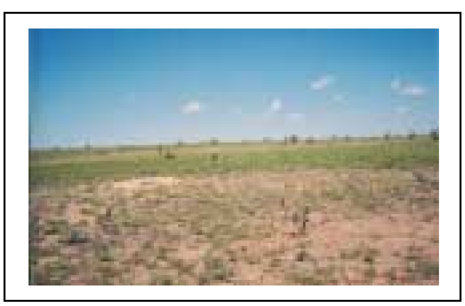
# Field Verification of Black-tailed Prairie Dog Remote Sensing Survey in New Mexico

## FINAL REPORT

Black-tailed Prairie Dogs



Ant Mounds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# Introduction

In 2002, Natural Heritage New Mexico surveyed for black-tailed prairie dog (BTPD, *Cynomys ludovicianus*) disturbance using digital orthophoto quadrangles (DOQs, Johnson et al. 2003). We surveyed 44,325,794 ac (17,938,403 ha), 99.9% of the species' estimated historical New Mexico range. That survey detected probable prairie dog disturbance in 16 of the 23 New Mexico counties in the historical range. We found 867 possible sites, covering 77,906 ac (31,528 ha). Of these we identified 60,294 ac (24,400 ha) as probable towns and 17,612 ac (7127 ha) as questionable towns. We found two complexes of over 5,000 ac (2023 ha). The largest towns, the largest number of towns, and the most acreage occurred in Roosevelt and Lea Counties (Johnson et al. 2003).

Although preliminary work had suggested that this method held promise, ours was the first effort to use DOQs to survey extensive areas for BTPDs, hence the accuracy of the method was unknown. The number 60,294 is subject to several potential sources of error. The DOQ images were taken primarily in 1996 and 1997, but the DOQ survey was completed in 2002. Changes that occurred in the intervening years would not have been detected by this method. The photographic quality of the imagery was somewhat variable, and prairie dog disturbance can sometimes be confused with other types of ground disturbance (Johnson et al. 2003).

To refine the results of the 2002 survey, in 2003 we field checked a subset of towns identified in the DOQ survey. The field verification data assisted in estimating the area of BTPD disturbance at the time of the DOQs and obtaining an estimate of acres of active towns in 2003. We were able to assess the accuracy of the method and understand reasons for errors in identifying towns. We also compared accuracy rates in several areas of the state. Here we report the results of the field verification and analyses of those data. Together, the DOQ survey (Johnson et al. 2003) and the current report provide an analysis of the usefulness of the DOQ survey method and an estimate of the number of acres of currently active BTPD towns in New Mexico.

# Methods

### *DOQ surveys*

The mounds created by prairie dogs at burrow entrances show up as bright, roughly-circular spots on DOQs. The burrows are typically clumped spatially and are often surrounded by a lighter halo on the image, indicative of vegetation cropped by the prairie dogs. We searched the imagery for this characteristic spot and halo pattern. When we identified a potential town, we extracted that portion of the DOQ to a new image and made a polygon shapefile of the town boundary using ERDAS Imagine software. Whenever possible, the town polygon was generated by outlining the clipped-vegetation halo surrounding the mounds. If no clip line was evident, the polygon connected the outermost mounds.

We assigned the same unique site identification number, beginning with the interpreter's initial, to the extracted image and the site polygon. We used the ArcView extension XTools (DeLaune 2001) to generate the area (acres and hectares) for each polygon. We employed an ESRI ArcView script to generate the geographic coordinates for the center of each site. After the first interpreter identified a site, a second person reviewed the image and also classified the site. If a site was deemed questionable, the reason was recorded, and the code was added to the shapefile attribute table. For more details on the methodology, see Johnson et al. (2003).

### *Field Checks (Ground-truthing)*

Of the 867 potential sites (Johnson et al. 2003), we selected 132 sites on or partially on public lands to be checked in the field (ground truthed). Surveys were conducted from 14 July 2003 to 16 October 2003. We designated six geographic areas, which grouped towns based primarily on ease of field visitation (Figure 1). Sites that could not be reached by crossing public land or that were on secure localities such as Department of Defense property were not visited. Potential sites had been previously photo-interpreted as being BTPD "towns" or "questionable towns". We downloaded the geographic coordinates for the center of each site to a Garmin 12 Global Positioning System (GPS) navigational unit. These coordinates, in conjunction with maps of the region, facilitated the location of each site on the ground. If no indication of current or previous black-tailed prairie dog activity was found, the surveyor looked for features that might have been confused with mounds on the corresponding DOQ, took a waypoint to confirm visitation, and in some cases took a photograph of the site.

If a BTPD town was discovered, the surveyor determined if it was active or inactive. A town was considered active if BTPDs were sighted and/or heard, or if there was evidence of recent use, such as fresh digging or scat.

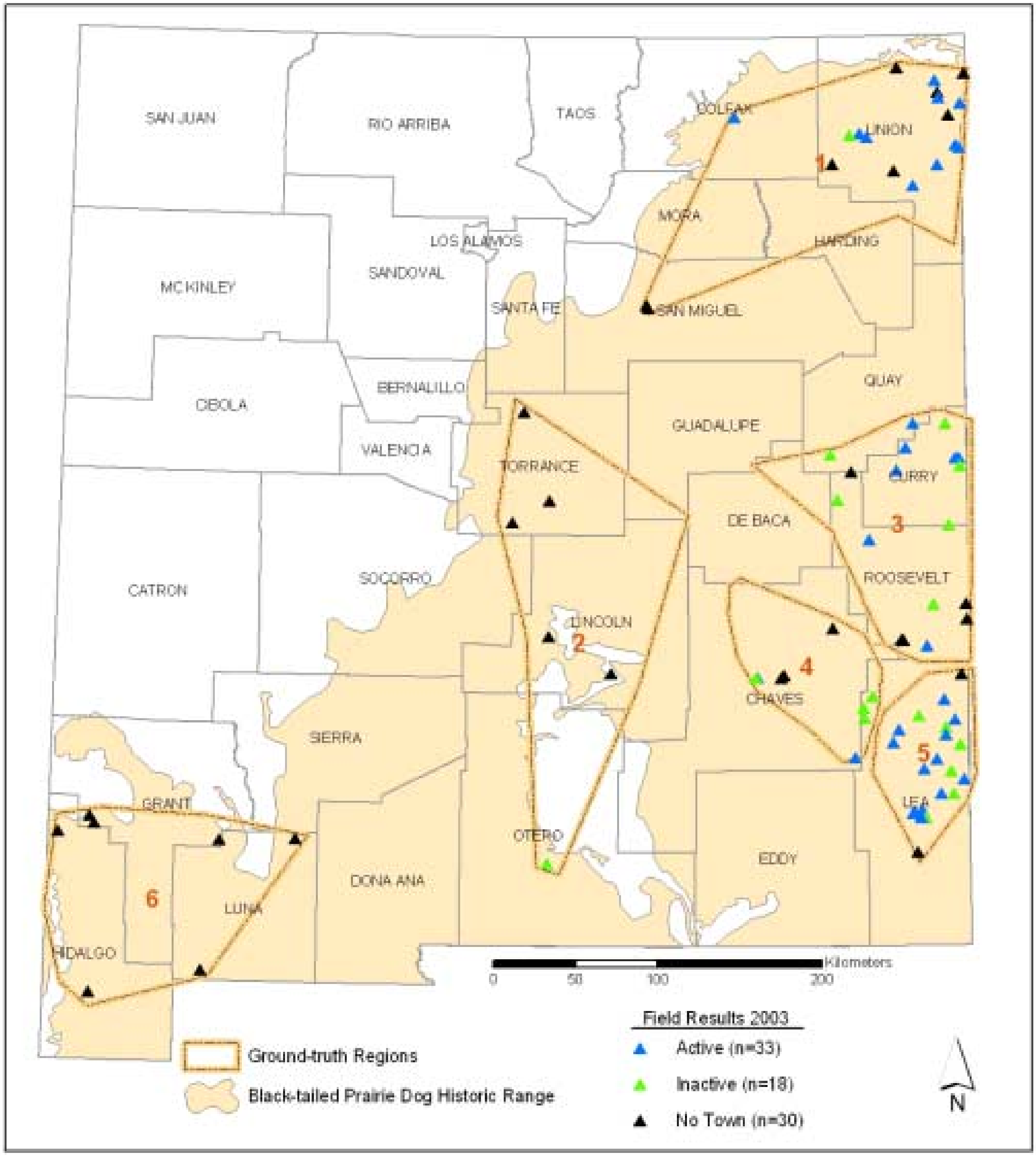


**Figure 1. Ground-truth geographic regions and 2003 field results.**

If an active BTPD town was found entirely on public land, the surveyor walked the perimeter of the town, logging waypoints into the GPS unit. The surveyor logged only the active parts of the town. Thus, mounds on the edge of the site that were caved in or covered with cobwebs, weeds, or trash were not included in the town perimeter. If an active BTPD town was only partially on public land, the surveyor did not log the perimeter. In some cases, to indicate the general size of a partially-accessible town, waypoints approximating the endpoints of the town were recorded from a nearby road.

If a town was an inactive BTPD town, the surveyor took a waypoint for confirmation of the visit only. For both active and inactive BTPD towns, the site was surveyed for the presence of burrowing owls (*Athene cunicularia*) and mountain plovers (*Charadrius montanus*). Vegetation and other wildlife were noted.

### *Analysis*

Waypoints from the ground-truth surveys were brought into ArcGIS and saved as point shapefiles. We determined the current size of active BTPD towns located entirely on public land by making polygon shapefiles from the waypoints logged around the perimeter of the towns and used X-Tools (DeLaune 2001) to determine area. We measured the distance between the geographic center of the photo-interpreted (DOQ) polygon and the polygon created from the ground-truthed active BTPD town.

