumed that the location closest to the collection site was more likely to represent the true origin of an owl. Therefore, we assigned each adult burrowing owl's origin to the closest geographic location on the grid among competing locations with the same *d*. We used this as a conservative approach intended to prevent the detection of spurious long-distance dispersal events. A basic assumption in this analysis is that stable isotope signatures of juvenile body feathers are comparable to those of rectrices in adult feathers grown in the same location (Langin et al. 2007, Smith et al. 2008). Meehan et al. (2003) showed a large, unexplained difference in δ^2H values between juvenile and adult Cooper's hawks. Burrowing owls molt their rectricies simultaneously or nearly so, towards the end of the nestling stage. Thus, we do not expect substantive differences such as those found in Cooper's hawk primaries that are molted over a longer time period during the post-breeding season. We decided to use juvenile body feathers (rather than rectrices of fledglings) because nestlings are considerably easier to trap and estimate age than fledglings (which can be mistaken as after-hatching-year birds) and we could obtain a large sample allowing for more precise estimates. Moreover, we did collect developing rectrices from juveniles to avoid any harm to the growing birds. We used program *R* v. 2.9.2 for Mac to perform all statistical analyses.

Linkages and migratory movements based on radio telemetry

We also placed radio transmitters on a subset of owls on Kirtland AFB and followed these birds as they began their fall migration. The information related to the telemetry portion of the project is presented as a stand-alone document in Part II (page 77 of this report).

RESULTS AND DISCUSSION

Training workshops and partnerships

We held 4 training workshops for DoD personnel and we sponsored DoD personnel who participated in our training workshops to obtain their banding sub-permits from the USGS National Bird Banding Laboratory. During the workshops, each participant received one-on-one instruction and ample first-hand practice on how to handle, band, and collect feathers from at least 3-4 owls. Additionally, we trained participants to accurately record data from Burrowing Owl captures, to store feathers, and to construct Burrowing Owl traps. We provided Burrowing Owl traps and banding supplies to those participants who needed them. We also provided participants with a booklet containing 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 workshops, each participant was competent to trap owls on their own. We sponsored the applications of 7 DoD personnel from 5 installations who are now sub-permittees under the Master Banding Permit of C. Conway. These individuals were then able to trap and band Burrowing Owls at their respective installations and were active team members in the project.

We also worked with a large number of partners from other agencies and organizations to accomplish the project's goals. This project is a good example of a true multi-agency partnership which used Legacy funds to encourage participation and leverage funds from other national and international partners. In addition to the many DoD installations in the region that have nesting Burrowing Owls, many other agencies manage lands that have breeding owls on lands adjacent to DoD installations. We partnered with these agencies and organizations since owl populations on these lands are likely not distinct from those on DoD installations. The project included 16 partner organizations in the U.S. and Canada, and 17 partner organizations in Mexico, in addition to the 38 individual DoD installations that helped with the project. Together, these partners provided matching funds and in-kind support for the project of >$550,000.00. The project partners included: U.S. Fish and Wildlife Service, Canadian Wildlife Service, U.S. Geological Survey, National Park Service, U.S. Environmental Protection Agency, U.S. Department of Energy, Sonoran Joint Venture, World Wildlife Fund, University of Arizona, National Fish and Wildlife Foundation, T&E Inc., Envirological Services Inc., University of Alberta, and National Council of Science and Technology (Mexico). DoD can take credit for leading this large-scale partnership throughout the western U.S. The project also generated many products: 10 papers published in peer-reviewed scientific journals, 4 graduate theses, 16 technical reports, 8 articles/programs in the popular press, 40 presentations at regional, national, and international meetings, and 17 awards given to the graduate students working on the project.

Standardized field protocols

We developed standardized protocols (Appendix 1) for each of the following activities: 1) surveying owls on DoD bases, 2) trapping adult and juvenile owls on bases, 3) banding owls, 4) collecting feather samples from adult and juvenile owls, 5) estimating Burrowing Owl demographic traits, and 6) collecting blood samples from owls (to infer population connectivity via genetic analyses).

Trapping and nest monitoring

We trapped a total of 3131 Burrowing Owls at 56 different locations (38 DoD installations and 18 areas managed by other project partners; Tables 1- 2) in 2005-09 and collected feathers and blood samples from each owl following standardized protocols (Appendix 1). The number of owls and nests provided in Table 2 represent the number captured on DoD and surrounding lands, and thus should be considered the minimum at each of those sites. Additionally, different levels of effort each year at each site affected the number caught. The location of nests and active satellite burrows are reported in Appendix 2. Along with our cooperators in Mexico, we visited 21 Mexican states (also see Part II). We collected blood and feather samples from 7152 Burrowing Owls throughout the species' breeding range, from Alberta and Saskatchewan in Canada, throughout the western United States and northern Mexico and as far south as Mexico City.

Range-wide patterns in body size of burrowing owls

Burrowing Owls captured on DoD and surrounding areas in the U.S. and Mexico were heavier ($F_{1,774} = 38.3$, $P < 0.001$) and their wing chords were longer ($F_{1,585} = 17.8$, $P < 0.001$) as latitude increased (after accounting for sex and capture date; Figs. 1 and 2). In contrast, we did not find a significant pattern in metatarsal length of Burrowing Owls with changing latitude after accounting for sex and capture date (Fig. 3) ($F_{1,756} = 0.9$, $P = 0.356$). Juvenile Burrowing Owls were also heavier with increasing latitude after accounting for the age of the juvenile and capture date (Fig. 4) ($F_{1,1389} = 27.3$, $P < 0.001$). The pattern that owls are heavier and larger as latitude increases is a common pattern in endotherms (Mayr 1963).

Estimating changes in burrowing owl distribution based on BBS data

Our model of burrowing owl breeding distribution based on BBS survey data suggests temporal and spatial changes in the likelihood of detecting burrowing owls on BBS routes throughout North America. The overall proportion of BBS routes at which surveyors detected burrowing owls has decreased in several areas near the northern and eastern edge of the burrowing owl distribution, especially in southern Canada, in eastern North and South Dakota, in eastern Nebraska, and in southern Texas since the first half of the 1970s. In this regard, our logistic regression model suggests a contraction of the burrowing owl's breeding distribution, primarily at the edges of its range (Fig. 5). Overall, the burrowing owl's breeding range evidently retreated from 1967 to 2008 in southern and northern California, Washington, southern Canada, eastern North and South Dakota, eastern Nebraska, eastern Kansas, and southern Texas. All 10 simulations (not shown) failed to reproduce the range contraction observed when we modeled the original dataset. Our simulations produced inconsistent, random contractions and expansions throughout the eastern and northern edges of the burrowing owl's breeding distribution. The results of these simulations suggest that our inferred contraction in the species' distribution is real and is not an artifact of the sampling scheme in the BBS.

Connectivity among populations based on genetic markers

We developed 10 new microsatellite markers for burrowing owls (Macias-Duarte et al. 2010). Burrowing owls exhibited high levels of genetic diversity (Table 5) with relatively low variation among study locations. Per-locus average of number of effective alleles (range 5.70–7.82), expected heterozygosity (range 0.78–0.84), observed heterozygosity (range 0.78–0.87), and fixation index (range -0.06–0.04) were similar among the 36 study locations (Table 5) in spite of the relatively large differences in sample size (range 21-73; Table 3), per-locus average number of alleles (range 9.40–15.70), and number of private alleles (alleles present at only 1 population, range 0.00–0.50; Table 5). We detected the possible occurrence of null alleles for locus ATCU13 in BUC and CUL study locations, for locus ATCU20 in LAG and SAK study locations, for locus ATCU39 in NTS study location, and for locus ATCU45 in MEX study location.

Burrowing owls had low levels of genetic differentiation among study locations as shown by relatively low overall F_{ST} ($\theta = 0.008$) and low pairwise F_{ST} statistics ($\overline{F}_{ST} = 0.0113 \pm 0.0002$, n=630). Low levels of genetic differentiation were also evident in our estimates of actual differentiation *D*, ranging from 0.00 to 0.11. In this regard, we found only a very weak relationship between genetic distance and geographic distance among our study locations (Fig. 6) with a non-significant Mantel's test ($r = 0.015$, $P = 0.43$ based on 1000 permutations). Nevertheless, pairwise comparisons of genetic and geographic distances among northern study locations and southern agricultural locations fall below the Mantel regression line (Fig. 6) in agreement with the prediction of the migration-mediated range-shift hypothesis.

Low levels of genetic differentiation among populations were also highlighted by our *AMOVA*s based on the R_{ST} and F_{ST} statistics. Genetic variation within study locations explained 99% of the total genetic variation, whereas between-study locations and between two-group classifications of study locations explained the remaining 1%. Despite the low levels of genetic differentiation described above, our *AMOVA* based on the F_{ST} statistic provided support the range-shift hypothesis. Both a standard *AMOVA* and a weighted-averaged *AMOVA* over all loci provided suggestive evidence that northern study locations (ALB, SAK, and GRL) and southern agricultural study locations (CAG, CAB, CUL, FUE, HER, MEX, YAQ) together are genetically differentiated from the rest of the study locations ($P = 0.03$ and $P = 0.01$, respectively) although this result did not hold true for the 2 *AMOVA*s based on R_{ST} (P=0.38 and P=0.34, respectively). In addition, only 1 of the 7 additional *AMOVA*s based on F_{ST} was significant for both the standard *AMOVA* and the weighted-averaged *AMOVA* over all loci (Table 4), which is precisely the *AMOVA* that included the nearest 3 study locations (CHI, JAN, and TUC) within Group 1.

STRUCTURE revealed a genetic structure consisting of 3 populations in the western burrowing owl in spite of the low levels of genetic differentiation among study locations shown by F_{ST} and *D* statistics. Mean log-likelihood of the observed genotypic data and ΔK was highest at K=3 (indicating 3 distinct populations). The posterior probabilities of membership of each of our 1,560 individual owls assigned to these putative populations had a noticeable geographic pattern (Fig. 7). Almost all burrowing owls in southern agricultural study locations in southern Sonora (YAQ) and Sinaloa (FUE and CUL) had a higher probability of membership to one inferred population (Sinaloan population). This genetic structure was corroborated by a standard *AMOVA* (based on the F_{ST}) which differentiates this Sinaloan population (CUL, FUE, and YAQ) from the rest of the study locations ($P = 0.005$). This Sinaloan fingerprint is relatively common within nearby populations in Sonora, southern Arizona, and as far as Chihuahua (CHI), northern Texas (TXP) and the Central Valley of California (DIX) (green color in pie charts in Fig. 7).

Similarly, burrowing owls from Nellis Air Force Base in southern Nevada (NEL) define a distinctive population (Mohave population), whose fingerprint also appears in burrowing owl populations in the western portion of the breeding range in Washington, California, and Utah (blue color in pie charts in Fig. 7). Finally, the great majority of the individuals in the remainder of the study locations, including northern study locations, had the fingerprint of a third inferred population (North American population) where northern study locations and the northern half of the southern agricultural study locations (HER, CAB, MEX, and CAG) are included. Under this scenario, our hypothesis is not supported. Individual owls from 4 southern agricultural study locations (CAG, MEX, CAB, HER) had similar probabilities of membership to those found in owls from northern locations but also similar to those found in owls from non-agricultural study locations in the southern part of the range (e.g., JAN, GAL). In addition, probabilities of membership were remarkably different in owls from the 3 southernmost agricultural locations (CUL, FUE, and YAQ), compared to those found in owls from northern locations (ALB, SAK, and GRL).

Our genetic analyses suggest differentiation among Burrowing Owl populations for the 2 island populations off the coast of Mexico (on Guadalupe Island and Clarion Island). Our genetic data suggest that Burrowing Owls on these 2 populations are genetically distinct and may warrant subspecies status. Our results suggest high levels of connectivity among Burrowing Owl populations throughout mainland North America with subtle structure indicating more than expected linkages between the northern-most populations and populations in southern agricultural areas. This pattern lends some support for the hypothesis that irrigated agriculture in northwestern Mexico and southwestern United States may have caused a change in migratory behavior of northern Burrowing Owl populations.

Connectivity and linkages based on stable isotope ratios of feathers

The distribution of isotopic signatures of nestling feathers varied among study populations (Fig. 8). We found a general pattern of increased enrichment in both $\delta^{13}C$ and $\delta^{15}N$ with decreasing latitude, but we also found some examples of similar ^{13}C–^{15}N signatures in nestling feathers from distant locations. For example, the northwestern Sonora ellipse (CAB) overlaps with that of distant populations in central Colorado (BRM; Fig. 8). In addition, the ellipse from northern Baja California (MEX) overlaps with those for Alberta and Saskatchewan. The use of 95th-percentile ellipses allows us to minimize the error of classifying a local burrowing owl as an immigrant, although this procedure may classify some immigrants as locals. The area of the 95th-percentile ellipses was not correlated ($r = 0.25$) with the number of data points used to generate them, suggesting that the sample sizes we used to generate the ellipses did not bias our results.

In most locations, the signatures of feathers collected from adults (open circles and triangles in Fig. 8) had higher intra-population variation than those of the nestlings in that same location (filled circles in Fig. 8), which is expected given the likely existence of immigrants within the adult population. We found a remarkable geographic pattern of philopatry-immigration among burrowing owl populations. Northern populations in Alberta (ALB), Saskatchewan (SAK), and southwestern Idaho (MNH) had the highest proportion of immigrants among all burrowing owl populations, with 95%, 92%, and 67% of their breeding populations originating elsewhere, respectively (Fig. 9). We also observed a high proportion of immigrants in the peripheral populations in central and southern Baja California (MUL and SDO), as well as in southwestern Utah (SGE), although our sample sizes in those locations were low. We observed the highest proportion of philopatic birds in an isolated population in central Mexico (TEX) where 100% of the adult owls shared the stable isotope signature of the local nestlings. The proportion of return birds in the remaining populations, including agricultural populations in northwestern Mexico, averaged 70.0±2.7% (range 41.7-89.5%). The highest proportion of philopatric birds among these populations (89.5%) was within an agricultural area in central Sonora (Hermosillo, HER; Fig. 9), providing some support to the first prediction of our hypothesis: that irrigated agricultural areas in the southern portion of the species' range have higher site fidelity than southern populations in non-agricultural areas. However, agricultural areas in Imperial Valley (SSW) had a relatively low proportion of philopatric owls (41.7%) compared to the rest of the interior populations. Populations in eastern Washington (TCY) at the northwestern edge of the species' breeding distribution also had relatively high levels of philopatry compared to that of populations in Canada.

LOESS regression allowed us to find geographic gradients in δ^2H, δ^{13}C, and δ^{15}N values in nestling feathers across North America (Fig. 10), and use these isoscapes to document general patterns of burrowing owl breeding dispersal throughout the North American continent. Deuterium showed a latitudinal gradient consistent with the well-known geographical pattern documented for precipitation, with more enriched deuterium in southern latitudes. However, we found a noticeable disruption in the general latitudinal pattern in δ^2H in southwestern United States and northwestern Mexico. This disruption originated from extraordinarily low δ^2H values in burrowing owl nestling feathers at Salton Sea National Wildlife Refuge (SSW) and the Mexicali valley (MEX) along the lower Colorado River (Fig. 11). We also observed a latitudinal pattern in δ^{15}N without major disruptions, with more ^{15}N -enriched nestling feathers in southern latitudes (Fig. 10). δ^{13}C showed a longitudinal pattern with the less ^{13}C-enriched values towards the Rocky Mountains (Fig. 10). Despite these latitudinal and longitudinal patterns in our 3 isotopes, we found large variation within study populations that limited our precision in predicting the origin of adult burrowing owls based solely on their isotopic signatures. The difference between the maximum and minimum predicted values (range) of δ^2H, δ^{13}C, and δ^{15}N in basemaps was 76.5, 9.7, and 5.6‰, respectively (Fig. 10). This overall geographic variation approaches the within-population variation in δ^2H, δ^{13}C, and δ^{15}N, with 95%-interpercentile range for residuals of 45.2, 9.2, and 5.3‰, respectively. Therefore, our results should be interpreted with caution.

Breeding dispersal in burrowing owls seemed unconstrained throughout the North American continent, although some latitudinal patterns in dispersion distances were evident. Northern populations (e.g., ALB, SAK, MOS, TCY and WYO) received immigrants from more southern populations. Populations in Canada received immigrants from locations as far south as central California, southern Nevada, and western Arizona. However, adult burrowing owls captured in Canada that were assigned to southern locations irrigated with water from the Colorado River may be an artifact of similar isotopic signatures in these 2 regions (Fig. 11). Burrowing owl breeding populations at intermediate latitudes, such as eastern Colorado (BRM) received immigrant owls from an extensive region spanning from Canada to northwestern Mexico, as well as central Mexico (Fig. 12). Southern populations relied more on local recruitment and immigration from neighbouring populations than northern populations. Populations in the California Central Valley (DIX) seemed to recruit breeding burrowing owls exclusively within the valley. Populations in the Mohave Desert (EDW) apparently received immigrants from populations in agricultural areas in southern California and northwestern Mexico, as well as from populations in Canada and central Mexico.

Burrowing owl populations breeding in agricultural areas in southwestern United States and northwestern Mexico differed in the geographic origin of their immigrants. Our study populations at Casa Grande (CAG) and Mexicali Valley (MEX) showed high levels of local recruitment and immigration from neighboring populations. However, the burrowing owl population in southern California (SSW), adjacent to the Mexicali Valley (MEX), received immigrants from a much larger segment of the species' breeding range, including central Sinaloa, eastern Washington, and Canada. Both Sinaloa populations (FUE and CUL) had high local recruitment in addition to immigrants from areas east of the Sierra Madre Occidental, but received no migrants from Canada. FUE and CUL appeared to receive fewer long-distance immigrants compared to other populations. Owl populations breeding in agricultural areas of southern Sonora (YAQ) relied exclusively on local recruitment and immigration from the Sonoran desert populations, including those in southern California. Our results suggest a relatively high proportion of local recruits in agricultural populations in central Sonora (HER), with some immigrants for central Mexico. Isotopic signatures of adults breeding in agricultural areas in northwestern Sonora (CAB) suggest immigration from neighbouring populations and from as far north as Canada and as far south as central Mexico. Therefore, we found evidence of burrowing owls from northern latitudes (where only migratory populations breed) becoming resident breeders in agricultural areas in both southern California and northwestern Sonora. This pattern is what was predicted by the migratory-mediated range-shift hypothesis.

Populations in the Mexican Highlands in Chihuahua (JAN, CHI, and DEL), Coahuila (LAG), and Nuevo Leon (GAL) suggest primarily breeding dispersal at a regional level (within the Mexican Highlands and the Great Plains) plus immigrants from elsewhere: eastern Washington for JAN and CHI, Sonora and Sinaloa for LAG and GAL, and central Mexico for all 5 populations.

CONCLUSIONS

The Burrowing Owl is a bird high on priority lists of regional and national Partners in Flight conservation plans. Numerous regional, national, and international efforts are underway to develop management or conservation plans for Burrowing Owls. Our modeling effort confirms that the breeding range of the burrowing owl has contracted over the past 40 years; local populations have been extirpated in the northern, eastern, and western periphery of the breeding range. Our results suggest that most Burrowing Owl populations throughout western North America have high connectivity with little or no genetic differentiation. However, we did find some evidence that northern-most populations (that are 100% migratory) are more closely linked to populations in southern agricultural areas (in the southwestern U.S. and northern Mexico) than would be expected by chance. Although this pattern, on the surface, supports the hypothesis that owls in the northern portion of their range are becoming less migratory, our stable isotope analysis suggests that dispersal is occurring in the opposite direction (owls originating from southern latitudes are dispersing to northern latitudes). In fact, our results suggest that owls at the northern extent of their range are being "rescued" by immigrants from the southern extent of the range. Moreover, we found evidence that suggests 3 genetically distinct populations of burrowing owls in Mexico. Levels of differentiation among these populations appear sufficient to warrant status as separate subspecies. Aside from these distinct populations in Mexico, the fate of burrowing owls at locations throughout the U.S. is dependent on healthy rates of dispersal from other locations within the species' range. Efforts to boost burrowing owl populations in one portion of their range may best be served by documenting the locations from where the target area typically receives dispersing immigrants.

Table 1. All DoD installations and other sites that participated in the DoD Legacy Program Burrowing Owl project, 2005-2009.

State	Site	DoD installation
AZ	Avra Valley	
AZ	Barry M. Goldwater Range	✓
AZ	Casa Grande National Monument	
AZ	Davis-Monthan AFB	✓
AZ	Salton Sea NWR	
AZ	Tucson	
AZ	Yuma	
AZ	Yuma Marine Corps Air Station	✓
AZ	Yuma Proving Ground	✓
AZ	Camp Pendleton	✓
CA	Dixon Navy Radio Transmitter Facility	✓
CA	Edwards AFB	✓
CA	El Centro, NAF	✓
CA	Fort Irwin	✓
CA	George Air Force Base/Adelanto	✓
CA	Hemet	
CA	March JARB	✓
CA	MCLB Barstow	✓
CA	NAS Lemoore	✓
CA	Naval Base Coronado	✓
CA	Seal Beach Naval Weapons Station	✓
CA	Sharpe Depot	✓
CA	Travis AFB	✓
CO	Buckley AFB	✓
CO	Fort Carson	✓
CO	Pinon Canyon Maneuver Site	✓
CO	Pueblo Chemical Depot	✓
CO	Rocky Flats	
CO	Rocky Mountain Arsenal NWR	
CO	Schriever AFB	✓
ID	Crooked Creek Ranch	
ID	Elmore	
ID	Hwy 26/Blackfoot	
ID	Mountain Home AFB	✓
ID	Orchard Training Range	✓
ID	Power	

State	**Site**	**DoD installation**
NM	Cannon AFB	✓
NM	Fort Bliss AFB	✓
NM	Holloman AFB	✓
NM	Kirtland AFB	✓
NM	White Sands Missile Range	✓
NV	Nellis AFB	✓
NV	Nevada Test Site	
OR	Boardman Bombing Range	✓
UT	Antelope Island	
UT	Deseret Chemical Depot	✓
UT	Dugway Proving Ground	✓
UT	Hill AFB	✓
UT	Kennecott Mining Co., Saltair	
UT	St. George	
UT	Stark Road	
UT	Vernon	
WY	Camp Guernsey	✓
WY	FE Warren AFB	✓
WY	Lovell Training Area	✓
WY	Sheridan Training Area	✓

Table 2. Number of females, males, adults of unknown sex, and juveniles captured at each participating site from 2005-2009. The number of nests is based on the number of owls captured, not a total count of nests in the area, and thus should only be considered a minimum. Additionally, the level of effort at each site varied across years.

State	Site	Year	Females	Males	Adults (sex unknown)	Juveniles	# of nests
AZ	Avra Valley	2006	1				1
AZ	Avra Valley	2007	3	1		6	3
AZ	Barry M. Goldwater Air Force Range	2006					0
AZ	Casa Grande	2005	84	53		253	109
AZ	Casa Grande	2006	51	43	10	7	78
AZ	Davis Monthan Air Force Base	2005	55	43	4	208	74
AZ	Davis Monthan Air Force Base	2006	26	24	6	18	38
AZ	Tucson	2005	16	7	2	49	26
AZ	Tucson	2006	6	3	1		8
AZ	Tucson	2007	18	10		33	22
AZ	Tucson	2008	5	2			6
AZ	Yuma	2006	3	3		3	5
AZ	Yuma Marine Corps Air Station	2006	2	5			5
AZ	Yuma Proving Ground	2006					0
CA	Camp Pendleton	2006					0[a]
CA	Dixon Navy Radio Transmitter Facility	2006	7	13		4	17
CA	Dixon Navy Radio Transmitter Facility	2007	9	4		34	12
CA	Edwards Air Force Base	2006	16	18		46	32
CA	Edwards Air Force Base	2007	13	16		7	19
CA	Fort Irwin	2006					0
CA	George Air Force Base/Adelanto	2005				3	1
CA	Hemet and surrounding areas	2005	11	6		19	16
CA	March Air Force Base	2006	3	2		10	5
CA	MCLB Barstow surrounding area	2007					0[b]
CA	Naval Air Facility El Centro	2006	22	20		8	24
CA	Naval Air Facility El Centro	2007	22	18		23	29
CA	Naval Air Station Lemoore	2006	18	14		70	31
CA	Naval Air Station Lemoore	2007	9	9		8	13
CA	Naval Air Station North Island	2005	1			7	3
CA	Naval Air Station North Island	2006	5	4		14	7
CA	Naval Air Station North Island	2007	3	2		4	3
CA	Naval Air Station North Island	2008	1	1		4	1
CA	Seal Beach Naval Weapons Station	2005	1	2		2	2
CA	Sharpe Depot	2007	11	7		35	17
CA	Travis Air Force Base	2007	8	5		15	8
CO	Buckley Air Force Base	2006	11	14		44	15
CO	Buckley Air Force Base	2007	3	5		10	6
CO	Fort Carson	2006	7	3		25	9
CO	Fort Carson	2007	1			18	5
CO	Pinon Canyon Maneuver Site	2006				19	9
CO	Pinon Canyon Maneuver Site	2007	7	2		32	20
CO	Pueblo Chemical Depot	2006	14	5		44	21
CO	Pueblo Chemical Depot	2007	1	2		27	10
CO	Rocky Mountain Arsenal	2007	10	6		14	12
CO	Rocky Flats	2006					0

State	Site	Year	Females	Males	Adults (sex unknown)	Juveniles	# of nests
CO	Schriever Air Force Base	2006	6	2		8	6
ID	Blackfoot	2007	3	1		28	9
ID	Blackfoot	2008	2			5	4
ID	Crooked Creek Ranch	2007	2	1		1	2
ID	Elmore	2008	3	1		9	3
ID	Mt. Home Air Force Base	2007	26	25		48	42
ID	Mt. Home Air Force Base	2008	12	4		28	14
ID	Orchard Training Range	2007					0[c]
ID	Power	2008	2			19	5
NM	Cannon	2008	2	1		3	5
NM	Fort Bliss	2006				2	1
NM	Fort Bliss	2007	1	1		10	4
NM	Fort Bliss	2008	2	0		0	2
NM	Holloman Air Force Base	2005				2	1
NM	Holloman Air Force Base	2006				8	4
NM	Holloman Air Force Base	2007	0	2		14	6
NM	Holloman Air Force Base	2008	4	2		13	9
NM	Kirtland Air Force Base	2005	9	10		41	22
NM	Kirtland Air Force Base	2006	7	5		67	23
NM	Kirtland Air Force Base	2007	6	8		61	25
NM	Kirtland Air Force Base	2008	6	12		60	30
NM	White Sands Missle Range	2005				4	1
NM	White Sands Missle Range	2006	3	1		16	5
NM	White Sands Missle Range	2007	7	2		22	7
NM	White Sands Missle Range	2008	4	2		4	4
NV	Nellis Air Force Base	2006	20	20		19	23
NV	Nellis Air Force Base	2007	11	11			19
NV	Nevada Test Site	2005	1			21	6
NV	Nevada Test Site	2006	12	4		18	12
NV	Nevada Test Site	2007	4	1		2	4
NV	Nevada Test Site	2008	6	1		2	7
OR	Boardman Bombing Range	2006	1			1	2
UT	Antelope Island	2008		2		4	3
UT	Deseret Chemical Depot	2008	1	2		8	2
UT	Dugway Proving Ground	2007		2			1
UT	Dugway Proving Ground	2008	9	2		30	11
UT	Hill Air Force Base	2007	1				1
UT	Kennecott Mining Co.	2007	1			3	1
UT	Stark Road	2008	1			5	1
UT	St. George	2007	5	1		14	9
UT	Vernon	2008	5	1		24	7
WY	Camp Guernsey	2007					0
WY	FE Warren AFB	2007					0
WY	Lovell Training Area	2007					0
WY	Sheridan	2007	1	1			1

[a] Camp Pendleton is no longer thought to have breeding owls but does support migrant (and perhaps wintering) owls.

[b] Only the area surrounding the base was surveyed.

[c] No owls were banded at Orchard but >0 owls were present.

Table 3. Numbers of individuals sampled within each of 36 burrowing owl study locations in Canada, United States, and Mexico. Study location acronyms with (*) and (†) denote southern agricultural populations and northern declining migratory populations, respectively

Study location	Acronym	Individuals genotyped
Southern Alberta, Alberta, Canada	ALB†	37
Baja California Sur, Mexico	BCS	23
Buckley Air Force Base, Colorado, U.S.A.	BUC	33
Buffalo Gap National Grassland, South Dakota, U.S.A.	BUF	54
Caborca Valley, Sonora, Mexico	CAB*	25
Casa Grande, Arizona, U.S.A.	CAG*	59
Fort Carson Army Base, Colorado, U.S.A.	CAR	23
Coyame and Ahumada, Chihuahua, Mexico	CHI	34
Comanche National Grassland, Colorado, U.S.A	COM	40
Culiacan Valley, Sinaloa, Mexico	CUL*	63
Delicias, Chihuahua, Mexico	DEL	25
Dixon Naval Radio Transmitter Facility, California, U.S.A.	DIX	29
Dugway Air Force Base, Utah, U.S.A.	DUG	30
Edwards Air Force Base, California, U.S.A.	EDW	44
Rio Fuerte Valley, Sinaloa, Mexico	FUE*	67
Galeana, Nuevo Leon, Mexico	GAL	47
Grand River-Little Missouri Natl. Grasslands, North Dakota	GRL†	21
Hermosillo, Sonora, Mexico	HER*	60
Holloman Air Force Base, New Mexico, U.S.A.	HOL	22
Janos, Chihuahua, Mexico	JAN	62
Kiowa - Rita Blanca National Grasslands, NM, TX, U.S.A.	KIB	29
Kirtland Air Force Base, New Mexico, U.S.A.	KIR	73
La Laguna, Coahuila, Mexico	LAG	54
Naval Air Station Lemoore, California, U.S.A.	LEM	47
Mexicali Valley, Baja California, Mexico	MEX*	59
Mountain Home Air Force Base, Idaho, U.S.A.	MNH	62
Moses Lake, Washington, U.S.A.	MOS	55
Nellis Air Force Base, Nevada, U.S.A.	NEL	55
Nevada Test Site, Nevada, U.S.A.	NTS	25
Pawnee National Grassland, Colorado, U.S.A.	PAW	54
Grasslands National Park and Regina Plains, Saskatchewan	SAK†	61
Tri-Cities, Washington, U.S.A.	TCY	54
Tucson, Arizona, U.S.A.	TUC	25
Texas Panhandle, Texas, U.S.A.	TXP	15
White Sands Missile Range, New Mexico, U.S.A.	WSM	24
Yaqui-Mayo Valley, Sonora, Mexico	YAQ*	70

Table 4. Statistical significance (*P*-values) of Analyses of Molecular Variance (*AMOVA*) based on the F_{ST} statistics for each of 8 two-group classifications of 36 burrowing owl study sites. Group 1 includes the southern agricultural study sites (CAB, CAG, CUL, FUE, HER, MEX, and YAQ) and the study sites listed in the table below. Group 2 includes the remainder of the study sites. Acronyms are listed in Table 3. Bold-face values denote significant comparisons for α = 0.05

Study sites in Group 1	*P*-value	
	Standard	Weighted averaged over all loci
ALB, GRL, SAK	**0.028**	**0.012**
MNH, MOS, TCY	0.240	0.218
BUF, CAR, PAW	0.131	0.117
EDW, NEL, NTS	0.220	0.238
COM, KIB, KIR	0.184	0.174
DEL, GAL, LAG	0.060	**0.046**
DIX, LEM	0.329	0.328
CHI, JAN, TUC	**0.027**	**0.008**

Table 5. Mean number of alleles (N_a), number of effective alleles (N_e), number of private alleles (N_p), observed heterozygosity (H_O), expected heterozygosity (H_E), and fixation index (F) averaged across all 11 loci for each of 36 study locations of burrowing owls in North America. Population acronyms are shown in Table 3.

Population	N_a	N_e	N_p	H_O	H_E	F
ALB	13.40±1.72	7.24±1.09	0.20±0.13	0.83±0.02	0.84±0.02	0.00±0.02
BCS	11.00±1.26	6.36±0.96	0.20±0.13	0.81±0.04	0.82±0.02	0.02±0.03
BUC	12.00±1.62	7.04±1.12	0.00±0.00	0.82±0.04	0.82±0.03	0.01±0.03
BUF	14.20±1.76	7.09±1.33	0.20±0.13	0.84±0.02	0.83±0.02	-0.01±0.01
CAB	10.80±1.27	6.70±0.78	0.00±0.00	0.84±0.03	0.83±0.02	-0.01±0.02
CAG	14.70±1.76	6.88±1.07	0.00±0.00	0.84±0.02	0.83±0.02	-0.01±0.01
CAR	10.40±0.79	5.77±0.65	0.00±0.00	0.86±0.03	0.81±0.02	-0.06±0.03
CHI	12.30±1.29	6.66±0.92	0.00±0.00	0.82±0.03	0.83±0.02	0.01±0.02
COM	13.40±1.76	7.42±1.15	0.00±0.00	0.87±0.03	0.84±0.02	-0.04±0.02
CUL	13.00±1.81	7.29±1.28	0.00±0.00	0.81±0.04	0.82±0.04	0.02±0.01
DEL	11.20±1.11	6.60±0.87	0.30±0.21	0.83±0.03	0.82±0.02	-0.01±0.03
DIX	10.00±1.03	6.17±0.72	0.00±0.00	0.86±0.03	0.82±0.02	-0.04±0.04
DUG	11.70±1.14	6.66±0.87	0.00±0.00	0.86±0.02	0.83±0.02	-0.04±0.02
EDW	12.30±1.10	6.58±0.95	0.10±0.10	0.83±0.02	0.83±0.02	0.00±0.02
FUE	13.50±1.68	6.85±0.98	0.10±0.10	0.83±0.03	0.82±0.03	0.00±0.02
GAL	13.30±1.56	7.25±1.17	0.00±0.00	0.84±0.02	0.84±0.02	-0.01±0.02
GRL	11.10±1.29	6.98±1.02	0.00±0.00	0.85±0.03	0.83±0.03	-0.03±0.03
HER	13.40±1.30	6.92±1.09	0.00±0.00	0.83±0.02	0.83±0.02	0.00±0.02
HOL	10.70±1.18	6.81±1.03	0.00±0.00	0.86±0.04	0.83±0.02	-0.04±0.03
JAN	14.10±1.63	7.22±1.21	0.20±0.13	0.86±0.02	0.83±0.02	-0.03±0.01
KIB	11.90±1.34	6.80±1.05	0.00±0.00	0.80±0.03	0.82±0.03	0.03±0.02
KIR	15.00±1.56	7.34±1.11	0.30±0.30	0.84±0.02	0.84±0.02	0.00±0.02
LAG	14.20±1.73	7.42±1.19	0.20±0.13	0.83±0.03	0.84±0.02	0.01±0.03
LEM	12.60±1.50	6.82±1.27	0.10±0.10	0.83±0.03	0.82±0.02	0.00±0.02
MEX	13.70±1.67	7.20±1.22	0.10±0.10	0.83±0.03	0.83±0.02	0.00±0.02
MNH	14.50±1.90	7.36±1.29	0.00±0.00	0.84±0.03	0.83±0.02	-0.01±0.01
MOS	14.20±1.36	7.37±1.15	0.50±0.40	0.84±0.03	0.84±0.02	0.00±0.01
NEL	12.50±1.34	6.15±0.57	0.00±0.00	0.83±0.02	0.82±0.02	-0.01±0.01
NTS	11.30±1.24	6.95±0.70	0.00±0.00	0.81±0.03	0.84±0.02	0.04±0.03
PAW	14.20±1.65	7.82±1.37	0.00±0.00	0.84±0.02	0.84±0.02	0.00±0.02
SAK	15.70±2.09	7.64±1.38	0.20±0.13	0.84±0.02	0.84±0.02	0.00±0.03
TCY	13.10±1.68	7.13±0.93	0.00±0.00	0.86±0.03	0.84±0.02	-0.02±0.03
TUC	9.40±1.13	5.70±0.76	0.00±0.00	0.78±0.04	0.79±0.03	0.01±0.03
TXP	9.50±1.26	5.95±0.93	0.00±0.00	0.78±0.05	0.78±0.04	0.00±0.04
WSM	11.70±1.09	7.11±0.98	0.10±0.10	0.85±0.03	0.84±0.02	-0.02±0.02
YAQ	13.50±1.55	6.79±0.96	0.20±0.20	0.82±0.02	0.83±0.02	0.01±0.01

Figure 1. Weight of adult Burrowing Owls increased with increasing latitude after accounting for sex and the date on which the adult was captured.

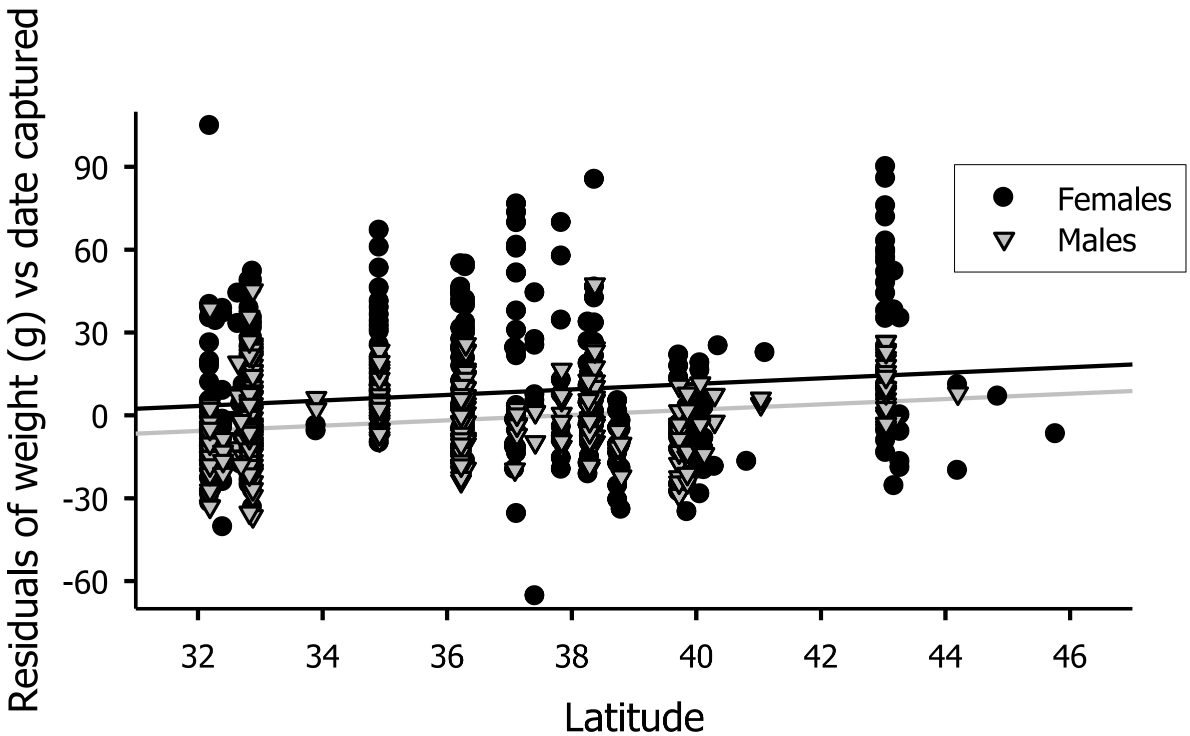


Figure 2. Size of adult Burrowing Owls (measured in wing-chord length) increased with increasing latitude after accounting for sex and the date on which the adult was captured.

