# White-tailed Prairie Dog Monitoring for the Pinedale Anticline Project Area

## Draft - Annual Report

## 2016

**Prepared for:**

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**December 5, 2016**

## REPORT REFERENCE

**C. LeBeau and S. Howlin. 2016. White-tailed Prairie Dog Monitoring for the Pinedale Anticline Project Area: 2016 Annual Report. Western EcoSystems Technology, Inc., Cheyenne, Wyoming, USA.**

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# INTRODUCTION

In 2008, the BLM issued its Record of Decision for the Supplemental Environmental Impact Statement for the Pinedale Anticline Oil and Gas Exploration and Development Project, which included specific requirements for monitoring of wildlife populations which may be impacted by the development, including impacts to the white-tailed prairie dog (*Cynomys leucurus*). The specific monitoring components in the Wildlife Monitoring and Mitigation Matrix (Appendix B in 2008 BLM ROD) that would trigger mitigation for sensitive species (i.e., white-tailed prairie dog and pygmy rabbit [*Brachylagus idahoensis]*) included documentation of three consecutive years of decline in presence/absence or an average 15% decline in numbers of individuals each year over three years. The methodology proposed for monitoring prairie dogs was to 1) identify white-tailed prairie dog towns on public lands within the Pinedale Anticline Project Area (PAPA), Core Development Area (CDA), and Reference areas, 2) monitor towns for white-tailed prairie dog presence/absence, and 3) monitor trends in relative abundance of prairie dogs (Biggins et al. 1993, BLM 2011).

In 2010, a pilot study was conducted to assess the potential implementation of an occupancy modeling protocol (Mackenzie et al. 2006) as recommended by the University of Wyoming COOP Unit. Following the 2010 field season and analysis, it was determined that the occupancy modeling approach was not practicable; therefore, the original methodology was put in place for the 2011 monitoring season. The original survey protocol was based on the mapping of prairie dog towns, which served as an index or surrogate for presence/absence, and estimation of the density of active prairie dog burrows within mapped towns. Hayden Wing Associates (2009) conducted aerial surveys and ground-based mapping of prairie dog towns within the PAPA and Reference areas in 2009, which were utilized as the baseline for the 2011 and all future surveys.

In 2016, surveys were conducted using the same protocols implemented in 2009, 2011, 2012, 2013, 2014, and 2016 with the objectives of delineating white-tailed prairie dog towns within the PAPA, CDA, and Reference areas and determining the density of active white-tailed prairie dog burrows. Prairie dog numbers were then estimated within each of the areas, based on the number of active burrows. The results of 2016 surveys were compared to those from 2009, 2011, 2012, 2013, 2014, and 2015 to evaluate changes in presence/absence (i.e., area of prairie dog towns in each area of interest) and relative abundance (i.e., active burrow density and/or numbers of prairie dogs) in order to assess the need for mitigation based on the triggers set forth in the Wildlife Monitoring and Mitigation Matrix (Appendix B in 2008 BLM ROD).

# METHODS

## Field Methods

### *Prairie Dog Town Mapping*

Prairie dog towns identified and mapped in 2009 and 2011 through 2015 were mapped again in 2016. New prairie dog towns observed while travelling throughout the project areas were also mapped and added to the existing database of prairie dog towns. Prairie dog towns were mapped based on the BLM survey protocol (BLM 2011) by recording the location of a burrow on the edge of the town with a hand-held GPS unit, then searching the area within 30 meters (m) of the burrow for the next burrow occurring along the edge of the prairie dog town. If another burrow was located within 30 m, the location was recorded on the GPS and served as a polygon vertex. This technique was repeated until the prairie dog town edge was defined by the points (i.e., vertices) located along the perimeter of the town and the surveyor returned to the starting burrow, closing the polygon and providing accurate delineation of the prairie dog town. Towns located on private lands that were not accessible were mapped on aerial photos from observations points on adjacent roads and later digitized using ArcGIS 10.1 (GIS). All towns were mapped regardless of size, which resulted in a number of small towns. Although some towns were not of substantial size, future surveys will allow for documentation of the expansion or abandonment of these small towns.

