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Monitoring Black-Tailed Prairie Dogs in Colorado with the 2015 NAIP Imagery

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Introduction

The 2015 National Agriculture Imagery Program (NAIP) images were surveyed within the current range of black-tailed prairie dog (BTPD, *Cynomys ludovicianus*) in Colorado to estimate the current extent of apparent BTPD colonies. Our primary objective was to conduct a census of these cells to provide estimates of total acres of all colonies in Colorado along with complementary confidence intervals. Recent work on monitoring prairie dog colony extent with aerial or satellite imagery has refined and improved this approach (Groose 2015, Kempema et al. 2015, McDonald et al. 2015, Sidle et al 2002). In this study, apparent BTPD colonies that were potentially active or inactive BTPD colonies were digitized and delineated in a Geographic Information System (GIS). Estimates of total acreage were corrected for colonies missed (false negatives) by the use of independent observers on a subset of survey units. Objectives also included estimation of the number of BTPD colonies. In addition to an adjustment for false negatives, aerial and ground surveys were conducted to correct estimates for false positives, or digitized areas that were not active or inactive BTPD colonies. The aerial surveys also provided information to estimate numbers and acreage of active BTPD colonies.

Methods

The study area was defined as the current known range of BTPD (Figure 1) as established by Colorado Parks and Wildlife and originally reported and described in a previous sampling effort (McDonald et al. 2015). We utilized the same contiguous tessellated 2.0-mile square grid in the USA_Contiguous_Albers_Equal_Area_Conic_USGS_version projection as the basis of this study. There were 11,101 grid cells in the 44,404 square-mile (approximately 28,420,000 acres) study area. A desktop survey of BTPD colonies was conducted using the 2015 NAIP imagery. State of Colorado year 2015 NAIP images had a one square meter resolution (USDA Farm Service 2016).

Digitizing Methods

The entire range of BTPD in Colorado was sampled for potential colonies. All detected colonies were delineated in a GIS. We used 2.0-by-2.0-mile viewing units to facilitate complete coverage of the Colorado BTPD habitat. By basing the surveys upon a sampling grid, we could implement the multiple interpreter approach detailed in McDonald et al. (2011) using analysis units compatible with units historically used in other complementary BTPD habitat estimation efforts (e.g., Kempema et al. 2015, McDonald et al. 2015). Pairs of interpreters surveyed a sample of the total set of grid cells to conduct a double sample of BTPD colonies in a subset of the survey units. The double sampling methods enabled estimation of the number of colonies not detected by either interpreter via logistic regression statistical models (Zar 2009). Ten percent of the study area was selected for double sampling using a sampling selection procedure to ensure spatial representativeness.

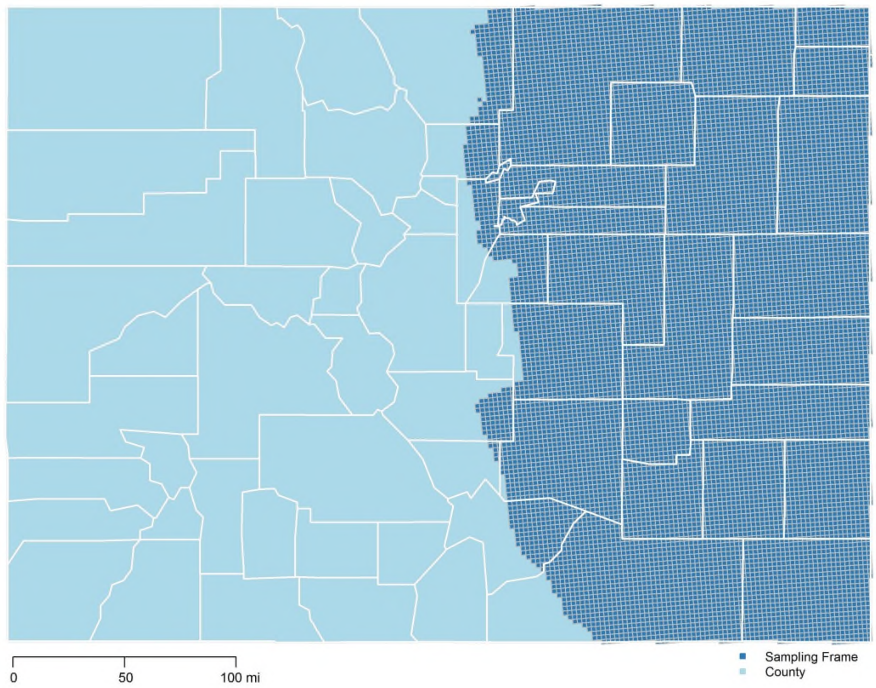

Figure 1. Range of black-tailed prairie dog in Colorado comprising the study area for the 2015 census.