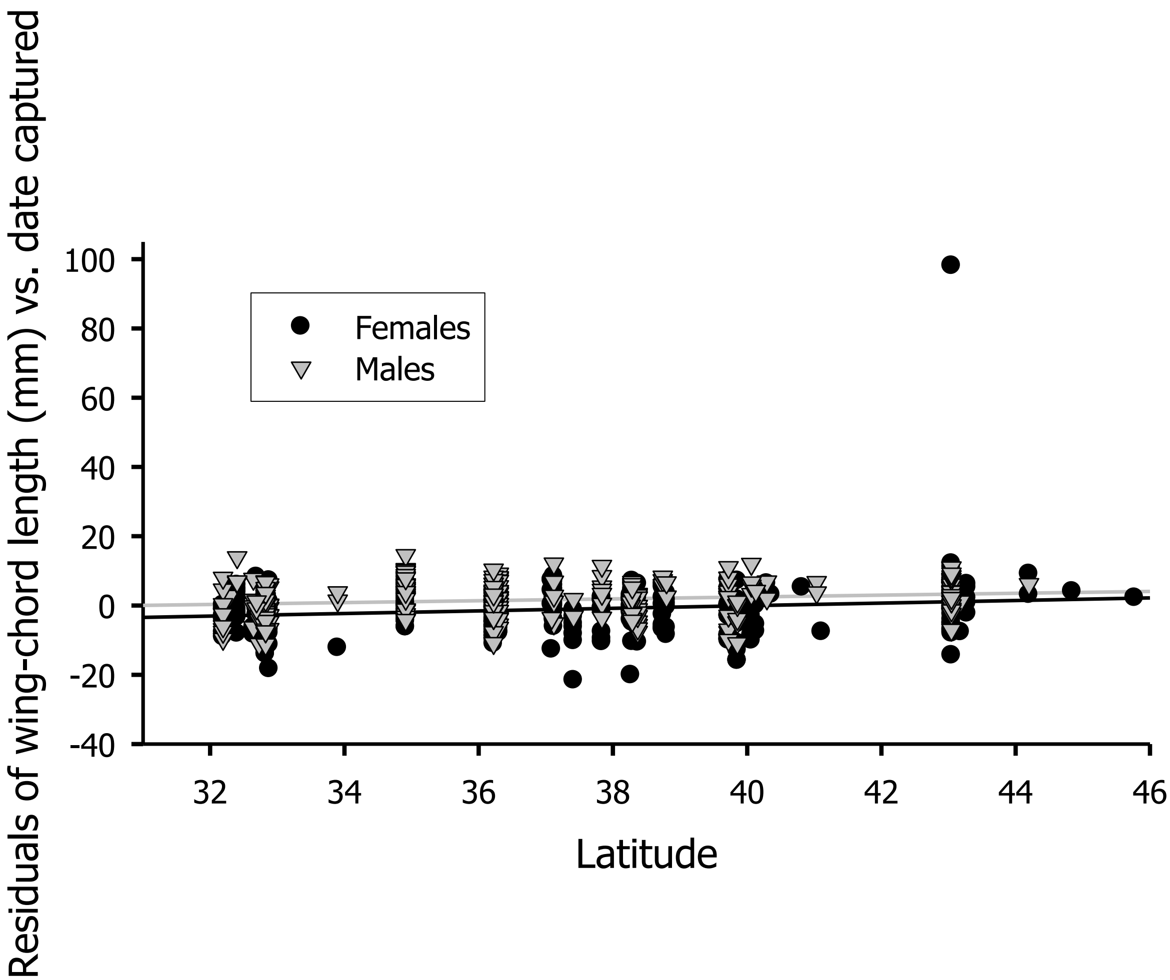


Figure 3. We did not find a significant change in size of adult Burrowing Owls (measured in metatarsal length) with increasing latitude after accounting for sex and the date on which the adult was captured.

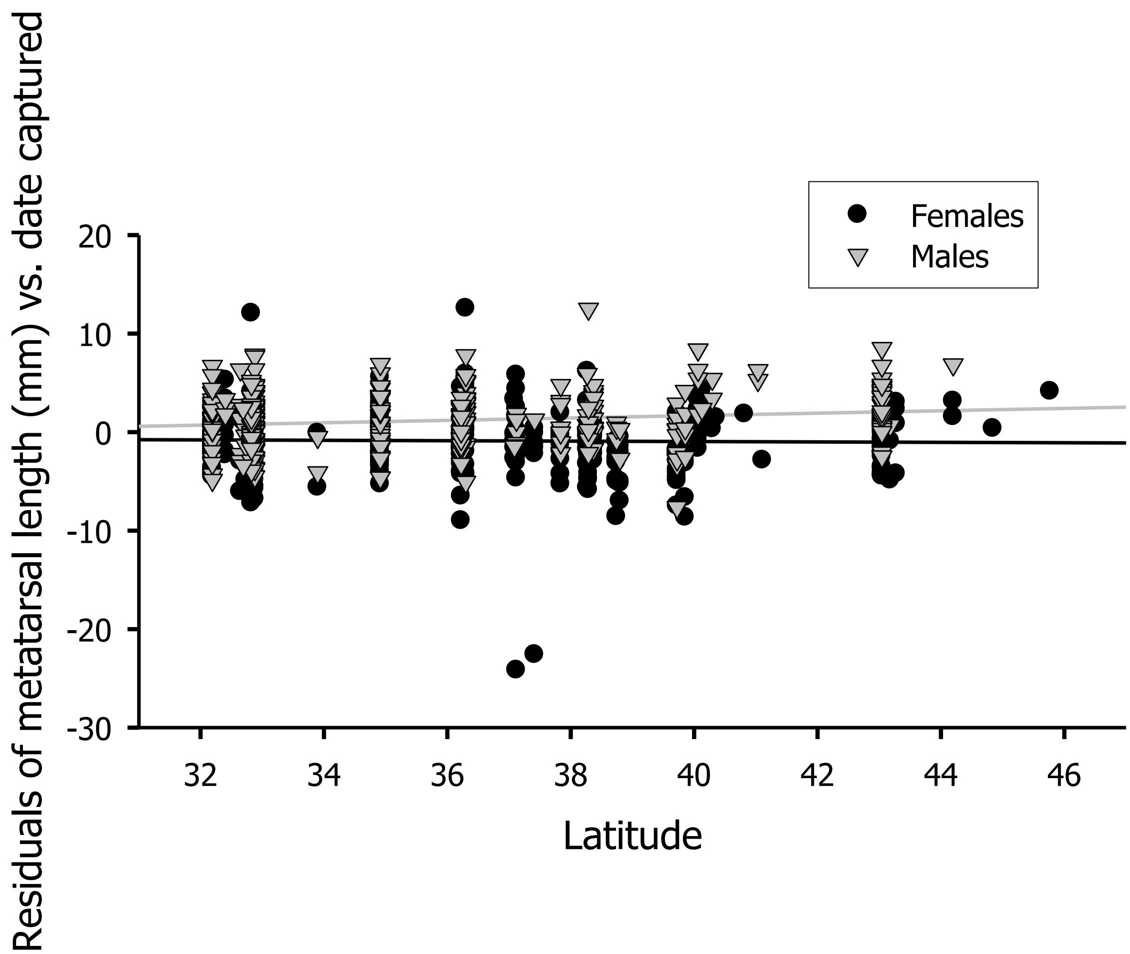


Figure 4. Weight of juvenile Burrowing Owls increased with increasing latitude after accounting for the age of the juvenile and the date on which it was captured.

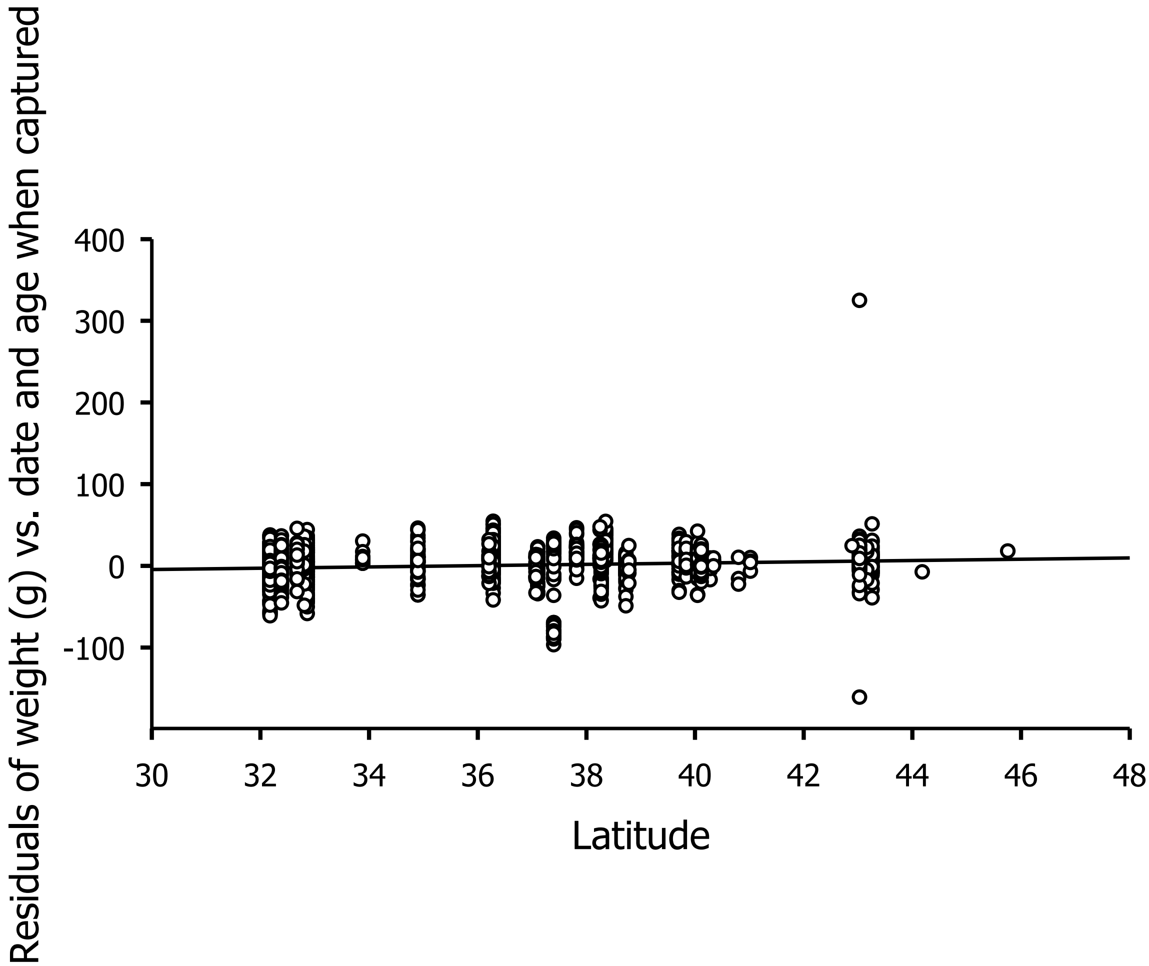


Figure 5. Estimated change in the breeding range of burrowing owls from 1967 to 2008 based on logistic regression of Breeding Bird Survey (BBS) data. The gray area denotes the owl's breeding range in 1967 as predicted by the model whereas the red area denotes the owl's breeding range in 2008 as predicted by the model. All dots show BBS routes at which >1 burrowing owl was detected. Empty dots indicate BBS routes where >1 burrowing owl was detected before 1987 but none after 1987. Black dots indicate BBS routes where >1 burrowing owl was detected after 1987 (regardless of how many were detected prior to 1987).

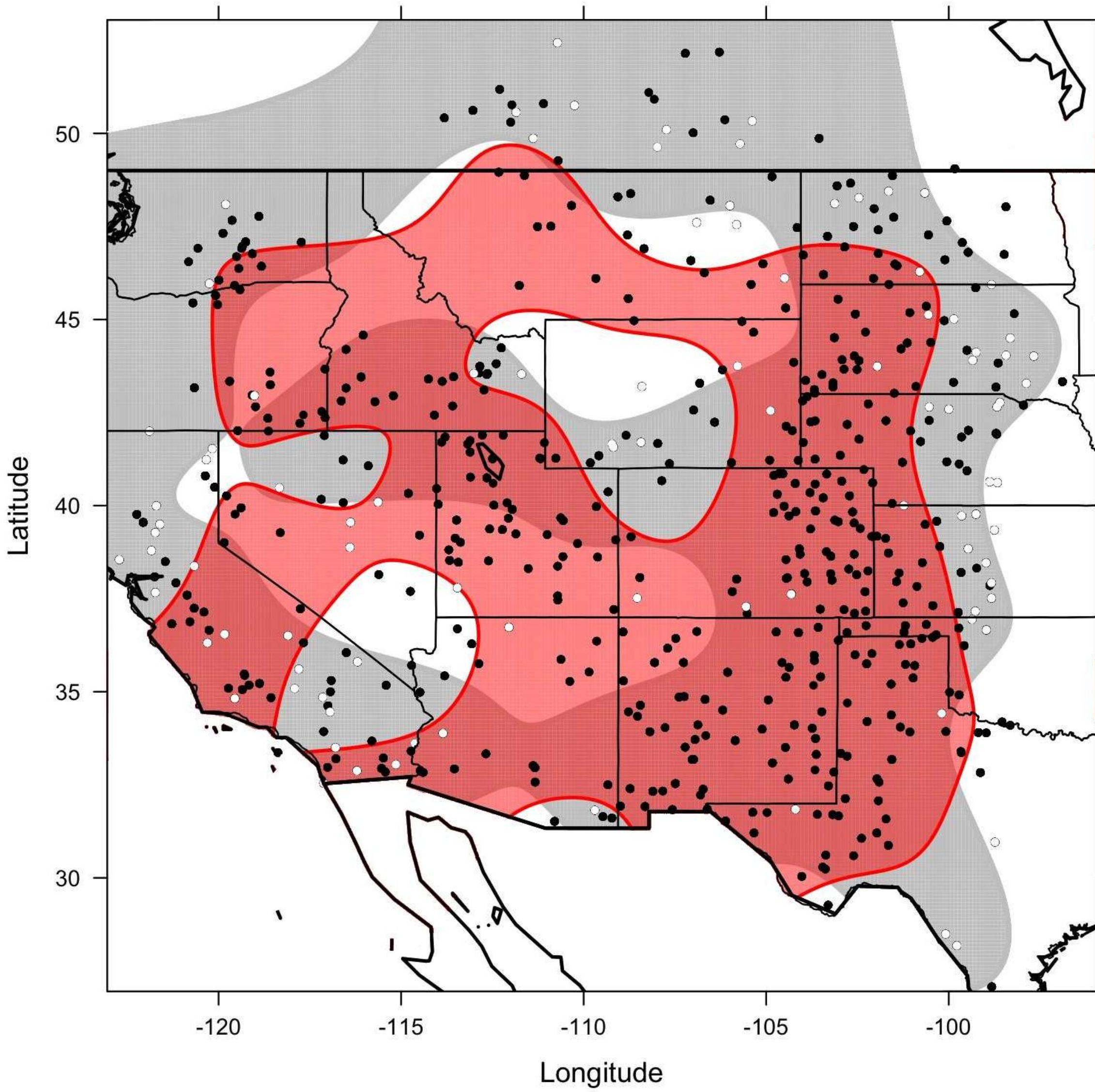


Figure 6. Scatterplot of actual differentiation D vs. geographic distances for all pairwise comparisons (n=630) among our 36 burrowing owl study locations across North America. Black dots indicate pairwise comparisons between northern study locations and southern agricultural locations, whereas empty dots indicate pairwise comparisons among the remainder of the study locations. Mantel correlation between geographic and genetic distance is not significantly different from zero (95% C. I. from -0.05 to 0.08).

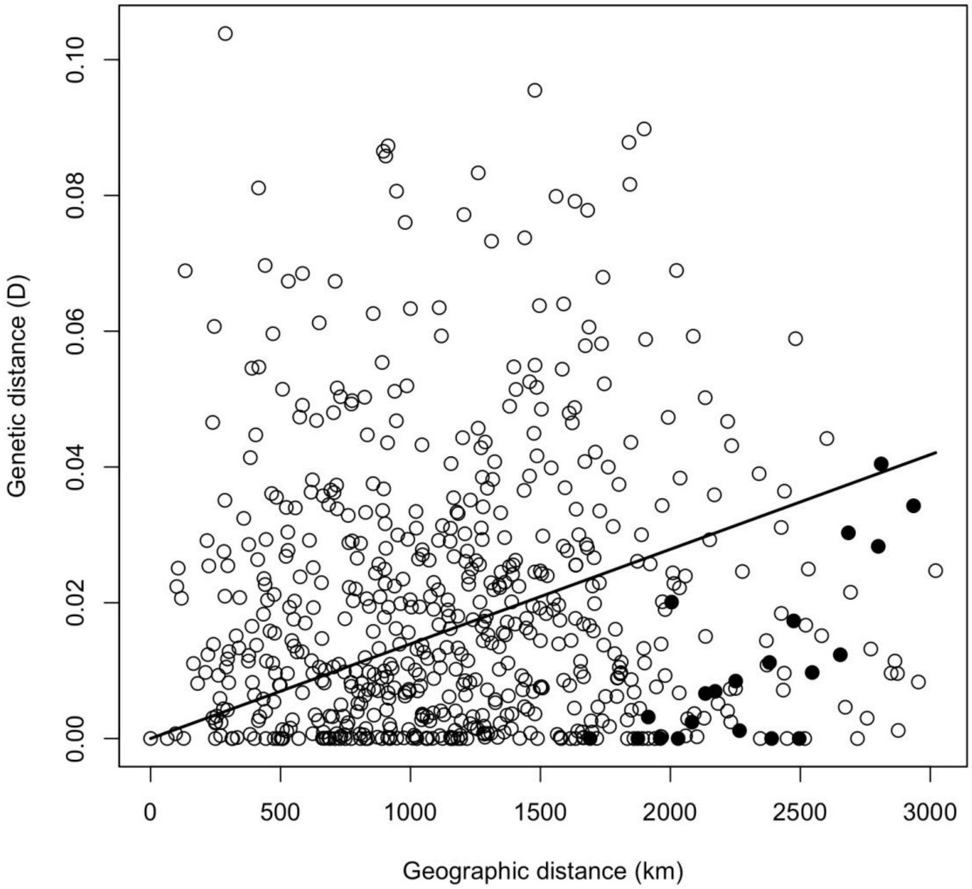


Figure 7. Geographic variation among study locations in the posterior probability of membership to each of the 3 populations inferred by program STRUCTURE. Pie chart sizes are proportional to the number of individuals genotyped at each study location.

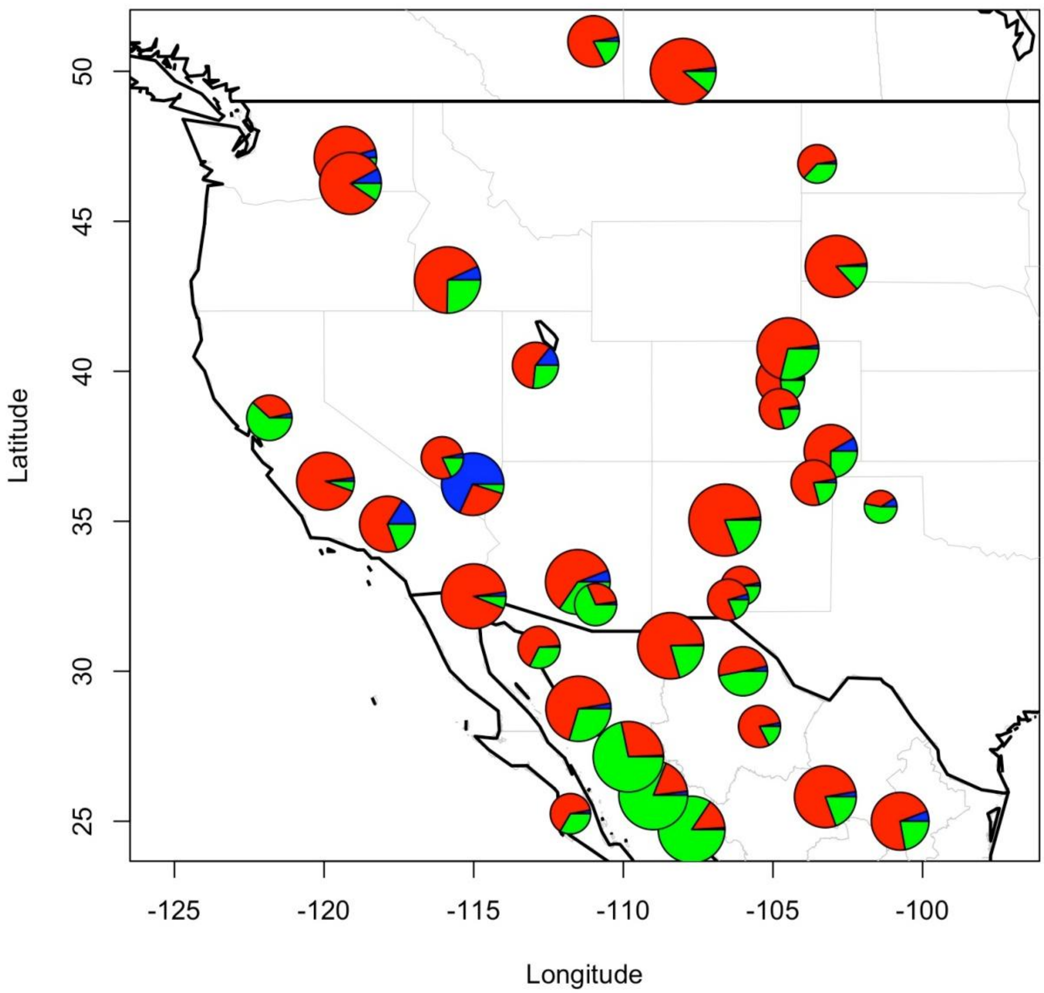
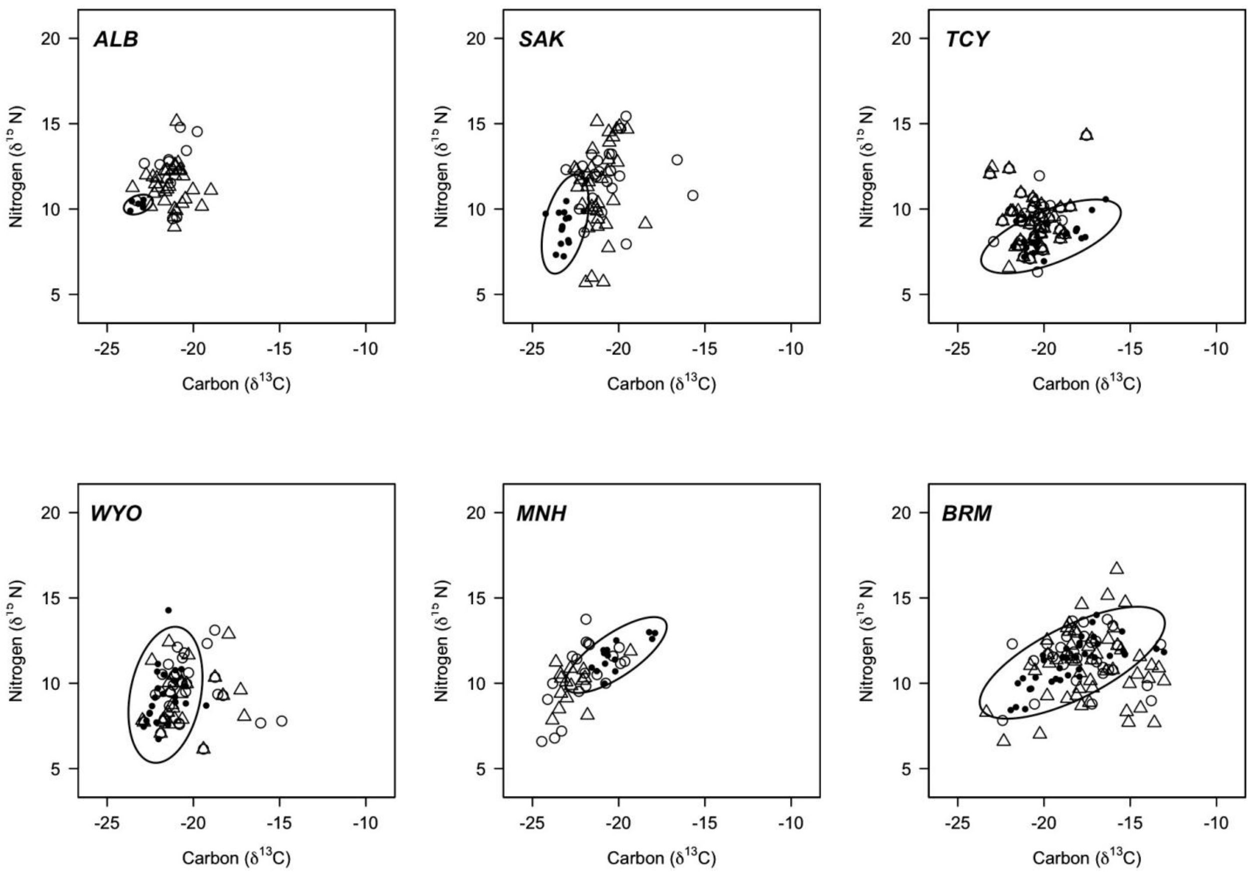
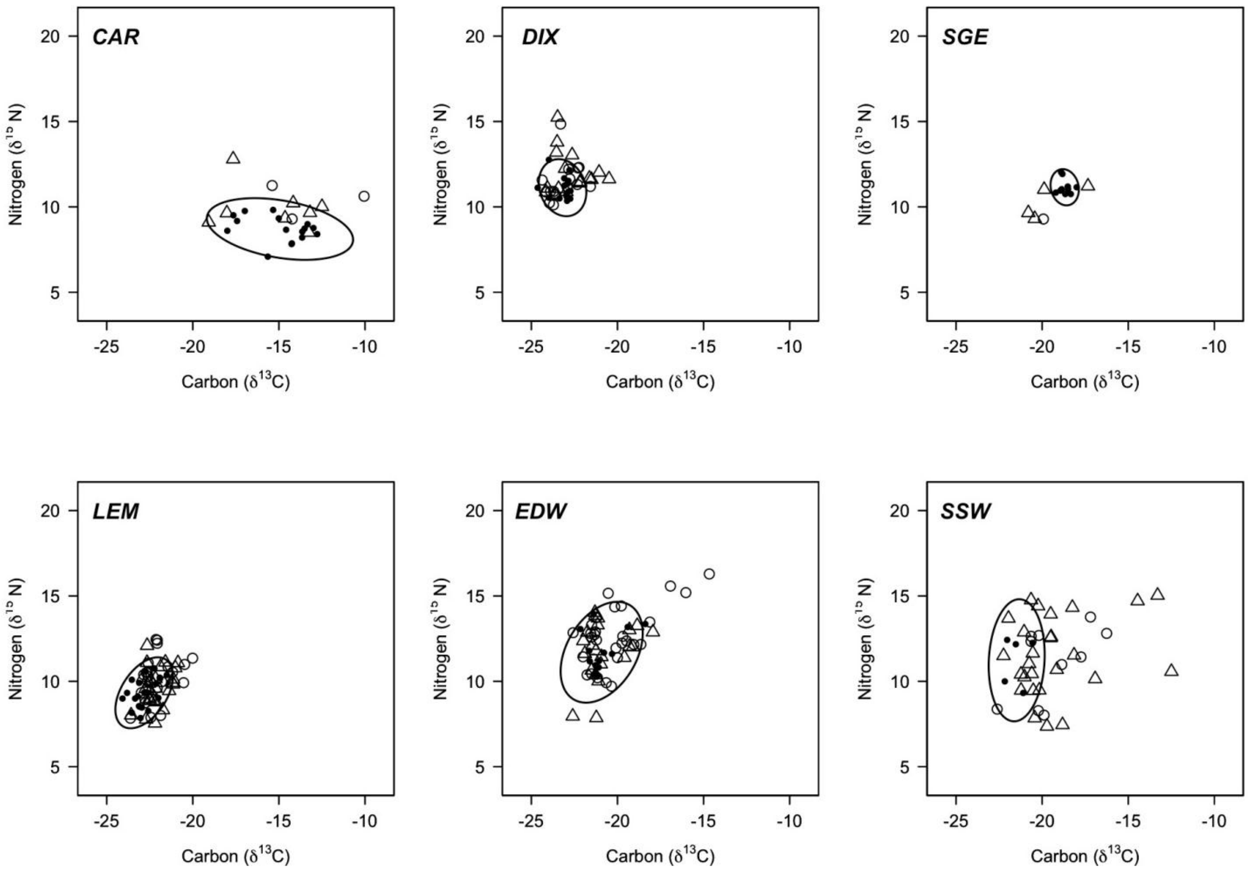
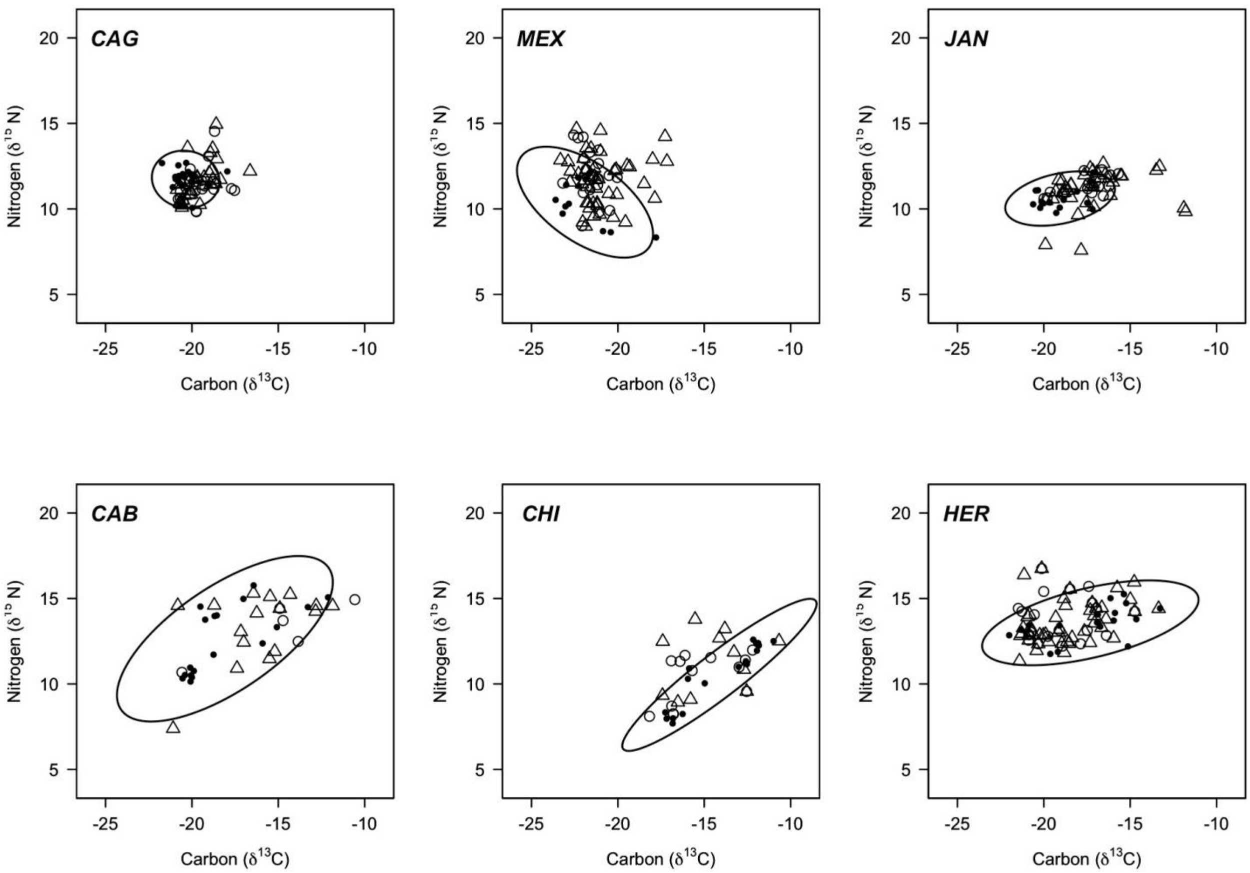
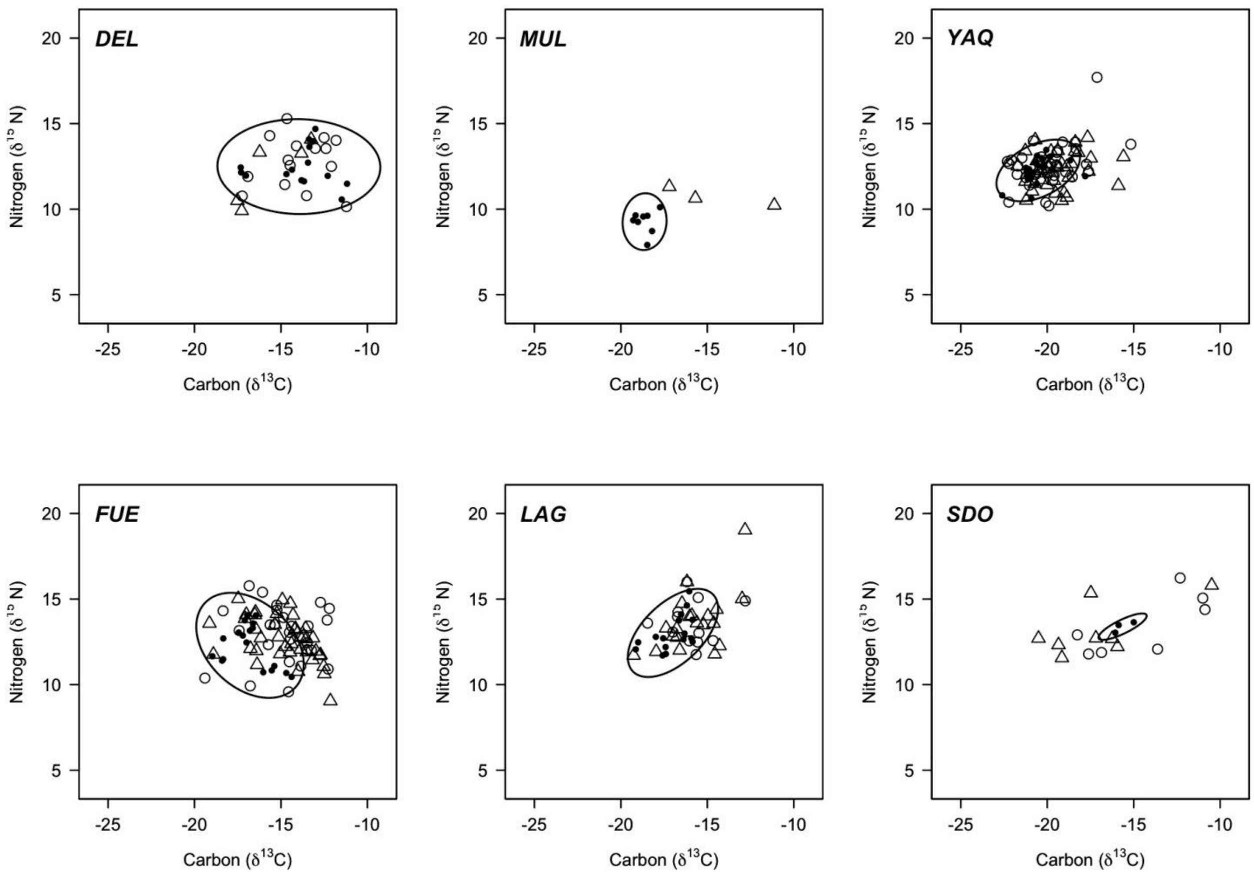


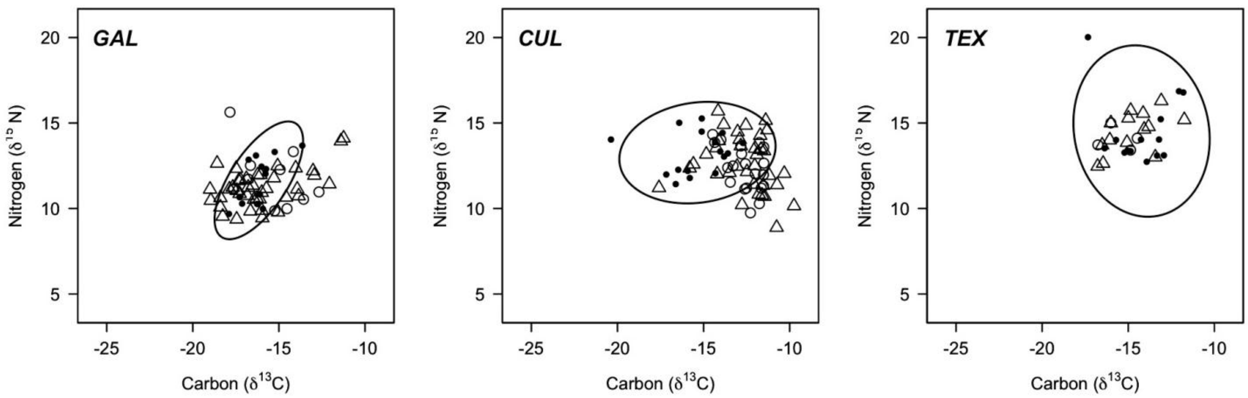
Figure 8. Stable isotope signatures of 13C and 15N in nesting and adult feathers collected in 27 burrowing owl study populations. Filled and open circles show the isotope signature of nestling and adult feathers, respectively. Circles and triangles denote males and females, respectively. Ellipses show the 95th-percentile ellipses for the bivariate normal distribution based on isotope data on nestling feathers. Study population acronyms are shown in Table 3.