*Active Burrow Survey*

Surveys to estimate burrow densities were based on the techniques described in Biggins et al. (1993). After completing the field mapping of all towns within the study area, GPS data were imported into a GIS for analysis. Within the GIS, each mapped town was overlaid with a series of parallel transects oriented in a north-south direction and spaced 60 m apart. Transects were then downloaded to handheld GPS units for use in the field. Using the GPS units and pre-determined transect lines, observers walked transects and counted the number of burrows (active and inactive) within 1.5 m of either side of each line, resulting in strip transects three meters wide. Burrows were counted if greater than seven centimeters in diameter and deep enough that the end could not be seen. Each burrow was identified as active or inactive, with active burrows defined by the presence of fresh prairie dog scat within 0.5 m of the burrow entrance. Burrows on the edge of transects (i.e., 1.5 m from the transect line) were counted if more than half of the burrow entrance was located within the strip transect (Biggins et al. 1993). Observers carried two handheld counters, using one for recording the total numbers of burrows and one for recording the number of active burrows.

## Database Management

A Microsoft Access database was used to maintain and manage the survey data. Quality assurance and quality control (QAQC) was conducted on all data collected and entered into the database. The project managers reviewed data forms to insure completeness and legibility, and corrected problems that were detected.

## Data Analysis

*Prairie Dog Town Mapping*

The total and average areas of mapped prairie dog towns were summarized for each area of interest (PAPA, CDA, and Reference areas). Throughout this report the PAPA refers to the entire area within the PAPA boundary, and includes the CDA (Figure 1). Towns that overlapped area boundaries were split among those areas and acreages assigned accordingly. Contiguous towns which extended outside of any study area of interest were mapped and included in the area containing at least a portion of the town. Acreages of towns mapped in 2016 were compared to acreages of towns mapped in 2009 and 2011 through 2015 to assess changes in prairie dog distribution over time for each of the three areas of interest.

*Burrow Density*

Density of white-tailed prairie dog burrows (total burrows and active burrows) was estimated for each prairie dog town, with the area surveyed within each town being the length of transects walked within the town multiplied by the transect width of three meters. Burrow density was calculated as the number of burrows observed divided by the area surveyed in each town. Burrow densities for each area (CDA, PAPA, and Reference) were calculated by averaging across all prairie dog towns within the specific area. The total number of active burrows was estimated by extrapolating the density of active burrows within each town to the area of the town. The estimated number of active burrows for each town was then summed to provide an estimate of active burrows for each area of interest. The number of prairie dogs in each area was then estimated by extrapolating the total number of active burrows using the conversion factor of 0.073 white-tailed prairie dogs per active burrow (Biggins et al. 1993).

Confidence intervals on burrow density and total active burrows were estimated using a bootstrap resampling approach (Manly 1997). Individual transects were considered subsamples within a census of individual towns. The bootstrap approach simulates variation present in the data as a substitute for inter-town variation and variation among transects within respective towns. Towns and their respective transects in each area were resampled with replacement to obtain a sampling intensity equal to the spatial area of all towns within the area. Total burrows and burrow densities were estimated for each bootstrap sample. Confidence intervals for the observed estimates were estimated by the $2.5^{th}$ and $97.5^{th}$ percentiles of the bootstrap distribution.

*Year-to-Year Variation*

To facilitate comparisons between 2011, 2012, 2013, 2014, 2015 and 2016 data, the average density of active white-tailed prairie dog burrows was estimated for 2011, 2012, 2013, 2014, 2015 and 2016 after excluding data points deemed to be outliers that were unduly influencing average active burrow density estimates. All outliers were towns which had active burrow densities greater than 100 burrows per acre and all of which were roughly 70% or more greater than the next lowest density estimate. However, unlike 2011, 2012, 2014, 2015, and 2016 there were no data points deemed to be outliers in 2013. Comparisons of changes in active burrow density and prairie dog populations were made using the revised datasets (i.e., excluding outliers) for the period 2011 to 2016 based on overlap of confidence intervals. Comparisons of occupied area (i.e., area of prairie dog towns) were made for the periods 2009 to 2016 and 2015 to 2016, but included all data for each respective year (i.e., occupied area was not influenced by outliers).