Digitizers used the latest version of ArcGIS (ArcMap 10.4) to conduct the GIS work in this study. Using ArcMap, we generated an MXD file for each 2.0-by-2.0-mile cell for digitizers to overlay on the NAIP imagery. Observers systematically searched each cell at a scale of approximately 1:4,000. Searchers were randomly assigned grid cells from within the study area to allow spatial evenness of any observer related effects in detecting BTPD colonies using an R package developed for this work (R Core Team 2015). To ensure complete coverage of each gird cell, we utilized a smaller mini-grid system within each 2.0-by-2.0-mile cell comprised of 5 rows and 5 columns. Given a cell, observers initialized searches by starting in the northwest corner. Observers then worked their way to the southeast corner scanning the cells of the mini-grid one at a time on a row-by-row basis.

Observers visually inspected each sampled grid cell and digitized those areas judged to be potential black-tailed prairie dog colonies. When an observer found a potential prairie dog colony, he/she digitized the perimeter (subsequently referred to as “features”). Observers zoomed in and out on the images depending on the geographic area and the feature to be digitized. Using the Freehand tool in ArcGIS, observers drew a boundary around the outermost burrows that could be identified on the NAIP imagery. For some colonies, visible clip lines of vegetation were observable to help identify the outermost burrows. Digitizers were instructed not to digitize colony perimeter by following the clip line in an effort to provide consistency across years with variable vegetation growth and to produce the most comparable results through time.

Observers were required to participate in training exercises involving the presentation of NAIP images showing known BTPD colonies (see Appendix A for examples). Images of ant colonies, rocks, patches of bare ground, etc. were included in the training exercises to help observers develop a “search image” for active or inactive BTPB colonies. BTPD burrows were usually surrounded by mounds of bare soil one to three meters in diameter. Mounds were often of different color than surrounding surface soil. Vegetation was typically reduced, or absent, contrasting in texture with vegetation outside the “clip line.” The size of mounds, color contrasts, presence of clip lines, and distances between mounds together formed the search image by which digitizers sought to identify potential BTPD colonies. Observers were instructed to digitize the entire perimeter of the potential colony that overlapped the assigned grid cell. Even in situations where the centroid of the polygon did not belong to the cell assigned, the observer still digitized the entire potential colony.

Double Sampling Methods

To estimate of the probability an observer missed a BTPD colony during review of the 2.0-by-2.0-mile cell (false negatives), two observers independently digitized detected features on a double sample of approximately 10% of the grid cells in the Colorado sampling frame (Figure 2, Table 1). We selected grid cells from the sample frame by an equal probability sampling procedure termed Balanced Acceptance Sampling (BAS, Robertson et al. 2013). The BAS procedure ranks grid cells while preserving spatial balance over the sampling frame, ensuring that any subset of grid cells, when taken in order, is an equal probability sample. The sampling order of the single digitized grid cells was also defined via the BAS procedure, with double cells randomly mixed into the total list of 11,101 cells. In this way, all digitizers’ sampled set of detected features formed an independent BAS sample.

Table 1. Total number of 2.0-by-2.0 mile grid cells in Colorado and the breakdown between double sampled cells and single sampled cells.

Sample Type	Sample Size
Double sample size	1,136
Single sample size	9,965
Total number of cells	11,101

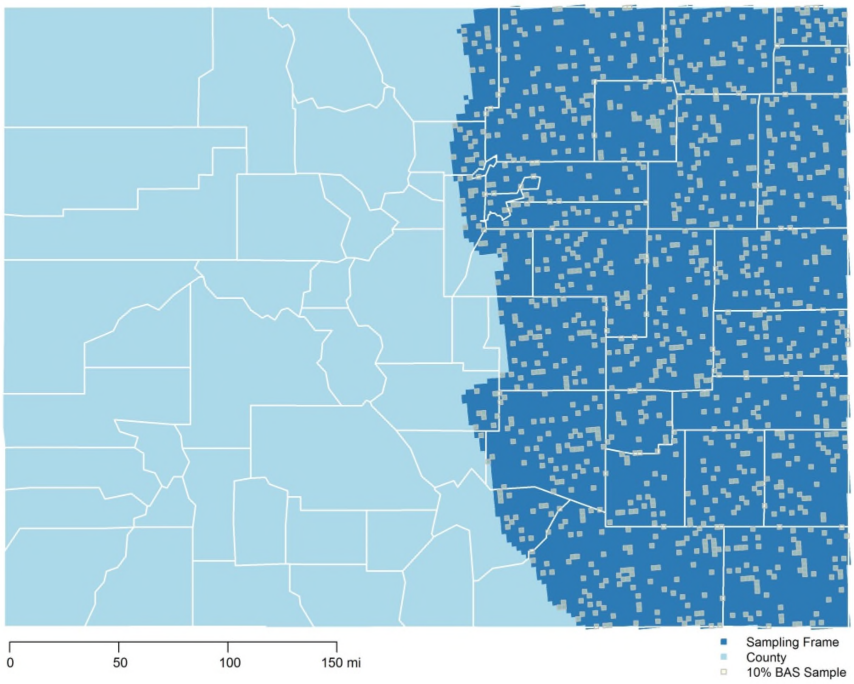

Figure 2. Sampling frame for Colorado with 11,101 2.0-by-2.0-mile grid cells. The 1,136 grid cells selected by the Balanced Acceptance Sampling (BAS) probabilistic sampling procedure for double sampling are shown.