CAR
DIX
SGE
LEM
EDW
SSW
Nitrogen (δ^{15}N)
Carbon (δ^{13}C)
20
15
10
5
-25
-20
-15
-10


CAG
MEX
JAN
CAB
CHI
HER
Nitrogen (δ15 N)
Carbon (δ13C)
20
15
10
5
-25
-20
-15
-10


DEL
MUL
YAQ
FUE
LAG
SDO
Nitrogen (δ15 N)
Carbon (δ13C)



GAL
CUL
TEX
Nitrogen (δ15 N)
Carbon (δ13C)
20
15
10
5
-25
-20
-15
-10

Figure 9. Geographic patterns of philopatry and immigration in burrowing owl populations across North America, as suggested by stable isotopes 13C and 15N. Each pie chart shows the proportion of phylopatric (gray) and immigrant (black) burrowing owls at each study population. The area of each pie chart is proportional to sample size ($n_{max} = 83$).

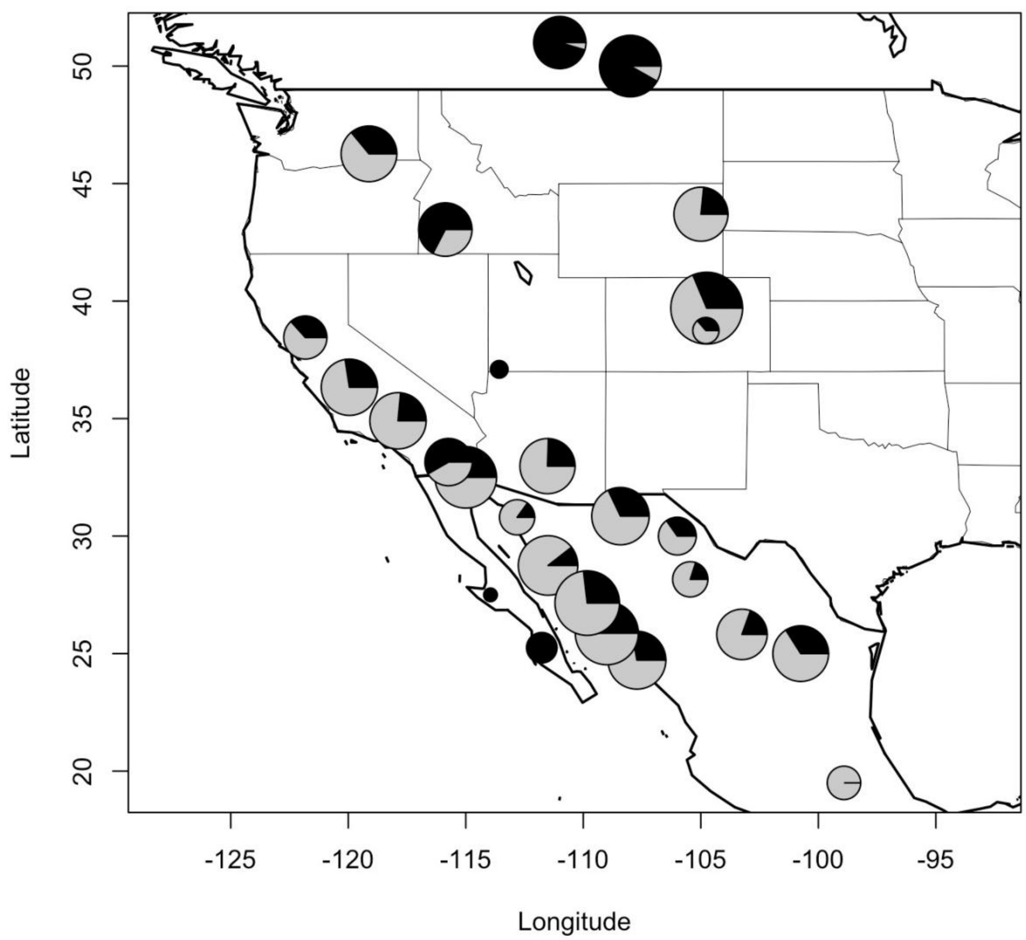


Figure 10. Base maps of δ^2H, $\delta^{13}C$, and $\delta^{15}N$ (from left to right) for nestling feathers as inferred by local regression analysis (LOESS) with latitude and longitude as explanatory variables. Black dots represent sampling locations.

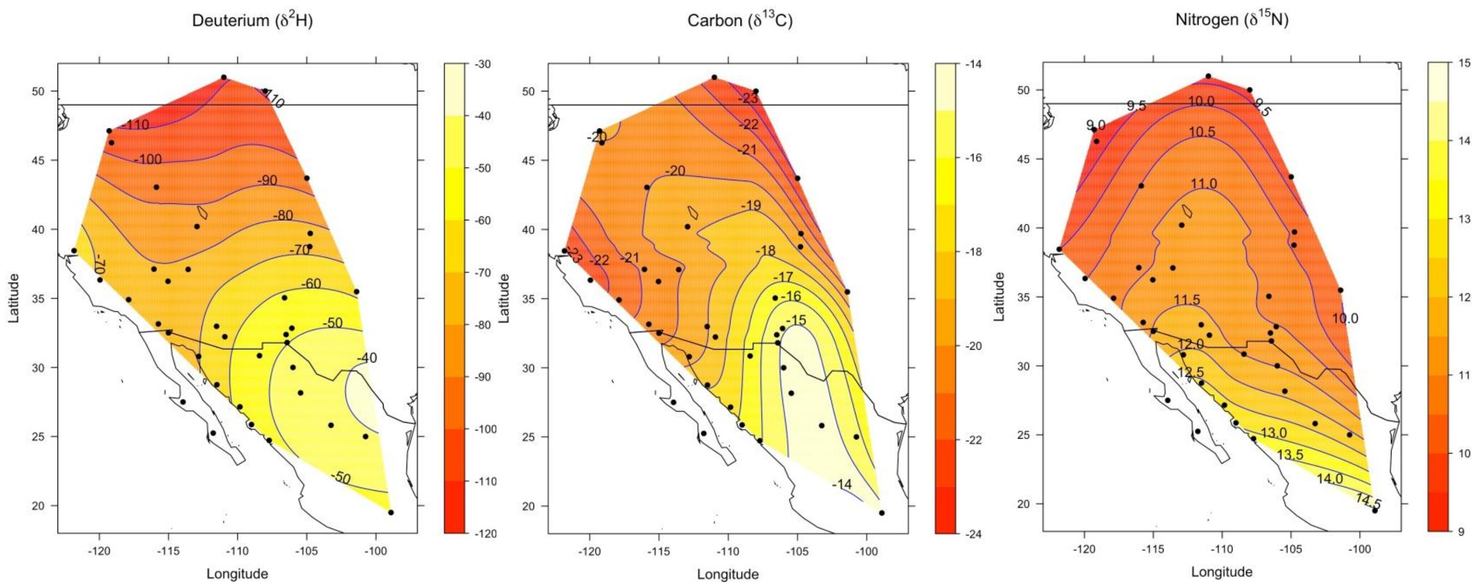


Figure 2. Latitudinal variation in δ^2H values in burrowing owl nestling feathers. The black dots represent individual feathers sampled from different latitudes. Samples from the lower Colorado River valley in Mexicali and Salton Sea deviate noticeably from the general latitudinal pattern. Longitude introduces variation δ^2H not illustrated in this graph (Figure 10).

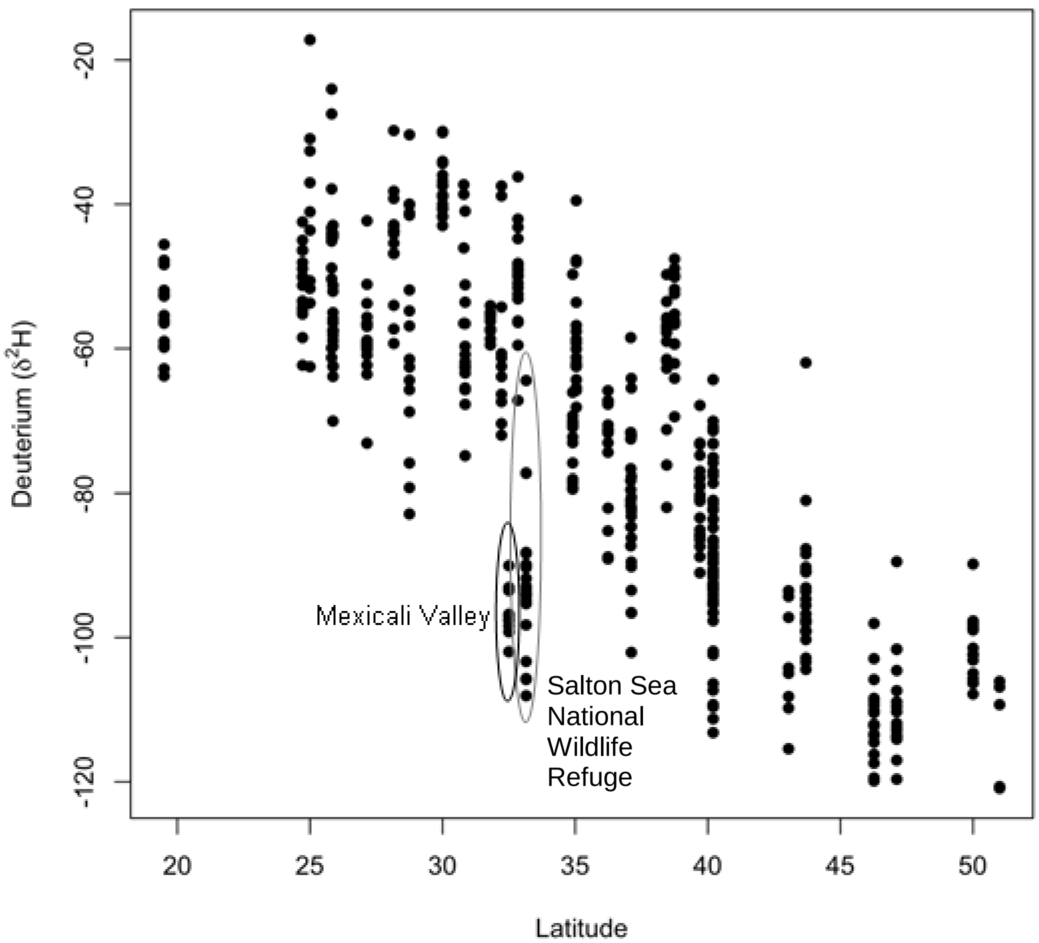
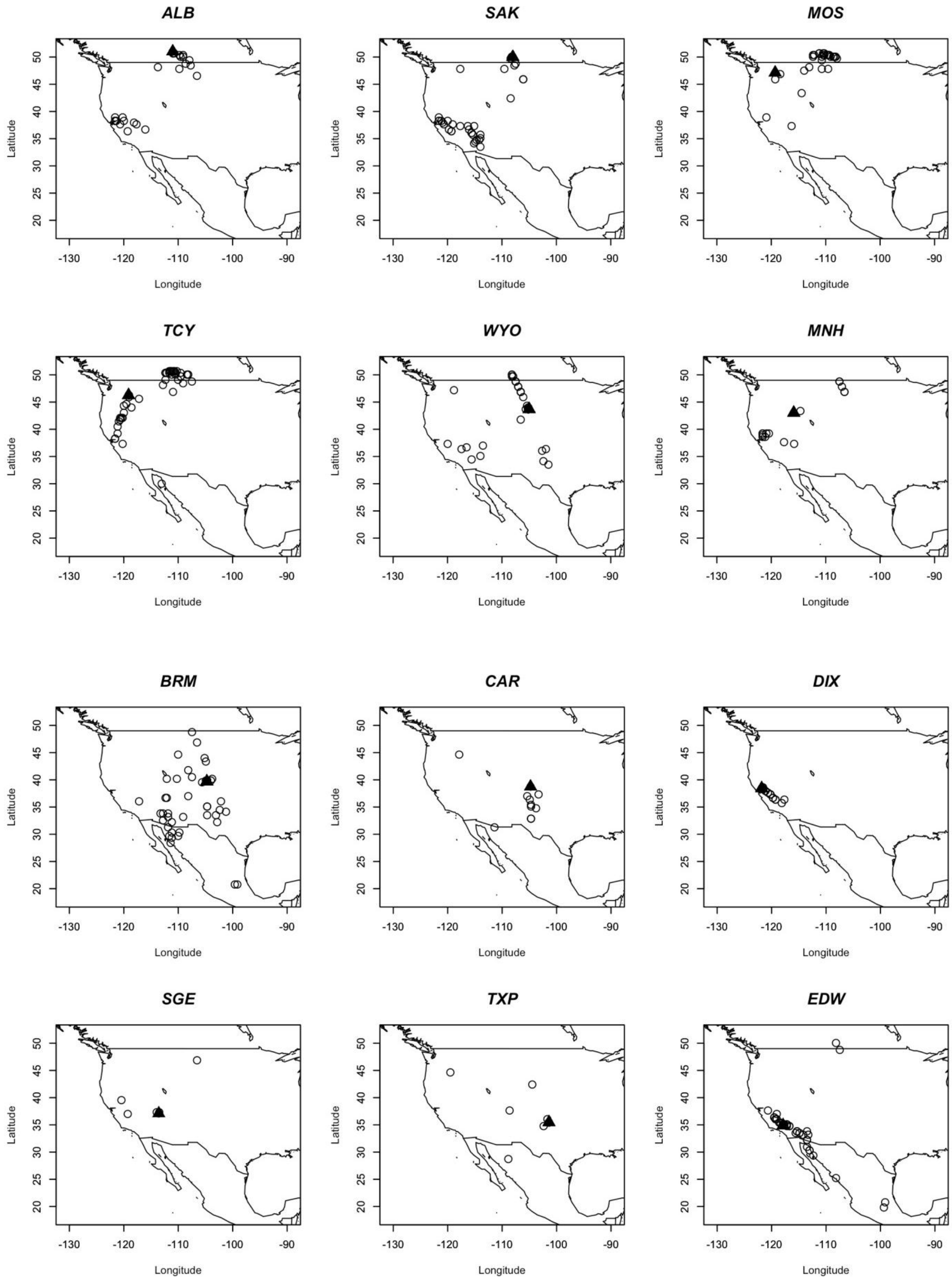
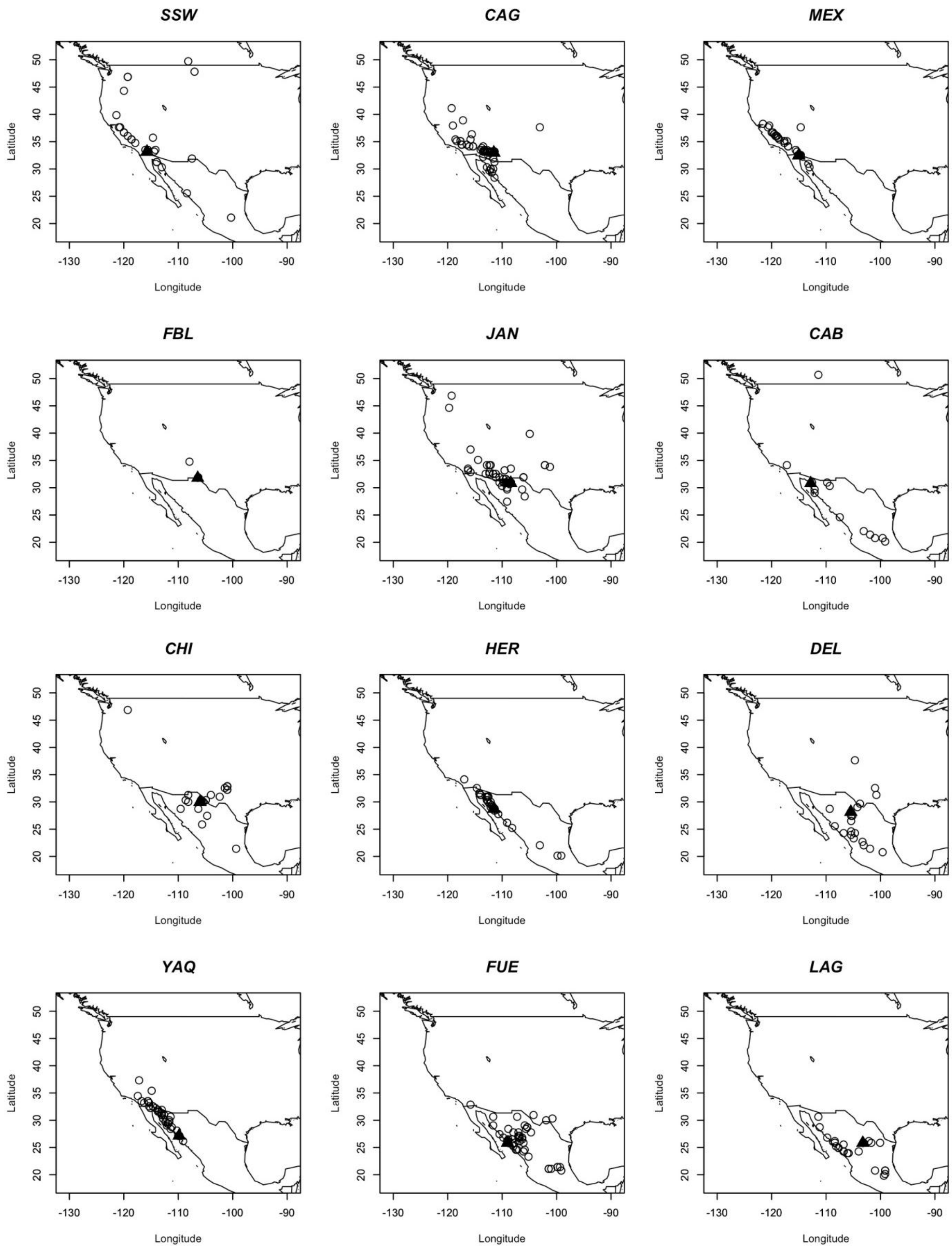
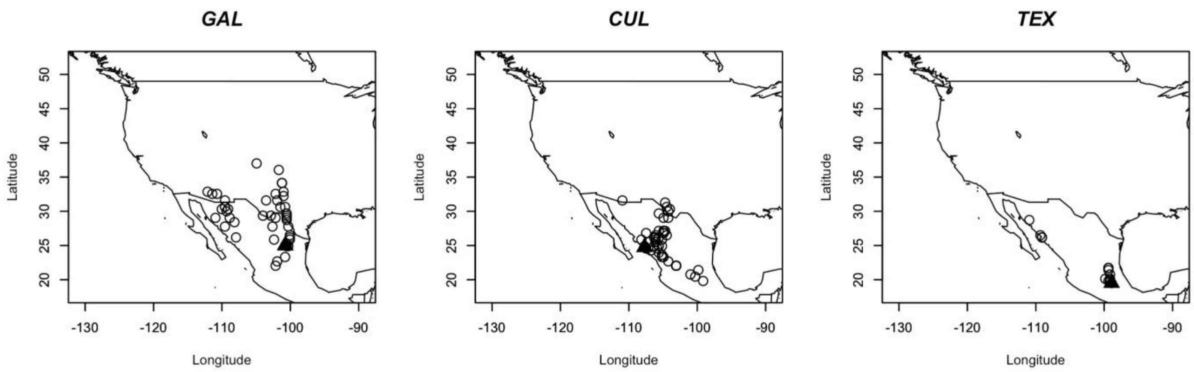


Figure 3. Geographic origin of breeding adult burrowing owls (open circles) at each of 21 study populations (triangles), as inferred from base maps of δ^2H, $\delta^{13}C$ and $\delta^{15}N$ data.




SSW
CAG
MEX
FBL
JAN
CAB
CHI
HER
DEL
YAQ
FUE
LAG
Latitude
Longitude
50
45
40
35
30
25
20
-130
-120
-110
-100
-90


GAL
CUL
TEX
Latitude
Longitude
50
45
40
35
30
25
20
-130
-120
-110
-100
-90

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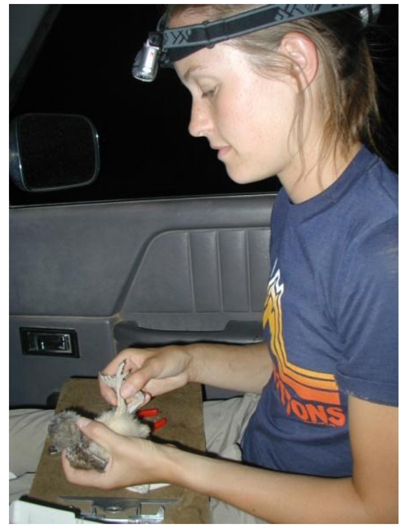
Appendix 1: Protocols

Standardized Monitoring Strategies for Burrowing Owls on DoD Installations



V. Garcia
C. J. Conway
L. A. Ellis
C. P. Nadeau

Arizona Cooperative Fish and Wildlife Research Unit

Table of Contents

Foreword

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, the reduction of prairie in the United States, and the control of burrowing mammals such as prairie dogs (*Cynomys spp.*) and ground squirrels (*Spermophilus spp*.) are thought to be the causes for the decline in Burrowing Owls (Sheffield 1997, Desmond et al. 2000, Klute et al. 2000). Due to concerns about persistence of remaining Burrowing Owl populations, Burrowing Owls are now federally endangered in Canada, and are listed as a Species of National Conservation Concern in the U.S. (U.S. Fish and Wildlife Service 2002).

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. Burrowing Owls have been reported on many DoD installations in the southwestern U.S., and therefore the DoD may play a key role in the maintenance or recovery of Burrowing Owl populations if declines continue. However, we currently lack information on the extent to which Burrowing Owl populations on DoD installations are self-contained and how much dispersal occurs among locations. In 2005, we initiated a project with support from the DoD Legacy program to help fill these needs. We are using 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, document the extent to which Burrowing Owls disperse between populations, and quantify land-use of migrating and wintering owls in the region. We are working with DoD installations in the western U.S. that have records of Burrowing Owls to test this hypothesis and to develop a coordinated, multi-agency program to help determine the extent to which Burrowing Owl populations are redistributing throughout North America.

As part of this project, we developed the following protocols for monitoring Burrowing Owl populations on DoD installations. The level of monitoring effort will undoubtedly vary among DoD installations, but these protocols provide a complete package such that each installation can use some or all of these protocols depending on their own needs or goals. We provide information for conducting standardized roadside surveys, conducting nest visits (intense monitoring), and banding Burrowing Owls. These protocols can be used singly or in combination. Additionally, natural resources staff may choose to decrease (or increase) the suggested frequencies of tasks depending on their particular programmatic goals. This project is funded by the following: DoD Legacy Resource Management Program, U.S. Department of Energy, U.S. Fish and Wildlife Service, U.S. Environmental Protection Agency, National Park Service, Sonoran Joint Venture, World Wildlife Fund, University of Arizona, Canadian Wildlife Service, University of Alberta, National Council of Science and Technology (Mexico), T&E, Inc., DSCESU.

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Standardized Roadside Survey Protocol

The goal of these surveys is two-fold: to locate as many owls as possible, as quickly as possible; and to establish a standardized, repeatable survey protocol with high detection probability, low (temporal) variation in detection probability, and low observer variability.

Systematic Survey Routes

Surveys should be conducted periodically (e.g., every morning, every morning and evening, once per week, twice per week) and should attempt to cover as much of the area as possible, while making it as likely as possible to find owls if owls are present. Therefore, if you have to cover a large area, you will have to stop at survey stations less often. Based on the distance to be covered, you should decide ahead of time how far apart your survey stations will be. However, you may alter this distance if you find you have overestimated or underestimated how much ground you can cover in the given time.

Identify systematic survey routes on topographic maps or road maps using all presumed passable roads (i.e., no 4-wheel drive or 2-tracks) within the area. How often you stop to survey will depend on how large the study area that you have to cover is. Minimum distance should be 400 m between points. If you have to cover a very large area, you may just drive very slowly, without ever stopping unless you locate an owl.

Observers should drive 24 km/hr (15 mi/hr) while looking for owls. If an owl is suspected or located, observers should stop the vehicle, and attempt to locate the burrow. If the burrow cannot be located after 30 minutes of searching, observers should take the GPS coordinates of the location where the owl was first seen. Observers should then continue the survey, but return later (at dusk or dawn) to attempt to locate the burrow of the owl that was just seen.

Recording the starting UTMs:

Start a new line every time you locate an owl, anytime to stop at a survey point, or anytime you change roads.

When choosing the exact location of a survey point you are allowed to move the point up to 200 additional meters along the road to allow a location with optimal viewing radius of the surrounding habitat. Adjacent survey points may be located more than 400 m (0.25 miles) apart if no Burrowing Owl habitat is available, but should not be located substantially less than 400 m (0.25 miles) apart. The location of each survey station must be accurately marked on a 7.5 minute topographic map or a gazetteer. Once downloaded to Map Source from GPS units the survey points' exact locations can also be seen by printing out maps from the program. A verbal description of its location (road and cross roads) and the UTMs recorded using the GPS receiver will also be recorded on the data sheet so that the exact survey location can be re-surveyed in future years.

At each survey station, the observer pulls off the road, parks on the road shoulder, exits the vehicle, and performs a 2-minute survey. During the 2-minute period, the observer will scan the surrounding landscape. Observers scan the landscape in a 360^o arc around the survey station during the entire survey. The observer may move around a bit to ensure that the vehicle does not obstruct their view of the surrounding area. For each owl that is detected, observers record whether each bird is heard and/or seen.

Observers also record the azimuth (degrees) and distance (m) to each owl detected, and whether the bird was at a nest burrow. Record whether each owl was detected visually, vocally, or both. Each adult owl detected at a survey point gets its own line, juveniles associated with one nest get one line for all juveniles. Hence, one nest detected at a point may produce 3 lines of data - one for the male, one for the female, and one for the juveniles. If no owls are detected at the survey point, there is one line filled out.

Once the 2-minute survey is complete, record the habitat types (See **Insert 1**) within a 200 m radius surrounding the survey point. Also record the percent of surrounding landscape (within the 200 m radius circle) that is visible from the survey point, and the percent of **the visible landscape** that is potential owl habitat.

Timing

Surveys will be conducted mid-March – mid-July. Surveys should be conducted between first light (typically ½ hour before sunrise) until 11:00am and between 5:00pm until dark. Do not conduct surveys during excessive rain or when wind speed is >20 mi/hr.

Insert I: Habitat Types/Land uses (*to be used on roadside surveys*)

Abandon Field (af): Fields which have been disturbed from their natural state and are now covered by non agricultural plants (most commonly invasive grasses and forbs which establish quickly in disturbed areas). These areas include abandon agriculture and other open fields. Areas with old development (gravel piles, cement slabs, old foundations) are not classified as abandon fields (see Vacant Lot). Areas with shrubs steppe or other large native plants are not classified as abandon fields (see Shrub Steppe, Paloverde-Cacti Scrub, Invaded Grassland, Creosote Flat).

Agriculture (ag): Any land being tilled, planted, harvested or other wise disturbed for agricultural purposes. This includes tilled fields, fields with crop stubble but little other vegetation, crops and orchards. Fields which have been inactive for long enough to have non-agricultural plants covering the majority of the field are not grouped in this category (see abandon field).

Airplane storage (as): Areas of AMARC - Tucson only.

Airport (ap): Self explanatory.

Creosote-Flats (cf): This is a desert habitat in Arizona which is dominated by tall creosote bush and little other vegetation. The substrate is normally sand.

Dry Wash (dw): This is a desert habitat in Arizona. It is any area which has evidence of running water (eroded banks, under cut banks) but is dry for most of the year and has vegetation (commonly paloverde, mesquite, and grasses) growing on the dry wash bed. This also includes dry rivers. This does not include irrigation canals or other man made ditches (see Irrigation Canal).

Feed Storage (fs): Any permanent buildings or areas where livestock feed is being stored (grain bins, grain elevators). Any non-permanent feed storage (hay bails, grain piles) are not included in this or any definition as they are not permanent and are not likely involved in the owls choice of burrow location.

Feedlot (fl): Areas with little to no ground vegetation, and where animals are fed using means other than grazing. These areas are usually completely trampled mud or dirt and do not have any vegetation which could be grazed. This includes pig pens.

Golf course (gc): Self explanatory.

Gravel Road (gr): Any public road which has a gravel surface. This does not include two tracks.

Housing Development (hd): Residential development and anything associated with the residential development. This includes houses, apartments, trailers, garages, barns, driveways, and yards/lawns. This does not include development such as industry or shopping malls not associated with a residence (see Industry/Development).

Industry/Development (id): Any non-residential buildings or anything associated with the non-residential buildings. This includes industry, shopping centers/gas stations, businesses, parking lots, parks and sports fields.

Irrigation Canal (ic): The main canals used to transport water for the purposes of irrigation. This category does not include small cement irrigation troughs found directly adjacent to crops. Irrigation canals are large enough that one would have to jump to cross the canal and are normally not lined with cement.

Rangeland (rl): Area dominated by native short grasses (in Arizona this area may be invaded with mesquite but shrubs are absent in other areas). This area may or may not be grazed by livestock and may be fenced by barbwire or electric wire. Differs from pasture in that it is not irrigated and not planted with unnatural grasses for grazing purposes.

Shrub Steppe (ss): Areas containing sagebrush and rabbit brush. Sagebrush and rabbit brush are often in low densities and the area between each shrub may consist of sand, grasses or forbs. The entire area between the area which has sparse shrub growth is considered shrub steppe (including vegetation, sand, etc, found between shrubs). Shrub steppe may be disturbed and is often found in the uncultivated corners of pivot or circle crops.

Paloverde-Cacti Scrub (pc): This is a desert habitat in Arizona which consists mainly of various cacti (Saguaro and Cholla) and shrubs (mainly paloverde). The substrate is usually gravel-sand and covered sparsely with grasses or low lying plants.

Pasture (pa): Any field which is used for grazing livestock (cows, horse, sheep, etc). This includes fields which are currently not in use but have unnatural (irrigated or planted) grasses being grown for the purpose of grazing. Often these fields are fenced with barbwire or electric wire and are irrigated. Feedlots or areas where livestock are fed using means other than grazing and contain little to no ground vegetation are not considered pastures (see feedlot).

Paved Road (pr): Any public road which is paved. This includes highways, off ramps, and any other paved road.

Prairie Dog Towns (pd): An area dominated by prairie dogs with high burrow density, large burrow mounds, very low vegetation height and large patches of bare ground.

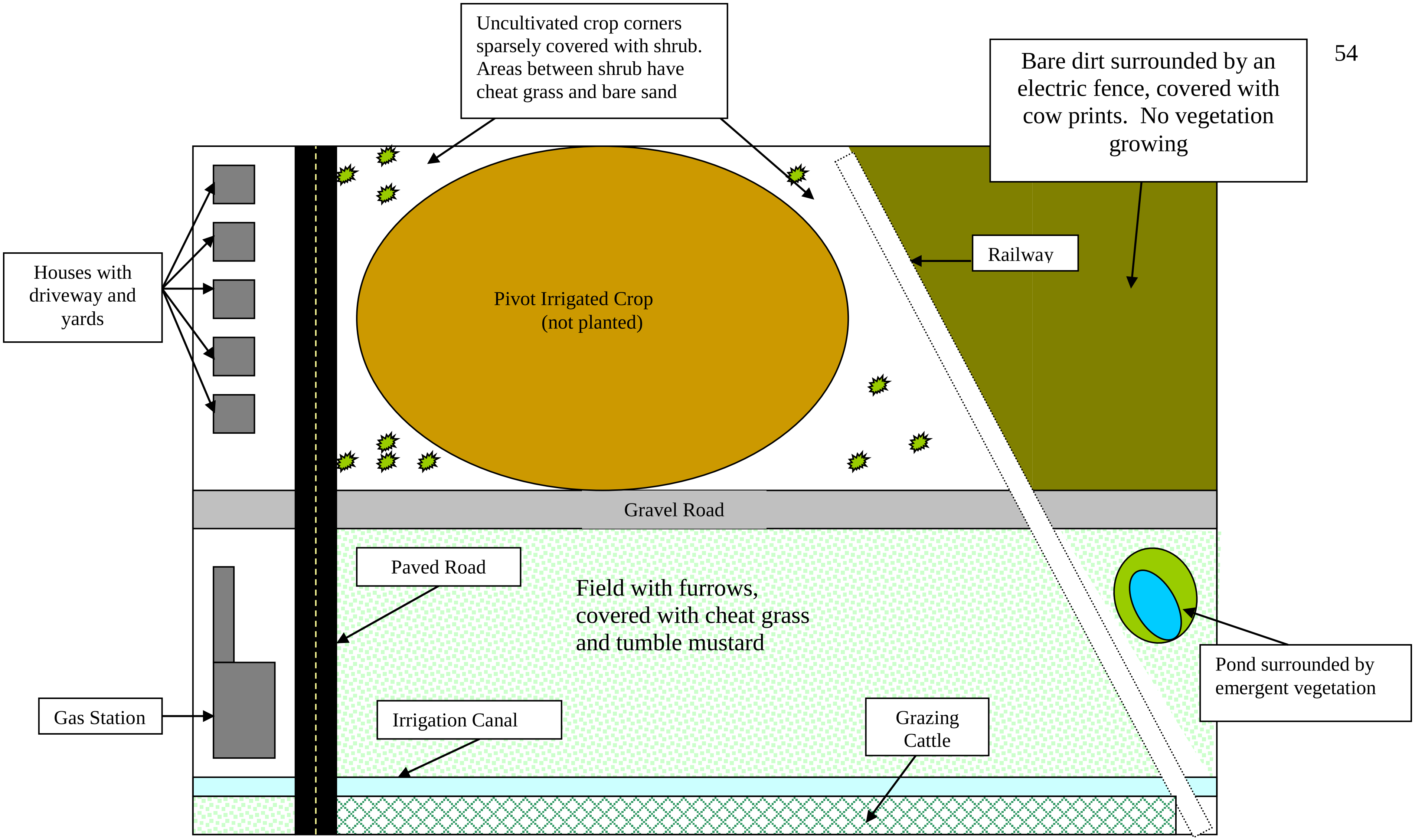
Railway (rw): Any rail road tracks. Rail yards with a lot of activity buildings, grain elevators, etc should be classified as industry/development. The railway leading in and out of a rail yard is classified as railway.

Resource Development (rd): Coalbed-methane, natural gas, oil pumpjack development and anything associated with the development (gravel roads, pump-houses, holding tanks, well markers).

Vacant Lot (vl): Areas which were once developed but have been abandoned leaving remains of foundations, gravel, old pavement, mounds of dirt, and other human debris. This may include areas which are currently under construction for development. These areas have sparse vegetation normally consisting of invasive plants such as cheat grass.

Wetland/Riparian (wr): Any area where the substrate is saturated or covered with water and contains emergent vegetation (such as cattails and rushes) and/or water dependent shrubs and trees (Red Osier Dogwood, Willows, Cotton wood). Irrigation canals are not considered wetlands (see irrigation canal).

Other (ot): When using other please evaluate all of the above explanations to be sure that you are not able to categorize the other as one of the above selections. If you are sure the other does not fit into any of the above categories record other on the data sheet followed by a description.



How would this area be classified? Roadside survey (*note the above area covers a 200m radius from the center for the purpose of roadside surveys*): Fallow agriculture, Agriculture, Feedlot, Shrub Steppe, Housing Development, Industry/Development, Pasture, Gravel Road, Paved Road, Railway, Wetland

Sample datasheet for Burrowing Owl Standardized Survey

Study Site: ____________ Year: ____________ Frequency of survey: ______________________________________

Entered by: ____________
Date: ____________
Checked by: ____________
Date: ____________

Driving Survey Data Sheet
V = Visual, C = Call, A = Alarm, P = Possible Nest, 0 = Nothing Detected
UA = Unknown Sex Adult, UNK = Unknown Age/Sex Owl, M=Male, F=Female, #J=Number of Juvies
Each adult BUOW = 1 line
All juvies from 1 brood = 1 line

Habitat types:
AG-Agriculture, AP- Airplane storage, **PA**-Pasture, **VL**-Vacant lot, **WR**-Wetland/Riparian, **RW**-Railway, **AP**-Airport, **AF**-Abandoned field, **FL**-Feedlot, **PR**-Paved road, **HD**-Housing development, **GC**-Golf course, **IC**-Irrigation Canal, **FS**-Feed storage, **GR**-Gravel road, **ID**-Industry/development, **SS**-Shrub-steppe (WA/WY), **DW**-Dry wash (AZ), **PC**-Palo Verde-cacti shrub (AZ), **CF**-Creosote flat (AZ), **RL**-Rangeland(WY/AZ), **PT**-Prairie Dog Town (WY), **RD**-Resource development (WY), **OT**-Other

Road/Crossroads Start	Start UTMs	Odometer	Obsesrver	Date	Start time	V, C, A, 0	Present? M, F, #J, UA, UNK	Distance (m)	Direction (degrees)	At Burrow?	Paired with other owl detected?	Repeat owl?	Nest Location Confirmed?	Nest location UTMs	NestID of new nest	Habitat type within 200m	# Livestock?	# Marmot?	# Ground squirrel?	# Prairie Dogs	End time	Road/Crossroads End	End UTMs	Comments

Protocol for Recording Roadside Survey Data

Field Name	Entry Example	Description
Road/Crossroads	*NELSON (RDA/RDB)*	Record the road on which the roadside survey was initiated Crossroads should also be recorded in parenthesis, separated by a forward slash (/). For example if you are on Nelson road between Road A and Road B the following should be recorded: Nelson (RdA/RdB). If the roadside survey start was at the intersection of two roads, both roads should be recorded separated by a slash (/).
Start UTMs	*0330868 5220296*	Record the UTMs of the location of the start of the roadside survey.
Odom	*15006*	Record the odometer reading on the vehicle used for the roadside survey. The reading should be taken at each survey point. This combined with the road information will help future surveyors locate the points without using a GPS.
Observer	*CPN*	The initials (three letters) of the individual who conducted the roadside survey.
Date	*15-MAR-02*	Record the date the roadside survey took place. This should be recorded as day-month (use three letter abbreviation to avoid confusion with month and day)-year.
Start Time	*0930*	The time at which the roadside survey began. The number should be recorded as a four-digit number in 24-hour time.
V, C, A, 0	*V*	Record what was heard or seen during this portion of the survey. Note that each adult owl detected gets its own line at the datasheet and all juveniles detected are grouped on one line.
Sex Present	*M*	If owls were observed during the trial, record the sex/age of the owl in this field using the codes at the top of the roadside survey datasheet. Note that each adult owl gets its own line on the datasheet and all juveniles are grouped on one line.
Distance	*100*	If owls were observed during the survey estimate the distance to the owl and record it

Field Name	Entry Example	Description
		in this field.
Direction	*120*	If owls were observed during the survey, use a compass to determine the azimuth to the owl and record it in this field.
At Burrow?	*Y*	If the owls observed during the survey were at or near a burrow, put a Y (yes) in this column. If the owls were not at or near a burrow put an N (no).
Paired w/ other owl detected?	*N*	If the owl being referred to on the current line was detected with a mate that was also detected (this includes owls detected at previous points) record Y (yes) in this field. If no mate was detected, record N (no).
Repeat owl?	*N*	If the owl detected was observed from a previous point record Y (yes) in this field. If this is the first time the owl was observed during the survey, record N (no) in this field.
Nest Location Confirmed?	*Y*	If owls were detected, you should make an attempt to locate the owl's burrow after the survey at that point has been completed. If you are able to locate the nest Y (yes) should be recorded in this field. If you were not able to locate the nest N (no) should be recorded. It may take several tries to find the nest. Once the nest is found be sure to change this to Y.
Nest location UTMs	*0362528 5523693*	Record the UTMs of the nest found.
Habitat Type within 200m		View the area within a 200m radius around the survey point and record the habitat types using the codes on the top of the roadside survey datasheet. (see **Insert I** for definitions). Habitat types should be listed in descending order from the habitat type covering the most area to the habitat type covering the least area.
Livestock?	*Y*	Record Y (yes) if there is evidence of livestock within a 200m radius of the survey point. Electric fences, cow patties, irrigated pastures are all evidence of livestock. Record N (no) if there is no evidence of livestock.