# RESULTS

## Prairie Dog Town Mapping

The mapping of prairie dog towns began on July 30, 2016 and was completed on October 1, 2016. There were 94 prairie dog towns mapped (Figure 1; Table 1). All towns within the PAPA and Reference Area were delineated on the ground.

The total area of towns mapped in 2016 was 8,347 acres (Table 1), which represented overall increases of 34% from 2009 to 2016 and a 4% increase from 2015 to 2016 (Table 2, Figure 2). Within the PAPA, the acreage of mapped towns decreased by 29% from 2009 to 2016, while the acreage of mapped towns increased during the same time period by 49% in the Reference Area and 62% in the CDA (Table 2, Figure 2). Changes in acreage from 2015 to 2016 increased within the CDA and Reference area by 35% and 14%, respectively, and decreased in the PAPA by 17% (Table 2, Figure 2).

**Table 1. Number and area of white-tailed prairie dog towns mapped in 2016.**

| Area | Number of Towns | Total Acreage Of Towns |
|---|---|---|
| CDA | 19* | 2,403 |
| PAPA | 42 | 2,998 |
| Reference | 33 | 2,946 |
| **Total** | **94** | **8,347** |

*Includes portions of towns that overlapped boundaries

**Table 2. Change in acreage of mapped white-tailed prairie dog towns between 2009 and 2016.**

| Area | Year | | | | | | | Change in Acreage from 2009 to 2016 | | Change in Acreage from 2015 to 2016 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2009 (acres) | 2011 (acres) | 2012 (acres) | 2013 (acres) | 2014 (acres) | 2015 (acres) | 2016 (acres) | Acres | % | Acres | % |
| CDA | 1,483 | 1,431 | 1,389 | 1,458 | 1,719 | 1,777 | 2,403 | 920 | 62 | 626 | 35 |
| PAPA | 4,248 | 4,309 | 4,341 | 3,855 | 4,023 | 3,627 | 2,998 | -1,250 | -29 | -629 | -17 |
| Reference | 1,974 | 2,003 | 2,176 | 2,351 | 2,560 | 2,583 | 2,946 | 972 | 49 | 363 | 14 |
| **Total** | **6,222** | **6,312** | **6,517** | **7,664** | **8,302** | **7,988** | **8,347** | **2,125** | **34** | **359** | **4** |