After two observers digitized the colonies in a grid cell selected for a double sample, the two observers met to reconcile the grid cell. The process of reconciliation involved discussion and editing to obtain one set of digitized features that each observer could agree on. For approximately half of the units that each team interpreted, one observer was designated as the primary observer. For the other half of the units, the other observer was designated as the primary observer. The optimal scenario occurred when both observers found and digitized the same feature in an assigned cell or when they agreed that no features were present. If features were present, the two observers discussed each feature and made decisions about the size and shape of the potential colony in question. To obtain the “reconciled” feature, either an originally sampled feature was selected, or the primary observer re-digitized the feature while the secondary observer was present.

Another scenario occurred when one observer found and digitized a feature missed by the other team member. In this case, the observers discussed the feature in question and made the decision whether it was a potential colony or not. When observers decided it was a potential colony, the primary observer was responsible for “re-digitizing” the reconciled feature while the secondary observer was present. The observers deleted features they decided were not potential colonies. Original features digitized by each observer were recorded in their original shapefile and post-reconciliation features were recorded in a reconciliation shapefile. Observers recorded which observer found which colonies and which observer failed to find a given colony. With these different sets of shapefiles, it is possible to compare the size of original versus reconciled features.

Probability of Detection and Adjustment for False Negatives

Using the double sampled grid cells, we developed statistical models to estimate the probability of an observer detecting a feature given the size of the feature. Observers will miss some active or inactive BTPD colonies (false negatives) and mistakenly include some features that erroneously trigger the "search image" (false positives). For example, if an observer digitized a small feature with a probability of detection of 0.70, then the feature's acreage was multiplied by (1/0.70) = 1.43 to account for features of that size missed (false negatives). Similarly, the estimate of the number of such small features was increased by 1.43. The double sampling for feature delineation between two observers allows estimation of probabilities of detection of a feature by each observer. We utilized logistic regression to estimate the probability that at least one digitizer detected a given feature, assuming independence between observers, and including a covariate for feature size. We expected smaller features to have lower probabilities of detection than large features and accounted for this variability in the false negative adjustment.

Aerial and Ground Survey Methods

Aerial surveys of digitized features were conducted to estimate the false positive rate, i.e. the probability of a digitizing a feature that is not a prairie dog colony. We visited a sample of features that the observers had digitized to ground truth the determination of a BTPD colony. We selected a set of features to aerial truth based on the application of inclusion and exclusion criteria. An emphasis on proximity to paved roads ensured success in subsequent ground truthing. The cells that were available to be selected for aerial truthing had to have been digitized by September 6th, 2016. This date was selected as a cut-off for sampling due to the possibility of early snows prohibiting truthing efforts. On this date, a total of 9,314 cells were digitized of the 11,101 (83.9%) cells in the study area. The 8,963 prairie-dog colonies within these cells formed the sampling frame for truthing. In the interim, digitizers continued to examine the remaining 1,787 cells; however, any prairie-dog colonies found after September 6th were not included as candidates for truthing.

We utilized three exclusion criteria for features in the aerial sample. The first criteria excluded all prairie-dog colonies within 1 km of 41 distinct Colorado airports, where 1-km-radius circular polygonal extents originated from a point shapefile. The second criteria excluded each of the 152 polygonal extents of demarcated Colorado cities. Due to the tendency of city borders to meet at right angles and exclude certain interior areas, thereby creating holes, all city polygons were buffered by 100 meters. Finally, the third criteria excluded the 10 identified Colorado polygonal military installations. Polygonal shapefiles for each of the three exclusion criteria were then combined through a union operation to create one final exclusion polygon for the state. All shapefiles originated from the CDOT (Colorado Department of Transportation) OTIS (Online Transportation Information System) Data Catalog, with the exception of the military installation shapefile, which originated from the Military Surface Deployment and Distribution Command.

There were also three inclusion criteria. All three criteria comprised different linear road shapefiles; these were the Highways, Local Roads, and Major Roads shapefiles from the OTIS website. To increase the probability that identified prairie-dog colonies can actually be surveyed during ground truthing, all three were restricted in similar ways to ensure the inclusion of paved roads. The Highways shapefile excluded all roads that variable PRISURF identified as "5 Unpaved (OnSystem)." The Local Roads shapefile excluded all roads that variable SURFNAME identified as either of "11 Other", "13 Primitive," or "14 Unimproved." Finally, the Major Roads shapefile excluded roads that variable SURFNAME identified as either of "11 Other" or "14 Unimproved." Following shapefile subsetting with these road attribute data, each line shapefile was then buffered by 25 meters, thus creating 50-meter-wide sampling strips. Resulting polygonal shapefiles for each of the inclusion criteria were then combined by a union operation to create one final inclusion polygon for the state.

Prairie-dog colonies intersecting the polygonal inclusion set, with at least some extent outside the exclusion set, were then identified as valid candidates for truthing. In an effort to optimize the survey time spent examining colonies, and reduce time traveling between prairie-dog-colony clusters, the sampling frame was reduced to two geographic subsets. Two subsets in opposite quarters of the state also served as a practical means of examining the variability in the proportion of digitized colonies that are ultimately identified as active.