## Results

Of the 132 sites proposed for field checking, 81 accessible sites were visited. Sites were inaccessible due to road construction, locked gates on the only access road, or private property between the public access and the state land. Based on the imagery, we had previously classified 50 of the 81 sites as towns and 31 as questionable towns (Appendix A). A "correct" determination of a site designated a town means that field checking found an active or inactive town. A "correct" determination of a site deemed "questionable" means that field checking found no town. At the time of the field check, 29 of the 50 were active towns, and 12 were inactive towns. Thus, 41 (82%) of sites identified on the imagery as towns were still identifiable as towns in the field. This provides a maximum false positive rate of 18% (but see Towns Lost and Gained over Time, below). Of 31 sites designated as questionable towns, 21 (67.7%) showed no sign of being towns when field checked, and six (19.4%) were inactive towns. Taking results for towns and questionable towns together, we correctly classified 76.5% of sites.

The surveyor noted burrowing owls at 13 field-checked towns (r209, j404, j429, j174, l014, l074, l075, l078, p029, p079, j216, l097, and l101). Because burrowing owls do not typically occupy inactive prairie dog towns for long (Desmond et al. 2000), we used only the estimated number of active BTPD towns to estimate the number of towns occupied by owls. Field checking showed 58% of sites interpreted as towns to be active; thus, an estimated 374 of the 644 interpreted towns were active. Thirteen of 29 active field-checked towns (45%) were occupied by owls, which provides an estimate of 168 active prairie dog towns occupied by burrowing owls. This number does not include any new towns established between the time the DOQs were made and the time of the field checking, nor does it include any towns we may have missed on the imagery. No mountain plovers were detected, but this is not surprising, given that surveys occurred after the mountain plover breeding season.

### *Results by Area of the State*

We field checked 19 towns from Area 1, in northeastern New Mexico (Figure 1). Eleven (73.3%) of the 15 sites designated as towns turned out to be towns, and none of the four (100%) designated as questionable were proven to be towns. Taking both types in Area 1 together, we correctly identified 78.9% of the 19 possible towns on the imagery (Table 1).

In Area 2, in central New Mexico near Mountainair, the only field-checked site designated as a town did not prove to be a town. Four (80%) of five sites designated as questionable were not towns, and one was an inactive town, giving a 66.7% success rate for both town types in Area 2 (Table 1).

For Area 3, in mideastern New Mexico near Clovis, interpretation was correct for 12 (80%) of the 15 field-checked sites designated as towns and two (66.7%) of the three sites designated as questionable, giving an overall success rate of 77.8% in Area 3 (Table 1).

For Area 4, in southeastern New Mexico near Roswell, only two field-checked sites were designated as towns, both correctly (100%). Of the seven checked sites designated as questionable, only three (42.8%) were not actually active or inactive towns. Taken together, these results yield a success rate of 55.6% for Area 4 (Table 1).

For Area 5, in southeastern New Mexico, designations were correct for 16 (94%) of the 17 field-checked sites designated as towns, and one (20%) of five sites designated as questionable (Table 1). The overall rate for Area 5 was 77.3%. Finally, in Area 6, in southwestern New Mexico near Lordsburg, all seven field-checked sites were designated as questionable, and all interpretations were correct (100%, Table 1).

Comparing the six areas, we had similar success rates in Areas 1, 3, and 5 (78.9, 77.8, and 77.3 percent, respectively), while we designated fewer towns correctly in Areas 2 and 4 (66.7 and 55.6 percent, respectively, Table 1). Sample sizes were considerably smaller in Areas 2 and 4 (6, 9) than in Areas 1, 3, and 5 (19, 18, and 22). In these areas, a single error would more strongly affect the accuracy rate than in areas with more towns. Since BTPDs were known to no longer occur in southwestern New Mexico, there was little or no chance of a false negative for sites found in Area 6; thus, our 100% success rate in that area likely overestimated our ability to distinguish towns.

Sample sizes for the field checking were determined largely by the number of sites and towns present in each area, and not the availability of sites for field checking; i.e., their location on public land (Table 1). There was no apparent relationship between land ownership and error rates in identifying towns (Table 1).

Differential habitat availability may explain the variation among the field checking areas in the number of BTPD towns. We looked at habitat types from the New Mexico GAP map (Thompson et al. 1996) in each of the six field checking areas. Using ArcGIS, we computed the percent of each of the six field checking areas covered in any of five grassland habitat types (Table 2): Shortgrass Steppe (blue and hairy grama), Mid-grass Prairie (sideoats grama, little bluestem, and New Mexico needlegrass), Chihuahuan Desert Grassland (black grama, dropseed, and tobosa), Chihuahuan Foothill-Piedmont Desert Grassland (black grama, dropseed) and Chihuahuan Lowland/Swale Desert

Grassland (tobosa). Eliminating Area 6 (see above), the two areas in which we found fewer towns and had larger error rates (2 and 4) also had smaller percentages of the grassland habitat types preferred by BTPD (Table 1). Thus, it appears that error rates were higher in areas with 1. lesser amounts of grassland habitats, 2. fewer towns and lower town densities, and 3. fewer towns field checked (Table 1).

**Table 1. Comparisons among field checking areas.**

| Field Check Area | Number of Towns | Number of Sites | Number of Field Checked Sites | % Correct | % Private Land | % Grassland Habitat |
|---|---|---|---|---|---|---|
| **1** | 102 | 116 | 19 | 78.9 | 99.6 | 77.3 |
| **2** | 4 | 58 | 6 | 66.7 | 98.2 | 43.6 |
| **3** | 310 | 346 | 18 | 77.8 | 97.4 | 60.8 |
| **4** | 19 | 30 | 9 | 55.6 | 95.6 | 46.6 |
| **5** | 141 | 174 | 22 | 77.3 | 89.4 | 72.1 |
| **6** | 1 | 20 | 7 | 100 | 71.2 | 38.5 |

**Table 2. Grassland habitat by field check area.**

| GAP Vegetation Mapping Unit | Area 1 (%) | Area 2 (%) | Area 3 (%) | Area 4 (%) | Area 5 (%) | Area 6 (%) |
|---|---|---|---|---|---|---|
| Short Grass Steppe (Blue and Hairy Grama Grass) | 29.6 | 32.2 | 36.0 | 30.8 | 66.0 | 5.2 |
| Mid-Grass Prairie (Sideoats Grama, Little Bluestem, and New Mexico Needlegrass) | 47.7 | 6.0 | 24.6 | 0.8 | 4.6 | 1.7 |
| Chihuahuan Desert Grassland (Black Grama, Dropseed, and Tobosa) | 0.0 | 0.0 | 0.1 | 12.2 | 1.5 | 0.0 |
| Chihuahuan Foothill-Piedmont Desert Grassland (Black Grama and Dropseed) | 0.0 | 5.3 | 0.1 | 2.8 | 0.0 | 28.6 |
| Chihuahuan Lowland/Swale Desert Grassland (Tobosa) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 3.0 |
| | | | | | | |
| *Percent of total area in grassland habitat* | 77.3 | 43.6 | 60.8 | 46.6 | 72.1 | 38.5 |

### *Towns Lost and Towns Gained over Time*

Prairie dog towns that were evident on the 1996-97 DOQs but disappeared by 2003 would appear to be false positives, when in fact the designations were correct, but the towns were lost. In two cases we have corroboration of our DOQ designations for towns that were later lost. One 27 ac (10.9 ha) site in the Clayton area appeared not to be a town on field checking but was confirmed by Sager (1996) to be a town. Another 23.6 ac (9.6 ha) site in the Clovis area was found by Paternoster (1997) to be a town but was not detectable in our field checks. These examples suggest that our actual false positive rate is somewhat lower than that indicated above.

Our data do not allow us to estimate numbers of new towns. A 100% ground survey of a selected area could provide an estimate of new activity, but such a survey would be costly and time consuming and was not part of this effort. The usefulness of ground surveys for new towns would depend on how well the sampled area represented the entire survey area.

### *Size and Location Changes over Time*

Of the 33 active BTPD towns, we collected GPS perimeter data on 18 sites located entirely on public land. We included only active sections of towns in the field data. Thirteen of the 18 towns were smaller when measured on the ground. The mean difference between the acreage of ground-measured towns and the acreage of DOQs of the same towns was –31.2 ac (-12.6 ha, n=18, sd=673.7, range= -223.1-51.7). Towns that were larger on the ground than in the photos were larger on average by 29.8 ac (12.1 ha, n=5, sd=20.0, range=1.4-51.7). The mean difference for towns that were smaller on the ground than in the DOQs was –54.6 ac (-22.1 ha, n=13, sd=57.4, range= -223.1-0.3). The total acreage lost in the 13 smaller towns was 710.3 ac (287.5 ha), and the total gained in the larger towns was 147.56 ac (59.7 ha). Thus, losses exceeded gains on average and in total. However, some losses may have occurred because inactive sections were excluded from the field analysis (see Discussion, below).

The center coordinates of the surveyed towns differed from the polygons drawn from DOQs, indicating that towns moved in the six or seven years between the photography and the field checking (mean=269.2 m, n=18, sd=124.9, range=31.5-532.3 m).

### *Reasons for Errors*

Of the 81 ground-truthed sites, predictions for 19 (23.5%) sites proved erroneous, either as false negatives (i.e., questionable designation, when the site was either an active or inactive BTPD town), or as false positives (i.e., town designation, when the site was not). The most common cause of false positives was atypical appearance of the dots that indicate mounds. Investigators sometimes interpreted indistinct, small, or variably-sized dots as mounds, when in fact they were created by other types of disturbance. In three cases, these dots were shown to be ant mounds on field checking (Figure 2, J376). False negative interpretations occurred because of misinterpreted dots and because of deceptive landscape or vegetation features.