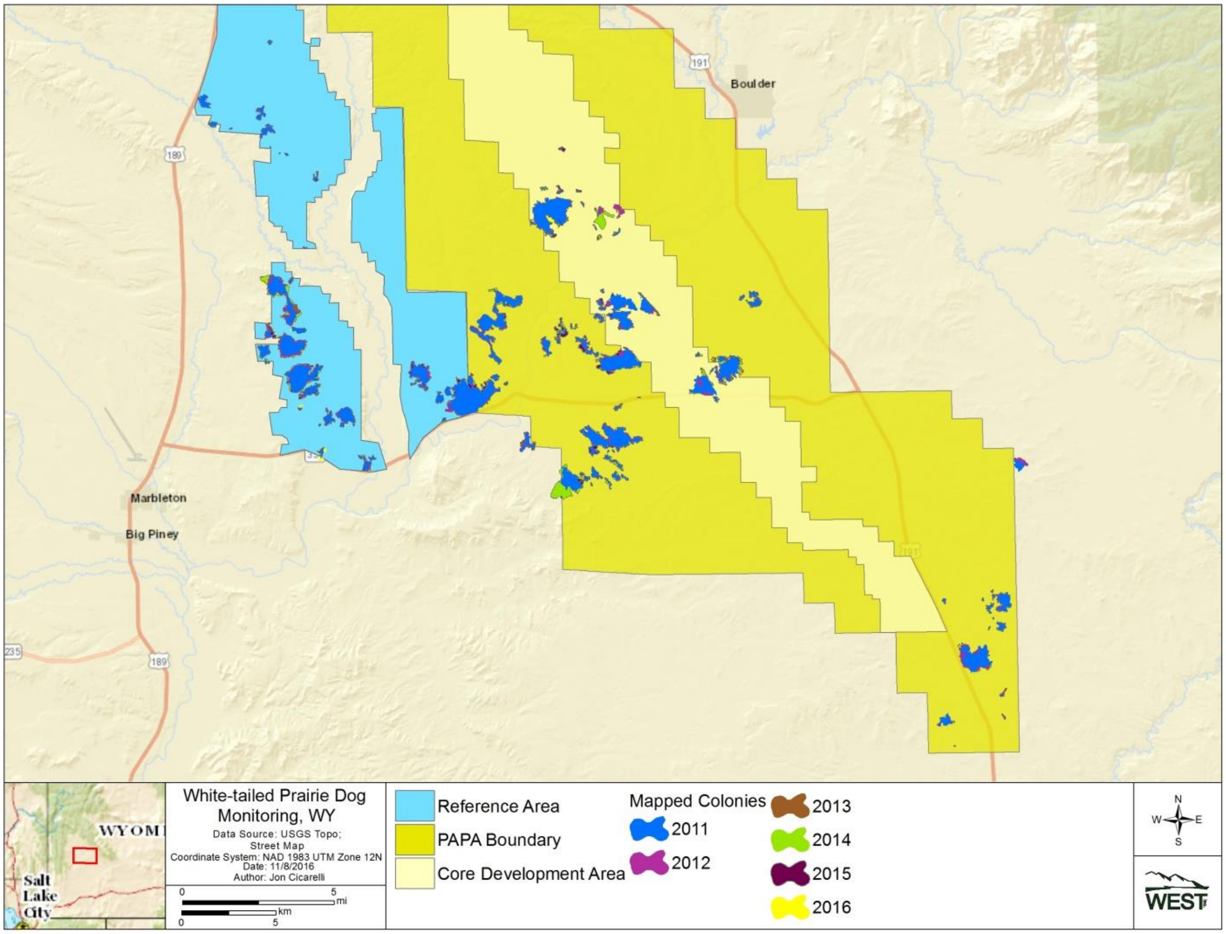


**Figure 1. White-tailed prairie dog towns mapped on the Pinedale Anticline Project Area (PAPA) Core Development Area (CDA) and the Reference areas.**