The first area comprised the northern portion of the state demarcated by a buffer 100 kilometers south of Interstate 76, i.e., the “North Region.” Interstate 76 follows the South Platte River in a northeasterly direction from Denver in the center of the state to its northeast corner, thus serving as a natural partition. This boundary formed the southern extent of the northern geographic region for aerial truthing, and contributed 957 colonies for possible selection.

The second region, or the “South Region,” focused on the southeastern quarter of the state, with New Mexico and Kansas serving as the southern and eastern boundary. Colorado State Route 109 formed the western extent from Las Animas County Road 90 south to the terminus of 109 near Kim, Colorado. At its terminus, the western extent was extended south to the New Mexico border. The northern extent followed County Road 90 east until Ninaview, Colorado, at which point a diagonal to Lamar, Colorado formed its northwestern extent. U.S. Routes 50 and 400 from Lamar to the Kansas state line formed the rest of its northern extent. Within this resulting southern study region, 381 colonies met the inclusion criteria (Figure 3).

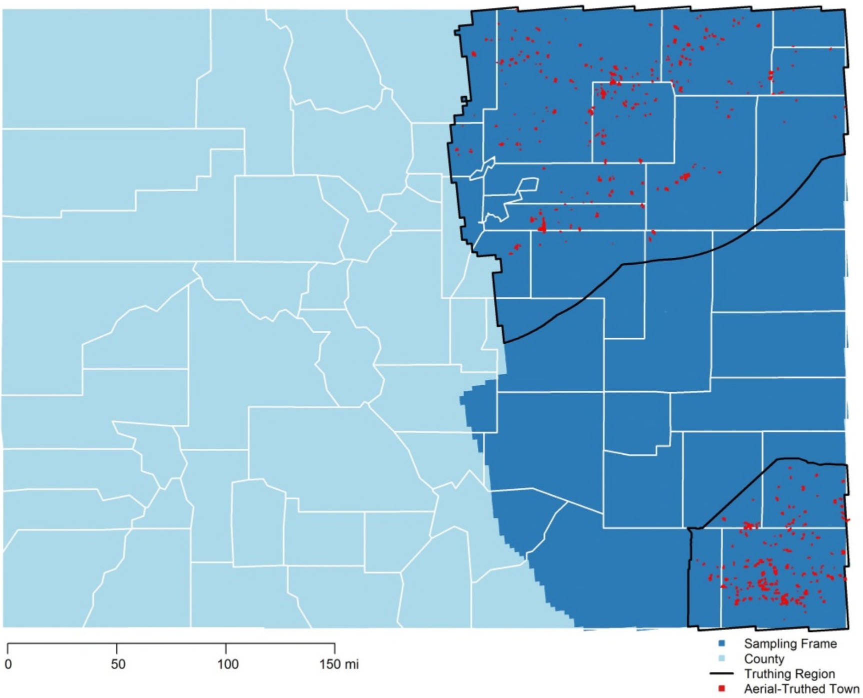

Figure 3. Black-tailed prairie dog features digitized on 2015 NAIP images and visited for aerial truthing.

Within the combined northern and southern geographic extent, 400 colonies were randomly selected from the set of 1,338 for aerial truthing with balanced acceptance sampling. The BAS sampling paradigm ensures spatial heterogeneity across the sampling frame. Once visited, colonies were identified as either "Active," "Inactive," or "Null." Active describes those colonies with obvious recent prairie dog sign or individuals observed, while the inactive category describes former prairie-dog colonies with no sign or individuals visible. The null category subsumes all digitized colonies that were something other than prairie-dog colonies, e.g., anthills or ground squirrels. A subset of colonies identified as Active or Inactive during aerial truthing were then further ground truthed. The proportion of colonies identified as active or inactive was used to adjust the estimated acreage and number of potential colonies digitized to correct for false positives (i.e., digitized features that were not active or inactive BTPD colonies).

Ground surveys were conducted from September 26-30, 2016 at digitized prairie dog features found to be active colonies during aerial truthing. The ground truthing features were selected from the 295 active colonies visited by the aerial truthing which had already been limited to features within 25 meters of the centerline of public roads, as described above. We visited 106 features that met these criteria following the same BAS ranked order of features for the aerial survey. For the 106 colonies selected, 87 colonies were successfully accessed on the ground for truthing, with 51 in the North Region, and 36 in the South Region (Figure 4).