We looked at the effect of town size on errors in DOQ interpretation. Active or inactive BTPD town sites that were correctly identified by interpreters were larger than those BTPD towns incorrectly interpreted, but not significantly so (mean correct towns=188.9, mean false positive=83.1, n=41, 9, t=1.57, p=0.12). Questionable towns correctly interpreted were significantly larger than questionable towns incorrectly interpreted (mean correct questionable=86.2, mean false negative=38.0, n=21, 10, t=2.25, p=0.033). Combining sites designated as towns with those designated as questionable towns, correctly interpreted sites were significantly larger than incorrectly interpreted sites (mean correct=154.2, mean incorrect=59.4, n=62, 19, t=2.28, p=0.032).

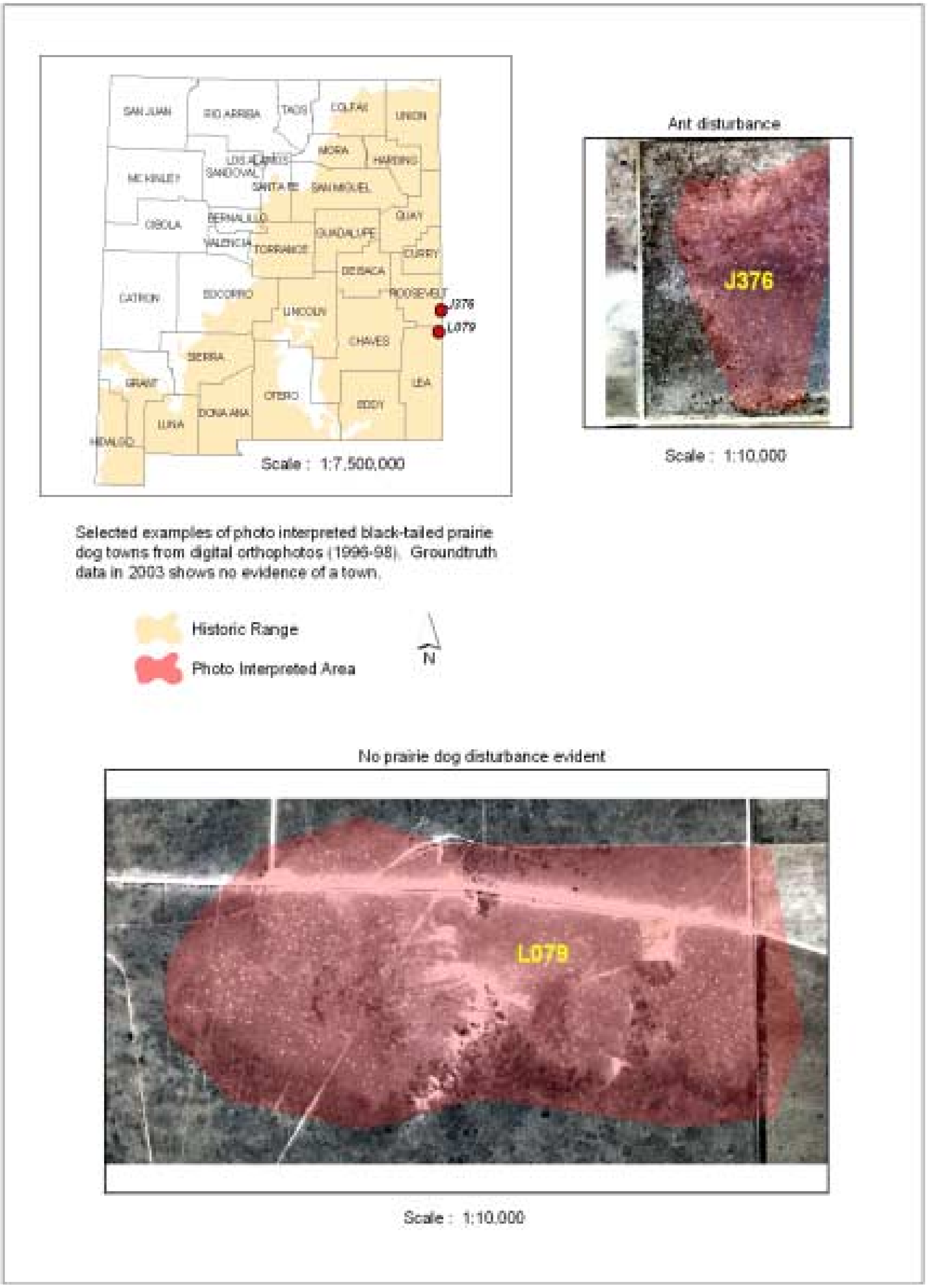


**Figure 2. Photo interpretation with negative field results.**

With the Area 6 sites removed from the towns comparison, results are the same as above (because no Area 6 sites were designated as towns). Removing Area 6 sites from the questionable analysis provides similar results as above (mean correct=109.8, mean incorrect=38.0, n=14, 10, t=2.491, p=0.025).

Town size should affect variation in error rates among the six areas. Mean town size was smaller in Areas 3 (56.4 ac, 22.8 ha) and 4 (88.7 ac, 35.9 ha) than in Areas 1, 2, and 5 (141.9, 123.5, and 234.6 ac; 57.4, 50, 94.9 ha, respectively). However, success rates were lowest in Areas 2 and 4. Thus, although town size may have had some effect on accuracy, the sample size of towns in an area probably had a greater effect on the observed variation in accuracy among areas.

Mean acreage for sites containing ant mounds was 77.6 ac (31.4 ha, n=9, sd=88.697). We found no striking pattern of interpreter error, either by individual or interpreter experience, although the largest error rate was turned in by the interpreter who performed the largest share of the photo-interpretation.

### *Estimates of Actual Acreage*

The field checking data allow us to refine the estimates of acreage that resulted from the imagery analysis. First, we account for discrepancies between the imagery and field checking results. The imagery analysis identified 60,294 ac of probable prairie dog towns (Johnson et al. 2003). Analysis of the field checking acreage (as opposed to sites, above) shows that 72.6% of acreage designated as towns was actually town acreage in 2003. We can apply that percentage to the acreage from the imagery, to estimate how many acres of prairie dog towns were present in 1996-97. If 72.6% of the 60,294 town acres were actually town acres, we estimate 43,773 ac (17,715 ha) in actual prairie dog towns. We identified 17, 612 ac of questionable towns. Given that 3.5% of field-checked questionable acreage was actually town acreage, we add another 616 acres, giving an estimate of 44,389 ac (17,964 ha) of prairie dog towns at the time of the imagery in 1996-97. Because we probably completely missed a few small towns, we round this estimate to somewhat over 45,000 ac (18,211 ha) of prairie dog towns at the time of the imagery.

To estimate the number of acres active in 2003, we adjust the town acres estimate to eliminate inactive town acres. Adjusting the 60,294 to account for the 62.4% of town acres that were active on field checking yields 37,623 ac (15,226 ha). Next we adjust for the percent of questionable acres found to be active on field checking. Adding 6.8% (percent of active town acres in 2003) of the 17,612 questionable acres (1,198) yields 38,821 ac (15,711ha) active in 2003. Accounting for a few small towns that were undoubtedly missed on the imagery, we round the 38,821 to provide and estimated 40,000 ac (16,188 ha) active in 2003. This does not include the number of acres of new towns that might have arisen between the time of the imagery and the time of the field check (see Discussion).

It would also be useful to account for towns that increased or decreased in area. Five field-checked towns increased by a mean of 29.8 ac (range 1-52; % range 5.6%-378%) from 1996-97 to 2003, and 13 towns decreased in area by a mean of 54.6 ac (range 27-223; % range -0.9% to -95.9%) in the same period. However, in the field a clip line (the edge of a vegetative area clipped by prairie dogs) was not evident surrounding inactive areas of towns, and it was difficult to delineate inactive areas using inactive burrows. Therefore, we collected GPS perimeter data only on active areas of towns. Thus, some apparent size reductions may be attributable to differences in the method for delineating town perimeters on imagery versus in the field (but see Discussion, below).

# Discussion

### *Errors in Photo Interpretation*

The field checks revealed that the DOQ method correctly identified 82% of prairie dog towns. Of towns designated as questionable, 67.7% were shown not to be towns. The overall success rate at identifying both types of sites was 76.5%. Success rates varied among areas of the state. Average town size was larger for correctly designated towns than for incorrectly designated towns, suggesting that town size affected error rate. However, differences in error rate between areas of the state appeared to be more clearly related to sample size than to town size.

The total number of towns detected also varied among the six areas. Our highest error rates occurred in the two areas (Areas 2 and 4) with the fewest towns and the smallest sample sizes of field-checked towns. Prairie dog control in the past may have been more effective in these areas, in which case ownership might be expected to correlate with number of towns; however, there was no apparent relationship between ownership and number of towns in a field-check area. Alternatively, the habitat in Areas 2 and 4 may have been less suitable than in Areas 1, 3, and 5. All BTPD towns in this study were found in grassland habitats. Resolution of available habitat maps of New Mexico such as the GAP map (Thompson et al. 1996) is not fine enough to allow analysis of habitat at the scale of individual towns, but we were able to analyze habitat in the six field-checking areas. The number of towns in an area was apparently related to the availability of the grassland habitats favored by the BTPDs (Table 1).

It is possible that all towns were found in grassland habitat because towns were more detectable in those habitats, and not because prairie dogs prefer grassland habitats. However, we think this is unlikely because 1. black-tailed prairie dogs have strong preferences for open grassland habitats (Hubbard and Schmitt 1984), 2. Gunnison's prairie dog disturbance, which is less obvious on DOQs than black-tailed prairie dog disturbance, is detectable in shrub and other habitat types (Johnson et al. 2004), and 3. if black-tailed prairie dogs occur in other habitat types, at least some towns should be apparent in those habitat types, but we found none in habitat types other than grasslands.