Field Name	Entry Example	Description
Marmot?	*Y*	Record Y (yes) if there is any evidence of marmots within a 200m radius of the roadside survey point. Record N (no) if there is no evidence of marmots within 200 m.
Ground squirrel?	*Y*	Record Y (yes) if there is any evidence of Ground Squirrels within a 200m radius of the roadside survey point. Record N (no) if there is no evidence of Ground Squirrels within 200 m.
# of Prairiedogs	*25*	Record the number of prairie dogs seen
End Time	*15:30*	Record the time you stopped surveying this section.
Road/Crossroads End	*Rd B/ Rd A*	Record the location where you ended this section of the survey.
End UTMs	*0362528 5523693*	Record the UTMs where you ended the this section of the survey.
Comments		Record any comments.

Nest Visit Protocol

Nest visits are one of the most important and most frequent activity conducted in monitoring birds during the breeding season. By visiting the known burrows on a frequent basis you can estimate a variety of parameters including nest success, timing, and clutch size. All other activities should be combined with nest checks whenever possible.

FREQUENCY

Visit all active nests every **3-4** days and unoccupied burrows every **7** days throughout the season. Once juveniles begin to fledge, unoccupied burrows can be visited every **10** days because the likelihood of the burrows becoming occupied at that stage is slim. Keep in mind that owls will use some of these burrows while migrating through the area, so it is still important to continue checking them. Burrows that have been unoccupied for two years in a row can be checked every **2** weeks. If there is no owl activity or sign at a previously occupied burrow, (e.g., a lack of whitewash/feces, pellets, feathers, etc.) on 3 subsequent visits (**3-4** days in between) then visit the nest once a week. If a burrow that was active goes inactive then becomes active again, return to visiting the nest every **3-4** days. Every other visit must include a nest approach to collect pellets, etc. An effort should be made to combine other activities (trapping, detection trials, etc.) with the nest approach visit to minimize disturbance to the owls. Spend as little time as possible around the nest and area in order to prevent trampling of the burrow and mound. Also, try to avoid making obvious trails to burrows. Leaving your sign and scent around the burrow may attract predators to the burrow, so your activity at the burrow should be limited.

If you visit a nest without doing a nest approach, please record "**DA**" for "didn't approach" in the **comments** section under each heading. If you are driving by a nest that is not scheduled for a visit but happen to observe owl activity (e.g., 2 adults standing on the mound), record your observations on the nest card and make sure to record it as a "drive by" visit in the comments section under each heading. Try to make every other nest visit at dawn or dusk.

Naming and Recording Info of Nests and Satellites

Fill out a nest card only for each pair (or resident male), not each nest burrow and each of its satellites. The idea is to monitor a pair of owls at their burrow and keep track of all satellite burrows the pair is using. All activities for this pair and the pair's offspring are recorded on the nest card. If/when the owls start using a satellite burrow (or many), the satellite burrows are to remain on the pair's nest card, not a new nest card for the satellite burrow. Example: Two owls from nest30 start using a satellite burrow, nest30B. When they are at nest30B, record all observations on the nest30 card, making sure to note that they are using satellite B. If a satellite burrow is being used for the first time, map the location of the satellite burrow in relation to the nest burrow so that others can easily find it in the future**.**

However, some burrows used as satellites will have their own nest card because the burrow may have previously been a nest of its own. For example: One year nest30 began using another satellite, nest40. Nest40 was a nest last year and already has its own nest card. If an owl uses one of the burrows that has a nest card as a satellite burrow, you still record the info on the nest burrow nest card (nest30). On the satellite burrow nest card (nest40), you only need to record that the owls from nest30 are using the burrow as a satellite.

If a satellite already named (given an A, B, C etc. designation) becomes occupied by a separate pair or you discover you were actually dealing with 2 pairs, the satellite should be **renamed** and get its own nest card. A note should be made on both nest cards indicating the change and on what date it occurred. For example: It is discovered that in fact there are 2 pairs using nest30 (one at A and one at B). Nest 30B should not keep this name but get a new designation such as nest31.

Using the GPS unit, make a new waypoint for each new burrow (nest and satellites) and name the waypoint after the **Nest ID** (the same name used on the nest card; the nest name with A, B, C for satellites). To obtain the most accurate coordinates possible, leave the unit at the burrow on "average" mode while completing the nest check. Nest names should be somewhat descriptive (use road names or area name followed by a number). This helps keep burrows organized and helps new people locate burrows that are grouped together.

RECORDING INFO ON THE FRONT NEST CARD

Fill out the front of the nest card to completion. Nest ID and Site (e.g., Ft. Carson)) as well as State are the first to be recorded. The sections for UTMs, Year, Date, Satellite burrows + UTMs, Years Occupied also need to be completed.

Be sure to record how the nest was found (**H** = historic, **I** = incidental, roadside **RS** = survey, **WOM** = word of mouth, **LY** = Last Year). Record the nest type the owls are using with one of the following burrow types: Artificial, Badger, Coyote, Culvert, Ground Squirrel, Irrigation trough/Badger, Irrigation trough/Unknown, Man-made, Man-made/Badger, Man-made/Coyote, Man-made/Ground Squirrel, Man-made/Marmot, Marmot, Prairie Dog, Other (if there is another animal burrow that can be identified that is not on the list) and Unknown (if it is impossible to determine what kind of burrow it is).
Badger burrows typically are flatter on the bottom of the entrance and more rounded at the top. They are usually found near the base of a slope or road cut, but can be found on level ground in Washington. Coyote burrows are fairly large and oval shaped (largest diameter from top to bottom). Marmot burrows, smaller and more round, are found among rocky outcrops or near cement, often with old marmot scat around the entrance. Man-made burrows include culverts, cement or concrete slabs, piles of dug up concrete that resemble rocky outcrops, or holes/cracks along irrigation canals or troughs. Often the man-made category needs to be combined with another category to reflect that the burrow was created or modified by an animal (e.g., a marmot dug under a cement slab).
Directions and maps will most likely need to be revised until everybody is satisfied with them, so please write lightly. Make sure all the info makes it to the front nest card so that when others go to find the burrow all the information is there and they can add the coordinates to other GPS units. As new satellites are discovered fill in their designation and UTMs in **Satellites +UTMs.**

Finally, for all individuals (males, females, and juveniles) that are banded, re-sighted, or re-captured at a burrow, record the color and alphanumeric code and USFWS # of the bands in appropriate space of the front nest sheet. Record this regardless of whether you banded, recapped, or just re-sighted the bird. (Note: when re-sighting birds you will not likely be able to read the USFWS band so just record it as AL).

RECORDING INFO ON PAGE 2 OF THE NEST CARD

Before Approaching the Nest

Observe the owls in the nest area from 125 to 300m away (depending on the sensitivity of the owls) using a spotting scope or binoculars before moving closer to read bands. Record the activity of all owls: What are they doing? Record the exact locations of males, females, and juveniles in relation to the burrow entrance (**Adult / Juv act + location**). Be sure to state what owls are at which burrows (e.g., M and F at Sat A, 4 juvies at nest burrow, 2 juvies at Sat D). It is extremely important to record this information so that others will know which burrows are actively being used (**Active Satellites**) when they visit a nest, especially when setting traps.

Record the observed **stage** of the nest (**NS =** No Sign, **O =** Occupied, **SAT =** Satellite, **G =** Sign, and **J =** Juveniles) for each visit. In other words, record what you saw not what you believe is there. Record the sex and age of each owl present based on plumage, behavior, or some other clue (never use band combos to sex the owls).
Also, record band combos (or lack thereof) for all owls present (leg/color/alpha numeric code: UNB = unbanded; NL = no legs/meaning you couldn't see their legs to read the band; CRB = banded but couldn't read) in **Juv + bands** and **Adults + bands**. When recording the color and alphanumeric code and USFWS # for each leg make sure you distinguish between combos that are vertical and horizontal, and be sure to include the line between the codes (record to band combos as: horizontal = **Re-X3**, vertical = **Re-X OVER 3**, vertical with a bar = **Re-X BAR 3**; horizontal with a bar **Re-X VBAR 3**).

Horizontal: X3	Vertical: X 3	Vertical with bar: X 3	Horizontal with a bar: X 3

Record band colors with a two letter code:

AL-Aluminum (USFWS)	Bk-Black	Bl-Blue	Br-Brown	Gr-Green	Ye-Yellow
Or-Orange	Pi-Pink	Pu-Purple	Re-Red	Wh-White	

When trying to determine whether an owl is banded or unbanded, wait until the owl's feet are visible. Burrowing Owls have extremely long legs and it is often difficult to determine the band status without actually seeing the entire leg down to the toes. Also, they often stand on one leg and tuck the other under their body. In the beginning of the season, it is imperative to read band combinations until every owl is identified. Once identified you must *try* to read bands every visit. This is necessary to confirm that even owls that have been identified have not switched burrows, which they frequently do early in the season.

It may take several trips over a course of days to confirm the identity of some owls (this is in addition to scheduled nest checks). If an adult owl's bands can not be read within an hour or so, do other nest visits in the area and periodically check back at that burrow to see if that owl has moved into a better position. It may become necessary to trap an adult owl, or set up a blind, if the adult's bands are still unread after repeated failed attempts to resight. If a nest is active but one/or both of the adults have not had their band status confirmed after 3 days, we need to try to trap that adult.

When copulations are observed, record them under **comments.** When a male is observed delivering food to the burrow entrance, or adults are observed feeding young, record it under **comments.**

Approaching the nest

JUVENILE ACTIVITY

Estimate the age (**Age Est**) of the oldest and youngest juvenile owls seen, using the Juvenile Ageing Guide, on each visit (don't EVER back-date age from a previous nest visit). If you think the juvenile is between 21-23 days, record the age as 22 days. Scan the nest area and record use of all satellite burrows under **Juv activity + location.** Record whether juveniles **Flush or Retreat** to a burrow and specifically to which burrow (nest burrow, satellite A, B, C). Record any evidence of juvenile flight under **Flight des** (**J** = flight jumps or wing flapping with or without leaving the ground, **W** = wobbly flights, **S** = short flights, **L** = long flights).

ADULT ACTIVITY

Before approaching the nest, listen for owls calling (coo-cooo, quick-quick). While approaching the nest on foot, note any owl activity as you approach and record under **Adult activity + location** (be sure to include satellite designation). Make sure you always keep an eye on the nest burrow. If an adult flushes from the nest burrow, keep an eye on where it goes so that you do not 'count' it as an owl from another nest. This is especially important at nest clusters as owls often flush toward other occupied nests (which makes differentiating between one owl and the next difficult without reading bands). Record each owl's response to your approach (**Flush or Retreat?**).

Note if owl calls are given. Record whether the male or female **alarm (A)** calls (quick, quick, quick) or **coo-cooos (C)**. Under **F/M Behvr**, record whether the owl 'swoops' or hovers over the observer during the nest visit by circling '**S**'. Record whether the owl 'bobs' after landing ('bob' = owl moves their body vertically up and down) by circling '**B**' on the data sheet. They may do this several times in succession, often while giving the alarm call. Record whether adults display the 'white-and-tall' stance ('white-and-tall'= owl stands completely vertical and contracts the white feathers around its face so they stand out) by circling '**W**'. Record whether the owl (usually the male) assumes the "territorial posture" by circling '**P**' (body horizontal and feathers puffed up, with "whites" display, usually accompanied by a coo-cooo and body rotation).

At the Nest: General Nest Area Observations

In the **Burrow Condition** section:

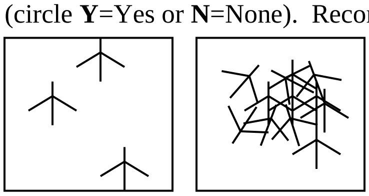
Be sure to include the satellite designation for all observations!

Record whether nest **lining** is present, as well as what type (horse/cow manure, grass etc. Note that shredded horse/cow manure looks like shredded grass, so examine the lining closely to be sure it is identified properly.) and the quantity (**N**=None, **S**=Some, **L**=Lots). Record whether nest decorations (**décor**) are present, as well as the type and the quantity (2 pieces of tin foil, 6 pinecones). Lining usually lines the tunnel and part of the mound near the entrance and is often shredded material. Decorations are usually single items found on the mound. Be sure to record items each visit even if they have been recorded previously. The presence of **scat** should also be recorded. This means canine scat, which is hypothesized to be brought to the burrow by the owls to discourage predators. Marmot scat can also be present on the mound but this should not be recorded under **scat**. Marmot scat is a sign that marmots are frequenting that burrow, not that the owls seek it out and place it on the mound. Marmot scat should be recorded in the comments.

Type and quantity of lining and décor is recorded because they indicate nest initiation. Remove all lining and décor at the first visit to a burrow unless the burrow was found after nest initiation. This avoids confusing lining or décor remaining from last year's nest. On subsequent visits, remove lining or décor if it is questionable whether it is new or from an owl. If it reappears on the next visit you should not remove it. Most burrows will not require a second removal, as nest initiation will be obvious from visual sightings of the owls (or by the use of the infrared scope).

Record any evidence of fresh **prey remains** on or in the burrow or satellite burrow (1/2 rodent, frog guts, insects, etc.- try to ID prey items if possible). Check for **pellets** (circle **Y** if there are pellets or **N** for none). Collect 2-4 whole fresh pellets each time you approach a nest burrow. Pellets disintegrate at different rates dependent upon composition. Pellets consisting of mainly insect remains disintegrate quickly and easily fall apart compared to pellets consisting mainly of mammal remains. This may make it tempting to not collect pellets consisting mainly of insect remains. Please make an effort to collect pellets that are representative of the types of pellets present at the burrow. Always remove all pellets, even those not collected. When you collect pellets put them in a paper bag and write the Nest ID, the date, and how many whole pellets were collected on the bag (circle **C**=collected pellets on the datasheet). Make sure to record the satellite designation of where the pellets were collected.

Record the amount of new whitewash seen on the burrow mounds and perches (specify the satellite designation or specific perch if applicable) (**Feces: N**one**, S**ome**, L**ots). Do not include old whitewash on surfaces that it cannot be removed from (e.g., rock). Also, record any Burrowing Owl feathers lying around the burrow area under **Feathers** (circle **Y**=Yes or **N**=None). Record if there appears to be owl footprints on and around the burrow mound. There can be both adult prints (**Ad Prints?**) and juvenile prints (**Juv Prints?**) present (circle **Y**=Yes or **N**=None). Adult prints generally occur spaced out over the mound while juvenile prints occur in a specific pattern close together at the burrow entrance. Adult prints can be useful to show the presence of owls when there may be no other sign (i.e., the owls may be perching and leaving whitewash and pellets elsewhere). The presence of juvenile prints indicates when the juveniles begin emerging.



Adult Prints | Juvie Prints

Record whether any eggshell fragments or eggs were seen outside the burrow (evidence that eggs were laid).

Record any evidence of depredation (**Signs of depred**) or any owl death, including piles of owl feathers, predator footprints on mound, etc. Search the surrounding area within 10-30m of the burrow closely. Collect any and all remains of deceased Burrowing Owls, place them in a plastic bag, and label the bag with the Nest ID, bands, cause of death and the date. Record what type of remains were found, note where in relation to burrow the remains were found, and what may have happened on the data sheet. Often the type of remains found can determine the type of predation. The following are examples of what various predators will leave behind. Raptors: piles of feathers with little other remains; Owls: decapitate bodies; Mammals: dismembered body parts usually the wings or the legs. If banded legs are found, record band numbers. If it is a banded bird, it should also be recorded on the front nest card.

Clear all sign on each visit by scuffing away the whitewash and prints, and removing the feathers and pellets. Do the same for satellite burrows. Note that you did this on the nest card (**Sign remo**, circle **Y**=Yes or **N**=No). If for some reason you do not remove all sign note that sign was not removed. Make sure that for all burrow conditions you record the satellite where they were observed.

Video probe all occupied burrows once every 7 days on the approach visit. Draw a map of the tunnels and record lengths of each on the back of the **front** nest card during the first scoping visit to the nest so the next person to scope will have it as a reference. If there are any changes to the burrow description update the map and record it in **Map updated** (circle **Y**=Yes or **N**=No).

Record the **Scope info**. This includes what was seen (e.g., 1 egg, 4 chicks <8 days old + female) and the tunnel description (e.g., 3m, no branches). Use the Juvenile Ageing Guide to best determine the age of the chicks. Burrowing Owls lay one egg an average of every 36 hours and generally have a clutch size of 7-10. Since Burrowing Owls may begin incubating after laying their first egg (usually on 4-7 eggs), the chicks will hatch asynchronously (at different times) meaning there will be chicks of various ages in the brood. Record any problems with the burrow – if you couldn't reach the chamber, if there was loose dirt, etc.

Finally, if **trapping**, record whether spring traps, 2-way traps or both were used. Make sure that when you trap at a burrow you specify which burrow(s) were trapped at (nest, Sat A, B and E, etc.) and how many/age/sex were caught at each on the nest card.

If there is no sign of owl activity

If no owl activity is observed, check the burrow entrance for cobwebs. Cobwebs that are in the burrow entrance but will allow a Burrowing Owl to pass are OK, but cobwebs that would prevent an owl from passing are a sign that the burrow is not in use and need to be recorded in the comments section. Scan the nest area and record any evidence of depredation of adult or juvenile owls (owl feathers, predator foot prints on mound, etc.) as above.

Before leaving the nest area, check the nest card and make sure everything that you observed was recorded and that nothing was missed.

Nest ID:	Site:	State:

UTMs:	Year:

Satellite burrows + UTMs :

How Found:	Nest Type:

Directions

Map

Adult Bands

Sex	Date	Yr. Banded	Bled	Left Leg	Right Leg	Dead

Juvenile Bands

Date	Freq.	Bled	Left Leg	Right Leg	Dead

Nest ID:		Site:		
Date				
Time				
Obs				
Stage	NS G O J SAT	NS G O J SAT	NS G O J SAT	NS G O J SAT
Active Satellites				
Juvenile Activity- Observations without peeper				
# Juvs + bands				
Age Est	Old: Yng:	Old: Yng:	Old: Yng:	Old: Yng:
Old/Young act + location	Old: Yng:	Old: Yng:	Old: Yng:	Old: Yng:
Flush or Retreat?	# Flush # retreat	# Flush # retreat	# Flush # retreat	# Flush # retreat
Flight des	J W S L	J W S L	J W S L	J W S L
Comment				
Adult Activity- Observations without peeper				
#Adults + bands				
Adult act + location	M F	M F	M F	M F
Flush or Retreat?	M Flsh / retrt F Flsh / retrt	M Flsh / retrt F Flsh / retrt	M Flsh / retrt F Flsh / retrt	M Flsh / retrt F Flsh / retrt
Dist away when flsh	M F	M F	M F	M F
Calls M	A C	A C	A C	A C
Calls F	A C	A C	A C	A C
M Behvr	S B W P	S B W P	S B W P	S B W P
F Behvr	S B W P	S B W P	S B W P	S B W P
Comment				
Burrow Condition				
Lining	N S L Type:	N S L Type:	N S L Type:	N S L Type:
Décor				
Scat				
Prey remains				
Pellets	N Y C	N Y C	N Y C	N Y C
Feces?	N S L	N S L	N S L	N S L
Ad Prints?	Y N	Y N	Y N	Y N
Juv Prints?	Y N	Y N	Y N	Y N
Feathers?	Y N	Y N	Y N	Y N
Sign remo	Y N	Y N	Y N	Y N
Signs of depred?				
Comment				
Trapping inform				
Scope info: birds + tunnel desc				

Banding Protocol

We band adult and juvenile Burrowing Owls in order to estimate population parameters such as annual survival, annual burrow fidelity, and dispersal distances. Each bird receives an aluminum USFWS band and an ACRAFT color band with a unique alphanumeric code. These bands allow individual identification of owls, which allows us to re-sight individuals and estimate population parameters. Banding is not overly stressful to the owls and allows a non-invasive way to individually identify the owl in the future. Many studies have looked at the effect of banding on survivorship and productively and have found no negative effects.

Because we use re-sight information to estimate these parameters, it is exceedingly important that band numbers and codes (the correct combination/number, color, and orientation) are recorded correctly during both banding and re-sighting. We have had field personnel make mistakes in recording band combinations each year. The models used to estimate these parameters, such as survival, are very sensitive so just a few mistakes can drastically bias our estimates. For this reason, please use the utmost care in recording the correct band combination both when banding owls and when re-sighting owls. Be as neat and clear as possible. Common mistakes are recording the number incorrectly on the USFWS band or mixing up the recording of letters and numbers on the ACRAFT bands (P & R, 5 & S, U & V, K & X, Z & 2 etc.), not recording the OVER or BAR for the orientation, or incorrectly recording which leg received which band. These mistakes take a long time to resolve and some are not resolvable.

After each bird has been banded, make sure that you double check that the leg and band combination that you just recorded on the data sheet (combination/number, color, and orientation) matches the band that you just put on the bird. To do this, the recorder must read the leg and band combo back to bander, while recorder confirms the combo is what was written on the data sheet. The bander also must confirm that the leg and color and numbers/letters are legible on the data sheet (re-write if not completely clear). Check off and date the ACRAFT band on the inventory list. Use the bands in sequential order because we are responsible for accounting for them to the National Bird Banding Laboratory and bands used out of sequence will help identify errors made in the field (although there shouldn't be any!) and resolve discrepancies.

When re-sighting a banded bird, make sure that you are 100% sure of the leg, color, combination, and orientation. If you are not 100%, you should follow what you think the band is with a "?". Even just a color and leg can be helpful in determining what bird you have seen. Colors can be difficult to distinguish at a distance and some colors, especially purple, fade over time. You may only be able to see the leg with the USFWS band, in which case you should record which leg that band is on and return later to try to read the ACRAFT. Additionally, when recording the sex of the bird, record what sex you believe the bird is, not the way it is banded or what the last person recorded.

TRAPPING

There are a variety of traps and techniques used to trap Burrowing Owls. The most common are the two-way trap and the spring trap. The two-way trap is a box trap with a one-way door on either side. The trap is placed in the burrow entrance and catches the owl as it goes in or out of the burrow. The advantages of this trap are that it can usually be left unattended for longer periods of time (2 hour max) and it can catch multiple owls at the same time. The spring trap uses a rodent (gerbil or mouse) in a cage to attract the owl. When the owl attempts to capture the rodent, the trap is tripped and a mesh dome springs over the owl. The spring trap is usually set in front of the burrow or on a level surface in close proximity to the burrow. The spring trap should not be left unattended for longer than 15 minutes at a time. When an owl is caught in the spring trap, the trapper should be as quick as possible getting to the trap to reduce the risk of injury to owl.

Both traps are very effective but can be used more efficiently at different times of the day and year. Early in the season spring traps are effective as owls are not always using one burrow and may be shy of going through a two-way. Also, food is less abundant early in the season making the rodent much more attractive. As owls begin to initiate nests, two-ways become very effective. Often the two-way works best when set a half-hour to an hour before dark and is checked about an hour after dark (although both the spring trap and the two way are effective at any time of day). *Note: Female owls who are known to be laying* ***should not*** *be trapped as they may lay an egg in the trap.* When juvenile owls begin to emerge two-way traps are very effective. It is very important to try to trap juveniles shortly after they emerge (age 20-25 days), as they are much easier to trap at a young age. However, trapping juveniles too young (less than 20 days) is not productive because their tarsus is too short to receive an ACRAFT band, which requires them to be recaptured for the ACRAFT to be added. As juveniles get older, spring traps may become more effective. If juveniles have not been trapped at a nest it is very important to keep trying a variety of methods.

It is important to try a variety of trapping techniques on individuals who are not falling for the usual tricks. Banding all the adult owls observed is an important part of the study, and owls that are not trapped soon after their first observation may leave without ever being banded. It is often effective to set a two-way in the burrow entrance upside down, covering the doors with dirt, for a period of time before properly setting the two-way. This allows the owl to go in and out of the burrow and trap, making the owl accustomed to the trap's presence. When the trap is flipped over the owl will not be shy and will normally walk into the trap. Other techniques include mist nets accompanied by broadcast calls and/or a stuffed burrowing or great horned owl, or noose carpets. If you have made 3 attempts with conventional spring trap and/or two-way methods some of these techniques should be attempted to increase your chances of catching the owl.

Be careful when setting traps on the edge of agricultural areas or in horse or cow pastures. Livestock are often curious and farmers on equipment may not see traps. If you suspect the trap could be damaged or worse, an owl be killed in a trap by livestock or farm equipment, monitor the trap from a distance or trap at a later date.

HANDLING AND BANDING

To avoid injuring the owl, be careful when removing it from any trap. This may require you to pry open feet or untangle legs, wings or head from the trap. After removing the owl, place it in a bird bag or sock. While banding and performing measurements, always pay close attention to the bird. Placing the owl in a sock during the actual banding and measuring makes handling easier, reduces stress for the owl, and reduces the chance of escape and injury. Banding and all measurements will be demonstrated in the field as well as described in attached descriptions and keys. Try to minimize handling time to reduce any stress to the owl.

Each time you catch or re-catch a bird, determine its sex, weigh it, and estimate its age (juveniles only). This allows you to look at the change of weight with age over the breeding season and between breeding seasons. Morphological measurements (tail length, meta-tarsus, wing chord) are made on adult birds that allow comparison of body size between sexes and sites. Age estimations are very important in determining success of nests and feather emergence is helpful in determining age. Follow the codes at the top of the banding sheet.

Protocol for Recording Bands

Field Name	Entry Example	Description
Left Leg	*Pu-G OVER 2* *Pu-CRB*	Record the band number and color of the band on the left leg. USFWS bands should be recorded as they appear on the band including the hyphen. For Acraft bands record the color abbreviation, followed by a hyphen (-), followed by the alphanumeric code. Alphanumeric codes should be recorded as follows. Horizontal: **AS**; looks like **A S** Vertical: **A OVER S**; looks like **A** / **S** Vertical separated by a line: **A BAR S**; looks like **A** / **S** Horizontal separated by a line: **A VBAR S**; looks like **A** | **S** Please be extremely careful when recording Acraft numbers and orientations. Record all band numbers clearly, anything that is unclear should be re-written.
Right Leg	*Al: 0844-12456* *Al*	Record the band number and color of the band on the right leg. See above.

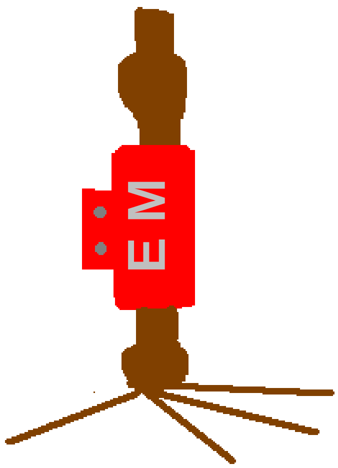
BAND COLORS *(Banding and Nest Cards)*

AL	Aluminum	**Re**	Red	**Bk**	Black
Pu	Purple	**Bl**	Blue	**Gr**	Green
Or	Orange	**Br**	Brown		

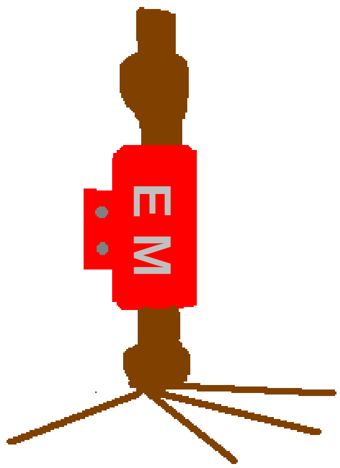
OTHER SITUATIONS

M - NL – a male, but you could not see his legs to determine if he is banded or not.
M - CRB – a banded male, but you cannot read the bands on either leg.
M - UNB – an unbanded male.
M - L:Re A OVER ? – A male with an Acraft on the left leg, but you cannot read the lower number on the band.

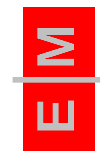
Guide to reporting ACRAFT bands



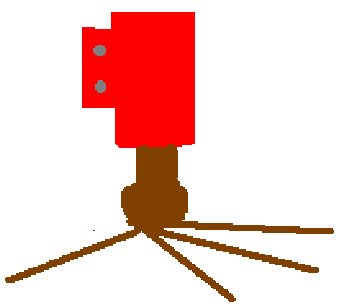
Re–EM
(This is the correct orientation for this type of band: foot to body)

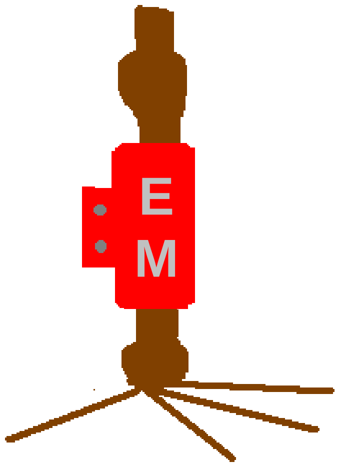


Re–EM (body to foot)
(But sometimes bands are placed this way by mistake; please make a note that the band is oriented body to foot)

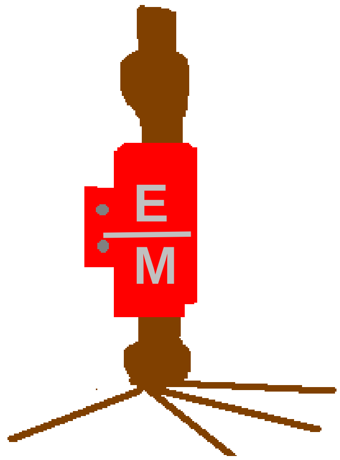


Re–E VBAR M
(This is the correct orientation for this type of band: foot to body. Sometimes they are placed body to foot by mistake. If so, please make a note of it.)





Re–E OVER M



Re–E BAR M

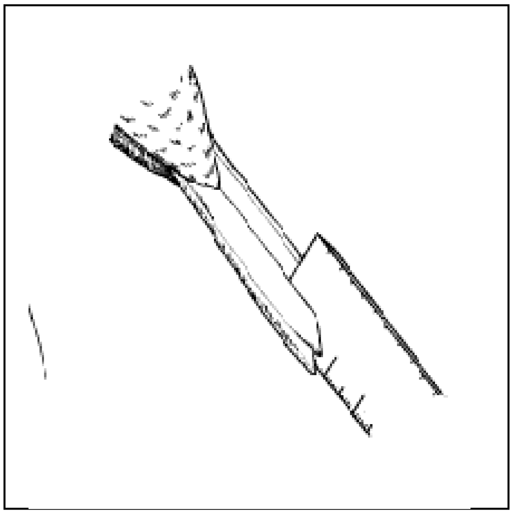
Protocol for Recording Banding Data

Field Name	Entry Example	Description
NESTID	*STEE3A*	Record the nestid (including satellite designation if applicable) for where the captured owl is from. This should be the nest or natal burrow and is not necessarily the same as the burrow at which the bird was captured. This field must be recorded for recaptures.
BURROW CAUGHT AT IF NOT NEST	*STEE5*	If the owl was not caught at the natal burrow record the burrow where the owl was captured (include satellite designation if applicable). This field must be recorded for recaptures.
DATE	*10-Jun-03*	Record the date for when the banding took place. This should be recorded as day-month (use three letter abbreviation to avoid confusion with month and day)-year. This field must be recorded for recaptures.
OBSERVER	*CPN*	Record the initials (three letters) of the individual who actually banded the owl and took the measurements. Only one set of initials should be recorded. This field must be recorded for recaptures.
LEFT LEG	*0844-39782*	The band number and color of the band placed on the left leg. USFWS bands should be recorded as they appear on the band including the hyphen. For acraft bands record the color abbreviation, followed by a hyphen (-), followed by the alphanumeric code. Alphanumeric codes should be recorded as follows. Horizontal: **AS** Vertical: **A** *or* **A OVER S** **S** Separated by a line**:** **A** *or* **A BAR S** **S** Be sure to triple check all bands before releasing the bird. Record all band numbers clearly, anything that is unclear should be re-written. This field must be recorded for recaptures.
RIGHT LEG	*Bl-2 OVER 3*	The band number and color of the band placed on the right leg. See the above description for the proper format. This field must be recorded for recaptures.
RE-CAP?	*Y*	Record whether the owl captured is a recapture or has been captured for the first time. Put a Y (yes) in the field if the owl is a recapture and N (no) if the owl is not a recapture.

Field Name	Entry Example	Description
		Record the information for all data fields in caps when dealing with recaptures.
BIRD-BAG WGHT	*190*	Record the combined weight (in grams) of the bird and the bag or sock the bird was weighed in. This must be recorded for adult recaptures.
BAG WGHT	*2*	Record the weight (in grams) of the sock or bag the bird was weighed in. This field must be recorded for adult recaptures.
SEX	*M*	Record the sex/age (M, F, J) of the owl captured. We do not attempt to sex juvenile owls, we simply record them as J. This must be recorded for recaptures.
HOW SEXED	*PL*	Record the method used to sex the owl. Accepted methods are listed at the top of the banding datasheet. This only needs to be recorded for adult owls and must be recorded for recaptures.
Brood Patch?	*0*	Examine the owl for signs of a brood patch (see **Insert III** for brood patch picture). Using one of the codes at the top of the banding datasheet, record the stage of the owl's brood patch. Note only adult female Burrowing Owls will have a brood patch.
Adult Left Wing	*180*	Use the method shown in **Insert II** to measure the owl's left wing chord length. Record the measurement in millimeters (mm). This measurement is only taken on adult owls.
Adult Right Wing	*178*	Use the method shown in **Insert II** to measure the owl's right wing chord length. Record the measurement in millimeters (mm). This measurement is only taken on adult owls.
Adult Left Meta-tarsus	*72*	Using the method shown in **Insert II** measure the owl's left meta-tarsus. Record the measurement in millimeters (mm). This measurement is only taken on adult owls.
Adult Right Meta-tarsus	*68*	Using the method shown in **Insert II** measure the owl's right meta-tarsus. Record the measurement in millimeters (mm). This measurement is only taken on adult owls.
JUVIE AGE RANGE	*24-27*	Use the Aging Guide to estimate the age of the juvenile Burrowing Owls. This is only recorded for juvenile owls and must be recorded for recaptures.
# of Feathers Collected?	*Y*	Record the number of feather collected from each body region.
Wing Pics?	*Y*	Take a picture of the outside of the owl's out stretched wing. Be sure the picture includes a piece of paper with the owl's

Field Name	Entry Example	Description
		acraft band written on it. Take a picture of both wings. Pictures are only taken on adult owls.
Blood Taken?	*Y*	Take blood from the owl's brachial vein and record Y (yes) in this field. Someone who is experienced taking blood should show you and watch you take blood for the first few times. Do not attempt to take blood if you are not completely confident you know what you are doing. This is an intrusive procedure and could cause serious injury or infection to the owl. Record N (no) in this field if you did not take blood.
Comments		Any comments applicable to the banding data should be entered in this field (injuries to bird, bands put on upside down or on the wrong legs, etc).

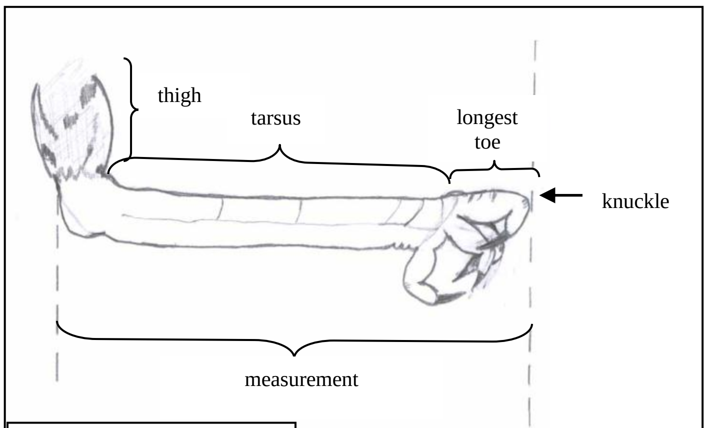
INSERT II
Morphological Measurements of Burrowing Owls



How to Take Tail Measurements of Burrowing Owls

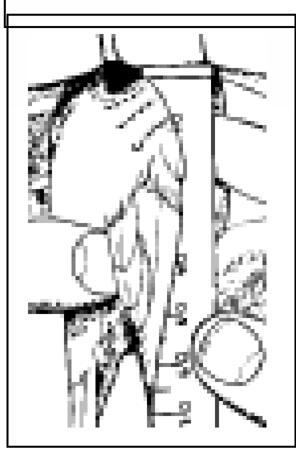
- Gently separate the tail feathers in approximately the middle of the tail.
- Insert the ruler perpendicular to the axis of the tail feathers (if the owl were standing the ruler would be vertical) until it touches the body where the tail feathers originate.
- Be sure the ruler is held parallel to the length of the feathers and read the measurement at the tip of the longest feather.
- Record the measurement in millimeters (mm).

How to Measure Metatarsal Length of Burrowing Owls



- Bend the leg to form a 90 degree angle with the thigh and tarsus.
- Bend the longest toe (third digit or middle of the three front digits) at the knuckle *(owls will usually have done this themselves as they normally clench their feet closed while being handled).*
- Extend the bent toe to form a straight line with the toe and the tarsus
- Measure from the back of the joint between the thigh and tarsus to the knuckle of the extended toe.
- Record the measurement in millimeters (mm).

How to Measure Wing Chord (unflattened wing) Length of Burrowing Owls



- Let the wing lay naturally on the bird’s side.
- Slide the ruler under the wing with the lip of the ruler on the joint above the primaries. (If you are not using a universal wing ruler be sure to use the correct ruler for the side you are measuring. Marking the rulers “left” and “right” will help stop mistakes).
- Holding the ruler against the joint, move the tip of the longest feather onto the ruler. Let the wing lay naturally on the ruler and record the measurement.
- Record the measurement in millimeters (mm).

Note: Be sure not to flatten the wing on the ruler. This is a different measurement and will cause inflated results in wing chord length.