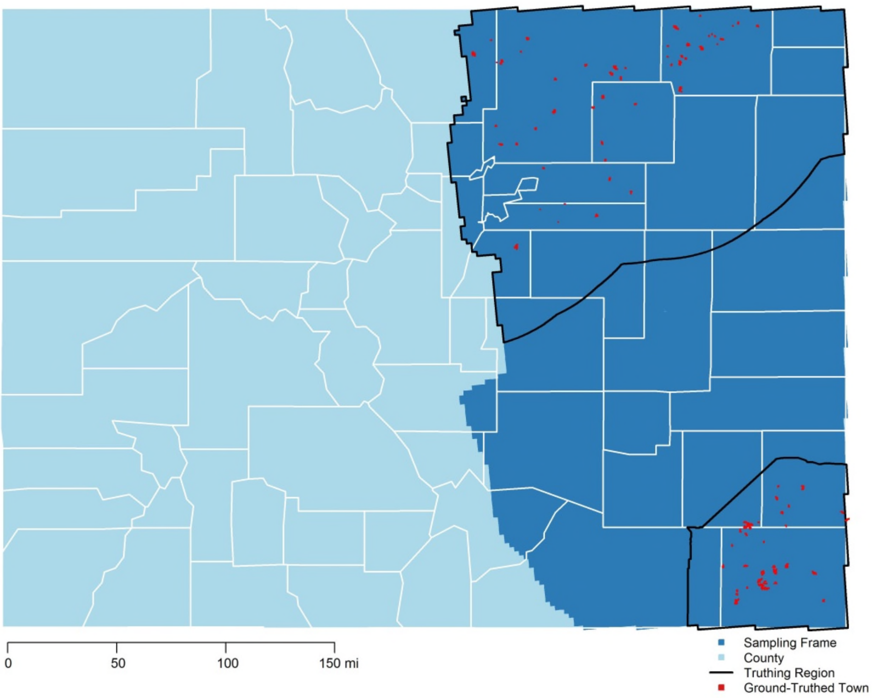

Figure 4. Black-tailed prairie dog features digitized on 2015 NAIP images and visited for ground truthing.

Estimation Methods

The total acreage of digitized features and number of features was estimated with the Horvitz-Thompson estimator (Thompson 2012). The estimation of the probability of detection for a feature enables the utilization of the Horvitz-Thompson estimator (Horvitz and Thompson, 1952) to estimate both total number of features present and areal extent. The estimate of total number (*N*) of features is

$$N = \sum_{j=1}^{G} \frac{1}{p_j}$$

where p_j is the probability of detection of feature j, and G is the number of features detected. The estimate of areal extent (S) of features is

$$S = \sum_{j=1}^{G} \frac{s_j}{p_j}$$

where s_j is the size, in acres, of the j^{th} feature. This estimator adjusted for false negatives in the set of potential BTPD colonies we digitized. The probability of detection specific to digitizer corrected the features in the single sampled cells and the probability of detection by at least one observer corrected the features in the double sampled cells. The clipping method of estimation was implemented to estimate aerial extent of acreage of digitized features and the centroiding method was implemented to estimate the number of digitized features, enabling us to apply a different probability of detection for the two types of grid cells. The ambiguous dichotomy that results from the failure of features to reside completely in any one cell suggests the use of these two different estimation approaches.

The clipping method involved determination of areal extent (S) of acreage of digitized features within each sampled cell even though digitized features often extended past that cell's boundary. Areal extents of the j^{th} feature only retain those portions of the feature that fall within the cell of interest. The Horvitz-Thompson estimator of aerial extent S incorporates the probability of detection of a feature. Using this method, we averaged the digitized acreage per cell and then multiplied the resulting average by the number of cells in the sample frame to estimate total acreage.

The centroiding method assigns each feature to one and only one grid cell in a sampling frame based on the location of the centroid of a feature. In highly convoluted features, the centroid may not actually fall within the feature's digitized boundary. Each cell in the sample frame was assigned the number of features whose centroids were in the cell. From this, standard statistical estimation methods allow for estimation of the number of features. The clipping method was not used to estimate the number of features N, since one delineated colony may have been clipped to several smaller distinct regions, thereby artificially inflating the observed total number of features.

After deriving the initial Horvitz-Thompson estimates in this manner, the adjustment for false positives was made using the results of the aerial surveys. A single constant multiplier of the estimate of the proportion to aerial truthed towns that were active or inactive BTPD colonies was applied to adjust both the acreage and number of features down, removing false positives from the totals. Before applying this correction, we removed the digitized features found to be "Null" during the aerial survey from the final estimates and only applied the correction to those features not visited during the aerial surveys.

In our census of grid cells, there was no "sampling error"; however, there was variance due to measurement errors, detection errors, and error in modeling the probability of detection. We accounted for these non-sampling errors in the variance by bootstrap sampling the entire census of 11,101 grid cells with replacement (Manly 1997). For each bootstrap sample we computed the estimated number and acreage of potential colonies corrected for false positives. We estimated the confidence intervals by the bias-corrected percentile method and the standard errors by computing the standard deviations of the sets of bootstrapped values for acreage and number of potential colonies.

To generate bootstrapped values for estimates of the total number and acreage of active colonies in Colorado, we selected a bootstrap resample of the 11,101 grid cells, with the accompanying aerially surveyed features. Following bootstrapping, we estimated confidence intervals for number and acreage of active colonies by the bias-corrected percentile method, with standard errors computed via the standard deviations of bootstrapped values for both metrics.

Results

In Colorado we digitized the perimeters of 10,538 features on the 2015 NAIP images over the study area (Figure 5). Shapefiles of the digitized features in Colorado will be made available to Colorado Parks and Wildlife and representatives of WAFWA. In addition, high-resolution county maps showing the sample of cells searched and features digitized will be available (an example low-resolution county map is in Figure 6). Figures of digitized features are included to establish the general distribution of potential BTPD colonies. However, missed colonies are not included. Also, we cannot determine which polygons in the frame are active or inactive BTPD colonies; that is, some digitized polygons may actually be false positives.