Aside from town size and number, error rates depended on the difficulty detecting BTPD disturbance on the imagery. The main factors that resulted in errors were clarity/quality of imagery (color images were less clear than black-and-white images, and quality varied between file format types; i.e., Mr. Sid compression files were less clear than Tiff files); confusion with ant mounds; presence of vegetation and other confusing landscape features; and presence of other ground disturbance that resembled haloing, for example, extensive cattle grazing.

Several individuals performed photo interpretation for this project. Error rates (false positives plus false negatives detected in quality checking of photo interpretation) varied among individual researchers: 3.22%, 2.38%, 1.38%, and 0.73%. Based on reexamination of DOQs of selected sites for which we now have field-checking data, we believe our error rates would be lower in future surveys. Some disturbance areas adjacent to colonies were classified as BTPD disturbance, when in retrospect they were probably caused by cattle or human activities. For example, Figure 3, town j429 (lower right of photo) shows bare areas originally interpreted on the imagery as part of the town, but more likely caused by other disturbance. Similar interpretation at the town level could have resulted in false positives. Hindsight suggests that regular spacing of mounds, as opposed to clumping, combined with atypical haloing patterns, indicate ant, not BTPD activity (Figure 2, J376). On at least one image surveyed early on, we identified a vegetated playa with bare areas as a BTPD town (Figure 4). With more experience, we would have distinguished these large, closely-spaced dots from the smaller, more dispersed prairie dog mounds.

### *Field Checking Error*

We know that some towns moved between the time of the imagery and the field checking. Although some town movement was slight, leaving considerable overlap between the imagery and the field polygons (Figure 3), others apparently moved large enough distances that they might not have been apparent from the old town site (Figure 3, L028). This occurred with four (J241, L014, L028, R204) of the 18 sites delineated on field checking (22%); hence, it may represent a significant source of error. Only the latter two towns (above) showed no overlap between the DOQ polygon and the field polygon.

It would be interesting to compare town shapes and sizes on the ground with those from DOQs taken in the same year. Only Paternoster (1997) provided town areas, and he did not provide perimeter polygons. Unfortunately, the corresponding DOQs are all from 2000-2002, three to five years after Paternoster's survey. A comparison of Paternoster's (1997) towns found on the 2000-2002 DOQs shows that only three of 28 towns were smaller on the DOQs. On average the towns increased in area by 58.9 ha. This difference could be due to town growth or Paternoster's methods for estimating town area, which were not provided.

Delineating town perimeter was not as straightforward as we expected. Only active areas of towns were easily delineated on the ground. It would be preferable to delineate both active and inactive areas, because activity may change seasonally. In addition to the difficulty in discriminating the clipped area of a town on the ground, horizontal viewing at the surveyor's eye level is limited, whereas photos offer near-nadir and wide area views.

The inherent error encountered with GPS technology is due to sources such as receiver hardware, multipath interference (blocking by surrounding objects), satellite geometry, and GPS satellite constellation status (Garmin 2003). The approximate error using a consumer-grade unit is reported to be approximately 15 m; however, we have found errors typically range from 2-6 m. Thus, GPS error in finding sites can probably be avoided by searching a small area (~15 m radius) around the original center point of a site.

A field observer can identify mounds at approximately 50 m with binoculars and about 30 m with the unaided eye. This, in combination with the average town movement (269.2 m), suggests that we might have missed seeing towns that we field checked. Figure 5 shows a site we interpreted as a town where the field surveyor found no town.

The center of the polygon is approximately 165 m from the road. If the surveyor walked from the road to the center point of the polygon, he would not have detected any mounds, even with binoculars, because the active areas of the town were not in the center of the polygon. We suggest the following transect method for detecting the majority of active and inactive burrows in a colony and for detecting towns that moved no more than the average distance of 269 m.

Upon arrival at a colony site, if no colony activity is apparent, the surveyor should locate the center point of the site identified on the DOQ. From there, walk 250 m in one of the cardinal directions, return to the center point, and repeat until four 250 m transects have been traversed. If BTPD burrows are encountered on any of the transect arms, the method changes to parallel north-south transects 100 m apart (Figure 6, a-d).

The surveyor should walk parallel, north-south transects through the town area. Each transect should continue 100 m past the last burrow detected, then the surveyor should move 100 m east or west and walk a new transect parallel to the first, again continuing 100 m past the last burrow. This pattern should continue until no burrows are encountered on a north-south transect. The surveyor should take waypoints at active and inactive mounds along each transect, to allow later delineation of the active and inactive areas of the colony.

We believe this method would have several advantages over simply searching a small area near the central point of the polygon or trying to delineate the edge of the site. The transect method would have detected 16 of 18 towns for which we have field-checked perimeter data, including towns that moved up to 250 m from the original town. Both inactive and active portions of the town would be delineated. The transect method is more systematic than zig-zag searching for a perimeter that has likely moved, and it is more likely to detect the actual perimeter of the current town.

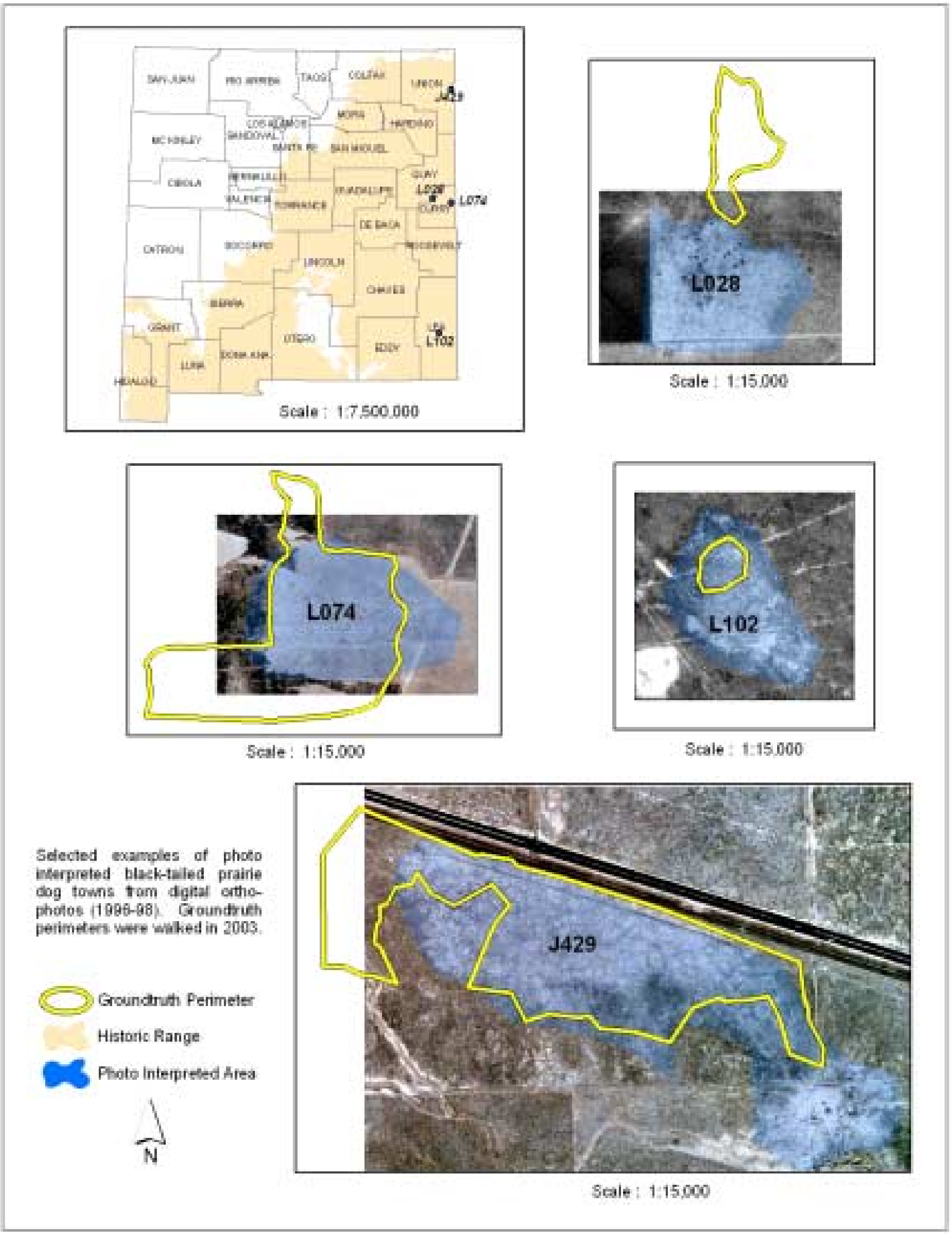


**Figure 3. Prairie dog town movement between 1996-97 and 2003.**


**Figure 4. Disturbance unrelated to prairie dog activity within a playa.**

### *Estimating Prairie Dog Acreage*

One goal of the DOQ survey was an estimate of the number of acres of BTPD towns in New Mexico. Several factors make it impossible to derive an accurate estimate of the area covered by BTPD towns. The most important factor is the temporal availability of imagery. Most of the DOQs used in this survey were six years old (Johnson et al. 2003). On the one hand, prairie dogs have high reproductive rates, allowing rapid town growth. On the other hand, plague can wipe out a BTPD town in several days. This potential for change over time means that any estimate will have inherent error. Additional sources of error in classifying features on the imagery are detailed above (see Errors in Photo Interpretation, above). Given these constraints, we attempted to model current area by making adjustments to acreage estimated from DOQs.