Insert III
Brood Patch Picture

Female Burrowing Owl with large vascularized brood patch. Note the blue/purple coloration in the middle of the brood patch. The intensity of the color will vary but the presence of the blue/purple coloration is key to recognizing a vascularized brood patch.

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.

Entered by:____________
Date:____________
Checked by:____________
Date:____________

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). Recaps from a previous year (rather than from this year) also should have feathers pulled and wing pics taken.

FOR ACRAFTS, WRITE OUT "OVER", "BAR" and "VBAR" – do not abbreviate or use slashes. Eg., Bk-5 VBAR 2 is correct.

Site: ________________________ **Year:**____________ **Map datum** (e.g., NAD 27 Conus): ____________ **Zone** (from UTMs, e.g. 11 S): ____________

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	# OF FEATHERS COLLECTED (collect once per year per BUOW)				WING PICS Y/N (once/year/Adult)	Blood Taken Y/N (once/BUOW)	Comments
																		WHOLE TAIL (ad:1)	PARTIAL TAIL	BODY (ad&J:3&3)	HEAD (ad:1)			

Protocol for Recording Trapping Log Data

Field Name	Entry Example	Description
NestID	*STEE3A*	Record the nestid including the satellite designation, if applicable, for the burrow where the trap was set.
Date	*17-MAR-02*	Record the date when the trap was set. This should be recorded as day-month (use three letter abbreviation to avoid confusion with month and day)-year.
Observer	*CPN*	Record the initials (three letters) of all the individuals involved in the trapping process.
Start Time	*0730*	Record the time when the trap was set. Use 4-digit military (24 hour) time.
End Time	*1310*	Record the time trapping activities stopped. Use 4-digit military (24 hour) time.
Trap Type	2W	Record the trap type used. Abbreviations for the traps types are: **2W**: two way, **ST**: spring trap, **NC**: noose carpet, **MN**: mist net.
Time Chck'd	*0830*	Record the time (4-digit military format) each time the trap is checked.
# Caught	*2*	Record the number of owls caught for each time the trap is checked.
Comments	*Banded 1 J and recaptured F*	Record any comments relevant to the trapping activities which were not recorded above. Record the number and sex/age (**M**, **F** or **J**), the leg (L or R) and the acraft alphanumeric code for all the owls captured. Also be sure to note if any of the owls were recaptures.

Burrowing Owl Trapping Log

Trap type: 2W = 2-way Trap; ST = Spring Trap; MN = Mist Net; HH = Have a Heart.
Record an entry on each trapping attempt even if the attempt is unsuccessful.

Study Area: ___________________ Year:_______________

Nest ID	Date	Obs.	Start time	End time	Trap type	Time chck'd	# caught	Time chck'd	# caught	Time chck'd	# caught	Time chck'd	# caught	Time chck'd	# caught	Comments

Quick Reference for Codes and Acronyms on Datasheets

Nest Information

HOW NESTS WERE FOUND *(Front Nest Cards)*

H	Historic	***I***	Incidental
PDTS	Prairie dog town surveys	**RS**	Roadside survey
LY	Last year		
WOM	Word of mouth		

SUBSTRATE *(Front Nest Card)*

Artificial	Badger	Coyote
Marmot	Ground Squirrel	Prairie Dog
Man made	Man made/Badger	Man made/Ground Squirrel
Man made/Marmot	Man made/Coyote	Irrigation trough/Unknown
Irrigation trough/ Badger	Culvert	Other

STAGES *(Nest Cards)*

NS	No sign	***G***	Sign
O	Occupied	**J**	Juveniles
SAT	Satellite		

* *Record the stage as you observed it, not what you believe the stage to be based on previous visits*

VISIT TYPES *(Nest Cards)*

DA	Didn't approach the nest	***DRIVE BY***	Observed birds at a nest incidentally on route to another location

* *Visit type descriptions need to be placed in the all the comment sections when applicable.*

Banding information

BAND COLORS *(Banding and Nest Cards)*

AL	Aluminum	***RE***	Red	**Ye**	Yellow
Pi	Pink	**Bl**	Blue	**Gr**	Green
Or	Orange	**Wh**	White	**Bk**	Black

BANDED STATUS *(Banding and Nest Cards)*

UNB	Unbanded	***NL***	No legs (could not tell if banded)
CRB	Banded but couldn't read the band		

All resighted bands should be recorded in the following manner:
Sex (**M** or **F** or **J**) : Leg (**R** or **L**) : Color (see above) – Alphanumeric code (written as it appears on the band)

Horizontal: **AS**
Vertical: **A** *or* **A OVER S**
S
Separated by a line: **A** *or* **A BAR S**

S

LAND-USE AND HABITAT TYPES *(Roadside Surveys)*					
AG	Agriculture	**GR**	Gravel road	**PA**	Pasture
Af	Abandoned field	**GC**	Golf course	**PC**	Paloverde-cacti scrub
AP	Airport	**HD**	Housing development	**PR**	Paved road
CF	Creosote flat	***Ic***	Irrigation canal	**RW**	Railway
DW	Dry wash	**ID**	Industry/development	**SS**	Shrub steppe
FL	Feedlot	**IG**	Invaded grassland	**VL**	Vacant lot
FS	Feed storage	**OT**	Other	**WR**	Wetland/riparian

Appendix 2: UTMs of nests and active satellite burrows on DoD installations and their surroundings

				NAD 27 CONUS		
Site	**US State**	**year**	**Nest ID**	**Zone for UTMs**	**Easting**	**Northing**
Yuma Marine Corps Air Station	AZ	2006	10e01	11S	735868	3604896
Yuma Marine Corps Air Station	AZ	2006	co19	11S	735319	3599246
Yuma Marine Corps Air Station	AZ	2006	orco01	11S	726466	3614164
Yuma Marine Corps Air Station	AZ	2006	orco02	11S	726350	3614219
Yuma Marine Corps Air Station	AZ	2006	rad01	11S	738696	3598266
Yuma	AZ	2006	trx01	11S	726855	3618051
Yuma	AZ	2006	wew01	11S	721822	3623414
Yuma	AZ	2006	wew02	11S	721813	3623412
Yuma	AZ	2006	wew03	11S	721556	3623687
Yuma	AZ	2006	wew04	11S	721569	3623687
Dixon Navy Radio Transmitter Facility	CA	2006	dix01	10S	607039	4247758
Dixon Navy Radio Transmitter Facility	CA	2006	dix01	10S	607040	4247807
Dixon Navy Radio Transmitter Facility	CA	2006	dix02	10S	607040	4247807
Dixon Navy Radio Transmitter Facility	CA	2006	dix03	10S	606957	4247881
Dixon Navy Radio Transmitter Facility	CA	2006	dix03	10S	607014	4247824
Dixon Navy Radio Transmitter Facility	CA	2006	dix05	10S	606957	4247833
Dixon Navy Radio Transmitter Facility	CA	2006	dix06	10S	606919	4247833
Dixon Navy Radio Transmitter Facility	CA	2006	dix08	10S	606477	4247822
Dixon Navy Radio Transmitter Facility	CA	2006	dix09	10S	606991	4248242
Dixon Navy Radio Transmitter Facility	CA	2006	dix14	10S	607848	4247183
Dixon Navy Radio Transmitter Facility	CA	2006	dix19	10S	607093	4247539
Dixon Navy Radio Transmitter Facility	CA	2006	dix20	10S	607084	4247521
Dixon Navy Radio Transmitter Facility	CA	2006	dix21	10S	607093	4247477
Dixon Navy Radio Transmitter Facility	CA	2006	dix22	10S	607006	4247527
Dixon Navy Radio Transmitter Facility	CA	2006	dix22	10S	607047	4247456
Dixon Navy Radio Transmitter Facility	CA	2006	dix23	10S	607099	4246904
Dixon Navy Radio Transmitter Facility	CA	2006	dix25	10S	607070	4247649
Dixon Navy Radio Transmitter Facility	CA	2006	dix26	10S	607156	4247472

				NAD 27 CONUS		
Site	**US State**	**year**	**Nest ID**	**Zone for UTMs**	**Easting**	**Northing**
Dixon Navy Radio Transmitter Facility	CA	2006	dix30	10S	607003	4247140
Dixon Navy Radio Transmitter Facility	CA	2006	dixsg	10S	607047	4247456
Dixon Navy Radio Transmitter Facility	CA	2007	babe	10S	607072	4247370
Dixon Navy Radio Transmitter Facility	CA	2007	cinco	10S	606631	4247839
Dixon Navy Radio Transmitter Facility	CA	2007	crab01	10S	607006	4247493
Dixon Navy Radio Transmitter Facility	CA	2007	crab01	10S	607108	4247487
Dixon Navy Radio Transmitter Facility	CA	2007	crab01	10S	607180	4247487
Dixon Navy Radio Transmitter Facility	CA	2007	crab02	10S	607006	4247493
Dixon Navy Radio Transmitter Facility	CA	2007	dix05	10S	606957	4247833
Dixon Navy Radio Transmitter Facility	CA	2007	dix13	10S	607060	4247267
Dixon Navy Radio Transmitter Facility	CA	2007	dix30	10S	607003	4247140
Dixon Navy Radio Transmitter Facility	CA	2007	enclosed	10S	606631	4247839
Dixon Navy Radio Transmitter Facility	CA	2007	enclosed	10S	606978	4247515
Dixon Navy Radio Transmitter Facility	CA	2007	enclosed	10S	607164	4247515
Dixon Navy Radio Transmitter Facility	CA	2007	pipe	10S	607050	4247755
Dixon Navy Radio Transmitter Facility	CA	2007	rbbit	10S	607077	4247618
Dixon Navy Radio Transmitter Facility	CA	2007	warn01	10S	607030	4247851
Dixon Navy Radio Transmitter Facility	CA	2007	warn03	10S	606631	4247839
Edwards AFB	CA	2006	arnp01	11S	416000	3864029
Edwards AFB	CA	2006	ball01	11S	415673	3863936
Edwards AFB	CA	2006	ball02	11S	415649	3863975
Edwards AFB	CA	2006	bmx02	11S	415877	3863862
Edwards AFB	CA	2006	commb01	11S	414967	3864980
Edwards AFB	CA	2006	commc01	11S	414908	3864998
Edwards AFB	CA	2006	commd01	11S	414959	3864979
Edwards AFB	CA	2006	haz01	11S	419295	3869113
Edwards AFB	CA	2006	haz04	11S	419259	3869023
Edwards AFB	CA	2006	haz05	11S	419221	3868975

				NAD 27 CONUS		
Site	US State	year	Nest ID	Zone for UTMs	Easting	Northing
Edwards AFB	CA	2006	haz07	11S	419292	3869148
Edwards AFB	CA	2006	haz09	11S	419282	3869118
Edwards AFB	CA	2006	inpit02	11S	412306	3867788
Edwards AFB	CA	2006	inpit02	11S	412310	3867783
Edwards AFB	CA	2006	inpit02	11S	412338	3867761
Edwards AFB	CA	2006	inpit03	11S	412416	3867850
Edwards AFB	CA	2006	inpit04	11S	412436	3867837
Edwards AFB	CA	2006	inpit05	11S	412299	3867847
Edwards AFB	CA	2006	inpit05	11S	412460	3867825
Edwards AFB	CA	2006	inpit06	11S	412593	3867640
Edwards AFB	CA	2006	ldfl01	11S	412997	3868002
Edwards AFB	CA	2006	museum02	11S	415787	3863484
Edwards AFB	CA	2006	nasa01	11S	418777	3867835
Edwards AFB	CA	2006	nasa02	11S	418741	3867858
Edwards AFB	CA	2006	nasa03	11S	418716	3867838
Edwards AFB	CA	2006	nb01	11S	419656	3871505
Edwards AFB	CA	2006	nb02	11S	420175	3871472
Edwards AFB	CA	2006	nb04	11S	420203	3871471
Edwards AFB	CA	2006	nb05	11S	420206	3871472
Edwards AFB	CA	2006	nb06	11S	419978	3871475
Edwards AFB	CA	2006	pit02	11S	412539	3867850
Edwards AFB	CA	2006	pit02	11S	412540	3867540
Edwards AFB	CA	2006	pit03	11S	412227	3867856
Edwards AFB	CA	2006	pit03	11S	412230	3867857
Edwards AFB	CA	2006	pit06	11S	412285	3867845
Edwards AFB	CA	2006	pit06	11S	412299	3867847
Edwards AFB	CA	2006	tp02	11S	415517	3863787
Edwards AFB	CA	2006	yea01	11S	414580	3865972
Edwards AFB	CA	2007	bike01	11S	416125	3864850
Edwards AFB	CA	2007	bike02	11S	415970	3865016
Edwards AFB	CA	2007	bike02b	11S	415923	3865059
Edwards AFB	CA	2007	bike03	11S	413043	3867533
Edwards AFB	CA	2007	bike03	11S	415730	3865031
Edwards AFB	CA	2007	bike04	11S	416078	3864686
Edwards AFB	CA	2007	crwsh	11S	519673	3542521
Edwards AFB	CA	2007	hous01	11S	412985	3865448
Edwards AFB	CA	2007	hous02	11S	412996	3865469
Edwards AFB	CA	2007	hrse	11S	413287	3866669
Edwards AFB	CA	2007	hrse	11S	413431	3866835
Edwards AFB	CA	2007	hrse02	11S	413636	3866672
Edwards AFB	CA	2007	inpit06-02	11S	412562	3867676
Edwards AFB	CA	2007	inpit-i	11S	412410	3867840
Edwards AFB	CA	2007	jns	11S	419138	3861365
Edwards AFB	CA	2007	landfl	11S	413043	3867533
Edwards AFB	CA	2007	noba01	11S	419655	3871504

				NAD 27 CONUS		
Site	US State	year	Nest ID	Zone for UTMs	Easting	Northing
Edwards AFB	CA	2007	pig	11S	413431	3866835
Edwards AFB	CA	2007	tire01	11S	412622	3867953
Edwards AFB	CA	2007	wood01	11S	412265	3867845
Edwards AFB	CA	2007	yeag02	11S	415357	3865468
March JARB	CA	2006	mar01	11S	477440	3749988
March JARB	CA	2006	mar02	11S	477246	3748658
March JARB	CA	2006	mar03	11S	477446	3749980
March JARB	CA	2006	oldm01	11S	476445	3751894
El Centro, NAF	CA	2006	7st01	11S	625380	3631065
El Centro, NAF	CA	2006	7st02	11S	625404	3631055
El Centro, NAF	CA	2006	coto01	11S	624409	3632486
El Centro, NAF	CA	2006	cst01	11S	623856	3632486
El Centro, NAF	CA	2006	cst02	11S	623835	3632568
El Centro, NAF	CA	2006	cst02	11S	623835	3632586
El Centro, NAF	CA	2006	ent01	11S	624421	3630989
El Centro, NAF	CA	2006	ent04	11S	624411	3630574
El Centro, NAF	CA	2006	ent05	11S	623954	3630939
El Centro, NAF	CA	2006	ent05	11S	624008	3630927
El Centro, NAF	CA	2006	ent06	11S	623954	3630939
El Centro, NAF	CA	2006	ent06	11S	624008	3630927
El Centro, NAF	CA	2006	ent07	11S	624194	3630932
El Centro, NAF	CA	2006	ent08	11S	623812	3630930
El Centro, NAF	CA	2006	finn01	11S	625916	3633334
El Centro, NAF	CA	2006	fuel01(atnafec)	11S	625549	3631262
El Centro, NAF	CA	2006	fuel02(atnafec)	11S	625555	3631001
El Centro, NAF	CA	2006	fuel03(atnafec)	11S	625751	3631365
El Centro, NAF	CA	2006	n40-01	11S	623913	3632988
El Centro, NAF	CA	2006	nef01	11S	626258	3632586
El Centro, NAF	CA	2006	nef02	11S	626500	3632590
El Centro, NAF	CA	2006	nst02	11S	624070	3632473
El Centro, NAF	CA	2006	rat01	11S	624594	3632206
El Centro, NAF	CA	2006	rat01	11S	624594	3632486
El Centro, NAF	CA	2006	sef01	11S	626016	3631547
El Centro, NAF	CA	2006	sef02	11S	626014	3631418
El Centro, NAF	CA	2006	sef03	11S	626788	3630861
El Centro, NAF	CA	2006	unk nest	11S	623999	3632516
El Centro, NAF	CA	2006	unk nest	11S	624067	3632491
El Centro, NAF	CA	2007	7st01	11S	625380	3631065
El Centro, NAF	CA	2007	aentr	11S	623771	3630943
El Centro, NAF	CA	2007	bank01	11S	624415	3630230
El Centro, NAF	CA	2007	bank05	11S	624406	3630742
El Centro, NAF	CA	2007	beale01	11S	624071	3632471
El Centro, NAF	CA	2007	dead01	11S	624474	3629745
El Centro, NAF	CA	2007	drn01a	11S	625588	3631359
El Centro, NAF	CA	2007	ent03	11S	624414	3630427

				NAD 27 CONUS		
Site	**US State**	**year**	**Nest ID**	**Zone for UTMs**	**Easting**	**Northing**
El Centro, NAF	CA	2007	entr	11S	624133	3630493
El Centro, NAF	CA	2007	entr	11S	624133	3630943
El Centro, NAF	CA	2007	fuel02	11S	625555	3631001
El Centro, NAF	CA	2007	grade01	11S	624010	3630915
El Centro, NAF	CA	2007	hay01	11S	626249	3629753
El Centro, NAF	CA	2007	hay01	11S	626749	3629753
El Centro, NAF	CA	2007	hay03	11S	626554	3629744
El Centro, NAF	CA	2007	hay03t	11S	626598	3629742
El Centro, NAF	CA	2007	hayrail03	11S	626323	3629728
El Centro, NAF	CA	2007	hayrail06	11S	626100	3629757
El Centro, NAF	CA	2007	hayrail07	11S	626330	3629745
El Centro, NAF	CA	2007	hayrail08	11S	626331	3629716
El Centro, NAF	CA	2007	hella01	11S	625588	3631359
El Centro, NAF	CA	2007	hella01	11S	625614	3631353
El Centro, NAF	CA	2007	nohe01	11S	626015	3631428
El Centro, NAF	CA	2007	nohe01a	11S	626015	3631428
El Centro, NAF	CA	2007	off01	11S	626749	3629753
El Centro, NAF	CA	2007	off01	11S	626784	3629752
El Centro, NAF	CA	2007	ostrg01	11S	624370	3632488
El Centro, NAF	CA	2007	pole01	11S	623842	3632538
El Centro, NAF	CA	2007	pole01	11S	623852	3632488
El Centro, NAF	CA	2007	rubble01	11S	625716	3631149
El Centro, NAF	CA	2007	rubble02	11S	625722	3631294
El Centro, NAF	CA	2007	rwbl	11S	621640	3629146
El Centro, NAF	CA	2007	sentr	11S	623973	3630933
El Centro, NAF	CA	2007	yellow01	11S	624411	3630372
NAS Lemoore	CA	2006	llw02	11S	234786	4024219
NAS Lemoore	CA	2006	llw04	11S	234843	4024009
NAS Lemoore	CA	2006	llw05	11S	235084	4023461
NAS Lemoore	CA	2006	llw06	11S	234720	4024031
NAS Lemoore	CA	2006	lrw01-01	11S	235422	4025593
NAS Lemoore	CA	2006	lrw02	11S	235385	4025712
NAS Lemoore	CA	2006	lrw04	11S	235182	4025675
NAS Lemoore	CA	2006	lrw06	11S	235170	4026146
NAS Lemoore	CA	2006	lrw07-02	11S	235422	4025593
NAS Lemoore	CA	2006	nl01	11S	234203	4027647
NAS Lemoore	CA	2006	nl02	11S	234063	4028104
NAS Lemoore	CA	2006	nl03	11S	234203	4028370
NAS Lemoore	CA	2006	nl07	11S	234109	4028059
NAS Lemoore	CA	2006	nl08	11S	234188	4027628
NAS Lemoore	CA	2006	nl10	11S	234314	4027353
NAS Lemoore	CA	2006	nl11	11S	233992	4028126
NAS Lemoore	CA	2006	nl14	11S	234069	4027976
NAS Lemoore	CA	2006	nl15	11S	233988	4028200
NAS Lemoore	CA	2006	nl18	11S	234093	4027887

				NAD 27 CONUS		
Site	US State	year	Nest ID	Zone for UTMs	Easting	Northing
NAS Lemoore	CA	2006	sas02	11S	236309	4020851
NAS Lemoore	CA	2006	sr01	11S	236242	4020886
NAS Lemoore	CA	2006	sr03	11S	236250	4020748
NAS Lemoore	CA	2006	srw01	11S	236322	4020767
NAS Lemoore	CA	2006	srw03	11S	236250	4020526
NAS Lemoore	CA	2006	srw05	11S	236280	4020540
NAS Lemoore	CA	2006	srw11	11S	236222	4020871
NAS Lemoore	CA	2006	srw14	11S	236176	4020308
NAS Lemoore	CA	2006	srw15	11S	236094	4020507
NAS Lemoore	CA	2006	srw16	11S	236111	4020554
NAS Lemoore	CA	2006	srw17	11S	236127	4020695
NAS Lemoore	CA	2007	flg	11S	234251	4028052
NAS Lemoore	CA	2007	frogatlem	11S	234124	4028228
NAS Lemoore	CA	2007	hide	11S	234124	4028571
NAS Lemoore	CA	2007	hill	11S	234377	4028584
NAS Lemoore	CA	2007	lrw04a	11S	235182	4025675
NAS Lemoore	CA	2007	nl04	11S	238836	4027093
NAS Lemoore	CA	2007	skull	11S	234393	4027584
NAS Lemoore	CA	2007	slvrflt	11S	237940	4027938
NAS Lemoore	CA	2007	sthflg	11S	234343	4027761
NAS Lemoore	CA	2007	sthflg02	11S	234350	4027863
NAS Lemoore	CA	2007	tank01	11S	236426	4021038
NAS Lemoore	CA	2007	tank01	11S	236426	4027093
NAS Lemoore	CA	2007	tankgrp	11S	236255	4021311
NAS Lemoore	CA	2007	thundr	11S	234689	4026931
Naval Base Coronado	CA	2005	awac1	11S	480731	3616888
Naval Base Coronado	CA	2005	beach2	11S	480565	3616709
Naval Base Coronado	CA	2006	lifeguard01/occ01	11S	480057	3616557
Naval Base Coronado	CA	2006	nolf01/occ14	11S	488575	3602819
Naval Base Coronado	CA	2006	occ5B	11S	479559	3617239
Naval Base Coronado	CA	2006	radar01/art03	11S	480754	3616874
Naval Base Coronado	CA	2006	radar02/art04	11S	480731	3616887
Naval Base Coronado	CA	2006	radar02/art04occ	11S	480701	3616881
Naval Base Coronado	CA	2006	testline02/occ15	11S	479399	3617518
Naval Base Coronado	CA	2007	art05	11S	480703	3616885
Naval Base Coronado	CA	2007	art05	11S	480731	3616887
Naval Base Coronado	CA	2007	occ34	11S	480574	3616720
Naval Base Coronado	CA	2007	radar01/art03	11S	480754	3616874
Naval Base Coronado	CA	2008	art03occ	11S	480754	3616874
Sharpe Depot	CA	2007	aaf	10S	652543	4188231
Sharpe Depot	CA	2007	d09	10S	652577	4188469
Sharpe Depot	CA	2007	east26	10S	625139	4188149
Sharpe Depot	CA	2007	east26	10S	652139	4188149
Sharpe Depot	CA	2007	est26	10S	652139	4188149
Sharpe Depot	CA	2007	estcmo	10S	652061	4189501

				NAD 27 CONUS		
Site	US State	year	Nest ID	Zone for UTMs	Easting	Northing
Sharpe Depot	CA	2007	fence	10S	652049	4188366
Sharpe Depot	CA	2007	fence03	10S	652029	4188498
Sharpe Depot	CA	2007	nrthcmo	10S	652035	4189495
Sharpe Depot	CA	2007	o16	10S	652858	4188294
Sharpe Depot	CA	2007	pb26	10S	652090	4188140
Sharpe Depot	CA	2007	pb26	10S	652090	4188170
Sharpe Depot	CA	2007	r-rd04	10S	652123	4188052
Sharpe Depot	CA	2007	seven	10S	652040	4188901
Sharpe Depot	CA	2007	seven	10S	6520404	4188901
Sharpe Depot	CA	2007	st26	10S	652087	4188112
Sharpe Depot	CA	2007	sth26	10S	652108	4188114
Sharpe Depot	CA	2007	sthstk	10S	652850	4188433
Sharpe Depot	CA	2007	sthstk02	10S	652848	4188351
Sharpe Depot	CA	2007	sthstk02	10S	652858	4188351
Sharpe Depot	CA	2007	under	10S	652030	4188306
Travis AFB	CA	2007	4babes	10S	591519	4235926
Travis AFB	CA	2007	721	10S	594108	4236682
Travis AFB	CA	2007	claw	10S	591476	4235867
Travis AFB	CA	2007	claw	10S	594108	4236682
Travis AFB	CA	2007	ditch02	10S	591351	4235907
Travis AFB	CA	2007	emerg	10S	595003	4236440
Travis AFB	CA	2007	piper	10S	591377	4235849
Travis AFB	CA	2007	schl	10S	591393	4235801
Travis AFB	CA	2007	schl	10S	591393	4235849
Travis AFB	CA	2007	seow	10S	591377	4235849
Buckley AFB	CO	2006	drm01	13S	518667	4396540
Buckley AFB	CO	2006	drm02	13S	518559	4396322
Buckley AFB	CO	2006	drm03	13S	518595	4396122
Buckley AFB	CO	2006	glfbatbuafb01	13S	518703	4395836
Buckley AFB	CO	2006	stea03	13S	520911	4395995
Buckley AFB	CO	2006	stea04	13S	522245	4394679
Buckley AFB	CO	2006	stea05	13S	522131	4394679
Buckley AFB	CO	2006	stea07	13S	520543	4396562
Buckley AFB	CO	2006	stea08	13S	520486	4396837
Buckley AFB	CO	2006	stea09	13S	522469	4395212
Buckley AFB	CO	2006	stea10	13S	522057	4395021
Buckley AFB	CO	2006	stea11	13S	520006	4396835
Buckley AFB	CO	2006	stea12	13S	521923	4394419
Buckley AFB	CO	2006	stea13	13S	519901	4396676
Buckley AFB	CO	2006	vailatbuafb01	13S	519691	4396665
Buckley AFB	CO	2007	buk01	13S	519986	4396801
Buckley AFB	CO	2007	buk02	13S	520340	4396669
Buckley AFB	CO	2007	buk03	13S	522294	4394667
Buckley AFB	CO	2007	buk04	13S	522279	4394504
Buckley AFB	CO	2007	buk05	13S	522096	4394282

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Site	US State	year	Nest ID	Zone for UTMs	Easting	Northing
Buckley AFB	CO	2007	buk06	13S	522169	4394728
Fort Carson	CO	2006	abr02	13S	511225	4254574
Fort Carson	CO	2006	butt01	13S	521290	4257635
Fort Carson	CO	2006	car01	13S	512198	4253426
Fort Carson	CO	2006	car02	13S	512502	4252093
Fort Carson	CO	2006	car03	13S	512626	4253131
Fort Carson	CO	2006	car04	13S	510397	4254057
Fort Carson	CO	2006	car05	13S	509734	4252719
Fort Carson	CO	2006	car06	13S	510231	4252070
Fort Carson	CO	2006	rt08-01	13S	511199	4262718
Fort Carson	CO	2007	car06a	13S	510231	4252070
Fort Carson	CO	2007	pc32b	13S	519191	4259355
Fort Carson	CO	2007	pc53a	13S	519907	4262481
Fort Carson	CO	2007	rng451	13S	521677	4281173
Fort Carson	CO	2007	ta11	13S	518924	4278219
Pinon Canyon Maneuver Site	CO	2006	pcms01	13S	592597	4144651
Pinon Canyon Maneuver Site	CO	2006	pcms02	13S	589585	4144651
Pinon Canyon Maneuver Site	CO	2006	pcms03	13S	574615	4140961
Pinon Canyon Maneuver Site	CO	2006	pcms04	13S	592151	4145215
Pinon Canyon Maneuver Site	CO	2006	pcms05	13S	588485	4139634
Pinon Canyon Maneuver Site	CO	2006	pcms06	11T	592382	4145029
Pinon Canyon Maneuver Site	CO	2006	pcms07	13S	582563	4140905
Pinon Canyon Maneuver Site	CO	2006	pcms08	13S	589977	4145113
Pinon Canyon Maneuver Site	CO	2006	pcms09	13S	589172	4144714
Pinon Canyon Maneuver Site	CO	2007	biern02	13S	596296	4319075
Pinon Canyon Maneuver Site	CO	2007	crossranch01	13S	598184	4153776
Pinon Canyon Maneuver Site	CO	2007	joel01	13S	584704	4139475
Pinon Canyon Maneuver Site	CO	2007	joella01	13S	584707	4139492
Pinon Canyon Maneuver Site	CO	2007	lockwoodcorral01a	13S	603526	4152781
Pinon Canyon Maneuver Site	CO	2007	minsics01	13S	601906	4146506
Pinon Canyon Maneuver Site	CO	2007	rock04	13S	592673	4144231
Pinon Canyon Maneuver Site	CO	2007	rockcrossing01	13S	592597	4144205
Pinon Canyon Maneuver Site	CO	2007	rockcrossing02	13S	592181	4144452
Pinon Canyon Maneuver Site	CO	2007	rockcrossing03	13S	592590	4144334
Pinon Canyon Maneuver Site	CO	2007	rockcrossing04	13S	592238	4144958
Pinon Canyon Maneuver Site	CO	2007	rockcrossing05	13S	592408	4144535
Pinon Canyon Maneuver Site	CO	2007	tyrone01	13S	574653	4140750
Pinon Canyon Maneuver Site	CO	2007	tyrone02	13S	574745	4140812
Pinon Canyon Maneuver Site	CO	2007	windmill03	13S	577106	4144605
Pinon Canyon Maneuver Site	CO	2007	wnd02	13S	588822	4139117
Pinon Canyon Maneuver Site	CO	2007	xrnch01n	13S	597991	4154209
Pinon Canyon Maneuver Site	CO	2007	xrnch06	13S	598187	4153467
Pinon Canyon Maneuver Site	CO	2007	xrnch07	13S	597984	4153803
Pinon Canyon Maneuver Site	CO	2007	xrnch07a	13S	598043	4153671
Pueblo Chemical Depot	CO	2006	dog01	13S	562796	4238801

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Site	US State	year	Nest ID	Zone for UTMs	Easting	Northing
Pueblo Chemical Depot	CO	2006	dog02	13S	560892	4241124
Pueblo Chemical Depot	CO	2006	dog03	13S	558945	4238243
Pueblo Chemical Depot	CO	2006	dog05	13S	559776	4236728
Pueblo Chemical Depot	CO	2006	dog06	13S	562771	4239926
Pueblo Chemical Depot	CO	2006	dog07	13S	562384	4239485
Pueblo Chemical Depot	CO	2006	dog08	13S	562756	4237879
Pueblo Chemical Depot	CO	2006	lynr01	13S	561443	4239362
Pueblo Chemical Depot	CO	2006	muga01	13S	558412	4243842
Pueblo Chemical Depot	CO	2006	muga02	13S	557993	4243885
Pueblo Chemical Depot	CO	2006	muga03	13S	557334	4243893
Pueblo Chemical Depot	CO	2006	muga04	13S	557343	4243921
Pueblo Chemical Depot	CO	2006	muga05	13S	557206	4243730
Pueblo Chemical Depot	CO	2006	muga06	13S	557213	4243054
Pueblo Chemical Depot	CO	2006	psb01	13S	557985	4238625
Pueblo Chemical Depot	CO	2006	psb02	13S	558316	4238588
Pueblo Chemical Depot	CO	2006	psb03	13S	559120	4238995
Pueblo Chemical Depot	CO	2006	pueb03	13S	556861	4241750
Pueblo Chemical Depot	CO	2006	pueb07	13S	556886	4241286
Pueblo Chemical Depot	CO	2006	swh01	13S	558688	4236500
Pueblo Chemical Depot	CO	2006	swh02	13S	559260	4236364
Pueblo Chemical Depot	CO	2007	north01	13S	557282	4243850
Pueblo Chemical Depot	CO	2007	north02a	13S	558962	4243650
Pueblo Chemical Depot	CO	2007	psb04	13S	556988	4239600
Pueblo Chemical Depot	CO	2007	psb05	13S	558598	4238691
Pueblo Chemical Depot	CO	2007	psb06	13S	558951	4238883
Pueblo Chemical Depot	CO	2007	psb07	13S	558751	4238913
Pueblo Chemical Depot	CO	2007	pueb08	13S	556353	4241484
Pueblo Chemical Depot	CO	2007	sw01a	13S	556931	4237491
Pueblo Chemical Depot	CO	2007	sw02	13S	557296	4237250
Pueblo Chemical Depot	CO	2007	sw03	13S	557202	4238025
Rocky Mountain Arsenal NWR	CO	2007	c01	13S	511524	4409338
Rocky Mountain Arsenal NWR	CO	2007	c02	13S	511419	4410809
Rocky Mountain Arsenal NWR	CO	2007	c03	13S	511572	4491726
Rocky Mountain Arsenal NWR	CO	2007	c04	13S	511616	4411636
Rocky Mountain Arsenal NWR	CO	2007	c07a	13S	513109	4412821
Rocky Mountain Arsenal NWR	CO	2007	c07a	13S	513135	4412733
Rocky Mountain Arsenal NWR	CO	2007	c08	13S	512597	4412888
Rocky Mountain Arsenal NWR	CO	2007	c09a	13S	511649	4411494
Rocky Mountain Arsenal NWR	CO	2007	c10	13S	513300	4412579
Rocky Mountain Arsenal NWR	CO	2007	c11	13S	517872	4409181
Rocky Mountain Arsenal NWR	CO	2007	c16	13S	516423	4411782
Rocky Mountain Arsenal NWR	CO	2007	c18	13S	511503	4412400
Rocky Mountain Arsenal NWR	CO	2007	c19	13S	511248	4411669
Schriever AFB	CO	2006	offs02	13S	543652	4293160
Schriever AFB	CO	2006	offs03	13S	539647	4294115

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Site	**US State**	**year**	**Nest ID**	**Zone for UTMs**	**Easting**	**Northing**
Schriever AFB	CO	2006	sch01	13S	539946	4294293
Schriever AFB	CO	2006	sch04	13S	540300	4293362
Schriever AFB	CO	2006	sch05	13S	543599	4293990
Schriever AFB	CO	2006	sch06	13S	543503	4293925
Hwy 26/Blackfoot	ID	2007	bf01	12T	375727	4794447
Hwy 26/Blackfoot	ID	2007	bf03	12T	378236	4792322
Hwy 26/Blackfoot	ID	2007	bf04	12T	371843	4797580
Hwy 26/Blackfoot	ID	2007	bf05	12T	371766	4797632
Hwy 26/Blackfoot	ID	2007	bf06	12T	371783	4797560
Hwy 26/Blackfoot	ID	2007	bf08	12T	364404	4786305
Hwy 26/Blackfoot	ID	2007	bf09	12T	364259	4784431
Hwy 26/Blackfoot	ID	2007	bf12	12T	366656	4786658
Hwy 26/Blackfoot	ID	2007	bf13	12T	366625	4786182
Hwy 26/Blackfoot	ID	2008	bf16	12T	367768	4794096
Hwy 26/Blackfoot	ID	2008	bf17	12T	367308	4794417
Hwy 26/Blackfoot	ID	2008	bf18	12T	377149	4788409
Hwy 26/Blackfoot	ID	2008	bf19	12T	369321	4793024
Crooked Creek Ranch	ID	2007	cc01	12T	366340	4896943
Crooked Creek Ranch	ID	2007	cc02	12T	368265	4895042
Elmore	ID	2008	elm01	11T	607505	4781168
Elmore	ID	2008	elm02	11T	607385	4781250
Elmore	ID	2008	elm04	11T	607935	4779955
Mountain Home AFB	ID	2007	ab01	11T	593142	4769780
Mountain Home AFB	ID	2007	air01	11T	591104	4767633
Mountain Home AFB	ID	2007	air02	11T	590759	4767273
Mountain Home AFB	ID	2007	air03	11T	591103	4767097
Mountain Home AFB	ID	2007	air04a	11T	591277	4766957
Mountain Home AFB	ID	2007	air05a	11T	591312	4766939
Mountain Home AFB	ID	2007	air06	11T	591464	4766746
Mountain Home AFB	ID	2007	air06a	11T	591464	4766746
Mountain Home AFB	ID	2007	air09	11T	591744	4766520
Mountain Home AFB	ID	2007	air09b	11T	591759	4766487
Mountain Home AFB	ID	2007	air10	11T	591945	4766254
Mountain Home AFB	ID	2007	air11	11T	592120	4766165
Mountain Home AFB	ID	2007	air12	11T	592155	4766130
Mountain Home AFB	ID	2007	air14	11T	592401	4765881
Mountain Home AFB	ID	2007	air16	11T	592652	4765635
Mountain Home AFB	ID	2007	air19	11T	593380	4764929
Mountain Home AFB	ID	2007	air22	11T	590298	4767575
Mountain Home AFB	ID	2007	air23	11T	590539	4767268
Mountain Home AFB	ID	2007	gate02	11T	590138	4768571
Mountain Home AFB	ID	2007	golf01	11T	594518	4766080
Mountain Home AFB	ID	2007	golf03	11T	594510	4766213
Mountain Home AFB	ID	2007	golf04	11T	594451	4766426
Mountain Home AFB	ID	2007	golf04	11T	594457	4766246