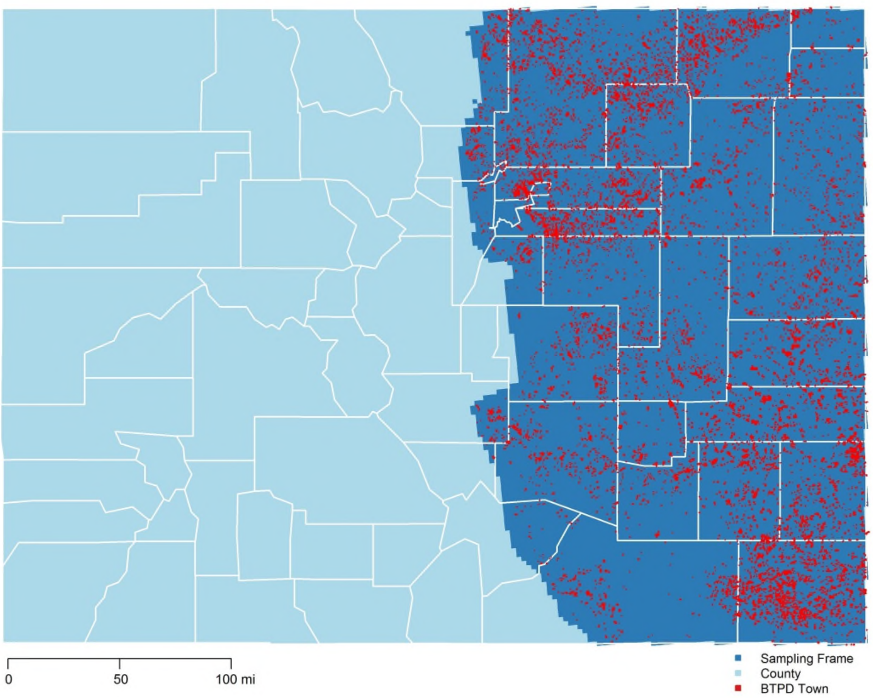

Figure 5. Map of black-tailed prairie dog features digitized on 2015 NAIP imagery in all census grid cells in Colorado.

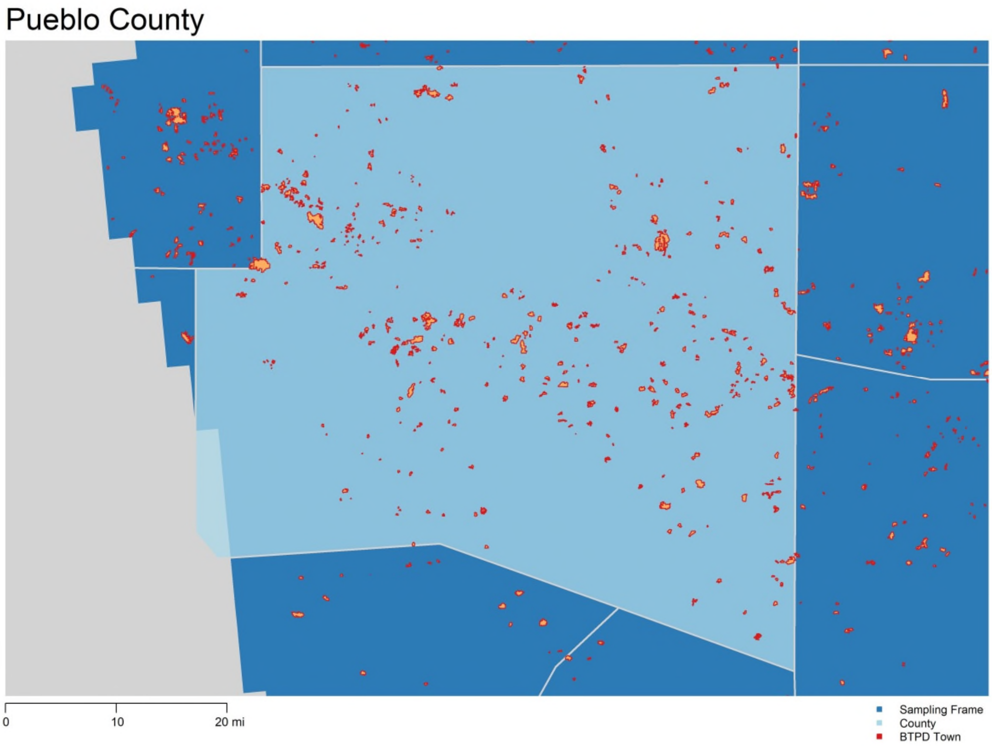

Figure 6. Digitized features on a census of grid cells in Pueblo County, Colorado.