To estimate the number of acres active in 2003, we adjusted the town acreage from the DOQs to account for the percent of town acres that were active on field checking, i.e., we reduced the total according to the false positive rate. We then added acreage, based on the percent of questionable acres active in 2003.

The most serious flaw in this approach is that we have no information on new towns that may have been started between the time of the imagery and the time of the field survey. Only a 100% ground survey of a sample area would give an indication of the rate of new town starts. Even a 100% ground search for new towns might be applicable to a limited area, because the rate of town starts would be expected to vary among field checking areas, as did the number of towns detected and the error rate in finding those towns.

This approach weighs area losses more heavily than area gains, because there is not a reliable method of gauging gains. The only indication of the rate at which acreage is added comes from the 18 towns for which we have perimeter data. Area losses exceeded gains in these towns; however, some of the excess losses may be attributable to differences in the way we delineated towns in the field versus on the imagery. On the imagery, we defined the edge of most towns based on the perimeter of the lighter, haloed area. This area was not apparent on the ground, and we elected to delineate the clearly active area of the town, as defined by the perimeter of active burrows. It is possible, however, that haloing only occurs in the active areas, in which case our photo-interpreted polygons would be comparable to our field delineated polygons.

In conclusion, the remote sensing method for surveying BTPD disturbance has several advantages. Using this method, we surveyed over 44 million ac (17.8 million ha), including large areas of private land, in about a year, for about $68,000. This would be impossible on the ground. The only other available method of conducting such a large-scale search is aerial transects, which are more expensive and do not provide the spatial component available with remote sensing technology (Sidle 1999). The primary disadvantage of the DOQ method is that there are several sources of error, which result in a fairly rough estimate of the current area of BTPD towns. These sources of error, however, would be less important if the method were used for monitoring, as they would apply equally to baseline and subsequent surveys, making it possible to detect relative increases and declines over time.

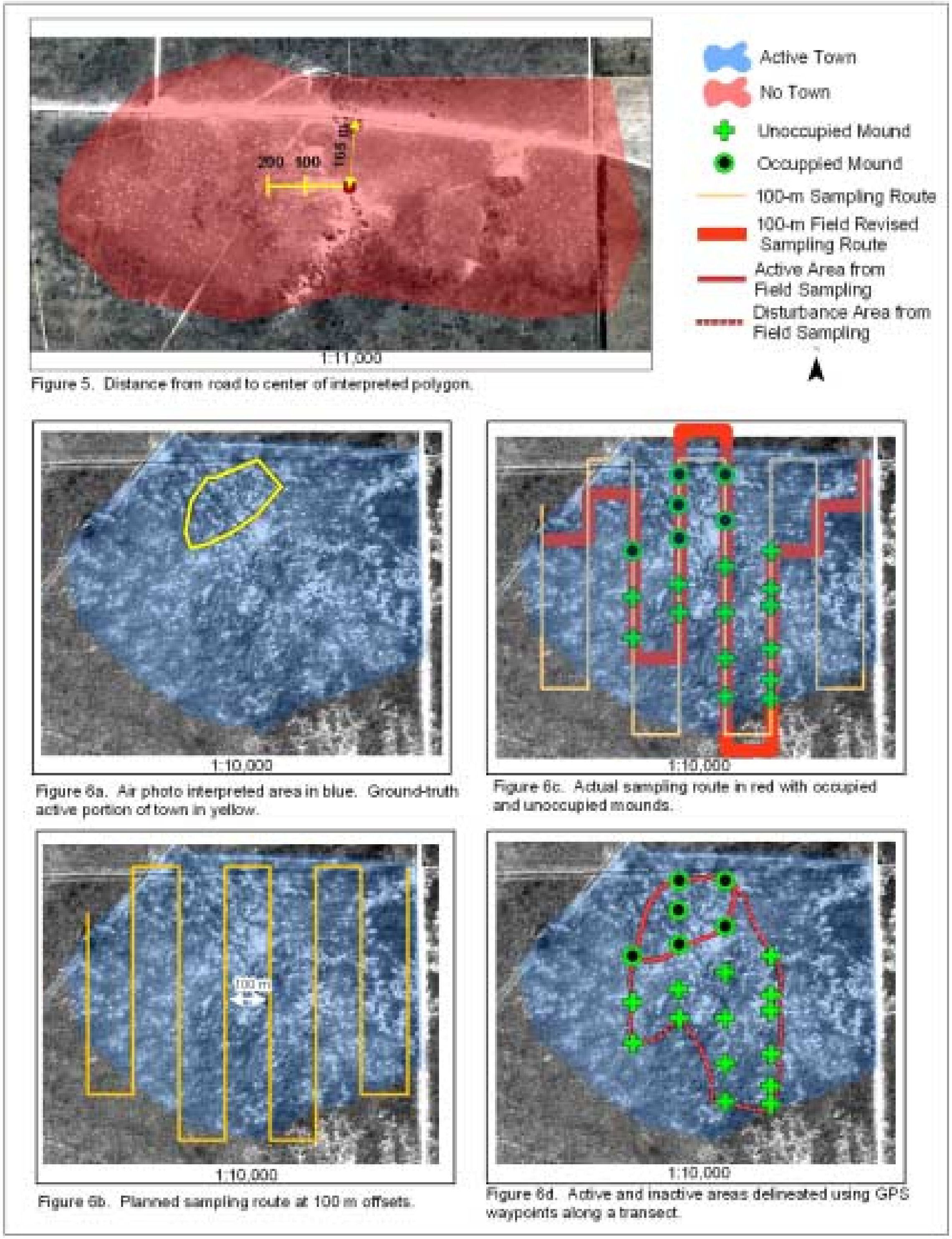


**Figure 5. Field checked colony. Surveyor walking from road to center point could fail to detect burrows.**

**Figure 6. Recommended field checking technique.**

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# Appendix A.

| Geographic Area | County | Site Code | Interpreted Status[1] | Field Check Result[2] | Field Check Date | Field Check Source | Interpreted Area (m2) | Interpreted Perimeter (m) | Interpreted Ac | Interpreted Ha | Ground-truth Area (m2) | Ground-truth Perimeter (m) | Ground-truth Ac | Ground-truth Ha | Ground-truth Method | Ground-truth Result |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Area 1 (Clayton) | UNION | j002 | t | no town | 2003 | NHNM | 63244.4 | 1221.9 | 15.6 | 6.3 | 0.0 | 0.0 | 0.0 | 0.0 | | No Town |
| Area 1 (Clayton) | UNION | j007 | t | | | | 428034.5 | 2761.5 | 105.8 | 42.8 | 0.0 | 0.0 | 0.0 | 0.0 | | Inaccessible |
| Area 1 (Clayton) | UNION | j049 | t | | | | 111379.0 | 1371.9 | 27.5 | 11.1 | 0.0 | 0.0 | 0.0 | 0.0 | | Inaccessible |
| Area 1 (Clayton) | UNION | j054 | t | | | | 36399.0 | 932.6 | 9.0 | 3.6 | 0.0 | 0.0 | 0.0 | 0.0 | | Inaccessible |
| Area 1 (Clayton) | COLFAX | j055 | t | | | | 83365.0 | 1112.6 | 20.6 | 8.3 | 0.0 | 0.0 | 0.0 | 0.0 | | Inaccessible |
| Area 1 (Clayton) | UNION | j069 | t | active | 2003 | NHNM | 201316.6 | 1644.2 | 49.7 | 20.1 | 0.0 | 0.0 | 0.0 | 0.0 | | Active |
| Area 1 (Clayton) | UNION | j071 | t | | | | 505254.0 | 3123.6 | 124.9 | 50.5 | 0.0 | 0.0 | 0.0 | 0.0 | | Inaccessible |
| Area 1 (Clayton) | UNION | j072 | t | no town | 2003 | NHNM | 479187.2 | 2564.2 | 118.4 | 47.9 | 0.0 | 0.0 | 0.0 | 0.0 | | No Town |
| Area 1 (Clayton) | SAN MIGUEL | j252 | q | no town | 2003 | NHNM | 372152.0 | 3283.7 | 92.0 | 37.2 | 0.0 | 0.0 | 0.0 | 0.0 | | No Town |
| Area 1 (Clayton) | SAN MIGUEL | j327 | q | no town | 2003 | NHNM | 558760.0 | 4423.2 | 138.1 | 55.9 | 0.0 | 0.0 | 0.0 | 0.0 | | No Town |
| Area 1 (Clayton) | HARDING | j338 | q | | | | 54034.0 | 914.2 | 13.4 | 5.4 | 0.0 | 0.0 | 0.0 | 0.0 | | Inaccessible |
| Area 1 (Clayton) | UNION | j351 | q | no town | 1996, 2003 | Sager, NHNM | 431270.0 | 3027.3 | 106.6 | 43.1 | 0.0 | 0.0 | 0.0 | 0.0 | | No Town |
| Area 1 (Clayton) | UNION | j367 | t | active | 2003 | NHNM | 393615.5 | 2367.3 | 97.3 | 39.4 | 22507.8 | 606.0 | 5.6 | 2.3 | GPS | Active |
| Area 1 (Clayton) | UNION | j387 | q | no town | 1996, 2003 | Sager, NHNM | 12278.0 | 495.8 | 3.0 | 1.2 | 0.0 | 0.0 | 0.0 | 0.0 | | No Town |
| Area 1 (Clayton) | UNION | j404 | t | active | 2002, 2003 | Cully, NHNM | 615122.0 | 3592.3 | 152.0 | 61.5 | 736859.2 | 5283.4 | 182.1 | 73.7 | GPS | Active |
| Area 1 (Clayton) | UNION | j407 | t | no town | 1996, 2003 | Sager, NHNM | 109521.0 | 1280.5 | 27.1 | 11.0 | 0.0 | 0.0 | 0.0 | 0.0 | | No Town |
| Area 1 (Clayton) | UNION | j412 | t | | | | 193986.0 | 1772.5 | 47.9 | 19.4 | 0.0 | 0.0 | 0.0 | 0.0 | | Inaccessible |
| Area 1 (Clayton) | UNION | j425 | t | active | 2003 | NHNM | 172712.5 | 1716.5 | 42.7 | 17.3 | 0.0 | 0.0 | 0.0 | 0.0 | | Active |
| Area 1 (Clayton) | UNION | j429 | t | active | 1996, 2002, 2003 | Sager, Cully, NHNM | 743076.0 | 4815.4 | 183.6 | 74.3 | 563198.6 | 5451.3 | 139.2 | 56.3 | GPS | Active |
| Area 1 (Clayton) | UNION | j430 | t | active | 2002, 2003 | Cully, NHNM | 136924.3 | 1619.6 | 33.8 | 13.7 | 20407.9 | 620.0 | 5.0 | 2.0 | GPS | Active |
| Area 1 (Clayton) | UNION | j432 | t | | 2002 | Cully | 701437.5 | 3376.3 | 173.3 | 70.1 | 0.0 | 0.0 | 0.0 | 0.0 | | Unknown |
| Area 1 (Clayton) | HARDING | r134 | t | | | | 763534.0 | 3633.4 | 188.7 | 76.4 | 0.0 | 0.0 | 0.0 | 0.0 | | Inaccessible |
| Area 1 (Clayton) | HARDING | r145 | t | | | | 974438.0 | 4371.7 | 240.8 | 97.4 | 0.0 | 0.0 | 0.0 | 0.0 | | Inaccessible |
| Area 1 (Clayton) | HARDING | r173 | t | | 1996 | Sager | 141049.0 | 1522.8 | 34.9 | 14.1 | 0.0 | 0.0 | 0.0 | 0.0 | | Inaccessible |
| Area 1 (Clayton) | UNION | r185 | t | active | 2003 | NHNM | 353332.0 | 2641.1 | 87.3 | 35.3 | 0.0 | 0.0 | 0.0 | 0.0 | | Active |
| Area 1 (Clayton) | COLFAX | r199 | t | active | 1996, 2003 | Sager, NHNM | 1466814.0 | 6638.2 | 362.5 | 146.7 | 564112.4 | 3368.7 | 139.4 | 56.4 | GPS | Active |
| Area 1 (Clayton) | UNION | r204 | t | active | 2003 | NHNM | 202552.0 | 1716.1 | 50.1 | 20.3 | 11458.3 | 408.5 | 2.8 | 1.1 | GPS | Active |