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Site	**US State**	**year**	**Nest ID**	**Zone for UTMs**	**Easting**	**Northing**
Mountain Home AFB	ID	2007	golf04	11T	594457	4766426
Mountain Home AFB	ID	2007	golf04a	11T	594451	4766426
Mountain Home AFB	ID	2007	golf05	11T	594358	4766005
Mountain Home AFB	ID	2007	golf05b	11T	594346	4765947
Mountain Home AFB	ID	2007	gv01	11T	584937	4767802
Mountain Home AFB	ID	2007	gv02	11T	585472	4768059
Mountain Home AFB	ID	2007	heat01	11T	591731	4767508
Mountain Home AFB	ID	2007	mw01a	11T	591521	4767795
Mountain Home AFB	ID	2007	mw02	11T	591379	4767840
Mountain Home AFB	ID	2007	mw02a	11T	591379	4767840
Mountain Home AFB	ID	2007	mw02a	11T	591384	4767843
Mountain Home AFB	ID	2007	mw03	11T	591132	4767838
Mountain Home AFB	ID	2007	stbl01	11T	593635	4766153
Mountain Home AFB	ID	2007	stbl03	11T	593420	4765966
Mountain Home AFB	ID	2007	stbl04	11T	594188	4765771
Mountain Home AFB	ID	2007	stbl05	11T	593610	4765969
Mountain Home AFB	ID	2007	stbl07	11T	594129	4765797
Mountain Home AFB	ID	2007	tower01	11T	590840	4766105
Mountain Home AFB	ID	2007	tower01a	11T	590838	4766103
Mountain Home AFB	ID	2007	ww01	11T	590117	4767032
Mountain Home AFB	ID	2007	ww02	11T	590068	4766413
Mountain Home AFB	ID	2007	ww03	11T	590111	4766874
Mountain Home AFB	ID	2008	air08a	11T	591620	4766639
Mountain Home AFB	ID	2008	air32	11T	591182	4767049
Mountain Home AFB	ID	2008	air38	11T	591491	4767471
Mountain Home AFB	ID	2008	drmo01	11T	592179	4767639
Mountain Home AFB	ID	2008	golf03	11T	594510	4766213
Mountain Home AFB	ID	2008	golf03	11T	654510	4766213
Mountain Home AFB	ID	2008	golf07	11T	594547	4766680
Mountain Home AFB	ID	2008	land01	11T	590609	4764951
Mountain Home AFB	ID	2008	land02	11T	590609	4964207
Mountain Home AFB	ID	2008	land02	11T	590609	4964207
Mountain Home AFB	ID	2008	mw01a	11T	591521	4767795
Mountain Home AFB	ID	2008	mw05a	11T	591470	4767714
Mountain Home AFB	ID	2008	pol01	11T	591722	4767155
Mountain Home AFB	ID	2008	stable04	11T	594199	4759767
Mountain Home AFB	ID	2008	stbl08	11T	593600	4765926
Mountain Home AFB	ID	2008	ww05	11T	590111	4766836
Power	ID	2008	p01	12T	328177	4745998
Power	ID	2008	p02	12T	328027	4746060
Power	ID	2008	p02a	12T	328072	4746188
Power	ID	2008	p03	12T	328025	4752409
Power	ID	2008	p04	12T	327625	4753998
White Sands Missile Range	NM	2005	omnd1	13S	380662	3698241
White Sands Missile Range	NM	2006	deadhorsemound	13S	380670	3698260

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Site	**US State**	**year**	**Nest ID**	**Zone for UTMs**	**Easting**	**Northing**
White Sands Missile Range	NM	2006	nike2	13S	377267	3585379
White Sands Missile Range	NM	2006	nike2	13S	377267	3855379
White Sands Missile Range	NM	2006	nike5a	13S	382299	3535823
White Sands Missile Range	NM	2006	nike5a	13S	382299	3585823
White Sands Missile Range	NM	2006	nike5b	13S	32282	3585694
White Sands Missile Range	NM	2006	nike5b	13S	382282	3585694
White Sands Missile Range	NM	2006	rr8/9	13S	381262	3701379
White Sands Missile Range	NM	2007	nike01	13S	328653	3585363
White Sands Missile Range	NM	2007	nike03	13S	378573	3585527
White Sands Missile Range	NM	2007	nike04	13S	382275	3585714
White Sands Missile Range	NM	2007	nike05	13S	382233	3585465
White Sands Missile Range	NM	2007	nike06	13S	378497	3585588
White Sands Missile Range	NM	2007	nike08	13S	381076	3585534
White Sands Missile Range	NM	2007	nike08	13S	381106	3585534
White Sands Missile Range	NM	2007	nike09	13S	382316	3585800
White Sands Missile Range	NM	2008	nike01	13S	328653	3585363
White Sands Missile Range	NM	2008	nike05	13S	382233	3585465
White Sands Missile Range	NM	2008	nike06	13S	378497	3585588
White Sands Missile Range	NM	2008	nike08	13S	381076	3585534
Nellis AFB	NV	2006	glfatnafb01	11S	675365	4008729
Nellis AFB	NV	2006	glfatnafb02	11S	675315	4008401
Nellis AFB	NV	2006	glfatnafb04	11S	675348	4008308
Nellis AFB	NV	2006	glfatnafb05	11S	675639	4008183
Nellis AFB	NV	2006	glfatnafb06	11S	675728	4008173
Nellis AFB	NV	2006	glfatnafb09	11S	675842	4009817
Nellis AFB	NV	2006	glfatnafb09	11S	675842	5009817
Nellis AFB	NV	2006	glfatnafb10	11S	675591	4009768
Nellis AFB	NV	2006	glfatnafb11	11S	675464	4009664
Nellis AFB	NV	2006	glfatnafb13	11S	675336	4009627
Nellis AFB	NV	2006	glfatnafb14	11S	675148	4009697
Nellis AFB	NV	2006	glfatnafb14	11S	675239	4009682
Nellis AFB	NV	2006	glfatnafb17	11S	674853	4009868
Nellis AFB	NV	2006	glfatnafb18	11S	674706	4009859
Nellis AFB	NV	2006	glfatnafb19	11S	674357	4009998
Nellis AFB	NV	2006	glfatnafb19	11S	674359	4010033
Nellis AFB	NV	2006	glfatnafb20	11S	674351	4009995
Nellis AFB	NV	2006	glfatnafb21	11S	674349	4010347
Nellis AFB	NV	2006	glfatnafb24	11S	675313	4008775
Nellis AFB	NV	2006	glfatnafb25	11S	675251	4008924
Nellis AFB	NV	2006	glfatnafb25	11S	675251	4008942
Nellis AFB	NV	2006	glfatnafb26	11S	675832	4008871
Nellis AFB	NV	2006	glfatnafb27	11S	674541	4009870
Nellis AFB	NV	2006	glfatnafb28	11S	674362	4010273
Nellis AFB	NV	2006	glfatnafb29	11S	674346	4010487
Nellis AFB	NV	2006	hol01	11S	677965	4011311

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Site	**US State**	**year**	**Nest ID**	**Zone for UTMs**	**Easting**	**Northing**
Nellis AFB	NV	2006	neap01	11S	677464	4013585
Nellis AFB	NV	2007	dog01	11S	675681	4008163
Nellis AFB	NV	2007	drng03	11S	675324	4008436
Nellis AFB	NV	2007	drngel	11S	675306	4008517
Nellis AFB	NV	2007	glfatnafb01	11S	675305	4008729
Nellis AFB	NV	2007	glfatnafb04	11S	675348	4008308
Nellis AFB	NV	2007	glfatnafb06	11S	674362	4010350
Nellis AFB	NV	2007	glfatnafb08	11S	675832	4009788
Nellis AFB	NV	2007	glfatnafb19	11S	674357	4009998
Nellis AFB	NV	2007	glfatnafb21	11S	674349	4010347
Nellis AFB	NV	2007	glfatnafb25	11S	675251	4008924
Nellis AFB	NV	2007	glfatnafb27	11S	674541	4009870
Nellis AFB	NV	2007	glfatnafb28	11S	674362	4010273
Nellis AFB	NV	2007	glfatnafb29	11S	674346	4010487
Nellis AFB	NV	2007	newglf03	11S	674369	4009614
Nellis AFB	NV	2007	newglf05	11S	674467	4009879
Nellis AFB	NV	2007	newglf05	11S	674563	4009847
Nellis AFB	NV	2007	ng07	11S	677539	4011484
Nellis AFB	NV	2007	ng09	11S	675239	4009726
Nellis AFB	NV	2007	ng10	11S	675340	4009614
Nellis AFB	NV	2007	ng12	11S	675576	4009767
Nevada Test Site	NV	2005	airportrd#1	11S	560708	4105734
Nevada Test Site	NV	2005	orrdpada	11S	577622	4110888
Nevada Test Site	NV	2005	u2-gga	11S	582580	4111032
Nevada Test Site	NV	2006	030ditch	11S	578979	4099657
Nevada Test Site	NV	2006	030wash	11S	579216	4099700
Nevada Test Site	NV	2006	18-03rd#2b	11S	562290	4109224
Nevada Test Site	NV	2006	2l18pada	11S	582700	4113100
Nevada Test Site	NV	2006	8dpada	11S	580594	4114509
Nevada Test Site	NV	2006	airportrd#1b	11S	560710	4105753
Nevada Test Site	NV	2006	airportrd#2	11S	561350	4108330
Nevada Test Site	NV	2006	bmrd	11S	553484	4111617
Nevada Test Site	NV	2006	m27	11S	590020	4067731
Nevada Test Site	NV	2006	orpad	11S	577844	4110951
Nevada Test Site	NV	2006	or-pad	11S	577844	4110951
Nevada Test Site	NV	2006	u2gg	11S	582583	4111030
Nevada Test Site	NV	2007	18-03rd#1	11S	561234	4109463
Nevada Test Site	NV	2007	18-03rd#3	11S	560075	4109387
Nevada Test Site	NV	2007	airportrd#2	11S	561350	4108330
Nevada Test Site	NV	2007	u20bb	11S	544673	4122030
Nevada Test Site	NV	2008	8dpada	11S	580594	4114509
Nevada Test Site	NV	2008	airportrd#2	11S	561350	4108330
Nevada Test Site	NV	2008	bmrd	11S	553484	4111617
Nevada Test Site	NV	2008	c56	11S	585700	4078350
Nevada Test Site	NV	2008	c56a	11S	585700	4078350

				NAD 27 CONUS		
Site	**US State**	**year**	**Nest ID**	**Zone for UTMs**	**Easting**	**Northing**
Nevada Test Site	NV	2008	m27	11S	590020	4067731
Nevada Test Site	NV	2008	u20bb	11S	544673	4122030
Boardman Bombing Range	OR	2006	bb08	11T	291125	5071911
Boardman Bombing Range	OR	2006	bb10	11T	290919	5071742
Antelope Island	UT	2008	ain03	12T	395169	4543295
Antelope Island	UT	2008	ain121	12T	404510	4549274
Antelope Island	UT	2008	ain65	12T	399462	4541433
Deseret Chemical Depot	UT	2008	dcd01	12T	388560	4461173
Deseret Chemical Depot	UT	2008	dcd01	12T	388560	4461173
Deseret Chemical Depot	UT	2008	dcd02	12T	387144	4460830
Dugway Proving Ground	UT	2007	dvg04	12T	306942	4437243
Dugway Proving Ground	UT	2008	dpg02	12T	328001	4464116
Dugway Proving Ground	UT	2008	dpg03	12T	334991	4442163
Dugway Proving Ground	UT	2008	dpg04	12T	306271	4437130
Dugway Proving Ground	UT	2008	dpg05	12T	306943	4437598
Dugway Proving Ground	UT	2008	dpg06	12T	327821	4444395
Dugway Proving Ground	UT	2008	dpg06	12T	339317	4434729
Dugway Proving Ground	UT	2008	dpg07	12T	339317	4434729
Dugway Proving Ground	UT	2008	dpg08	12T	339609	4434723
Dugway Proving Ground	UT	2008	dpg09	12T	329197	4447638
Dugway Proving Ground	UT	2008	dpg10	12T	322729	4444949
Dugway Proving Ground	UT	2008	dpg12	12T	306786	4437695
Dugway Proving Ground	UT	2008	dpg13	12T	306779	4437698
Hill AFB	UT	2007	hill01	12T	340017	4552418
Kennecott Mining Co	UT	2007	kn03	12T	467770	4518166
Stark Road	UT	2008	sr01	12T	387274	4468018
Stark Road	UT	2008	sr01	12T	387274	4468018
St. George	UT	2007	NONEST	12S	275873	4107456
St. George	UT	2007	st02	12S	276136	4107372
St. George	UT	2007	st03	12S	276072	4107440
St. George	UT	2007	st03	12S	276136	4107354
St. George	UT	2007	st04	12S	276072	4107440
St. George	UT	2007	st05	12S	276078	4107435
St. George	UT	2007	st06	12S	276091	4107390
St. George	UT	2007	st06	12S	276091	4187390
St. George	UT	2007	st08	12S	276006	4107367
St. George	UT	2007	st11	12S	276070	4107588
St. George	UT	2007	stc	12S	276191	4107471
Vernon	UT	2008	tc03	12T	388147	4450595
Vernon	UT	2008	tc04	12T	388340	4450101
Vernon	UT	2008	tc05	12T	387912	4449544
Vernon	UT	2008	tc06	12T	388158	4448252
Vernon	UT	2008	tc08	12T	385032	4441673
Vernon	UT	2008	tc09	12T	396725	4444750
Vernon	UT	2008	tc11	12T	373255	4438300

				NAD 27 CONUS		
Site	US State	year	Nest ID	Zone for UTMs	Easting	Northing
Sheridian Training Area	WY	2007	sh02	13T	337456	4967328

				NAD 27 Central		
Site	US State	year	Nest ID	Zone for UTMs	Easting	Northing
Fort Bliss AFB	NM	2006	1	13 S	428667	3588271
Fort Bliss AFB	NM	2006	1	13 S	428667	3588271
Holloman AFB	NM	2006	4	13 S	392112	3462531
Holloman AFB	NM	2006	4	13 S	392112	3462531
Holloman AFB	NM	2006	4	13 S	392112	3462531
Holloman AFB	NM	2006	33	13 S	392138	3643693
Holloman AFB	NM	2006	37	13 S	392216	3642985
Holloman AFB	NM	2006	37	13 S	392216	3642985
Holloman AFB	NM	2006	37	13 S	392216	3642985
Holloman AFB	NM	2006	7 (1A)	13 S	392098	3642876
Kirtland AFB	NM	2005	3	13 S	358085	3879040
Kirtland AFB	NM	2005	4	13 S	358165	3879048
Kirtland AFB	NM	2005	27	13 S	357258	3879278
Kirtland AFB	NM	2005	38	13 S	358324	3878871
Kirtland AFB	NM	2005	68	13 S	358091	3879132
Kirtland AFB	NM	2005	69	13 S	357792	3878606
Kirtland AFB	NM	2005	73	13 S	357874	3878686
Kirtland AFB	NM	2005	87	13 S	357756	3878666
Kirtland AFB	NM	2005	88	13 S	357747	3878566
Kirtland AFB	NM	2005	94	13 S	358117	3879094
Kirtland AFB	NM	2005	95	13 S	357801	3878784
Kirtland AFB	NM	2005	96	13 S	358543	3877765
Kirtland AFB	NM	2005	97	13 S	358607	3877813
Kirtland AFB	NM	2005	98	13 S	358366	3878611
Kirtland AFB	NM	2005	99	13 S	359204	3881261
Kirtland AFB	NM	2005	100	13 S	359040	3881298
Kirtland AFB	NM	2005	101	13 S	356904	3878820
Kirtland AFB	NM	2005	102	13 S	356858	3878789
Kirtland AFB	NM	2005	103	13 S	356973	3879107
Kirtland AFB	NM	2005	104	13 S	354432	3879771
Kirtland AFB	NM	2005	106	13 S	356949	3879257
Kirtland AFB	NM	2005	107	13 S	358261	3879186
Kirtland AFB	NM	2005	108	13 S	361154	3877451
Kirtland AFB	NM	2005	109	13 S	358558	3877810
Kirtland AFB	NM	2005	111	13 S	360187	3875782
Kirtland AFB	NM	2005	112	13 S	358847	3881315
Kirtland AFB	NM	2005	114	13 S	361171	3877365
Kirtland AFB	NM	2005	115	13 S	357723	3879070
Kirtland AFB	NM	2005	116	13 S	356095	3879535
Kirtland AFB	NM	2005	117	13 S	356845	3878682

				NAD 27 Central		
Site	**US State**	**year**	**Nest ID**	**Zone for UTMs**	**Easting**	**Northing**
Kirtland AFB	NM	2005	106B	13 S	354807	3880274
Kirtland AFB	NM	2006	48	13 S	358194	3879044
Kirtland AFB	NM	2006	48	13 S	358194	3879044
Kirtland AFB	NM	2006	68	13 S	358091	3879132
Kirtland AFB	NM	2006	68	13 S	358091	3879132
Kirtland AFB	NM	2006	68	13 S	358091	3879132
Kirtland AFB	NM	2006	73	13 S	357874	3878686
Kirtland AFB	NM	2006	95	13 S	357801	3878784
Kirtland AFB	NM	2006	95	13 S	357801	3878784
Kirtland AFB	NM	2006	96	13 S	358543	3877765
Kirtland AFB	NM	2006	100	13 S	359040	3881298
Kirtland AFB	NM	2006	100	13 S	359040	3881298
Kirtland AFB	NM	2006	102	13 S	356858	3878789
Kirtland AFB	NM	2006	102	13 S	356858	3878789
Kirtland AFB	NM	2006	102	13 S	356858	3878789
Kirtland AFB	NM	2006	102	13 S	356858	3878789
Kirtland AFB	NM	2006	102	13 S	356858	3878789
Kirtland AFB	NM	2006	103	13 S	356987	3879148
Kirtland AFB	NM	2006	103	13 S	356987	3879148
Kirtland AFB	NM	2006	103	13 S	356987	3879148
Kirtland AFB	NM	2006	104	13 S	354432	3879771
Kirtland AFB	NM	2006	104	13 S	354432	3879771
Kirtland AFB	NM	2006	104	13 S	354432	3879771
Kirtland AFB	NM	2006	120	13 S	361241	3877120
Kirtland AFB	NM	2006	120	13 S	361241	3877120
Kirtland AFB	NM	2006	120	13 S	361241	3877120
Kirtland AFB	NM	2006	120	13 S	361241	3877120
Kirtland AFB	NM	2006	120	13 S	361241	3877120
Kirtland AFB	NM	2006	120	13 S	361241	3877120
Kirtland AFB	NM	2006	120	13 S	361241	3877120
Kirtland AFB	NM	2006	121	13 S	361505	3877210
Kirtland AFB	NM	2006	121	13 S	361505	3877210
Kirtland AFB	NM	2006	121	13 S	361505	3877210
Kirtland AFB	NM	2006	121	13 S	361505	3877210
Kirtland AFB	NM	2006	122	13 S	359879	3881313
Kirtland AFB	NM	2006	122	13 S	359879	3881313
Kirtland AFB	NM	2006	122	13 S	359879	3881313
Kirtland AFB	NM	2006	125	13 S	358199	3878878
Kirtland AFB	NM	2006	125	13 S	358199	3878878
Kirtland AFB	NM	2006	125	13 S	358199	3878878
Kirtland AFB	NM	2006	125	13 S	358199	3878878
Kirtland AFB	NM	2006	125	13 S	358199	3878878
Kirtland AFB	NM	2006	125	13 S	358199	3878878
Kirtland AFB	NM	2006	128	13 S	358021	3879106
Kirtland AFB	NM	2006	128	13 S	358021	3879106

				NAD 27 Central		
Site	**US State**	**year**	**Nest ID**	**Zone for UTMs**	**Easting**	**Northing**
Kirtland AFB	NM	2006	130	13 S	357825	3879242
Kirtland AFB	NM	2006	130	13 S	357825	3879242
Kirtland AFB	NM	2006	131	13 S	356334	3879655
Kirtland AFB	NM	2006	131	13 S	356334	3879655
Kirtland AFB	NM	2006	131	13 S	356334	3879655
Kirtland AFB	NM	2006	131	13 S	356334	3879655
Kirtland AFB	NM	2006	131	13 S	356334	3879655
Kirtland AFB	NM	2006	134	13 S	359810	3880123
Kirtland AFB	NM	2006	134	13 S	359810	3880123
Kirtland AFB	NM	2006	134	13 S	359810	3880123
Kirtland AFB	NM	2006	134	13 S	359810	3880123
Kirtland AFB	NM	2006	134	13 S	359810	3880123
Kirtland AFB	NM	2006	134	13 S	359810	3880123
Kirtland AFB	NM	2006	134	13 S	359810	3880123
Kirtland AFB	NM	2006	135	13 S	356042	3879658
Kirtland AFB	NM	2006	135	13 S	356042	3879658
Kirtland AFB	NM	2006	135	13 S	356042	3879658
Kirtland AFB	NM	2006	135	13 S	356042	3879658
Kirtland AFB	NM	2006	136	13 S	357865	3879083
Kirtland AFB	NM	2006	136	13 S	357865	3879083
Kirtland AFB	NM	2006	136	13 S	357865	3879083
Kirtland AFB	NM	2006	137	13 S	359359	3881329
Kirtland AFB	NM	2006	137	13 S	359359	3881329
Kirtland AFB	NM	2006	137	13 S	359359	3881329
Kirtland AFB	NM	2006	137	13 S	359359	3881329
Kirtland AFB	NM	2006	137	13 S	359359	3881329
Kirtland AFB	NM	2006	137	13 S	359359	3881329
Kirtland AFB	NM	2006	141	13 S	358630	3878730
Kirtland AFB	NM	2006	141	13 S	358630	3878730
Kirtland AFB	NM	2006	144	13 S	358387	3878900
Kirtland AFB	NM	2006	152	13 S	361783	3877581
Kirtland AFB	NM	2006	152	13 S	361783	3877581
Kirtland AFB	NM	2006	152	13 S	361783	3877581
Kirtland AFB	NM	2006	152	13 S	361783	3877581
Kirtland AFB	NM	2006	152	13 S	361783	3877581
Kirtland AFB	NM	2007	4	13 S	358165	3879048
Kirtland AFB	NM	2007	4	13 S	358165	3879048
Kirtland AFB	NM	2007	4	13 S	358165	3879048
Kirtland AFB	NM	2007	4	13 S	358165	3879048
Kirtland AFB	NM	2007	68	13 S	358091	3879132
Kirtland AFB	NM	2007	106	13 S	356949	3879257
Kirtland AFB	NM	2007	117	13 S	356845	3878682
Kirtland AFB	NM	2007	120	13 S	361241	3877120
Kirtland AFB	NM	2007	122	13 S	359879	3881313
Kirtland AFB	NM	2007	122	13 S	359879	3881313

				NAD 27 Central		
Site	US State	year	Nest ID	Zone for UTMs	Easting	Northing
Kirtland AFB	NM	2007	122	13 S	359879	3881313
Kirtland AFB	NM	2007	122	13 S	359879	3881313
Kirtland AFB	NM	2007	122	13 S	359879	3881313
Kirtland AFB	NM	2007	124	13 S	358584	3878117
Kirtland AFB	NM	2007	131	13 S	356334	3879655
Kirtland AFB	NM	2007	131	13 S	356334	3879655
Kirtland AFB	NM	2007	135	13 S	356042	3879658
Kirtland AFB	NM	2007	135	13 S	356042	3879658
Kirtland AFB	NM	2007	147	13 S	361868	3877166
Kirtland AFB	NM	2007	151	13 S	361641	3874700
Kirtland AFB	NM	2007	151	13 S	361641	3874700
Kirtland AFB	NM	2007	154	13 S	358537	3877841
Kirtland AFB	NM	2007	154	13 S	358537	3877841
Kirtland AFB	NM	2007	154	13 S	358537	3877841
Kirtland AFB	NM	2007	154	13 S	358537	3877841
Kirtland AFB	NM	2007	154	13 S	358537	3877841
Kirtland AFB	NM	2007	154	13 S	358537	3877841
Kirtland AFB	NM	2007	155	13 S	358509	3877707
Kirtland AFB	NM	2007	156	13 S	358208	3878521
Kirtland AFB	NM	2007	156	13 S	358208	3878521
Kirtland AFB	NM	2007	156	13 S	358208	3878521
Kirtland AFB	NM	2007	156	13 S	358208	3878521
Kirtland AFB	NM	2007	158	13 S	358583	3878660
Kirtland AFB	NM	2007	158	13 S	358583	3878660
Kirtland AFB	NM	2007	158	13 S	358583	3878660
Kirtland AFB	NM	2007	158	13 S	358583	3878660
Kirtland AFB	NM	2007	158	13 S	358583	3878660
Kirtland AFB	NM	2007	158	13 S	358583	3878660
Kirtland AFB	NM	2007	160	13 S	357938	3879226
Kirtland AFB	NM	2007	160	13 S	357938	3879226
Kirtland AFB	NM	2007	160	13 S	357938	3879226
Kirtland AFB	NM	2007	160	13 S	357938	3879226
Kirtland AFB	NM	2007	161	13 S	359919	9879949
Kirtland AFB	NM	2007	161	13 S	359919	9879949
Kirtland AFB	NM	2007	161	13 S	359919	9879949
Kirtland AFB	NM	2007	161	13 S	359919	9879949
Kirtland AFB	NM	2007	161	13 S	359919	9879949
Kirtland AFB	NM	2007	161	13 S	359919	9879949
Kirtland AFB	NM	2007	162	13 S	361648	3874829
Kirtland AFB	NM	2007	162	13 S	361648	3874829
Kirtland AFB	NM	2007	162	13 S	361648	3874829
Kirtland AFB	NM	2007	162	13 S	361648	3874829
Kirtland AFB	NM	2007	163	13 S	360566	3875931
Kirtland AFB	NM	2007	163	13 S	360566	3875931
Kirtland AFB	NM	2007	163	13 S	360566	3875931

				NAD 27 Central		
Site	US State	year	Nest ID	Zone for UTMs	Easting	Northing
Kirtland AFB	NM	2007	163	13 S	360566	3875931
Kirtland AFB	NM	2007	164	13 S	361340	3874471
Kirtland AFB	NM	2007	164	13 S	361340	3874471
Kirtland AFB	NM	2007	164	13 S	361340	3874471
Kirtland AFB	NM	2007	164	13 S	361340	3874471
Kirtland AFB	NM	2007	164	13 S	361340	3874471
Kirtland AFB	NM	2007	164	13 S	361340	3874471
Kirtland AFB	NM	2007	165	13 S	361575	3874860
Kirtland AFB	NM	2007	166	13 S	361587	3874918
Kirtland AFB	NM	2007	167	13 S	361545	3874939
Kirtland AFB	NM	2007	167	13 S	361545	3874939
Kirtland AFB	NM	2007	167	13 S	361545	3874939
Kirtland AFB	NM	2007	167	13 S	361545	3874939
Kirtland AFB	NM	2007	168	13 S	361421	3874566
Kirtland AFB	NM	2007	168	13 S	361421	3874566
Kirtland AFB	NM	2007	168	13 S	361421	3874566
Kirtland AFB	NM	2007	168	13 S	361421	3874566
Kirtland AFB	NM	2007	168	13 S	361421	3874566
Kirtland AFB	NM	2008	68	13 S	358091	3879132
Kirtland AFB	NM	2008	73	13 S	357874	3878686
Kirtland AFB	NM	2008	73	13 S	357874	3878686
Kirtland AFB	NM	2008	114	13 S	361171	3877365
Kirtland AFB	NM	2008	114	13 S	361171	3877365
Kirtland AFB	NM	2008	114	13 S	361171	3877365
Kirtland AFB	NM	2008	114	13 S	361171	3877365
Kirtland AFB	NM	2008	122	13 S	359879	3881313
Kirtland AFB	NM	2008	122	13 S	359879	3881313
Kirtland AFB	NM	2008	122	13 S	359879	3881313
Kirtland AFB	NM	2008	122	13 S	359879	3881313
Kirtland AFB	NM	2008	131	13 S	356334	3879655
Kirtland AFB	NM	2008	131	13 S	356334	3879655
Kirtland AFB	NM	2008	131	13 S	356334	3879655
Kirtland AFB	NM	2008	132	13 S	358391	3877815
Kirtland AFB	NM	2008	132	13 S	358391	3877815
Kirtland AFB	NM	2008	158	13 S	358583	3878660
Kirtland AFB	NM	2008	161	13 S	359919	3879949
Kirtland AFB	NM	2008	161	13 S	359919	3879949
Kirtland AFB	NM	2008	162	13 S	361648	3874829
Kirtland AFB	NM	2008	164	13 S	361340	3874471
Kirtland AFB	NM	2008	164	13 S	361340	3874471
Kirtland AFB	NM	2008	167	13 S	361545	3874939
Kirtland AFB	NM	2008	167	13 S	361545	3874939
Kirtland AFB	NM	2008	170	13 S	359917	3881249
Kirtland AFB	NM	2008	171	13 S	359979	3880805
Kirtland AFB	NM	2008	171	13 S	359979	3880805

				NAD 27 Central		
Site	US State	year	Nest ID	Zone for UTMs	Easting	Northing
Kirtland AFB	NM	2008	171	13 S	359979	3880805
Kirtland AFB	NM	2008	171	13 S	359979	3880805
Kirtland AFB	NM	2008	171	13 S	359979	3880805
Kirtland AFB	NM	2008	172	13 S	358587	3878903
Kirtland AFB	NM	2008	173	13 S	357128	3879033
Kirtland AFB	NM	2008	173	13 S	357128	3879033
Kirtland AFB	NM	2008	173	13 S	357128	3879033
Kirtland AFB	NM	2008	176	13 S	358449	3877814
Kirtland AFB	NM	2008	176	13 S	358449	3877814
Kirtland AFB	NM	2008	176	13 S	358449	3877814
Kirtland AFB	NM	2008	178	13 S	359968	3880403
Kirtland AFB	NM	2008	178	13 S	359968	3880403
Kirtland AFB	NM	2008	178	13 S	359968	3880403
Kirtland AFB	NM	2008	178	13 S	359968	3880403
Kirtland AFB	NM	2008	178	13 S	359968	3880403
Kirtland AFB	NM	2008	178	13 S	359968	3880403
Kirtland AFB	NM	2008	179	13 S	361317	3874459
Kirtland AFB	NM	2008	179	13 S	361317	3874459
Kirtland AFB	NM	2008	181	13 S	358617	3878209
Kirtland AFB	NM	2008	181	13 S	358617	3878209
Kirtland AFB	NM	2008	181	13 S	358617	3878209
Kirtland AFB	NM	2008	181	13 S	358617	3878209
Kirtland AFB	NM	2008	181	13 S	358617	3878209
Kirtland AFB	NM	2008	182	13 S	359281	3881308
Kirtland AFB	NM	2008	182	13 S	359281	3881308
Kirtland AFB	NM	2008	182	13 S	359281	3881308
Kirtland AFB	NM	2008	183	13 S	356893	3878841
Kirtland AFB	NM	2008	183	13 S	356893	3878841
Kirtland AFB	NM	2008	184	13 S	358447	3877782
Kirtland AFB	NM	2008	184	13 S	358447	3877782
Kirtland AFB	NM	2008	185	13 S	361641	3874722
Kirtland AFB	NM	2008	185	13 S	361641	3874722
Kirtland AFB	NM	2008	185	13 S	361641	3874722
Kirtland AFB	NM	2008	188	13 S	359929	3880972
Kirtland AFB	NM	2008	188	13 S	359929	3880972
Kirtland AFB	NM	2008	191	13 S	359913	3881056
Kirtland AFB	NM	2008	191	13 S	359913	3881056
Kirtland AFB	NM	2008	191	13 S	359913	3881056
Kirtland AFB	NM	2008	191	13 S	359913	3881056
Kirtland AFB	NM	2008	192	13 S	355043	3879778
Kirtland AFB	NM	2008	192	13 S	355043	3879778
Kirtland AFB	NM	2008	192	13 S	355043	3879778
Kirtland AFB	NM	2008	192	13 S	355043	3879778
Kirtland AFB	NM	2008	192	13 S	355043	3879778
Kirtland AFB	NM	2008	193	13 S	354974	3880237

				NAD 27 Central		
Site	US State	year	Nest ID	Zone for UTMs	Easting	Northing
Kirtland AFB	NM	2008	195	13 S	361573	3874757
Kirtland AFB	NM	2008	195	13 S	361573	3874757
Kirtland AFB	NM	2008	196	13 S	354059	3880092
Kirtland AFB	NM	2008	196	13 S	354059	3880092
Kirtland AFB	NM	2008	Gourd	13 S	359822	3877924
Kirtland AFB	NM	2008	Gourd	13 S	359822	3877924

				NAD 83		
Site	US State	year	Nest ID	Zone for UTMs	Easting	Northing
Cannon AFB	NM	2008	5	13 S	652876	3805497
Cannon AFB	NM	2008	5	13 S	652876	3805497
Cannon AFB	NM	2008	6	13 S	653052	3805360
Cannon AFB	NM	2008	7	13 S	654523	3804388
Cannon AFB	NM	2008	9	13 S	654606	3804243
Cannon AFB	NM	2008	10	13 S	654648	3804405
Fort Bliss AFB	NM	2007	2	13 S	437300	3583064
Fort Bliss AFB	NM	2007	3	13 S	437529	3582645
Fort Bliss AFB	NM	2007	3	13 S	437529	3582645
Fort Bliss AFB	NM	2007	3	13 S	437529	3582645
Fort Bliss AFB	NM	2007	3	13 S	437529	3582645
Fort Bliss AFB	NM	2007	3	13 S	437529	3582645
Fort Bliss AFB	NM	2007	3	13 S	437529	3582645
Fort Bliss AFB	NM	2007	4	13 S	437503	3582643
Fort Bliss AFB	NM	2007	4	13 S	437503	3582643
Fort Bliss AFB	NM	2007	4	13 S	437503	3582643
Fort Bliss AFB	NM	2007	4	13 S	437503	3582643
Fort Bliss AFB	NM	2007	5	13 S	437949	3582616
Fort Bliss AFB	NM	2008	6	13 S	437191	3583016
Fort Bliss AFB	NM	2008	7	13 S	437703	3582979
Holloman AFB	NM	2007	7	13 S	392098	3642876
Holloman AFB	NM	2007	7	13 S	392098	3642876
Holloman AFB	NM	2007	7	13 S	392098	3642876
Holloman AFB	NM	2007	33	13 S	392138	3643693
Holloman AFB	NM	2007	33	13 S	392138	3643693
Holloman AFB	NM	2007	33	13 S	392138	3643693
Holloman AFB	NM	2007	33	13 S	392138	3643693
Holloman AFB	NM	2007	33	13 S	392138	3643693
Holloman AFB	NM	2007	45	13 S	392718	3641873
Holloman AFB	NM	2007	45	13 S	392718	3641873
Holloman AFB	NM	2007	45	13 S	392718	3641873
Holloman AFB	NM	2007	45	13 S	392718	3641873
Holloman AFB	NM	2007	50	13 S	393009	3639452
Holloman AFB	NM	2007	50	13 S	393009	3639452
Holloman AFB	NM	2007	51	13 S	398546	3637866
Holloman AFB	NM	2007	52	13 S	397877	3637907

				NAD 83		
Site	**US State**	**year**	**Nest ID**	**Zone for UTMs**	**Easting**	**Northing**
Holloman AFB	NM	2008	5	13 S	392120	3642006
Holloman AFB	NM	2008	7	13 S	392098	3642876
Holloman AFB	NM	2008	37	13 S	392216	3642985
Holloman AFB	NM	2008	37	13 S	392216	3642985
Holloman AFB	NM	2008	37	13 S	392216	3642985
Holloman AFB	NM	2008	37	13 S	392216	3642985
Holloman AFB	NM	2008	37	13 S	392216	3642985
Holloman AFB	NM	2008	50	13 S	393009	3639452
Holloman AFB	NM	2008	50	13 S	393009	3639452
Holloman AFB	NM	2008	50	13 S	393009	3639452
Holloman AFB	NM	2008	50	13 S	393009	3639452
Holloman AFB	NM	2008	61	13 S	398057	3636381
Holloman AFB	NM	2008	61	13 S	398057	3636381
Holloman AFB	NM	2008	62	13 S	391754	3639122
Holloman AFB	NM	2008	67	13 S	397910	3636265
Holloman AFB	NM	2008	67	13 S	397910	3636265
Holloman AFB	NM	2008	67	13 S	397910	3636265
Holloman AFB	NM	2008	68	13 S	395372	3637174
Holloman AFB	NM	2008	69	13 S	392419	3640176

Part II.

Surveys for Wintering Burrowing Owls (*Athene cunicularia*) in Southern New Mexico, the Texas Coastal Bend, and North Central Mexico

Surveys for Wintering Burrowing Owls (*Athene cunicularia*) in Southern New Mexico, the Texas Coastal Bend, and North Central Mexico

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Abstract

Burrowing Owls (*Athene cunicularia***)** are species of concern because of their decline. One proposed cause for this decline is winter habitat condition. In order to determine if this is indeed a cause of decline, owls from Kirtland Air Force Base were equipped with radio transmitters in order to locate their winter grounds. During the 2007 breeding season, collar transmitters were attached to 30 juvenile owls. Dispersal surveys were conducted on Kirtland Air Force Base to determine timing and behaviors.

Efforts to locate owls on their winter grounds in southern New Mexico, south Texas, and north central Mexico were conducted by ground surveys. Surveys were conducted in December 2007, January 2008, and February 2008. Forty-three wintering owls were located in New Mexico, 20 were located in Texas, and 199 were located in Mexico, for a total of 262 owls. No transmitter signals were detected.

Some of the observed threats to owls in southern New Mexico include a decrease in available burrows, heavy grazing, and oil extraction. Two possible threats to wintering Burrowing Owls in south Texas include collisions with vehicles and pesticide contamination. Habitat loss was an observed threat to wintering owls in Mexico.

Telemetry studies will again be conducted in 2008. Coded transmitters will be attached to 60 owls from Kirtland Air Force Base, and aerial and ground surveys will take place during the winter of 2008 and 2009.

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 2002). 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 (KAFB), the population of owls has increased slightly since 2005, but an overall decrease has been documented since monitoring efforts began in 1998.

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 third year of a five-year study attempting to locate wintering grounds of the owls that breed in New Mexico.

Burrowing Owls range from southern and southwestern Canada throughout the western United States to México. Their wintering range withdraws from the northern portion of this range. In México, Burrowing Owl habitat is found in arid and semi-arid zones as well as other open areas and agricultural fields in the Mexican Plateau. Southern New Mexico and south Texas are also important wintering grounds for Burrowing Owls (James and Ethier 1989, McIntyre 2004, Williford et al. 2007).

During the 2007 breeding season, owls from KAFB were outfitted with radio transmitters. During the winter of 2007 / 2008, attempts were made to locate these owls in southern New Mexico, southeast Texas, and northern México. In addition, surveys were conducted in several regions of central and northern Mexico to determine habitat condition and presence of wintering owls. By learning more about habitat quality of wintering grounds, and where owls from KAFB are spending their winter, we can determine if winter habitat conditions are contributing to the decline of the Burrowing Owl.

Study Area

New Mexico

New Mexico is characterized by a mild, arid, or semiarid climate with a relatively large annual and diurnal temperature range, low annual precipitation, low relative humidity, and abundant sunshine. Wind speeds are usually moderate but can be quite strong, with winds generally stronger in the eastern plains. For this study, surveys occurred between 3000 and 4500 feet in elevation. Average annual precipitation in this area from 1971-2000 ranged from less than 12 inches to 20 inches (PRISM Group). Most precipitation falls in the summer, with 80 percent of the annual total in the eastern plains falling between May and October. Winter is the driest season in New Mexico for the portion of the state east of the Continental Divide. In January, average daytime temperatures range in the mid-50°Fs in the southern and central valleys.

The principal industries of New Mexico are agriculture, mining, logging, gas and oil production, and recreation. Livestock raising is the most extensive agricultural use, with more than half of the state used as pastureland.