Probability of Detection

We fit the double sampling data to logistic regression using features detected by one observer as the sampled "set" and modelled whether the second observer detected those features or not. The probability of detection varied among observers and the probability of detection of large colonies was estimated to be less than 1.00 for some observers. The estimated probability of detection by individual observers was generally between 0.60 and 0.95 for small features and increased to 0.9 or more for larger features. In Figure 7, as an example, Digitizer A's probability of detection was about 0.95 for towns approximately 200 acres in size. When only observer A searched a grid cell and detected a feature, the inflation factor was about (1/0.95) = 1.05; i.e. for every feature detected by observer A, another 0.05 feature was estimated to have been missed to adjust for false negatives. Digitizer B's estimated probability of detection in Colorado was lower, ranging from about 0.65 to about 0.95, exhibiting higher variation, but a similar increasing slope, indicating a higher probability of detection with increasing town size. Despite the overall differences between Digitizer A and Digitizer B with the Colorado imagery, the estimated probability of detection by at least 1 observer was greater than 0.97 for towns larger than 200 acres in size.

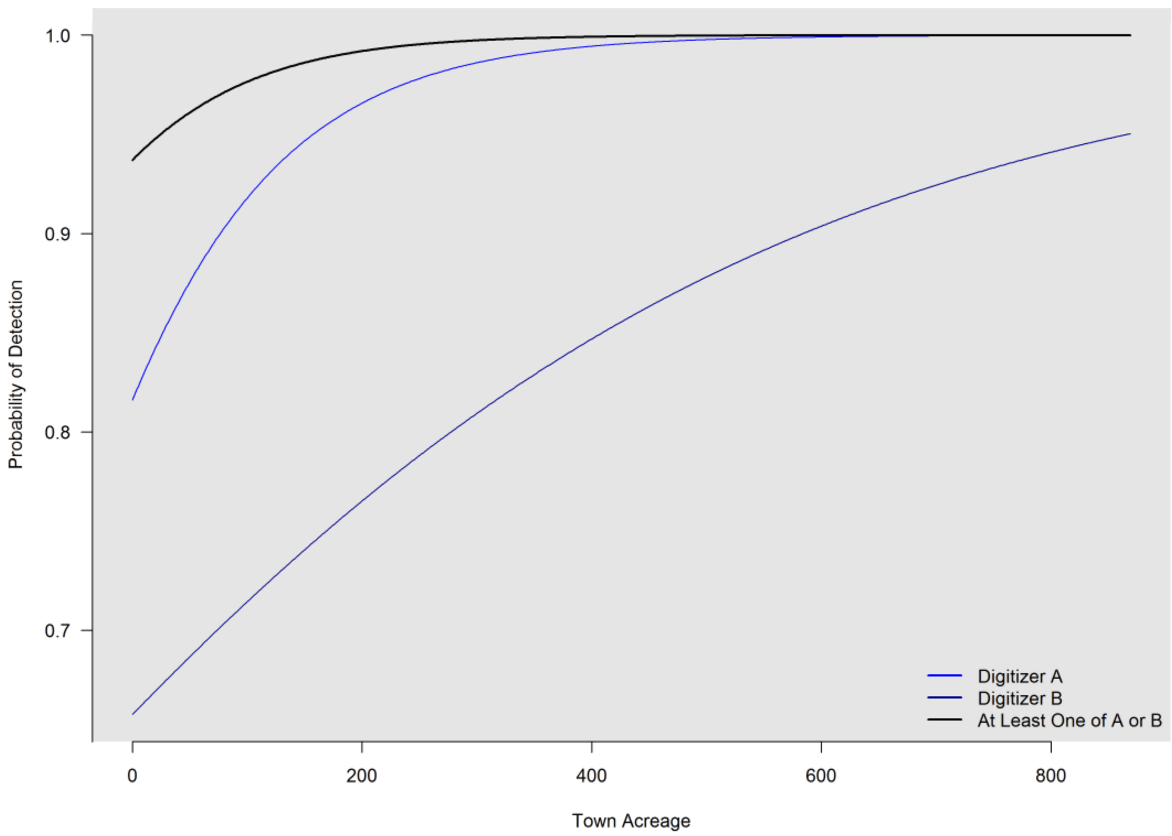

Figure 7. Estimated average probability of detection of potential Black-tailed prairie dog colonies as a function of size by two digitizers labeled "A" and "B" when searching 2015 NAIP images of Colorado. The black curve is the estimated average probability of detection by at least one of the two observers on grid cells independently searched by digitizers A and B.

Aerial Survey

The aerial survey conducted for the aerial truthing effort visited 400 digitized colonies. Of the 400 digitized features randomly visited, a total of 244 were in the North Region, with the balance of 156 in the South. The proportion of colonies identified as either "Active" or "Inactive" was similar in each, with 178 (73.0%) identified in the North and 117 (75.0%) in the South (Table 2). A test of binomial proportions failed to reject a null of equality in these two proportions (p=0.7355), suggesting that the probability of a potential digitized feature being a BTPD colony is the same throughout the state. The false positive adjustment was made using the combined value of 73.8%

Table 2. Counts of colony identified as either of “Active,” “Inactive,” or “Not a Colony (Null)” during aerial truthing for each of the North and South Regions. Percentages in the margins and row “BTPD Colony” utilize a denominator representing all colonies visited (400), while all others utilize the total feature counts within each Region. Percentages may not sum to 100 due to rounding.