| Geographic Area | County | Site Code | Interpreted Status[1] | Field Check Result[2] | Field Check Date | Field Check Source | Interpreted Area (m2) | Interpreted Perimeter (m) | Interpreted Ac | Interpreted Ha | Ground-truth Area (m2) | Ground-truth Perimeter (m) | Ground-truth Ac | Ground-truth Ha | Ground-truth Method | Ground-truth Result |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Area 1 (Clayton) | UNION | r209 | t | active | 1996, 2003 | Sager, NHNM | 529642.0 | 3132.3 | 130.9 | 53.0 | 738667.3 | 4128.5 | 182.5 | 73.9 | GPS | Active |
| Area 1 (Clayton) | UNION | r210 | t | inactive | 1996, 2003 | Sager, NHNM | 2912336.0 | 10564.1 | 719.7 | 291.2 | 0.0 | 0.0 | 0.0 | 0.0 | | Inactive |
| Area 1 (Clayton) | UNION | r212 | t | no town | 2003 | NHNM | 1157250.0 | 4333.0 | 286.0 | 115.7 | 0.0 | 0.0 | 0.0 | 0.0 | | No Town |
| Area 1 (Clayton) | COLFAX | r213 | t | | | | 696542.0 | 4156.4 | 172.1 | 69.7 | 0.0 | 0.0 | 0.0 | 0.0 | | Inaccessible |
| Area 2 (Mountainair) | TORRANCE | j383 | q | | | | 2364584.1 | 7534.7 | 584.3 | 236.5 | 0.0 | 0.0 | 0.0 | 0.0 | | Inaccessible |
| Area 2 (Mountainair) | TORRANCE | j385 | q | no town | 2003 | NHNM | 268807.0 | 2026.5 | 66.4 | 26.9 | 0.0 | 0.0 | 0.0 | 0.0 | | No Town |
| Area 2 (Mountainair) | TORRANCE | j400 | q | | | | 299358.0 | 2226.5 | 74.0 | 29.9 | 0.0 | 0.0 | 0.0 | 0.0 | | Inaccessible |
| Area 2 (Mountainair) | TORRANCE | j434 | t | no town | 2003 | NHNM | 78699.0 | 1166.2 | 19.4 | 7.9 | 0.0 | 0.0 | 0.0 | 0.0 | | No Town |
| Area 2 (Mountainair) | OTERO | l124 | q | ?,inactive | ?, 2003 | BLM-LCFO, NHNM | 340631.0 | 2676.4 | 84.2 | 34.1 | 0.0 | 0.0 | 0.0 | 0.0 | | Inactive |
| Area 2 (Mountainair) | LINCOLN | r036 | q | | | | 211368.5 | 3296.5 | 52.2 | 21.1 | 0.0 | 0.0 | 0.0 | 0.0 | | Inaccessible |
| Area 2 (Mountainair) | LINCOLN | r037 | q | no town | 2001-09-03, 2003 | NHNM, NHNM | 103441.5 | 1734.4 | 25.6 | 10.3 | 0.0 | 0.0 | 0.0 | 0.0 | | No Town |
| Area 2 (Mountainair) | LINCOLN | r042 | q | | | | 229986.0 | 2538.3 | 56.8 | 23.0 | 0.0 | 0.0 | 0.0 | 0.0 | | Inaccessible |
| Area 2 (Mountainair) | LINCOLN | r043 | q | no town | 2001-09-03, 2003 | NHNM, NHNM | 1161486.2 | 5067.5 | 287.0 | 116.1 | 0.0 | 0.0 | 0.0 | 0.0 | | No Town |
| Area 2 (Mountainair) | LINCOLN | r048 | q | | | | 24787.5 | 669.2 | 6.1 | 2.5 | 0.0 | 0.0 | 0.0 | 0.0 | | Unknown |
| Area 2 (Mountainair) | LINCOLN | r052 | q | | | | 105159.0 | 1503.6 | 26.0 | 10.5 | 0.0 | 0.0 | 0.0 | 0.0 | | Unknown |
| Area 2 (Mountainair) | GUADALUPE | r061 | q | no town | 2002 | Schmitt | 4448.5 | 303.6 | 1.1 | 0.4 | 0.0 | 0.0 | 0.0 | 0.0 | | Inaccessible |
| Area 2 (Mountainair) | TORRANCE | r150 | q | no town | 2003 | NHNM | 1045296.0 | 4648.4 | 258.3 | 104.5 | 0.0 | 0.0 | 0.0 | 0.0 | | No Town |
| Area 3 (Clovis) | ROOSEVELT | j161 | q | no town | 2003 | NHNM | 12007.5 | 472.6 | 3.0 | 1.2 | 0.0 | 0.0 | 0.0 | 0.0 | | No Town |
| Area 3 (Clovis) | ROOSEVELT | j162 | q | no town | 2003 | NHNM | 15907.5 | 498.8 | 3.9 | 1.6 | 0.0 | 0.0 | 0.0 | 0.0 | | No Town |
| Area 3 (Clovis) | ROOSEVELT | j170 | t | | | | 323128.5 | 2432.2 | 79.8 | 32.3 | 0.0 | 0.0 | 0.0 | 0.0 | | Inaccessible |
| Area 3 (Clovis) | ROOSEVELT | j171 | t | | | | 251167.5 | 2161.4 | 62.1 | 25.1 | 0.0 | 0.0 | 0.0 | 0.0 | | Inaccessible |
| Area 3 (Clovis) | ROOSEVELT | j174 | q | active | 2003 | NHNM | 48588.0 | 850.1 | 12.0 | 4.9 | 232245.5 | 1980.2 | 57.4 | 23.2 | GPS | Active |
| Area 3 (Clovis) | ROOSEVELT | j177 | t | inactive | 2003 | NHNM | 141041.0 | 1615.0 | 34.9 | 14.1 | 0.0 | 0.0 | 0.0 | 0.0 | | Inactive |
| Area 3 (Clovis) | ROOSEVELT | j256 | q | | | | 678404.7 | 4756.0 | 167.6 | 67.8 | 0.0 | 0.0 | 0.0 | 0.0 | | Inaccessible |
| Area 3 (Clovis) | ROOSEVELT | j265 | t | | | | 26205.5 | 622.3 | 6.5 | 2.6 | 0.0 | 0.0 | 0.0 | 0.0 | | Unknown |
| Area 3 (Clovis) | ROOSEVELT | j303 | t | | | | 371450.0 | 2903.9 | 91.8 | 37.1 | 0.0 | 0.0 | 0.0 | 0.0 | | Unknown |
| Area 3 (Clovis) | ROOSEVELT | j312 | t | cultivated | 2003 | NHNM | 2406455.6 | 9791.3 | 594.6 | 240.6 | 0.0 | 0.0 | 0.0 | 0.0 | | Cultivated |
| Area 3 (Clovis) | ROOSEVELT | j323 | t | active | 2003 | NHNM | 535396.0 | 2769.4 | 132.3 | 53.5 | 0.0 | 0.0 | 0.0 | 0.0 | | Active |
| Area 3 (Clovis) | ROOSEVELT | j376 | t | no town | 2003 | NHNM | 135249.0 | 1521.7 | 33.4 | 13.5 | 0.0 | 0.0 | 0.0 | 0.0 | | No Town |