Surveys were conducted in three of the ecoregions of New Mexico; the High Plains and the Southwestern Tablelands in the east, and the Chihuahuan Desert in the south (Griffith et al. 2006). The region of the southern High Plains is characterized by smooth to slightly irregular plains with a high percentage of cropland. The natural vegetation occurring in this shortgrass prairie includes blue grama *(Bouteloua gracilis)* and buffalo grasses (*Bouteloua dactyloides),* as well as sand sage *(Artemisia filifolia),* Havard shin-oak *(Quercus havardii),* four-wing saltbush *(Atriplex canescens),* yucca *(Yucca spp.),* mesquite *(Prosopis spp.),* and lotebush *(Ziziphus obtusifolia).* This ecoregion includes the Llano Estacado where thousands of playa lakes occur. Livestock grazing is the dominate land use, and oil and gas production activities are widespread.

The Southwestern Tablelands are characterized by broad, rolling plains, tablelands, and piedmonts, broken by drainages. The natural vegetation of these shortgrass steppes and midgrass prairies include blue grama *(Bouteloua gracilis),* buffalo grass (*Bouteloua dactyloides)*, galleta (*Hilaria jamesii),* sand dropseed (*Sporobolus cryptandrus*), three-awn (*Aristida spp.*), ring muhly (*Muhlenbergia spp.*), broom snakeweed (*Gutierrezia sarothrae*), yucca *(Yucca spp.),* cacti, and cholla. Little of this region is cropland, as it is more rugged and less arable. Livestock grazing is the dominant land use.

The Chihuahuan Desert is characterized by alternating mountains and valleys, with the valley vegetative cover predominantly desert grassland and arid shrubland. Typical vegetation includes black grama (*Bouteloua eriopoda*), blue grama *(Bouteloua gracilis),* sideoats grama (*Bouteloua curtipendula*), and gyp grama *(Bouteloua breviseta),* bush muhly *(Muhlenbergia porteri),* tobosa grass *(Pleuraphis mutica),* alkali sacaton *(Sporobolus airoides),* creosote bush (*Larrea tridentate),* tarbush *(Flourensia cernua),* four-wing saltbush *(Atriplex canescens),* prickly pear (*Opuntia spp.*), and chollas, dropseeds, and acacias. Heavy grazing has causing an increase in the desert shrubland.

In New Mexico, Burrowing Owls are associated with certain plant communities. These include desert grasslands dominated by various annual and perennial grasses, snakeweed (*Gutierrezia sp.*), rabbitbrush (*Chrysothamnus naoseosus*), four-wing saltbush (*Atriplex canescensi*), Russian thistle (*Salsola kali*), yucca (*Yucca spp.*), and prickly pear (*Opuntia spp.*) (Martin 1973, Botelho and Arrowood 1996, McDonnell and Cruz 2005, Mershon and Bailey 2006).

South Texas

The natural vegetation of the Texas Coastal Bend consists mostly of mixed prairie grasses, transitional riparian forest, oak savanna, and Tamaulipan thornscrub. The climate is subtropical, with an average mean temperature of 71°F, and an average of 76 cm of rain per year (Williford et al. 2007). December and January are the coldest months. Outside of the cities, livestock production and agriculture are the predominant land-uses. Much of the native prairie and brushlands in the Coastal Bend have been converted to farmland (Jahrsdoerfer and Leslie 1988). Sorghum and cotton are among the most important crops grown in the area (Williford et al. 2007).

Surveys in Texas were conducted in two ecoregions; the Western Gulf Coastal Plain and the Southern Texas Plains (Griffith et al. 2004). The Western Gulf Coastal Plain is characterized by grassland vegetation and a relatively flat topography. Much of this grassland has now been converted to agriculture, with the principal crops of rice, grain sorghum, cotton, and soybeans. Urban and industrial land uses are also expanding, and oil and gas production are widespread.

The Southern Texas Plains were once characterized by grassland and savanna vegetation, but due to continued grazing and fire suppression, now are mostly the thorny brush lands characteristic of Tamualipan Thornscrub. The natural vegetation is dense and thorny. The region is subhumid to dry, and the area is generally lower in elevation and with warmer winters than the Chihuahuan Desert. Oil and natural gas production are widespread.

Mexico

Mexico is a country with high diversity of landscape. Coastal plains extend along the east and west coastlines. 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 Mexico. This is a vast high elevation arid plateau in the center of the country that extends through central and northern Mexico. To the south of the plateau, running east to west across the middle 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 Mexico (and three of the top ten peaks in North America) reaching heights of 5636 meters (18,491 feet).

The dominant habitat of north and northwest coast of Mexico is desert, which is prime habitat for Burrowing Owls. The Chihuahuan Desert is found in the high plateau bordered by the two mountain ranges, with its southern border extending into Zacatecas, Aguascalientes, and San Luis Potosi 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.

Microphilous scrublands (small leaved scrublands) are the dominant vegetation type of the Chihuahuan Desert, which include creosote bush (*Larrea tridentate*) and tarbush (*Flourensia cernua*). Characteristic succulents of the xerophilous scrubland (desert or arid scrubland) include yuccas (*Yucca elata*, *Yucca torreyi*), agaves (*Agave spp*.), and a variety of small to medium sized cacti. Common grass species (some associated with halophile or saline soil vegetation areas) include black grama (*Bouteloua eriopoda)* and tobosa grass (*Pleuraphis mutica).* Other plant species include bear grass (*Nolina spp*.), sotol (*Dasylirion sp*.), candelilla (*Euphorbia antisyphilitica*), ocotillo (*Fouquieria spendens)*, and prickly pear (*Opuntia spp*.). 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, western Texas, and southeastern New Mexico.
- Mapimian Chihuahuan Desert (Desierto o Bolson de Mapimí) is located in the northeast of Durango, southeast of Chihuahua, and central and west of Coahuila states.
- Saladan Chihuahuan Desert (Desierto o Bolson del Salado), or what is also considered south of the Chihuahuan Desert, is comprised of northeastern Jalisco, northeastern Aguascalientes, east and north of Zacatecas, central and eastern Durango, south of Coahuila, southwestern Nuevo Leon, southwestern Tamaulipas, and central and northern San Luis Potosi (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 Mapimi Chihuahuan Desert and with a higher density in the Saladan Chihuahuan Desert at the south end of the plateau.***

The Chihuahuan Desert gradually merges into Thornscrub to the south. This is a transitional area between the desert and Tropical Forest biomes. Thornscrub is composed of 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 join the Tropical Deciduous Forest that lines the east and west coasts of southern Mexico. 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 owls.

Methods

Transmitters

For this study, collar transmitters were attached to juvenile Burrowing Owls. Studies have associated backpack transmitters on Burrowing Owls to an increase in mortality (Gervais et al. 2006). Also, previous studies that mounted transmitters on adults suggest adults may have difficulty adapting to the equipment (Gervais et al. in press), while studies with juveniles suggest no effect (Clayton and Schmutz 1999, Conway and Garcia 2005).

Thirty radio collar transmitters were used in this study. Transmitters were digitally encoded, allowing birds to be uniquely identified on the same frequency. All transmitters were programmed to 162.440 MHz frequency (Appendix B). In compliance with the state permit, the weight of the transmitters could not exceed three percent of the owl body weight (New Mexico Department of Game and Fish, 2007). The weight of the transmitters was between 3.1 and 3.4 grams, and therefore could only be attached to owls weighing at least 103.3 grams. Transmitters were programmed to automatically turn on and off every 12 hours (set 7 am to 7 pm), and the pulse rate of the units was set to emit pulses every 4 seconds. The expected battery life was 315 days, and the expected range was 3 km to 6 km.

Owls were trapped using one-way door box traps placed in the burrow entrance. While attaching transmitters, health measurements were taken from each owl to determine physical condition. Only owls that were determined to be in good physical condition (according to weight, fat levels, feather condition, parasites) were equipped with a transmitter. Elastic collars coated with heat shrink tubing were placed around the neck of the owl, knotted in place, and the knot was glued to prevent it from loosening. Owls were monitored daily to be certain they were adapting to the transmitter. Once this was determined, owls were monitored two to three times a week in July, twice a week in August and September, and weekly in October and November to determine dispersal behavior, movements, and timing.

Materials and equipment

Avian NanoTag coded transmitters were produced by Lotek Wireless, Inc. An SRX 400 receiver (Lotek Wireless) was used for the surveys by vehicle. Two 4-element Yagi antennas (Lotek Wireless) were mounted on top of a car to conduct the surveys (Images A). An ACU_1 switch box (Lotek Wireless) was attached to the receiver to separate the incoming signal from each of the antennas if a radio signal was detected. An R-1000 receiver (Communications Specialists, Inc.) was used while walking potential habitat. An omni directional whip antenna (Radiall / Larson Antenna Technologies) with a magnetic mount attachment was also used for some surveys by vehicle. A variety of other field equipment including binoculars (10x50 and 10x42), spotting scopes (20-60x and 15-60x), GPS, and digital cameras were used to register information while conducting surveys.

Ground surveys

Ground surveys were conducted to search for telemetry signals and document wintering owl locations. Areas were surveyed by driving through suitable habitats searching for owls by sight and with the receiver. Prairie dog colonies were thoroughly walked searching for owls and signs of owl use while listening for a signal with the hand held receiver. Data on density of burrows, signs of prairie dog use, and signs of Burrowing Owl use were collected. Once an owl was located, description of the habitat, digital photographs, and the Universal Transverse Mercator (UTM) were taken.

Surveys were conducted on all types of secondary roads (paved, dirt, and two-track) while avoiding heavily traveled highways where owls were less likely to be found. Vehicle speeds never exceeded 50mph, and were most often slower. Surveys were conducted between 7am and 7pm while the transmitters were set on. With the antennas attached on top of the vehicle, surveys could be conducted whenever the car was in use and while in appropriate habitat.

Mexican collaborative survey effort

A network of Mexican collaborators was established for the 2005 / 2006 winter season to carry out a series of observations in several regions of the central and northern parts of Mexico.

This group of professionals gathered specific information on the habitat structure and quality, as well as recording owl sightings. The 2007 / 2008 surveys were conducted in the same areas as the previous surveys, in order to compare the two winter habitat surveys. In order to make the quality of the information collected consistent, Envirological Services, Inc. (ES) provided collaborators with standardized protocol for surveys.

Each of our collaborators conducted surveys in mid-December and mid-January. 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 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 et al. 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.

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. In addition, 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.

Table 1. Summary of data to be collected, explanation, and examples for collaborators in Mexico for the winter surveys of 2005 / 2006 and 2007 / 2008.

DATA COLLECTED	EXPLANATION AND EXAMPLE
Name	Full name of the observers: example Octavio Cruz
Date	In this format DD/mmm/YY: example 11/nov/07
Start and finish time	In 24 hour format: example 1610 – 1935
Start and finish UTM	In NAD 83 datum
UTM at each observation point	In NAD 83 datum
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% and 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.

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 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.

Results

Breeding grounds

Thirty radio transmitters were attached to owls on KAFB during the breeding season. Transmitters were attached to juveniles from 14 different burrows from different areas of KAFB (Appendix A). Transmitters were deployed beginning on June 13 and concluding on July 16. Transmitters were attached to owls weighing between 120.5g and 161.0g with an age range of approximately 22 to 45 days (Appendix B). All owls seemed to accept the radio collar without prolonged nuisance. Owls biting the radio and tugging on the collar were commonly observed the morning after attachment. After the first day, this behavior was observed less frequently.

Failure of the transmitters

After the transmitters were attached to the owls for about two weeks, the units began to malfunction. The antennas were breaking off the units, causing a loss in the range of the transmitters. Therefore, efforts were modified to track the owls on their winter grounds. Nevertheless, the units could be detected at a close range (about 200 meters), and this was used to locate their dispersal movements inside KAFB, and to search for owls by ground during the winter. Lotek Wireless will replace all 30 units for use in 2008.

Dispersal

The owls with transmitters were monitored from the day after they were radio tagged until they left the base on dispersal or migration. On KAFB, surveys for owls with transmitters were conducted in the cantonment area, landfill area, Four Hills area, golf course area, Peacekeeper, and horse stables. Monitoring began on June 14 and continued until November 9. An additional survey was conducted on January 4.

From the data gathered, it was found that owls showed different dispersal patterns, timing, and behaviors. One individual (unit 16 from burrow 4, placed with a transmitter on June 13) was not located again after it left its natal burrow area as young fledgling (June 28). Other individuals were located intermittently at their natal burrow or in alternate burrows nearby. Some owls (units 12, 17, 19, 23, 25, 29, 30, 31, 33, and 34) traveled over 0.5 kilometers from their natal burrows and established themselves in a specific territory for the rest of the season, until they left on migration or late dispersal. Some of these owls (units 12, 19, 25, 30, and 34) remained in these new territories for even longer (Appendix C).

The remaining radio collared individuals were located again in their nest burrow area after some time away, often over one week. The various movement patterns were irregular (Appendix C). The radio tagged owls used habitat of several areas inside and outside of the military base boundaries during these dispersal movements.

On July 5, an owl from burrow 158 (unit 35) was found dead, hit by a car close to its natal burrow. The owl was reported to Carol Finley and transmitter located during examination.

Another signal (unit 26 from the same burrow 158) was located inside the burrow. Prior to the discovery, the last recorded observation of this particular owl was on July 30. The owl was never sighted again, but the signal remained in the burrow. It is assumed that either the owl died underground, or the unit came off the owl's neck. The nest burrow and surrounding alternates were checked using a video probe, but no owl or collar was found.

Dispersal surveys were also conducted in the open areas surrounding the military base to the south, east, and west. Surveys were conducted south of KAFB around Bosque Farms, accessible areas around Isleta Pueblo, and around Los Lunas and Belen east to the Manzano Mountains and west of I-40 (Appendix D). Surveys were also conducted west of KAFB to I-40, north around the outskirts of Santa Ana Pueblo and Sandia Pueblo, and around the fields to the east of KAFB between the Eubank gate and the Manzano Mountains. No transmitter signals or banded owls were detected.

Winter surveys

Surveys for wintering Burrowing Owls were conducted during December, January, and February. Surveys were conducted in New Mexico, Texas, and Mexico. Forty-three wintering owls were located in New Mexico, 20 were located in Texas, and 199 were located in Mexico, for a total of 262 owls (Table 2). No transmitter signals were detected.

Table 2. Number of owls observed during the winter of 2007 to 2008 by location.

Location	**Sub-location**	**# owls**	**# observed unbanded**
Texas	Gulf Coast	20	20
New Mexico	KAFB	3	2
New Mexico	HAFB	5	3
New Mexico	Fort Bliss	1	1
New Mexico	Luna County	0	0
New Mexico	Dona Ana County	3	3
New Mexico	Lea County	2	2
New Mexico	Chaves County	6	3
New Mexico	Roosevelt County	2	2
New Mexico	Ladder Ranch	13	11
New Mexico	Armendaris Ranch	8	4
Mexico	Chihuahua	55	23
Mexico	Aguascalientes	29	16
Mexico	Coahuila	26	24
Mexico	San Luis Potosi	28	28
Mexico	Zacatecas	61	43
	Total Owls	262	185

Southern New Mexico surveys

Surveys took place in south and southeast New Mexico in the counties of Bernalillo, Luna, Sierra, Socorro, Dona Ana, Otero, Chaves, Lea, and Roosevelt (Table 3). Surveys were conducted in prairie dog colonies on public lands (Appendix F), in and around New Mexico State University in Las Cruces, on the southern Turner Ranches, and on the military instillations of New Mexico (Images B). Surveys were carried out during December, January, and February.

Table 3. Number of prairie dog colonies (historic and current) surveyed during the winter of 2007 to 2008 by county.

County	Location	# of colonies
Bernalillo	KAFB	25
Luna	Public Land	1*
Sierra	Ladder and Armendaris Ranch	13
Socorro	Armendaris Ranch	2
Dona Ana	Public Land	1*
Otero	Fort Bliss	2
Chaves	Public Land	7*
Lea	Public and Private Land[1]	29*
Roosevelt	Public Land	18*
	Total	98

*These colony locations were determined by aerial photos (Natural Heritage New Mexico) and not necessarily ground truthed.

[1]In addition to the public land colonies, two private land colonies were also surveyed in Lea County as they were discovered off public roads.

South Texas surveys

Surveys were conducted in the Texas Coastal Bend in the counties of Nueces, San Patricio, Refugio, and Aransas. Surveys were carried out in February. Rural county roads were driven in search of owls and transmitter signals (Images C). Historic owl roost locations (provided by USGS Texas Gulf Coast Field Station) and surrounding areas were visited. Current owl locations were also provided by responses to our post on the Texas birders listserv. These sites were either visited or information was provided by the observer on band status.

Mexico surveys - Mexican collaborative survey effort

Surveys were conducted in five states of Mexico including Chihuahua, Aguascalientes, Coahuila, San Luis Potosi, and Zacatecas. These states are located in the high plateau of north central Mexico. Surveys were conducted in suitable habitat and in areas where surveys were previously carried out in the winter of 2005 / 2006.

Chihuahua

Surveys were conducted in the Janos Valley, located in the northwest portion of the state of Chihuahua, Mexico. Surveys were conducted in January. Prairie dog colonies of the area were surveyed (Images D). Collaborators provided information on locations of prairie dog towns and locations where Burrowing Owls have been documented. Survey routes began in an 18,500 hectare private natural reserve, Rancho El Uno, where the largest remaining complexes of black-tailed prairie dog colonies *(Cynomys ludovicianus)* are located. Survey routes crisscrossed a large area surrounding the ranch on rural dirt roads. The majority of prairie dog towns were found north, west and south of the ranch. Fifty five owls were recorded during surveys.

Aguascalientes

Surveys were conducted to the east of Aguascalientes City. The localities surveyed included the areas of Potrero Las Laminas, Rancho La Soledad, Camino La Union, Potrero La Florida, Tanque Los Arrieros, Rancho San Isidro, Ruta Betulia, Paraje La Frontera, and Ejido El Tildio. Surveys were carried out by Salvador Medina Torres from Procuraduría Estatal de Protección al Ambiente de Aguascalientes and a field crew. In Aguascalientes, 29 owls were recorded during these surveys, 13 owls in December and 16 owls in January.

Coahuila

Surveys in Coahuila were conducted in the south end of the state. The localities surveyed included the areas of San Vicente, Los Angeles, and La India. In these locations owls were primarily observed in Mexican prairie dog (*Cynomys mexicanus*) colonies. Surveys in both Coahuila and San Luis Potosi were carried out by Gabriel Garcia Ayma and a field crew from the Laboratorio de Ornotologia of the University of Nuevo Leon. In Coahuila, a total of 26 Burrowing Owls were recorded, 14 owls were registered during December and 12 owls in January.

San Luis Potosi

Surveys in San Luis Potosi were conducted in the north end of the state. The localities surveyed included the areas of El Manantial and El Gallo. These areas contain Mexican prairie dog colonies. In San Luis Potosi, a total of 28 owls were recorded, 13 owls were registered during December and 15 owls in January.

Zacatecas

Surveys in Zacatecas were conducted in several sites of the north portion of the state in suitable habitat. Most of the areas where owls were registered contained natural burrows created by ground squirrels and Mexican prairie dogs. The survey effort was coordinated by Araceli Valverde and a field crew from Faunotica AC. In Zacatecas, a total of 61 Burrowing Owls were recorded, 33 owls were registered during December and 28 owls in January.

Bands

One banded owl was discovered during winter surveys on HAFB. This owl was banded by ES during the 2007 breeding season on HAFB. No other banded owl was observed during winter surveys.

Discussion

Southern New Mexico surveys

KAFB is known to support a few wintering owls every year, and this year was no different. Adult males may remain during the winter to hold territories for the following breeding season (Carol Finley pers. comm.). The three owls located during winter surveys were observed in areas annually occupied by breeding owls.

The wintering owls on Holloman Air Force Base (HAFB) were located either in historic territories or in new territories that have been used recently by owls during the breeding season, as the population on HAFB has been increasing and expanding. Owls here use artificial burrows, rabbit and badger burrows, and depressions and cavities created along underground pipelines or cable lines.

On Fort Bliss Army Base, the two active prairie dog towns were surveyed. No owls were located in the small colony, but one owl was located in the large colony. This colony supports many owls during the breeding season (Envirological Services unpubl. data).

The area around New Mexico State University in Las Cruces contains Burrowing Owls year round, and has a well-studied breeding population (Betelho and Arrowood 1996, 1998). Owls here are commonly seen around campus, the university golf course, cemeteries, and agriculture fields and irrigation ditches (Carol Finley, pers. comm.). One wintering owl was located on campus, and two were located in an area near campus with sandy banks and creosote bush.

The highest density of wintering owls was observed on the Turner Ranches. Owls here were more commonly located in smaller prairie dog towns rather than in larger colonies. These prairie dog towns are re-establishment sites and are researched and managed. This area also is private land and protected, with a focus on ecological sustainability. Owls on these ranches are also observed in tortoise burrows and in kangaroo rat dens.

As for the remaining prairie dog colonies surveyed in southern New Mexico, although many colonies were surveyed, only ten owls were detected. Some of the observed threats to owls in southern New Mexico include a decrease in available burrows (through prairie dog control, conversion to agriculture, and unknown causes), heavy grazing, and oil extraction.

Although precise data is not available, the perception of ES surveyors was that fewer colonies exist now than when colonies were last surveyed in 2001-2004 (Natural Heritage New Mexico data). The county that appeared most negatively impacted was Lea County. In addition, as colony size information was provided by Natural Heritage New Mexico, often the colonies were smaller than previously estimated. Although this is no surprise, it was disheartening to see during this decade.

ES observers witnessed the shooting of prairie dogs in Lea County. Two men were observed with rifles in an active colony on public land shooting at prairie dogs, a flock of passerines, and possible other wildlife in the colony (Images B). Although shooting prairie dogs is not illegal, shooting passerines is illegal under the Migratory Bird Treaty Act.

During surveys, wintering Burrowing Owls were located in active prairie dog colonies but also in inactive colonies with tall grass cover. This suggests habitat requirements may be less specialized during the winter, and that even if the burrows are not actively maintained, they may be suitable roost sites for wintering owls.

South Texas surveys

Owls in south Texas disperse widely over cultivated fields and grasslands (Williford et al. 2007). They commonly roost in small diameter roadside culverts in agricultural areas, in addition to the natural burrows in remaining grasslands on private land (Woodin et al. 2007). Large mammals are uncommon in the agriculture areas, and therefore natural burrows are relatively uncommon (Woodin et al. 2007).

Drainage culverts are found under the many rural county roads that cross the agricultural fields, and under the roads in these fields used to service wells for the oil and gas industry. During the winter, the agriculture fields remain dormant following the harvest.

Band status of the owls observed was easily determined, as it was easy to see the owl legs clearly in the barren agriculture fields. Twenty owls were located in south Texas, and all were determined to be unbanded.

Two possible threats to wintering Burrowing Owls in south Texas include collisions with vehicles, as so many owls are roosting off roads, and pesticide contamination from the agriculture fields. In a 2001-02 study reported by Woodin et al. (2007), Burrowing Owl prey and pellets were collected from agriculture fields near roost sites and tested for 28 different carbamate and organophosphate pesticide residues. Although all contaminants detected were below lethal doses, all but three contaminants were detected.

Mexico surveys

Rancho El Uno in Janos, Chihuahua was purchased by the Nature Conservancy and its Mexican partner Pronatura Noreste in April of 2005 to accommodate biological research and promote grassland conservation in the area, particularly with neighbouring ranchers. Several prairie dog colonies were surveyed on Rancho El Uno. These colonies had many wintering owls, and since this land can now be considered a private natural reserve, these owls and prairie dogs are protected. A variety of conservation strategies will be used on Rancho El Uno to protect its desert grasslands, including reseeding, prescribed burning, rotation of grazing areas, and the re-colonization of prairie dogs (The Nature Conservancy 2005).

Prairie dog colonies surrounding Rancho El Uno were also surveyed. Many of these colonies were small and located on private land or land referred to as ejido (land that is shared among local residents for purposes such as agricultural or livestock grazing). Other colonies of varying size were located on public lands, and many were found to be abandoned or containing few prairie dogs. The colonies located on private land, public land, and ejido are threatened due to conversion to agriculture, agricultural practices, overgrazing, and expansion of communities and human activity.

In other states of Mexico, prairie dog colonies are also threatened. Although they host many wintering owls, many colonies are not protected as natural reserves, and owls and prairie dogs are not protected by Mexican legislation.

Outside of prairie dog colonies, habitat loss is a concern throughout Burrowing Owl habitat in Mexico. Conversion of the desert grassland to agriculture and human settlements is a widespread concern.

Future plans of Envirological Services, Inc.

- Attach radio transmitters to 60 Burrowing Owls during the 2008 breeding season on Kirtland Air Force Base.

- Help to redesign radio transmitters for Burrowing Owls, in collaboration with Lotek Wireless and their partner in England, Biotrack. A new design was developed with a stronger antenna and improved anchoring and collar system in order to respond to the needs of this project.
- Study the dispersal of owls with telemetry units inside KAFB and on adjacent lands.
- Attempt to locate the transmittered owls through aerial surveys over their winter grounds in southern New Mexico and northern Mexico during the winter of 2008 and 2009.
- Develop flying routes with GIS to be used for aerial surveys in 2008 and 2009.
- Continue to identify Burrowing Owl wintering grounds through the collaborative monitoring efforts already in place throughout Mexico.
- Complete a three-year study to be compiled in 2009 that will compare the differences in Burrowing Owl's density and habitat distribution from the results obtained during the winters of 2005 / 2006, 2007 / 2008, and 2008 / 2009.

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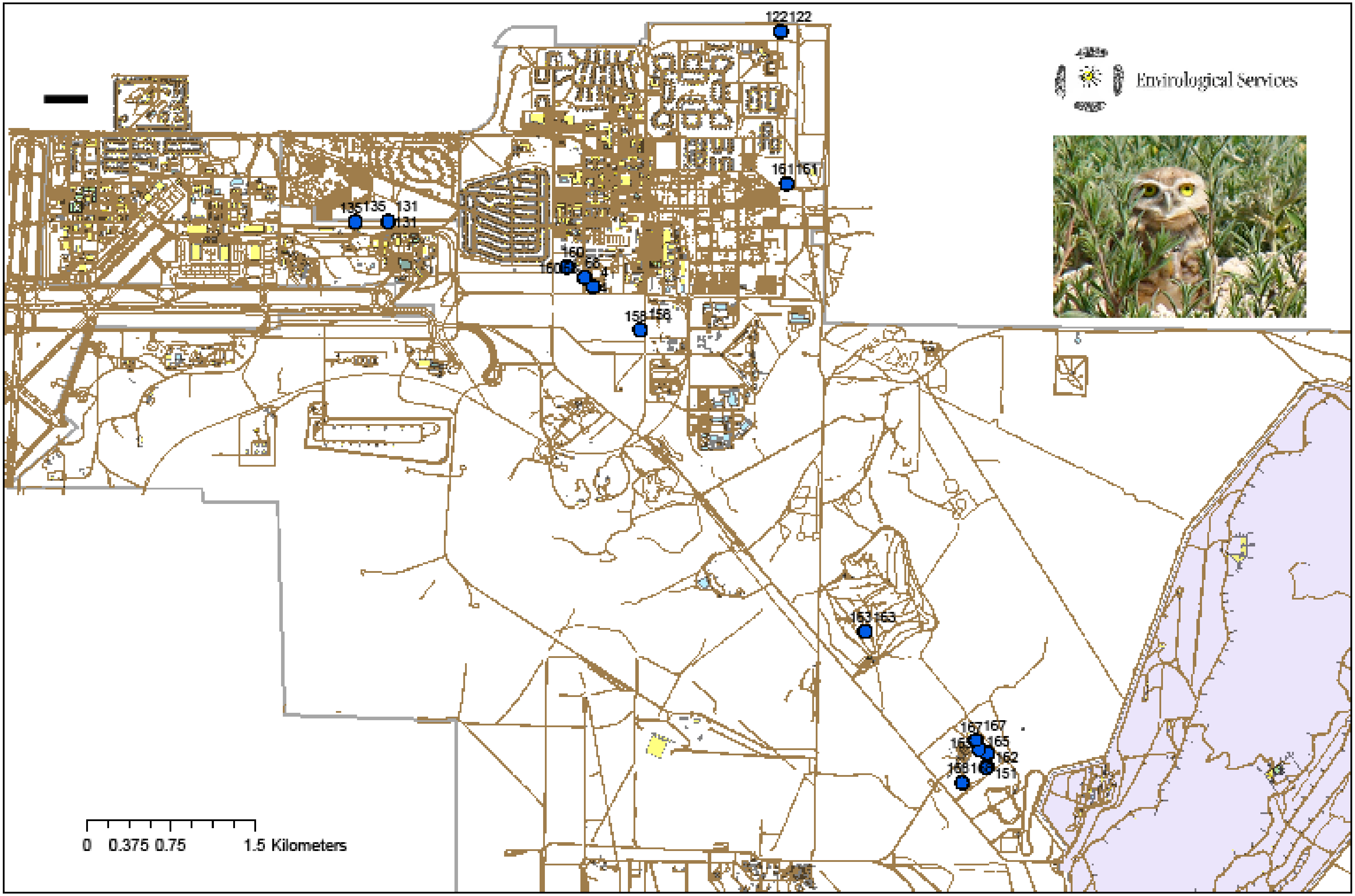
Appendix A. Locations of Nest Burrows for Burrowing Owls with Transmitters on Kirtland Air Force Base, Albuquerque, New Mexico, 2007



Appendix B. Burrowing Owl telemetry data on Kirtland Air Force Base, Albuquerque, New Mexico, 2007

	Date	Burrow No.	Age	Wing Pit Fat (0-3)	Para-sites	Age	Owl Weight(g)	Transmitter Unit #	Frequency	Transmitter Weight (g)
1	13-Jun-07	165	HY	1	N	37-38 days	135.5	11	162.440	3.3
2	13-Jun-07	162	HY	1	N	40 days	132.5	13	162.440	3.3
3	13-Jun-07	162	HY	1	N	40 days	132.8	15	162.440	3.2
4	13-Jun-07	162	HY	1	N	44 days	141.8	21	162.440	3.2
5	13-Jun-07	131	HY	1	N	44 days	141.3	18	162.440	3.3
6	13-Jun-07	131	HY	2	N	44 days	145.9	14	162.440	3.3
7	13-Jun-07	4	HY	1	N	42 days	130.2	16	162.440	3.3
8	13-Jun-07	4	HY	1	N	45+ days	124.8	22	162.440	3.2
9	13-Jun-07	162	HY	1	N	37 days	140	10	162.440	3.3
10	13-Jun-07	151	HY	1	N	36 days	134.8	37	162.440	3.2
11	13-Jun-07	4	HY	1	N	45 days	124.1	17	162.440	3.1
12	14-Jun-07	167	HY	1	N	36 days	120.5	28	162.440	3.4
13	14-Jun-07	168	HY	1	N	28 days	142.6	36	162.440	3.3
14	14-Jun-07	167	HY	1	N	37 days	122.5	34	162.440	3.2
15	14-Jun-07	167	HY	1	N	37 days	126.5	12	162.440	3.3
16	14-Jun-07	167	HY	1	N	36 days	125.4	20	162.440	3.2
17	14-Jun-07	168	HY	1	N	25 days	127.4	38	162.440	3.2
18	14-Jun-07	168	HY	2	N	34 days	128.6	23	162.440	3.4
19	18-Jun-07	122	HY	0	N	35-37 days	136.8	39	162.440	3.2
20	18-Jun-07	122	HY	0	N	40 days	139.3	19	162.440	3.3
21	18-Jun-07	122	HY	0	N	40 days	133	25	162.440	3.3
22	18-Jun-07	122	HY	1	N	39 days	141.6	33	162.440	3.3
23	18-Jun-07	163	HY	2	N	22 days	128	31	162.440	3.3
24	19-Jun-07	160	HY	1	N	35 days	145.6	24	162.440	3.3
25	19-Jun-07	160	HY	2	N	36 days	150.9	27	162.440	3.2
26	19-Jun-07	68	HY	1	N	38 days	161	29	162.440	3.3
27	19-Jun-07	158	HY	1	N	26 days	126.1	35	162.440	3.3
28	19-Jun-07	158	HY	3	N	25 days	134.9	26	162.440	3.2
29	19-Jun-07	135	HY	2	lice	45+ days	154.5	32	162.440	3.3
30	16-Jul-07	161	HY	3	N	30 days	143.9	30	162.440	3.4

	Color / USFWS # (right leg)	top / bottom color (left leg)	Capture Time	Release Time	Zone (NAD 27)	Easting	Northing	Comments
1	Green / 934-28231	Red / Hot Pink	1832	1850	13 S	361575	3874860	
2	Green / 934-28232	Purple / Green	1925	1956	13 S	361648	3874829	
3	Green / 934-28233	White / Pink	1950	2008	13 S	361648	3874829	
4	Green / 934-28234	Light Green / Green	2000	2018	13 S	361648	3874829	
5	Green / 934-28235	Light Blue / White	2012	2029	13 S	356334	3879655	
6	Green / 934-28324	Light Green / Black	2025	2040	13 S	356334	3879655	
7	Green / 934-28334	Black / Red	2030	2050	13 S	358165	3879048	
8	Green / 934-28335	Black / Purple	2050	2100	13 S	358165	3879048	
9	Green / 934-28336	Black / Dark Blue	2113	2125	13 S	361648	3874829	
10	Green / 934-28337	Black / Black	2118	2136	13 S	361641	3874700	
11	Green / 934-28339	Red / Purple	2149	2203	13 S	358165	3879048	
12	Green / 934-28342	Red / Red	2023	2041	13 S	361545	3874939	
13	Green / 934-28343	Red / Light Green	2030	2051	13 S	361421	3874566	
14	Green / 934-28345	Red / Dark Blue	2106	2121	13 S	361545	3874939	
15	Green / 934-28346	Red / Black	2121	2130	13 S	361545	3874939	
16	Green / 934-28347	Green / Purple	2129	2141	13 S	361545	3874939	
17	Green / 934-28348	Green / Hot Pink	2136	2148	13 S	361421	3874566	
18	Green / 934-28349	Green / Pink	2145	2157	13 S	361421	3874566	
19	Green / 934-28355	Green / Black	1830	1848	13 S	359879	3881313	
20	Green / 934-28357	Dark Blue / Purple	1957	2010	13 S	359879	3881313	
21	Green / 934-28358	Dark Blue / Hot Pink	2003	2015	13 S	359879	3881313	
22	Green / 934-28359	Dark Blue / Pink	2010	2022	13 S	359879	3881313	
23	Green / 934-28360	Dark Blue / Light Blue	2048	2100	13 S	360566	3875931	
24	Green / 934-28362	Dark Blue / Black	2022	2035	13 S	357938	3879226	
25	Green / 934-28363	Dark Blue / White	2028	2047	13 S	357938	3879226	
26	Green / 934-28364	Dark Blue / Red	2040	2057	13 S	358091	3879132	
27	Green / 934-28365	Dark Blue / Light Green	2055	2108	13 S	358583	3878660	owl hit by car on Wyoming, July 5
28	Green / 934-28367	Light Blue / Purple	2126	2135	13 S	358583	3878660	transmitter signal remained in burrow
29	Green / 934-28368	Light Blue / Hot Pink	2135	2150	13 S	356042	3879658	
30	Green / 934-28373	Light Blue / Dark Blue	2042	2055	13 S	359919	3879949	

Appendix C. Burrowing Owl dispersal data, Kirtland Air Force Base, Albuquerque, New Mexico, 2007

Solid color indicates located on KAFB, white indicates not located on KAFB

DATES

Burrow #	UNIT #	22-Jun	25-Jun	28-Jun	4-Jul	6-Jul	12-Jul	18-Jul	20-Jul	24-Jul	27-Jul	30-Jul	3-Aug	6-Aug	10-Aug	14-Aug	17-Aug	22-Aug	24-Aug	27-Aug	31-Aug	3-Sep	7-Sep	10-Sep	13-Sep	18-Sep	21-Sep	24-Sep	28-Sep	4-Oct	8-Oct	18-Oct	25-Oct	2-Nov	6-Nov	9-Nov	4-Jan
4	16																																				
4	17																																				
4	22																																				
68	29																																				
122	19																																				
122	25																																				
122	33																																				
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131	14																																				
131	18																																				
135	32																																				
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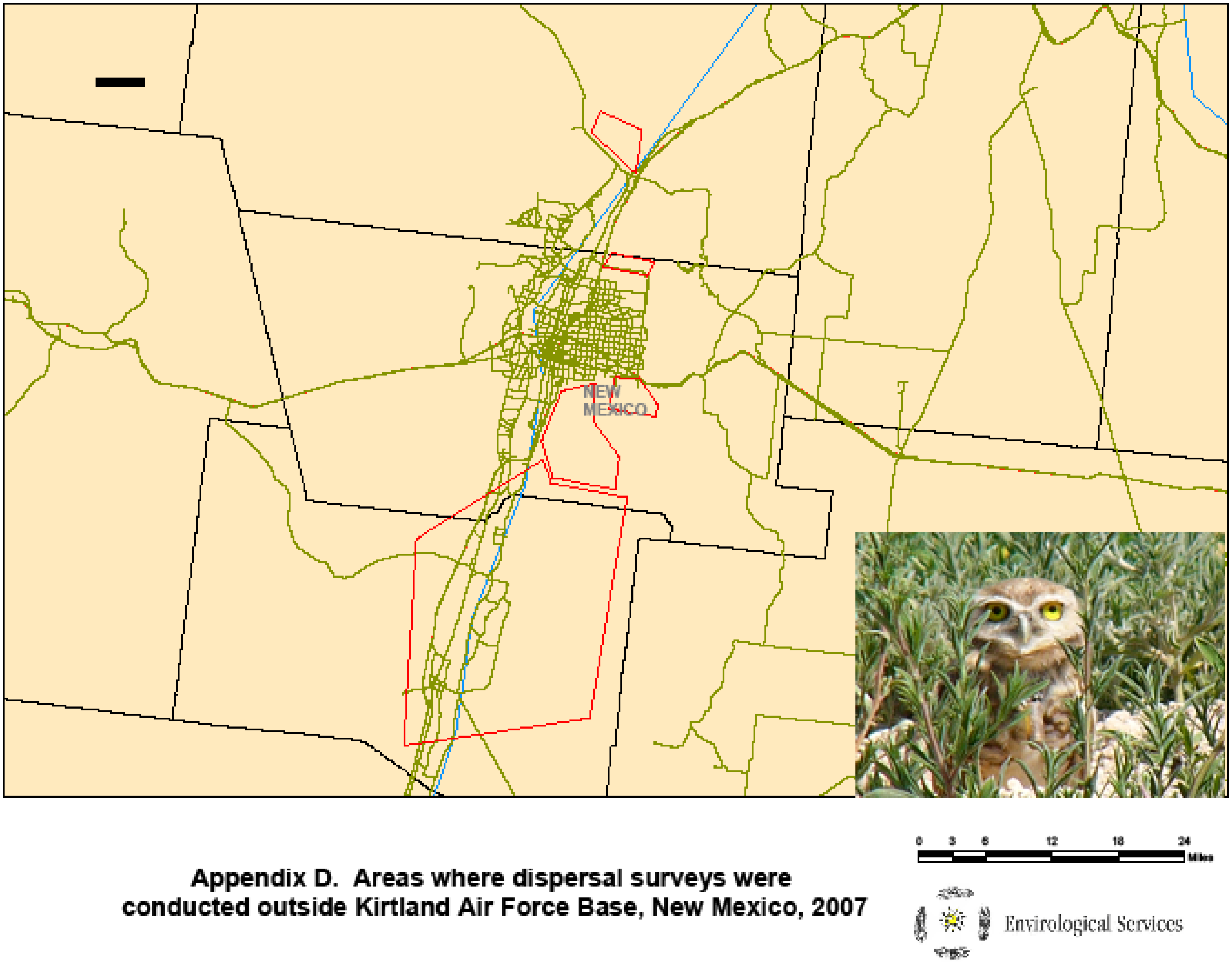
168	23																																				
168	36																																				
168	38																																				