	North N (%)	South N (%)	Total N (%)
Active	154 (63.1)	64 (41.0)	218 (54.5)
Inactive	24 (9.8)	53 (34.0)	77 (19.3)
BTPD Colony	178 (44.5)	117 (29.3)	295 (73.8)
Not a Colony (Null)	66 (27.0)	39 (25.0)	105 (26.3)
Total	244 (61.0)	156 (39.0)	400 (100)

Ground Survey

Nineteen of the colonies classified as active during aerial surveys did not have good access from roads when ground truthing was attempted. Thus, no conclusion could be ascertained for these colonies. Of the 87 colonies with good access, all were identified as either Active or Inactive in the North Region, while 8 were Not a Colony (Table 3). Even though these 8 colonies were labelled Not a Colony, it is possible that the road via which the alleged colony was visited traversed a portion of colony that was no longer occupied, but in which other digitized areas remain occupied. Thus, ground truthing conclusions must be considered conservative.

Table 3. Counts of colonies identified as either of “Active,” “Inactive,” or “Not a Colony (Null)” during ground truthing for each of the North and South Regions. Percentages in the margins and row “BTPD Colony” utilize a denominator representing all colonies visited (87), while all others utilize the total feature counts within each Region. Percentages may not sum to 100 due to rounding.

	North N (%)	South N (%)	Total N (%)
Active	48 (94.1)	15 (41.7)	63 (72.4)
Inactive	3 (5.9)	13 (36.1)	16 (18.4)
BTPD Colony	51 (58.6)	28 (32.2)	79 (90.1)
Not a Colony (Null)	0 (0.0)	8 (22.2)	8 (9.2)
Total	51 (58.6)	36 (41.3)	87 (100)

Estimates of Potential Black-tailed Prairie Dog Colonies

Adjusting for false negatives and false positives, we estimated 9,339 (90% CI: 8,202, 10,374) potential BTPD colonies totaling 500,570 acres (90% CI: 435,524, 556,617) in Colorado (Table 4).

Table 4. Estimated acreage, total numbers and 90% confidence intervals for total potential colonies, adjusted for false negatives, in the census of grid cells in Colorado black-tailed prairie dog range. Digitized potential colonies adjusted for false negatives and false positives.

Estimated Acreage of Active Colonies	500,570
Lower Bound	435,524
Upper Bound	556,617
Standard Error	37,556
CV (%)	7.55
Estimated Number of Active Colonies	**9,339**
Lower Bound	8,202
Upper Bound	10,374
Standard Error	660
CV (%)	7.07

Number of Colonies Greater than 100 and 500 Acres

Based on a census of the study area, there were an estimated 96 colonies larger than 500 acres (90% CI: 81, 115), and 1,234 colonies larger than 100 acres (90% CI: 1,095, 1,371) in the BTPD range of Colorado.

Discussion

Conducting a census of the BTPD range in Colorado using the NAIP imagery was an efficient and effective method to determine the current status of the number and acres of potential and active colonies. Plans exist to update NAIP images every 3 years or more often, facilitating a long-term monitoring program for Colorado (U.S. Department of Agriculture, 2016). The census of BTPD features in Colorado allowed us the opportunity to further evaluate the feasibility of sample methods similar to those documented during the pilot study (McDonald et al. 2015). As documented during that work, it appears the sampling methods were biased low and preliminary review of these data, when viewed as a sample, supports that assertion. The bias undoubtedly will decrease as the sample size increases. Additional investigation of these data to derive an appropriate adjustment factor is possible and will be important for designing a long-term monitoring plan based on NAIP imagery.

Within our study area, it did appear that the surveyed areas in the south were much drier than in the north, arguing a future analysis could be refined by developing a spatially variable correction factor for false positives. Of the BTPD features that were active or inactive as identified during the aerial truthing, there was a disparate percentage of features identified as “Inactive” in the Southern Region, 34.0%, as compared to 9.8% the Northern Region. A test of binomial proportions confirms a large significant difference between the areas ($p<0.0001$). The large discrepancy in these two proportions, coupled with the non-difference in the identification of colonies overall, as described in the results section, suggests that BTPD features in the Southern Region either experienced a recent die-off, or perhaps, drier conditions leading to the longer preservation of prairie-dog colonies that have long since been vacated. Given the disparity in active proportions between these two regions, we did not apply a blanket correction to all BTPD colonies to obtain the acreage of active colonies in the state.

With the data management methods employed during this study, it is possible to compare the sizes of original and reconciled features. Our preliminary review of the process found large towns became smaller during reconciliation and small towns became larger. Estimation methods employed here for the acreage and number of BTPD features could be refined by establishing the suspected curvilinear relationship between original and reconciled town size.

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Appendix A. 2015 NAIP images of digitized BTPD features

Figure A.1. A black-tailed prairie dog colony delineated in Colorado on 2015 NAIP imagery.

Figure A.2. A black-tailed prairie dog colony delineated in Colorado on 2015 NAIP imagery.

Figure A.3. A black-tailed prairie dog colony delineated in Colorado on 2015 NAIP imagery.

Figure A.4. A black-tailed prairie dog colony delineated in Colorado on 2015 NAIP imagery.