| Geographic Area | County | Site Code | Interpreted Status[1] | Field Check Result[2] | Field Check Date | Field Check Source | Interpreted Area (m2) | Interpreted Perimeter (m) | Interpreted Ac | Interpreted Ha | Ground-truth Area (m2) | Ground-truth Perimeter (m) | Ground-truth Ac | Ground-truth Ha | Ground-truth Method | Ground-truth Result |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Area 3 (Clovis) | ROOSEVELT | j379 | t | | | | 242726.0 | 2461.6 | 60.0 | 24.3 | 0.0 | 0.0 | 0.0 | 0.0 | | Inaccessible |
| Area 3 (Clovis) | CURRY | l004 | t | inactive | 2003 | NHNM | 116089.0 | 1288.4 | 28.7 | 11.6 | 0.0 | 0.0 | 0.0 | 0.0 | | Inactive |
| Area 3 (Clovis) | CURRY | l014 | t | active | 2003 | NHNM | 395782.0 | 2348.8 | 97.8 | 39.6 | 16250.7 | 487.1 | 4.0 | 1.6 | GPS | Active |
| Area 3 (Clovis) | CURRY | l028 | t | active | 2003 | NHNM | 211849.0 | 1905.7 | 52.3 | 21.2 | 65334.0 | 1340.6 | 16.1 | 6.5 | GPS | Active |
| Area 3 (Clovis) | CURRY | l043 | t | inactive | 2003 | NHNM | 1025125.0 | 4256.9 | 253.3 | 102.5 | 0.0 | 0.0 | 0.0 | 0.0 | | Inactive |
| Area 3 (Clovis) | CURRY | l066 | t | | | | 126456.0 | 1307.9 | 31.2 | 12.6 | 0.0 | 0.0 | 0.0 | 0.0 | | Unknown |
| Area 3 (Clovis) | CURRY | l074 | t | active | 2003 | NHNM | 271542.0 | 1995.3 | 67.1 | 27.2 | 354279.3 | 3198.2 | 87.5 | 35.4 | GPS | Active |
| Area 3 (Clovis) | CURRY | l075 | t | active | 2003 | NHNM | 96953.5 | 1181.1 | 24.0 | 9.7 | 102590.2 | 1301.3 | 25.4 | 10.3 | GPS | Active |
| Area 3 (Clovis) | CURRY | l076 | t | | | | 134465.5 | 1394.3 | 33.2 | 13.4 | 0.0 | 0.0 | 0.0 | 0.0 | | Unknown |
| Area 3 (Clovis) | CURRY | l078 | t | inactive | 2003 | NHNM | 299188.5 | 2178.4 | 73.9 | 29.9 | 0.0 | 0.0 | 0.0 | 0.0 | | Inactive |
| Area 3 (Clovis) | QUAY | p014 | t | no town | 2003 | NHNM | 181227.5 | 2028.7 | 44.8 | 18.1 | 0.0 | 0.0 | 0.0 | 0.0 | | No Town |
| Area 3 (Clovis) | QUAY | p029 | t | inactive | 2003 | NHNM | 19639.0 | 533.6 | 4.9 | 2.0 | 0.0 | 0.0 | 0.0 | 0.0 | | Inactive |
| Area 3 (Clovis) | QUAY | p079 | t | active | 2003 | NHNM | 119974.0 | 1905.3 | 29.6 | 12.0 | 0.0 | 0.0 | 0.0 | 0.0 | | Active |
| Area 3 (Clovis) | ROOSEVELT | r021 | t | | | | 517241.0 | 3576.7 | 127.8 | 51.7 | 0.0 | 0.0 | 0.0 | 0.0 | | Inaccessible |
| Area 3 (Clovis) | ROOSEVELT | r022 | t | | | | 1598482.0 | 5443.4 | 395.0 | 159.8 | 0.0 | 0.0 | 0.0 | 0.0 | | Inaccessible |
| Area 3 (Clovis) | ROOSEVELT | r024 | t | inactive | 2003 | NHNM | 386110.5 | 3634.4 | 95.4 | 38.6 | 0.0 | 0.0 | 0.0 | 0.0 | | Inactive |
| Area 3 (Clovis) | ROOSEVELT | r081 | t | | | | 98730.0 | 1220.0 | 24.4 | 9.9 | 0.0 | 0.0 | 0.0 | 0.0 | | Unknown |
| Area 3 (Clovis) | ROOSEVELT | r101 | t | active, no town | 1997, 2003 | Paternoster, NHNM | 95667.0 | 1155.0 | 23.6 | 9.6 | 0.0 | 0.0 | 0.0 | 0.0 | | No Town |
| Area 3 (Clovis) | ROOSEVELT | r102 | t | | | | 219686.0 | 1782.9 | 54.3 | 22.0 | 0.0 | 0.0 | 0.0 | 0.0 | | Unknown |
| Area 3 (Clovis) | ROOSEVELT | r103 | t | | | | 325355.0 | 2464.1 | 80.4 | 32.5 | 0.0 | 0.0 | 0.0 | 0.0 | | Unknown |
| Area 3 (Clovis) | ROOSEVELT | r118 | t | | | | 17765.0 | 533.0 | 4.4 | 1.8 | 0.0 | 0.0 | 0.0 | 0.0 | | Inaccessible |
| Area 4 (Roswell) | LEA | j097 | q | inactive | 2003 | NHNM | 80172.0 | 1065.3 | 19.8 | 8.0 | 0.0 | 0.0 | 0.0 | 0.0 | | Inactive |
| Area 4 (Roswell) | LEA | j098 | q | inactive | 2003 | NHNM | 137530.0 | 1677.6 | 34.0 | 13.8 | 0.0 | 0.0 | 0.0 | 0.0 | | Inactive |
| Area 4 (Roswell) | LEA | j099 | q | inactive | 2003 | NHNM | 69459.5 | 2045.1 | 17.2 | 6.9 | 0.0 | 0.0 | 0.0 | 0.0 | | Inactive |
| Area 4 (Roswell) | LEA | l083 | q | active | 2002 | Schmitt | 207157.0 | 1795.9 | 51.2 | 20.7 | 0.0 | 0.0 | 0.0 | 0.0 | | Unknown |
| Area 4 (Roswell) | CHAVES | l085 | q | active | 2002, 2003 | Schmitt, NHNM | 298179.0 | 2285.0 | 73.7 | 29.8 | 0.0 | 0.0 | 0.0 | 0.0 | | Active |
| Area 4 (Roswell) | CHAVES | r069 | q | inactive, no town | 2002, 2003 | Schmitt, NHNM | 1173082.0 | 5014.6 | 289.9 | 117.3 | 0.0 | 0.0 | 0.0 | 0.0 | | No Town |
| Area 4 (Roswell) | CHAVES | r070 | q | inactive, no town | 2002, 2003 | Schmitt, NHNM | 579172.0 | 4145.1 | 143.1 | 57.9 | 0.0 | 0.0 | 0.0 | 0.0 | | No Town |
| Area 4 (Roswell) | CHAVES | r071 | t | active | 10/11/2001, 2003 | BLM-RFO, NHNM | 219840.0 | 2562.4 | 54.3 | 22.0 | 161747.0 | 2047.0 | 40.0 | 16.2 | GPS | Active |