Appendix D. Areas where dispersal surveys were conducted outside Kirtland Air Force Base, New Mexico, 2007

Appendix E. Locations of Burrowing Owls observed during the winter of 2007 to 2008, showing location, date observed, UTM*, and whether the owl was banded unknown
*UTM for New Mexico, Texas, and Janos, Mexico are given in NAD 27 Central, UTM for Zacatecas, Aguascalientes, Coahuila, and San Luis Potosi are given in NAD 83

Location	Date	UTM	Easting	Northing	Bands
Holloman Air Force Base	11-Dec-07	13S	397052	3645625	unknown
Holloman Air Force Base	14-Dec-07	13S	392077	3639824	unbanded
Holloman Air Force Base	14-Dec-07	13S	392079	3638880	unbanded
Holloman Air Force Base	10-Jan-08	13S	398578	3637664	banded
Holloman Air Force Base	12-Jan-08	13S	394340	3633332	unbanded
Fort Bliss Army Base	15-Dec-07	13S	437971	3582613	unbanded
Zacatecas, Mexico	17-Dec-07	13Q	802694	2504847	unbanded
Zacatecas, Mexico	17-Dec-07	13Q	801993	2503761	unbanded
Zacatecas, Mexico	17-Dec-07	13Q	801993	2503761	unbanded
Zacatecas, Mexico	17-Dec-07	13Q	801490	2503533	unbanded
Zacatecas, Mexico	17-Dec-07	13Q	801490	2503533	unbanded
Zacatecas, Mexico	17-Dec-07	13Q	802258	2504113	unbanded
Zacatecas, Mexico	17-Dec-07	13Q	802258	2504113	unbanded
Zacatecas, Mexico	17-Dec-07	13Q	802258	2504113	unbanded
Zacatecas, Mexico	17-Dec-07	13Q	802526	2504492	unbanded
Zacatecas, Mexico	17-Dec-07	13Q	802526	2504492	unbanded
Zacatecas, Mexico	17-Dec-07	13Q	802526	2504492	unbanded
Zacatecas, Mexico	17-Dec-07	13Q	802526	2504492	unbanded
Zacatecas, Mexico	17-Dec-07	13Q	802158	2504761	unbanded
Zacatecas, Mexico	17-Dec-07	13Q	802158	2504761	unbanded
Zacatecas, Mexico	17-Dec-07	13Q	802158	2504761	unbanded
Zacatecas, Mexico	17-Dec-07	13Q	802158	2504761	unbanded
Zacatecas, Mexico	17-Dec-07	13Q	801864	2504300	unbanded
Zacatecas, Mexico	17-Dec-07	13Q	801864	2504300	unbanded
Zacatecas, Mexico	17-Dec-07	13Q	801864	2504300	unbanded
Zacatecas, Mexico	17-Dec-07	13Q	801864	2504300	unbanded
Zacatecas, Mexico	17-Dec-07	13Q	801864	2504300	unbanded
Zacatecas, Mexico	18-Dec-07	14O	223435	2504753	unknown
Zacatecas, Mexico	18-Dec-07	14O	223446	2504995	unknown
Zacatecas, Mexico	18-Dec-07	14O	223507	2504854	unknown
Zacatecas, Mexico	18-Dec-07	14O	224296	2504064	unknown
Zacatecas, Mexico	19-Dec-07	14O	223556	2505173	unknown
Zacatecas, Mexico	19-Dec-07	14O	224691	2504274	unknown
Zacatecas, Mexico	19-Dec-07	14O	201249	2513512	unknown
Zacatecas, Mexico	19-Dec-07	14O	201257	2513717	unknown
Zacatecas, Mexico	23-Dec-07	13Q	807123	2496760	unbanded
Zacatecas, Mexico	26-Dec-07	13Q	221362	2583486	unbanded
Zacatecas, Mexico	26-Dec-07	13Q	265897	2619890	unbanded
Zacatecas, Mexico	27-Dec-07	13Q	269704	2615635	unbanded
Zacatecas, Mexico	17-Jan-08	13Q	802694	2504847	unknown
Zacatecas, Mexico	17-Jan-08	13Q	801490	2503533	unknown
Zacatecas, Mexico	17-Jan-08	13Q	801993	2503761	unbanded
Zacatecas, Mexico	17-Jan-08	13Q	801993	2503761	unbanded

Location	Date	UTM	Easting	Northing	Bands
Zacatecas, Mexico	17-Jan-08	13Q	802526	2504492	unbanded
Zacatecas, Mexico	17-Jan-08	13Q	802526	2504492	unbanded
Zacatecas, Mexico	17-Jan-08	13Q	802526	2504492	unbanded
Zacatecas, Mexico	17-Jan-08	13Q	802258	2504113	unbanded
Zacatecas, Mexico	17-Jan-08	13Q	802258	2504113	unbanded
Zacatecas, Mexico	17-Jan-08	13Q	802258	2504113	unbanded
Zacatecas, Mexico	17-Jan-08	13Q	801864	2504300	unbanded
Zacatecas, Mexico	17-Jan-08	13Q	801864	2504300	unbanded
Zacatecas, Mexico	17-Jan-08	13Q	801864	2504300	unbanded
Zacatecas, Mexico	17-Jan-08	13Q	801864	2504300	unbanded
Zacatecas, Mexico	17-Jan-08	13Q	802158	2504761	unbanded
Zacatecas, Mexico	17-Jan-08	13Q	802158	2504761	unbanded
Zacatecas, Mexico	17-Jan-08	13Q	802158	2504761	unbanded
Zacatecas, Mexico	17-Jan-08	13Q	802158	2504761	unbanded
Zacatecas, Mexico	22-Jan-08	14O	221362	2583486	unbanded
Zacatecas, Mexico	22-Jan-08	14O	265897	2619890	unknown
Zacatecas, Mexico	23-Jan-08	14O	269704	2615635	unbanded
Zacatecas, Mexico	23-Jan-08	14O	270154	2614755	unknown
Zacatecas, Mexico	26-Jan-08	14O	222572	2504327	unknown
Zacatecas, Mexico	27-Jan-08	14O	222352	2503320	unknown
Zacatecas, Mexico	27-Jan-08	14O	224541	2502917	unknown
Zacatecas, Mexico	27-Jan-08	14O	224384	2503029	unknown
Zacatecas, Mexico	27-Jan-08	14O	224317	2504001	unknown
Zacatecas, Mexico	27-Jan-08	14O	223983	2504176	unknown
Aguascalientes, Mexico	18-Dec-07	13Q	807991	2420123	unbanded
Aguascalientes, Mexico	18-Dec-07	13Q	807991	2420123	unbanded
Aguascalientes, Mexico	18-Dec-07	13Q	807991	2420123	unbanded
Aguascalientes, Mexico	18-Dec-07	13Q	807991	2420123	unbanded
Aguascalientes, Mexico	18-Dec-07	13Q	807991	2420123	unbanded
Aguascalientes, Mexico	19-Jan-08	13Q	807482	2421463	unknown
Aguascalientes, Mexico	19-Jan-08	13Q	807966	2420174	unknown
Aguascalientes, Mexico	19-Jan-08	13Q	807966	2420174	unknown
Aguascalientes, Mexico	19-Jan-08	13Q	807966	2420174	unknown
Aguascalientes, Mexico	19-Jan-08	13Q	807966	2420174	unknown
Aguascalientes, Mexico	19-Jan-08	13Q	807966	2420174	unknown
Aguascalientes, Mexico	19-Jan-08	13Q	807123	2423461	unknown
Aguascalientes, Mexico	19-Jan-08	13Q	807123	2423461	unknown
Aguascalientes, Mexico	19-Dec-07	13Q	802269	2424028	unbanded
Aguascalientes, Mexico	19-Dec-07	13Q	802378	2423701	unbanded
Aguascalientes, Mexico	21-Jan-08	13Q	802381	2423713	unknown
Aguascalientes, Mexico	19-Dec-07	13Q	806866	2421569	unbanded
Aguascalientes, Mexico	19-Dec-07	13Q	806711	2421622	unbanded
Aguascalientes, Mexico	19-Dec-07	13Q	806711	2421622	unbanded
Aguascalientes, Mexico	19-Dec-07	13Q	806711	2421622	unbanded
Aguascalientes, Mexico	17-Jan-08	13Q	806841	2421580	unbanded
Aguascalientes, Mexico	17-Jan-08	13Q	806730	2421634	unbanded
Aguascalientes, Mexico	17-Jan-08	13Q	806730	2421634	unbanded

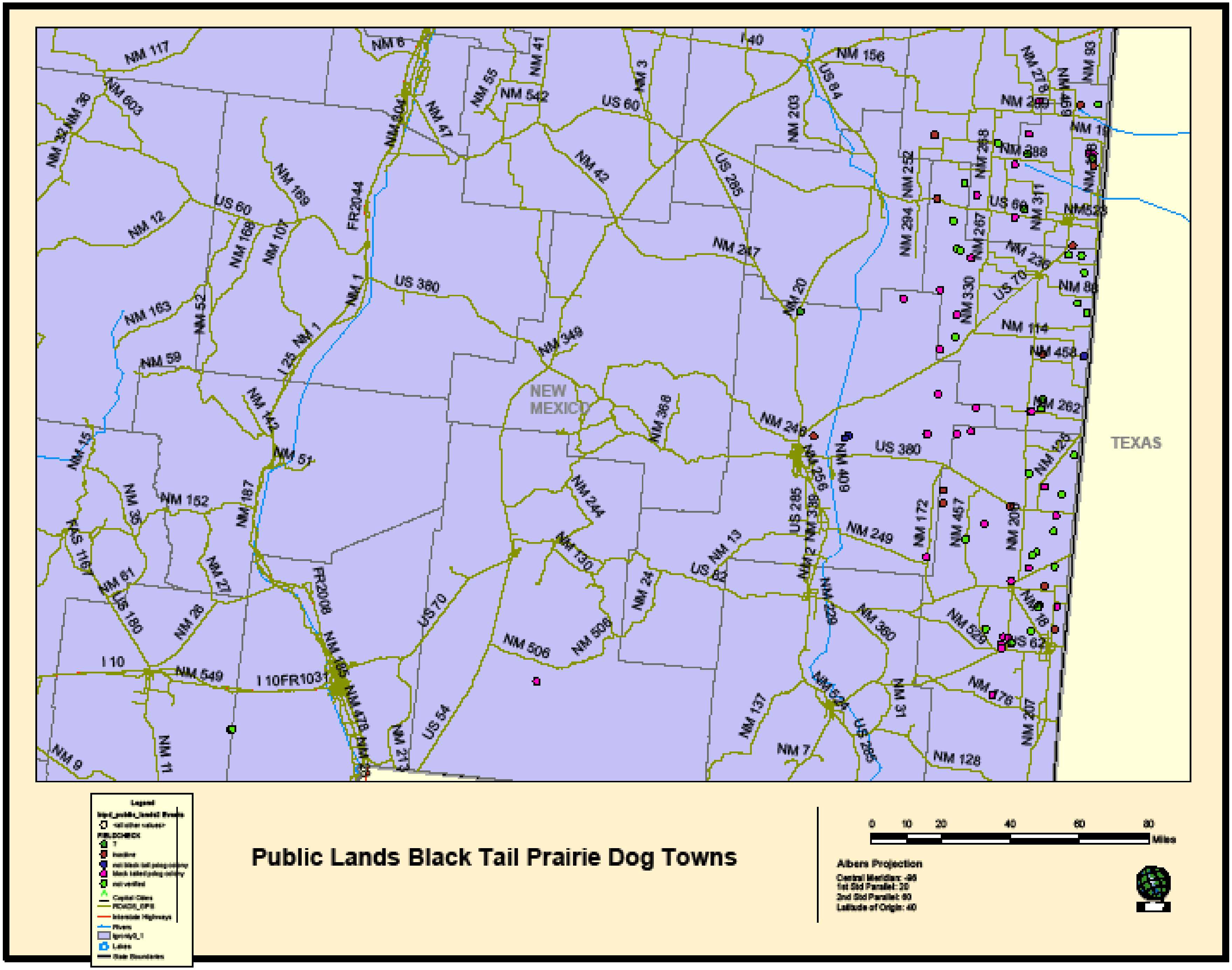
Location	Date	UTM	Easting	Northing	Bands
Aguascalientes, Mexico	18-Jan-08	13Q	805947	2420112	unknown
Aguascalientes, Mexico	16-Dec-07	13Q	801360	2421359	unbanded
Aguascalientes, Mexico	20-Jan-08	13Q	800791	2421207	unknown
Aguascalientes, Mexico	20-Jan-08	13Q	800791	2421207	unknown
Aguascalientes, Mexico	20-Jan-08	13Q	800791	2421207	unknown
Aguascalientes, Mexico	19-Dec-07	13Q	802203	2424662	unbanded
Coahuila, Mexico	19-Dec-07	14R	289351	2764115	unbanded
Coahuila, Mexico	19-Dec-07	14R	288913	2763876	unknown
Coahuila, Mexico	19-Dec-07	14R	286848	2764147	unknown
Coahuila, Mexico	20-Dec-07	14R	277662	2771269	unbanded
Coahuila, Mexico	20-Dec-07	14R	276231	2771710	unbanded
Coahuila, Mexico	20-Dec-07	14R	275706	2771710	unbanded
Coahuila, Mexico	20-Dec-07	14R	273177	2771723	unbanded
Coahuila, Mexico	21-Dec-07	14R	273177	2771723	unbanded
Coahuila, Mexico	26-Jan-08	14R	277696	2771269	unbanded
Coahuila, Mexico	26-Jan-08	14R	276274	2771709	unbanded
Coahuila, Mexico	26-Jan-08	14R	274295	2772517	unbanded
Coahuila, Mexico	20-Dec-07	14R	301071	2777984	unbanded
Coahuila, Mexico	20-Dec-07	14R	300685	2778289	unbanded
Coahuila, Mexico	20-Dec-07	14R	299910	2778904	unbanded
Coahuila, Mexico	20-Dec-07	14R	293764	2781263	unbanded
Coahuila, Mexico	20-Dec-07	14R	294195	2781024	unbanded
Coahuila, Mexico	20-Dec-07	14R	294195	2781024	unbanded
Coahuila, Mexico	26-Jan-08	14R	301141	2777927	unbanded
Coahuila, Mexico	26-Jan-08	14R	300702	2778256	unbanded
Coahuila, Mexico	26-Jan-08	14R	295587	2780266	unbanded
Coahuila, Mexico	26-Jan-08	14R	295140	2780501	unbanded
Coahuila, Mexico	26-Jan-08	14R	289319	2764096	unbanded
Coahuila, Mexico	26-Jan-08	14R	288409	2763653	unbanded
Coahuila, Mexico	26-Jan-08	14R	288060	2763754	unbanded
Coahuila, Mexico	26-Jan-08	14R	286467	2764021	unbanded
Coahuila, Mexico	26-Jan-08	14R	285936	2765928	unbanded
San Luis Potosi, Mexico	19-Dec-07	14R	287114	2764174	unbanded
San Luis Potosi, Mexico	19-Dec-07	14R	305956	2779069	unbanded
San Luis Potosi, Mexico	19-Dec-07	14R	306770	2679840	unbanded
San Luis Potosi, Mexico	19-Dec-07	14R	306150	2668603	unbanded
San Luis Potosi, Mexico	19-Dec-07	14R	306150	2668603	unbanded
San Luis Potosi, Mexico	25-Jan-08	14R	305937	2679062	unbanded
San Luis Potosi, Mexico	25-Jan-08	14R	306124	2678605	unbanded
San Luis Potosi, Mexico	25-Jan-08	14R	306124	2678605	unbanded
San Luis Potosi, Mexico	25-Jan-08	14R	305987	2679531	unbanded
San Luis Potosi, Mexico	25-Jan-08	14R	305987	2679531	unbanded
San Luis Potosi, Mexico	25-Jan-08	14R	306419	2679700	unbanded
San Luis Potosi, Mexico	25-Jan-08	14R	306419	2679700	unbanded
San Luis Potosi, Mexico	25-Jan-08	14R	306419	2679700	unbanded
San Luis Potosi, Mexico	19-Dec-07	14R	306509	2679751	unbanded
San Luis Potosi, Mexico	19-Dec-07	14R	304378	2670173	unbanded

Location	**Date**	**UTM**	**Easting**	**Northing**	**Bands**
San Luis Potosi, Mexico	19-Dec-07	14R	304292	2669663	unbanded
San Luis Potosi, Mexico	19-Dec-07	14R	304245	2668691	unbanded
San Luis Potosi, Mexico	19-Dec-07	14R	304958	2668842	unbanded
San Luis Potosi, Mexico	19-Dec-07	14R	305112	2669422	unbanded
San Luis Potosi, Mexico	19-Dec-07	14R	305112	2669422	unbanded
San Luis Potosi, Mexico	19-Dec-07	14R	304805	2670426	unbanded
San Luis Potosi, Mexico	25-Jan-08	14R	304344	2670588	unbanded
San Luis Potosi, Mexico	25-Jan-08	14R	304275	2669581	unbanded
San Luis Potosi, Mexico	25-Jan-08	14R	304516	2668104	unbanded
San Luis Potosi, Mexico	25-Jan-08	14R	304886	2668475	unbanded
San Luis Potosi, Mexico	25-Jan-08	14R	304961	2669455	unbanded
San Luis Potosi, Mexico	25-Jan-08	14R	304599	2670949	unbanded
San Luis Potosi, Mexico	25-Jan-08	14R	304402	2671823	unbanded
Kirtland Air Force Base	4-Jan-08	13S	359879	3881313	unbanded
Kirtland Air Force Base	4-Jan-08	13S	361545	3874939	unbanded
Kirtland Air Force Base	4-Jan-08	13S	354432	3879771	unknown
Janos, Chihuahua, Mexico	16-Jan-08	12R	741954	3423776	unknown
Janos, Chihuahua, Mexico	16-Jan-08	12R	741954	3423776	unknown
Janos, Chihuahua, Mexico	17-Jan-08	12R	747357	3421308	unknown
Janos, Chihuahua, Mexico	17-Jan-08	12R	747357	3421308	unbanded
Janos, Chihuahua, Mexico	17-Jan-08	12R	741308	3412776	unbanded
Janos, Chihuahua, Mexico	17-Jan-08	12R	741308	3412776	unbanded
Janos, Chihuahua, Mexico	17-Jan-08	12R	741308	3412776	unbanded
Janos, Chihuahua, Mexico	17-Jan-08	12R	740333	3412720	unknown
Janos, Chihuahua, Mexico	17-Jan-08	12R	740333	3412720	unknown
Janos, Chihuahua, Mexico	17-Jan-08	12R	740333	3412720	unknown
Janos, Chihuahua, Mexico	18-Jan-08	12R	743237	3407670	unknown
Janos, Chihuahua, Mexico	18-Jan-08	12R	743237	3407670	unknown
Janos, Chihuahua, Mexico	18-Jan-08	12R	743237	3407670	unbanded
Janos, Chihuahua, Mexico	18-Jan-08	12R	743237	3407670	unbanded
Janos, Chihuahua, Mexico	18-Jan-08	12R	743237	3407670	unbanded
Janos, Chihuahua, Mexico	18-Jan-08	12R	743237	3407670	unbanded
Janos, Chihuahua, Mexico	18-Jan-08	12R	743237	3407670	unbanded
Janos, Chihuahua, Mexico	18-Jan-08	12R	743237	3407670	unbanded
Janos, Chihuahua, Mexico	18-Jan-08	12R	743237	3407670	unbanded
Janos, Chihuahua, Mexico	18-Jan-08	12R	743237	3407670	unbanded
Janos, Chihuahua, Mexico	18-Jan-08	12R	743237	3407670	unbanded
Janos, Chihuahua, Mexico	18-Jan-08	12R	743237	3407670	unbanded
Janos, Chihuahua, Mexico	18-Jan-08	12R	743237	3407670	unbanded
Janos, Chihuahua, Mexico	18-Jan-08	12R	743237	3407670	unknown
Janos, Chihuahua, Mexico	18-Jan-08	12R	743237	3407670	unknown
Janos, Chihuahua, Mexico	18-Jan-08	12R	743237	3407670	unbanded
Janos, Chihuahua, Mexico	18-Jan-08	12R	730192	3415026	unknown
Janos, Chihuahua, Mexico	18-Jan-08	12R	730192	3415026	unknown
Janos, Chihuahua, Mexico	18-Jan-08	12R	730192	3415026	unknown
Janos, Chihuahua, Mexico	18-Jan-08	12R	730192	3415026	unknown
Janos, Chihuahua, Mexico	18-Jan-08	12R	730192	3415026	unknown

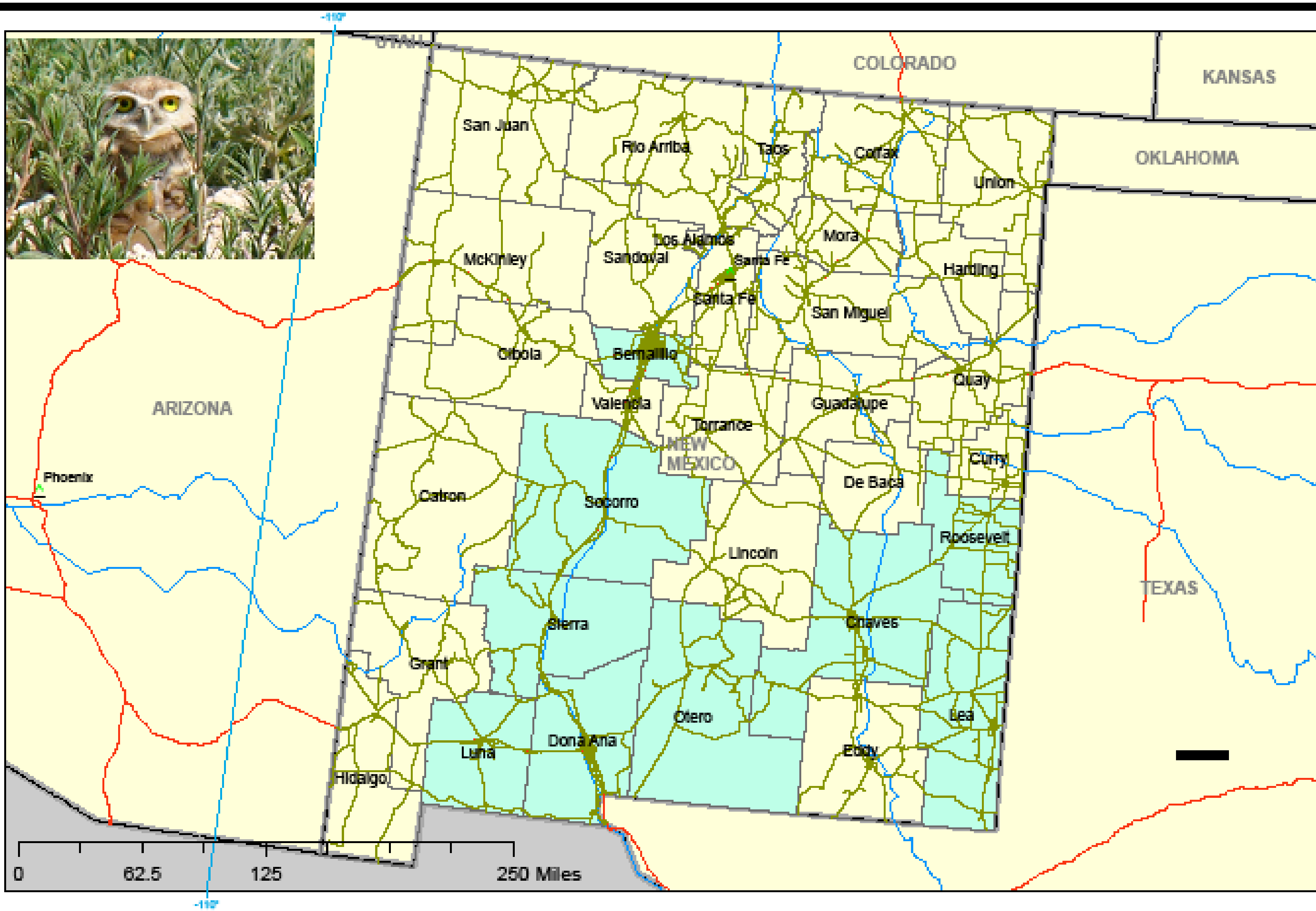
Location	Date	UTM	Easting	Northing	Bands
Janos, Chihuahua, Mexico	18-Jan-08	12R	730192	3415026	unknown
Janos, Chihuahua, Mexico	18-Jan-08	12R	730192	3415026	unknown
Janos, Chihuahua, Mexico	18-Jan-08	12R	730192	3415026	unknown
Janos, Chihuahua, Mexico	18-Jan-08	12R	730192	3415026	unknown
Janos, Chihuahua, Mexico	18-Jan-08	12R	730192	3415026	unknown
Janos, Chihuahua, Mexico	18-Jan-08	12R	730192	3415026	unknown
Janos, Chihuahua, Mexico	18-Jan-08	12R	730192	3415026	unknown
Janos, Chihuahua, Mexico	18-Jan-08	12R	730192	3415026	unknown
Janos, Chihuahua, Mexico	18-Jan-08	12R	744361	3404969	unknown
Janos, Chihuahua, Mexico	18-Jan-08	12R	744361	3404969	unknown
Janos, Chihuahua, Mexico	19-Jan-08	12R	746644	3405731	unknown
Janos, Chihuahua, Mexico	19-Jan-08	12R	755598	3399611	unbanded
Janos, Chihuahua, Mexico	19-Jan-08	12R	755598	3399611	unbanded
Janos, Chihuahua, Mexico	19-Jan-08	12R	755598	3399611	unbanded
Janos, Chihuahua, Mexico	20-Jan-08	12R	721470	3420945	unbanded
Janos, Chihuahua, Mexico	20-Jan-08	12R	721470	3420945	unbanded
Janos, Chihuahua, Mexico	20-Jan-08	12R	721470	3420945	unbanded
Janos, Chihuahua, Mexico	20-Jan-08	12R	721470	3420945	unknown
Janos, Chihuahua, Mexico	20-Jan-08	12R	721470	3420945	unknown
Janos, Chihuahua, Mexico	20-Jan-08	12R	721470	3420945	unknown
Janos, Chihuahua, Mexico	20-Jan-08	12R	721470	3420945	unknown
Janos, Chihuahua, Mexico	20-Jan-08	12R	721470	3420945	unknown
Janos, Chihuahua, Mexico	20-Jan-08	12R	743145	3417144	unbanded
Janos, Chihuahua, Mexico	21-Jan-08	12R	741508	3415604	unknown
Southeast New Mexico	23-Jan-08	13S	334288	3572826	unbanded
Southeast New Mexico	23-Jan-08	13S	336339	3572055	unbanded
Southeast New Mexico	23-Jan-08	13S	336339	3572055	unbanded
Southeast New Mexico	26-Jan-08	13S	652298	3619000	unbanded
Southeast New Mexico	19-Feb-08	13S	674001	3772986	unbanded
Southeast New Mexico	19-Feb-08	13S	674001	3772986	unbanded
Southeast New Mexico	20-Feb-08	13S	620759	3711321	unbanded
Southeast New Mexico	20-Feb-08	13S	606068	3709397	unbanded
Southeast New Mexico	20-Feb-08	13S	606068	3709397	unbanded
Southeast New Mexico	20-Feb-08	13S	606068	3709397	unbanded
Southeast New Mexico	20-Feb-08	13S	606068	3709397	unknown
Southeast New Mexico	20-Feb-08	13S	606068	3709397	unknown
Southeast New Mexico	20-Feb-08	13S	606068	3709397	unknown
South Texas	2-Feb-08	14R	645055	3089643	unbanded
South Texas	2-Feb-08	14R	642932	3092984	unbanded
South Texas	2-Feb-08	14R	632125	3102536	unbanded
South Texas	2-Feb-08	14R	629660	3097737	unbanded
South Texas	3-Feb-08	14R	620834	3082228	unbanded
South Texas	3-Feb-08	14R	609069	3075801	unbanded
South Texas	3-Feb-08	14R	607584	3077528	unbanded
South Texas	3-Feb-08	14R	611428	3058487	unbanded
South Texas	3-Feb-08	14R	616041	3057085	unbanded
South Texas	3-Feb-08	14R	616041	3057085	unbanded

Location	Date	UTM	Easting	Northing	Bands
South Texas	3-Feb-08	14R	638637	3061472	unbanded
South Texas	4-Feb-08	14R	644728	3055229	unbanded
South Texas	4-Feb-08	14R	642783	3056542	unbanded
South Texas	5-Feb-08	14R	669576	3097082	unbanded
South Texas	5-Feb-08	14R	669389	3104734	unbanded
South Texas	5-Feb-08	14R	671869	3115891	unbanded
South Texas	7-Feb-08	14R	651791	3093709	unbanded
South Texas	7-Feb-08	14R	651797	3094459	unbanded
South Texas	7-Feb-08	14R	651036	3096138	unbanded
South Texas	7-Feb-08	14R	6548415	3096165	unbanded
Ladder Ranch, New Mexico	12-Feb-08	13S	269732	3653699	unbanded
Ladder Ranch, New Mexico	12-Feb-08	13S	269732	3653699	unbanded
Ladder Ranch, New Mexico	12-Feb-08	13S	269732	3653699	unbanded
Ladder Ranch, New Mexico	12-Feb-08	13S	272373	3651353	unbanded
Ladder Ranch, New Mexico	12-Feb-08	13S	272373	3651353	unknown
Ladder Ranch, New Mexico	12-Feb-08	13S	269899	3651903	unbanded
Ladder Ranch, New Mexico	12-Feb-08	13S	269899	3651903	unbanded
Ladder Ranch, New Mexico	12-Feb-08	13S	269899	3651903	unknown
Ladder Ranch, New Mexico	12-Feb-08	13S	267924	3652840	unbanded
Ladder Ranch, New Mexico	12-Feb-08	13S	267821	3652812	unbanded
Ladder Ranch, New Mexico	12-Feb-08	13S	267506	3652747	unbanded
Ladder Ranch, New Mexico	12-Feb-08	13S	267429	3652799	unbanded
Ladder Ranch, New Mexico	12-Feb-08	13S	267714	3653436	unbanded
Armendaris Ranch, New Mexico	13-Feb-08	13S	313404	3688200	unknown
Armendaris Ranch, New Mexico	13-Feb-08	13S	308833	3709780	unknown
Armendaris Ranch, New Mexico	13-Feb-08	13S	311218	3696719	unbanded
Armendaris Ranch, New Mexico	13-Feb-08	13S	311218	3696719	unknown
Armendaris Ranch, New Mexico	14-Feb-08	13S	309745	3703043	unbanded
Armendaris Ranch, New Mexico	14-Feb-08	13S	309745	3703043	unknown
Armendaris Ranch, New Mexico	14-Feb-08	13S	309728	3702340	unbanded
Armendaris Ranch, New Mexico	14-Feb-08	13S	315140	3696142	unbanded

Appendix F. Public land locations of Black-tailed prairie dog colonies in southern New Mexico (provided by Natural Heritage New Mexico)



Public Lands Black Tail Prairie Dog Towns

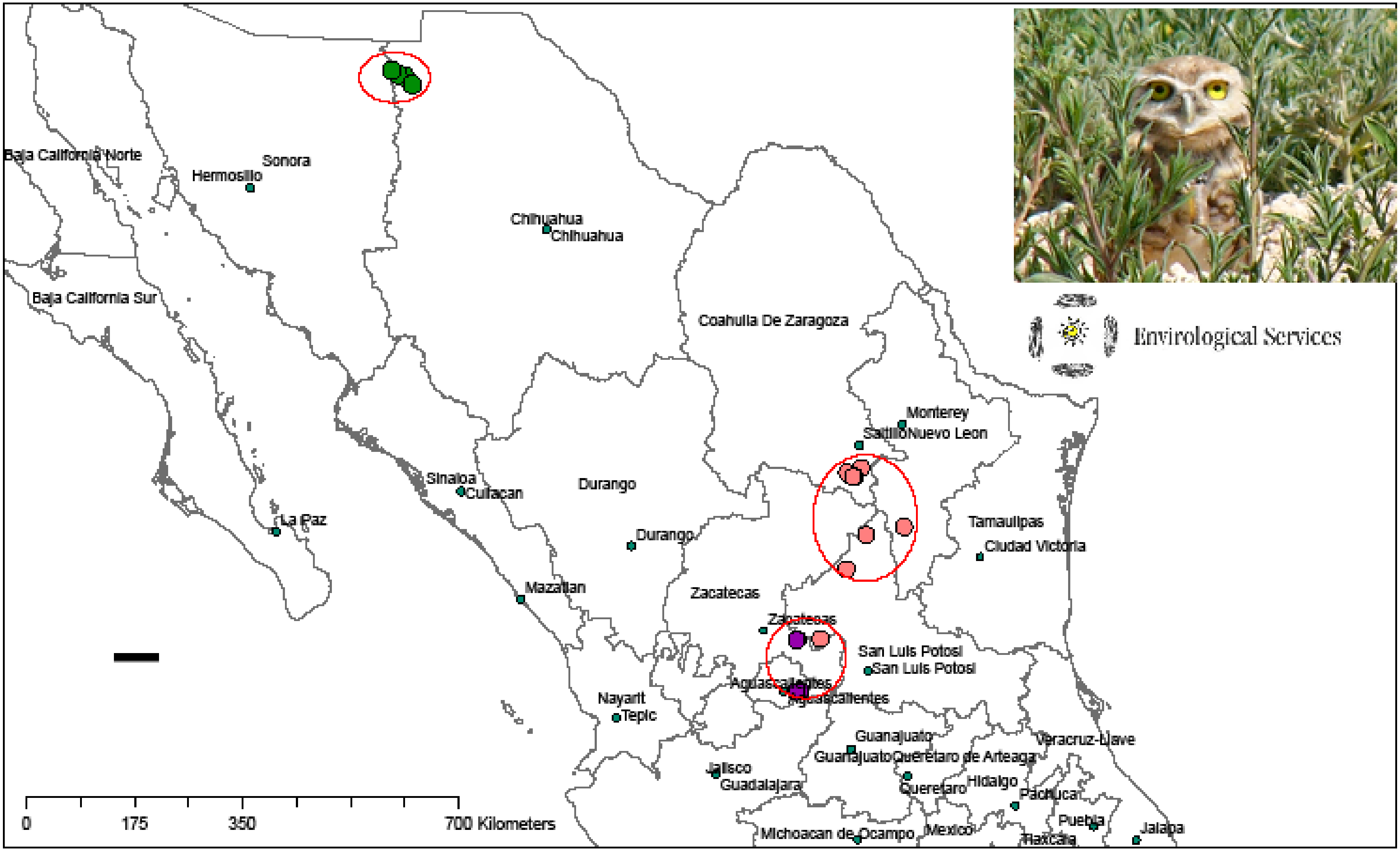


Appendix G. New Mexico counties where winter owl surveys were conducted in 2007 / 2008

Envirological Services

Appendix H. Texas counties where winter owl surveys were conducted in 2008

Envirological Services



Appendix I: Mexico areas where winter owl surveys were conducted in 2007/2008

Appendix J. Summary of DoD Legacy products from 2005 to 2008

Table 1. Number of Burrowing Owls banded, amount of feather samples taken, and the amount of blood samples taken from 2005 to 2008 on Kirtland Air Force Base (KAFB), Holloman Air Force Base (HAFB), Fort Bliss Army Base (FBAB), and Cannon Air Force Base (CAFB), New Mexico.

		KAFB	HAFB	FBAB	CAFB	TOTAL
2005	Banded	80	2			82
	Feather Samples	78	2			80
	Blood Samples	0	0			0
2006	Banded	79	8	2		89
	Feather Samples	79	8	2		89
	Blood Samples	0	0	0		0
2007	Banded	75	16	12		103
	Feather Samples	74	16	12		102
	Blood Samples	22	6	3		31
2008	Banded	80	19	2	6	107
	Feather Samples	74	19	2	6	101
	Blood Samples	40	11	2	5	58
TOTAL	Banded	314	45	16	6	**381**
	Feather Samples	305	45	16	6	**372**
	Blood Samples	62	17	5	5	**89**

Table 2. Number of radio transmitters attached to Burrowing Owls from 2006 through 2008 on Kirtland Air Force Base, New Mexico.

Year	Number of Transmitters
2006	28
2007	30
2008	60
TOTAL	118

Surveys to locate Burrowing Owls on their wintering grounds have been conducted from 2005 through 2008. Although many owls have been located on their wintering grounds, no owls with telemetry units have been located thus far.

During 2005, ground surveys were conducted in the Mexican states of Aguascalientes, Chihuahua, Coahuila, Durango, Estado de Mexico, Guadalajara, Guanajuato, Jalisco, Nayarit, Nuevo Leon, Oaxaca, Puebla, San Luis Potosi, Sinaloa, Sonora, Tlaxcala, Veracruz, and Zacatecas.

During 2006, radio telemetry units were deployed and aerial and ground surveys were conducted in the Mexican states of Aguascalientes, Chihuahua, Coahuila, Durango, Estado de Mexico, Guanajuato, Hidalgo, Jalisco, Queretaro, San Luis Potosi, and Zacatecas.

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During 2007 radio telemetry units were again deployed and ground surveys were conduced in the Mexican states of Aguascalientes, Chihuahua, Coahuila, San Luis Potosi, and Zacatecas. Surveys were also conducted in New Mexico and Texas.

During 2008, radio telemetry units were deployed, and aerial and ground surveys during the winter of 2008 / 2009 will be conducted during December, January, and February in Mexico and New Mexico.