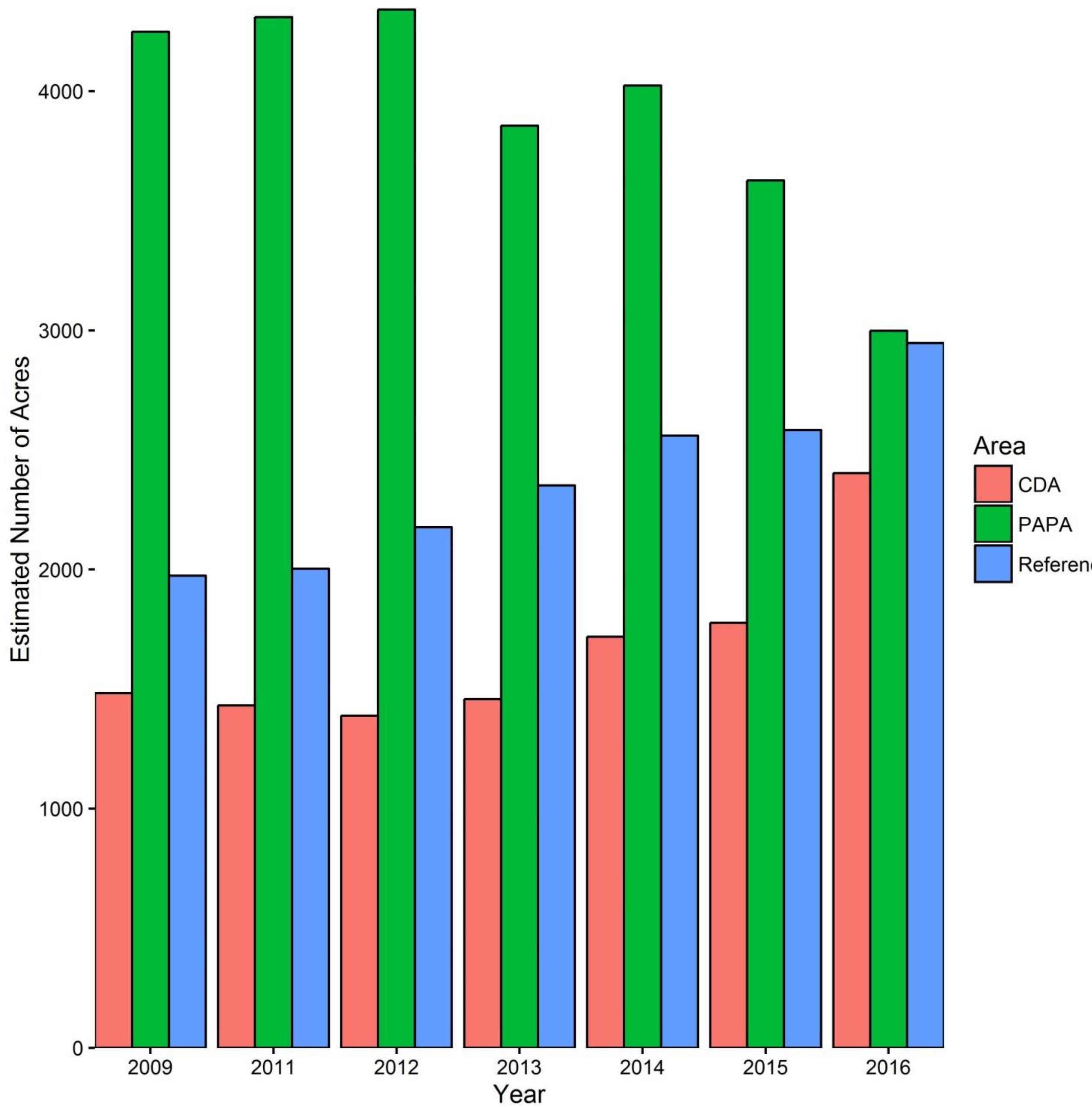


**Figure 2. Number of prairie dog colony acres mapped within the CDA, PAPA, and Reference study areas.**

## Burrow Density

In 2016, average burrow densities were 211.11 burrows/ac in the CDA, 119.27 burrows/ac in the PAPA, and 46.33 burrows/ac in the Reference Area (Table 3). Average active burrow densities were 151.63 burrows/ac in the CDA, 50.02 active burrows/ac in the PAPA, and 21.52 active burrows/ac in the Reference Area (Table 4). The number of active burrows was estimated for each area (Table 5) and used to estimate prairie dog population sizes within the three areas

(Table 6). The estimated number of white-tailed prairie dogs was 3,009 in the Reference Area and 6,404 in the PAPA, with 5,471 estimated to occur within the CDA (Table 6).

**Table 3. Average burrow density (number per acre surveyed) in each area with 95% bootstrap confidence intervals, 2016.**

| Area | Density | 95% Confidence Interval | |
|---|---|---|---|
| | | Lower | Upper |
| CDA | 211.11 | 57.88 | 640.50 |
| PAPA | 119.27 | 44.56 | 305.99 |
| Reference | 46.33 | 34.80 | 60.87 |

**Table 4. Average active burrow density (number per acre) in each area with 95% bootstrap confidence interval, 2016.**

| Area | Density | 95% Confidence Interval | |
|---|---|---|---|
| | | Lower | Upper |
| CDA | 151.63 | 33.75 | 489.64 |
| PAPA | 50.02 | 26.90 | 99.62 |
| Reference | 21.52 | 13.91 | 32.51 |