| Geographic Area | County | Site Code | Interpreted Status[1] | Field Check Result[2] | Field Check Date | Field Check Source | Interpreted Area (m2) | Interpreted Perimeter (m) | Interpreted Ac | Interpreted Ha | Ground-truth Area (m2) | Ground-truth Perimeter (m) | Ground-truth Ac | Ground-truth Ha | Ground-truth Method | Ground-truth Result |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Area 4 (Roswell) | CHAVES | r073 | t | | | | 279752.0 | 2697.3 | 69.1 | 28.0 | 0.0 | 0.0 | 0.0 | 0.0 | | Inaccessible |
| Area 4 (Roswell) | CHAVES | r076 | t | | 10/11/2001 | BLM-RFO | 576669.4 | 3207.0 | 142.5 | 57.7 | 0.0 | 0.0 | 0.0 | 0.0 | | Inaccessible |
| Area 4 (Roswell) | CHAVES | r089 | t | inactive, inactive | 2001-10-11, 2003 | BLM-RFO, NHNM | 230590.0 | 2101.8 | 57.0 | 23.1 | 0.0 | 0.0 | 0.0 | 0.0 | | Inactive |
| Area 4 (Roswell) | CHAVES | r124 | q | no town | 2001-11-12, 2003 | NHNM, NHNM | 442548.5 | 2968.5 | 109.4 | 44.3 | 0.0 | 0.0 | 0.0 | 0.0 | | No Town |
| Area 4 (Roswell) | CHAVES | r126 | t | active | 2001-10-11 | BLM-RFO | 198960.0 | 2505.3 | 49.2 | 19.9 | 0.0 | 0.0 | 0.0 | 0.0 | | Unknown |
| Area 4 (Roswell) | CHAVES | r127 | t | active | 2001-10-11 | BLM-RFO | 32844.0 | 734.7 | 8.1 | 3.3 | 0.0 | 0.0 | 0.0 | 0.0 | | Unknown |
| Area 4 (Roswell) | CHAVES | r128 | t | inactive | 2002 | Schmitt | 815766.0 | 3374.6 | 201.6 | 81.6 | 0.0 | 0.0 | 0.0 | 0.0 | | Unknown |
| Area 5 (Hobbs) | LEA | j014 | q | no town | 2003 | NHNM | 41972.5 | 787.1 | 10.4 | 4.2 | 0.0 | 0.0 | 0.0 | 0.0 | | No Town |
| Area 5 (Hobbs) | LEA | j073 | t | | | | 148678.5 | 1411.7 | 36.7 | 14.9 | 0.0 | 0.0 | 0.0 | 0.0 | | Inaccessible |
| Area 5 (Hobbs) | LEA | j079 | t | active | 2003 | NHNM | 261490.0 | 2291.8 | 64.6 | 26.1 | 47257.9 | 1011.3 | 11.7 | 4.7 | Estimated | Active |
| Area 5 (Hobbs) | LEA | j095 | q | inactive | 2003 | NHNM | 136166.0 | 1540.7 | 33.6 | 13.6 | 0.0 | 0.0 | 0.0 | 0.0 | | Inactive |
| Area 5 (Hobbs) | LEA | j104 | t | inactive | 2003 | NHNM | 116000.0 | 1425.6 | 28.7 | 11.6 | 0.0 | 0.0 | 0.0 | 0.0 | | Inactive |
| Area 5 (Hobbs) | LEA | j107 | t | active | 2003 | NHNM | 877744.0 | 4646.8 | 216.9 | 87.8 | 0.0 | 0.0 | 0.0 | 0.0 | | Active |
| Area 5 (Hobbs) | LEA | j116 | t | active | 2003 | NHNM | 1673720.0 | 5959.1 | 413.6 | 167.4 | 0.0 | 0.0 | 0.0 | 0.0 | | Active |
| Area 5 (Hobbs) | LEA | j156 | t | | | | 455250.0 | 3479.0 | 112.5 | 45.5 | 0.0 | 0.0 | 0.0 | 0.0 | | Inaccessible |
| Area 5 (Hobbs) | LEA | j188 | q | active | 2003 | NHNM | 144606.5 | 1538.3 | 35.7 | 14.5 | 0.0 | 0.0 | 0.0 | 0.0 | | Active |
| Area 5 (Hobbs) | LEA | j191 | t | inactive | 2003 | NHNM | 1884160.0 | 6529.3 | 465.6 | 188.4 | 0.0 | 0.0 | 0.0 | 0.0 | | Inactive |
| Area 5 (Hobbs) | LEA | j200 | q | inactive | 2003 | NHNM | 167082.0 | 1761.9 | 41.3 | 16.7 | 0.0 | 0.0 | 0.0 | 0.0 | | Inactive |
| Area 5 (Hobbs) | LEA | j216 | t | active | 2003 | NHNM | 128849.5 | 1759.3 | 31.8 | 12.9 | 80523.2 | 1129.7 | 19.9 | 8.1 | GPS | Active |
| Area 5 (Hobbs) | LEA | j224 | t | active | 2003 | NHNM | 590300.0 | 3577.3 | 145.9 | 59.0 | 0.0 | 0.0 | 0.0 | 0.0 | | Active |
| Area 5 (Hobbs) | LEA | j228 | t | | | | 174111.5 | 1859.8 | 43.0 | 17.4 | 0.0 | 0.0 | 0.0 | 0.0 | | Inaccessible |
| Area 5 (Hobbs) | LEA | j236 | t | | | | 96388.5 | 1290.9 | 23.8 | 9.6 | 0.0 | 0.0 | 0.0 | 0.0 | | Inaccessible |
| Area 5 (Hobbs) | LEA | j238 | t | active | 2003 | NHNM | 357582.0 | 2440.3 | 88.4 | 35.8 | 28231.0 | 824.6 | 7.0 | 2.8 | Estimated | Active |
| Area 5 (Hobbs) | LEA | j241 | q | active | 2003 | NHNM | 116056.5 | 1406.9 | 28.7 | 11.6 | 114956.2 | 1377.9 | 28.4 | 11.5 | GPS | Active |
| Area 5 (Hobbs) | LEA | j276 | q | | | | 537702.0 | 3033.5 | 132.9 | 53.8 | 0.0 | 0.0 | 0.0 | 0.0 | | Inaccessible |
| Area 5 (Hobbs) | LEA | l079 | t | no town | 2003 | NHNM | 727764.5 | 3568.5 | 179.8 | 72.8 | 0.0 | 0.0 | 0.0 | 0.0 | | No Town |
| Area 5 (Hobbs) | LEA | l080 | t | | | | 386520.5 | 2496.1 | 95.5 | 38.7 | 0.0 | 0.0 | 0.0 | 0.0 | | Inaccessible |
| Area 5 (Hobbs) | LEA | l089 | t | | | | 1915285.0 | 7615.8 | 473.3 | 191.5 | 0.0 | 0.0 | 0.0 | 0.0 | | Inaccessible |
| Area 5 (Hobbs) | LEA | l091 | t | active | 2003 | NHNM | 9548846.5 | 17638.2 | 2359.6 | 954.9 | 0.0 | 0.0 | 0.0 | 0.0 | | Active |

| Geographic Area | County | Site Code | Interpreted Status[1] | Field Check Result[2] | Field Check Date | Field Check Source | Interpreted Area (m2) | Interpreted Perimeter (m) | Interpreted Ac | Interpreted Ha | Ground-truth Area (m2) | Ground-truth Perimeter (m) | Ground-truth Ac | Ground-truth Ha | Ground-truth Method | Ground-truth Result |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Area 5 (Hobbs) | LEA | l097 | t | active | 2002, 2003 | Schmitt, NHNM | 164181.0 | 1561.4 | 40.6 | 16.4 | 20151.4 | 536.5 | 5.0 | 2.0 | GPS | Active |
| Area 5 (Hobbs) | LEA | l098 | t | active | 2003 | NHNM | 133146.5 | 1414.0 | 32.9 | 13.3 | 0.0 | 0.0 | 0.0 | 0.0 | | Active |
| Area 5 (Hobbs) | LEA | l099 | t | active | 2003 | NHNM | 571642.0 | 3068.0 | 141.3 | 57.2 | 0.0 | 0.0 | 0.0 | 0.0 | | Active |
| Area 5 (Hobbs) | LEA | l101 | t | active | 2002, NHNM | Schmitt, NHNM | 227649.0 | 2040.5 | 56.3 | 22.8 | 64655.3 | 994.5 | 16.0 | 6.5 | GPS | Active |
| Area 5 (Hobbs) | LEA | l102 | t | active | 2002, 2003 | Schmitt, NHNM | 193997.0 | 1746.9 | 47.9 | 19.4 | 21664.8 | 550.3 | 5.4 | 2.2 | GPS | Active |
| Area 5 (Hobbs) | LEA | l104 | t | active | 2002 | Schmitt | 1296214.0 | 4782.1 | 320.3 | 129.6 | 0.0 | 0.0 | 0.0 | 0.0 | | Unknown |
| Area 5 (Hobbs) | LEA | l105 | t | | | | 497141.5 | 3188.3 | 122.8 | 49.7 | 0.0 | 0.0 | 0.0 | 0.0 | | Inaccessible |
| Area 5 (Hobbs) | LEA | l106 | t | | | | 285029.0 | 2015.7 | 70.4 | 28.5 | 0.0 | 0.0 | 0.0 | 0.0 | | Inaccessible |
| Area 5 (Hobbs) | LEA | l107 | t | inactive | 2003 | NHNM | 323737.5 | 2103.1 | 80.0 | 32.4 | 0.0 | 0.0 | 0.0 | 0.0 | | Inactive |
| Area 5 (Hobbs) | LEA | l111 | t | inactive | 2003 | NHNM | 2501534.6 | 7329.0 | 618.1 | 250.2 | 0.0 | 0.0 | 0.0 | 0.0 | | Inactive |
| Area 6 (Lordsburg) | GRANT | j012 | q | no town | 2003 | NHNM | 302174.0 | 3414.5 | 74.7 | 30.2 | 0.0 | 0.0 | 0.0 | 0.0 | | No Town |
| Area 6 (Lordsburg) | HIDALGO | j022 | q | no town | 2003 | NHNM | 112437.5 | 1594.0 | 27.8 | 11.2 | 0.0 | 0.0 | 0.0 | 0.0 | | No Town |
| Area 6 (Lordsburg) | LUNA | j023 | q | no town | 2003 | NHNM | 303170.0 | 2535.0 | 74.9 | 30.3 | 0.0 | 0.0 | 0.0 | 0.0 | | No Town |
| Area 6 (Lordsburg) | LUNA | j025 | q | no town | 2003 | NHNM | 192490.0 | 2456.5 | 47.6 | 19.2 | 0.0 | 0.0 | 0.0 | 0.0 | | No Town |
| Area 6 (Lordsburg) | HIDALGO | j028 | q | no town | 2003 | NHNM | 54043.0 | 1105.8 | 13.4 | 5.4 | 0.0 | 0.0 | 0.0 | 0.0 | | No Town |
| Area 6 (Lordsburg) | GRANT | j059 | q | no town | 2003 | NHNM | 127999.5 | 1514.7 | 31.6 | 12.8 | 0.0 | 0.0 | 0.0 | 0.0 | | No Town |
| Area 6 (Lordsburg) | HIDALGO | j061 | q | | | | 943112.0 | 4136.3 | 233.0 | 94.3 | 0.0 | 0.0 | 0.0 | 0.0 | | Unknown |
| Area 6 (Lordsburg) | GRANT | j329 | q | no town | 2003 | NHNM | 15660.0 | 492.4 | 3.9 | 1.6 | 0.0 | 0.0 | 0.0 | 0.0 | | No Town |

[1] Photo interpretation techniques were used to determine the status prior to field surveys, the code is t= town and q=questionable.

[2] Where field check status is the same for all observers (sources), only one status is given; if observations differ, both results are given.