**Table 5. Number of active burrows in each area with 95% bootstrap confidence interval, 2016.**

| Area | Number | 95% Confidence Interval | |
|---|---|---|---|
| | | Lower | Upper |
| CDA | 74,942 | 35,991 | 125,113 |
| PAPA | 87,726 | 32,225 | 167,714 |
| Reference | 41,216 | 14,932 | 73,782 |

**Table 6. Number of white-tailed prairie dogs in each area, based on the Biggins conversion, with 95% bootstrap confidence interval, 2016.**

| Area | Number | 95% Confidence Interval | |
|---|---|---|---|
| | | Lower | Upper |
| CDA | 5,471 | 2,627 | 9,133 |
| PAPA | 6,404 | 2,352 | 12,243 |
| Reference | 3,009 | 1,090 | 5,386 |

### Year-to-Year Variation

In 2011, there were five towns with high densities considered to be outliers (Table 7; Figure 3). These five towns collectively encompassed approximately 45 acres of the total area sampled during the study in 2011. In 2012, there were four towns with high densities considered to be outliers (Table 8; Figure 3). These four towns collectively encompassed approximately four acres of the total area sampled during the study in 2012. No outliers were identified in the 2013 data. In 2014, there were five towns with high densities considered to be outliers (Table 9). These five towns collectively encompassed approximately 162 acres (2%) of the total area sampled during the study in 2014. Six outliers were identified in 2015 (Table 10, Figure 4) and covered a collective area of approximately 75.40 acres or 1% of the total area sampled in 2015.

One outlier was identified in 2016 (Table 11, Figure 5, Figure 6) and covered a collective area of approximately 0.59 acres or <1% of the total area sampled in 2016.

Removal of the outliers resulted in decreased estimates of average burrow density in the two areas which had outliers in 2011 (CDA and PAPA) and in all three areas in 2012, 2014, 2015, 2016 (Table 9; Table 10; Table 11). Removal of outliers also substantially reduced the 95% confidence intervals surrounding point estimates for active burrows and numbers of prairie dogs (Figure 6). There were no outliers identified in the 2013 data.

**Table 7. Five outliers identified in 2011 data.**

| Town ID | Area | Size of Town (acres) | Active Burrow Density (#/Acre) |
|---|---|---|---|
| JT630 | CDA | 0.27 | 177.97 |
| 178l | PAPA | 0.71 | 160.61 |
| 97acmmm | PAPA | 42.68 | 194.39 |
| CRO180f | PAPA | 1.28 | 531.69 |
| CRO182f | PAPA | 0.14 | 329.35 |

**Table 8. Four outliers identified in 2012 data.**

| Town ID | Area | Size of Town (acres) | Active Burrow Density (#/Acre) |
|---|---|---|---|
| 12f | Reference | 0.49 | 211.51 |
| 130CRO1 | CDA | 1.17 | 130.33 |
| CRO104c | PAPA | 1.18 | 183.95 |
| CRO180f | PAPA | 1.21 | 163.01 |

**Table 9. Five outliers identified in 2014 data.**

| Town ID | Area | Size of Town (acres) | Active Burrow Density (#/Acre) |
|---|---|---|---|
| 178v | PAPA | 11.41 | 196.80 |
| CRO170b | CDA | 108.67 | 378.33 |
| CRO98a | CDA | 4.28 | 102.53 |
| mgp167 | Reference | 25.48 | 148.70 |
| mgp33 | Reference | 12.60 | 152.4 |

**Table 10. Six outliers identified in 2015 data.**

| Town ID | Area | Size of Town (acres) | Active Burrow Density (#/Acre) |
|---|---|---|---|
| 178l | PAPA | 1.01 | 290.45 |
| 178v | PAPA | 12.51 | 2,709.49 |
| acmcd1 | CORE | 11.73 | 1,764.93 |
| cro103c | PAPA | 6.87 | 803.28 |
| cro180a | CORE | 5.66 | 731.76 |
| mgp166 | REF | 37.62 | 7,087.39 |

**Table 11. Two outliers identified in 2016 data.**

| Town ID | Area | Size of Town (acres) | Active Burrow Density (#/Acre) |
|---|---|---|---|
| cro182f | PAPA | 0.59 | 80.52 |

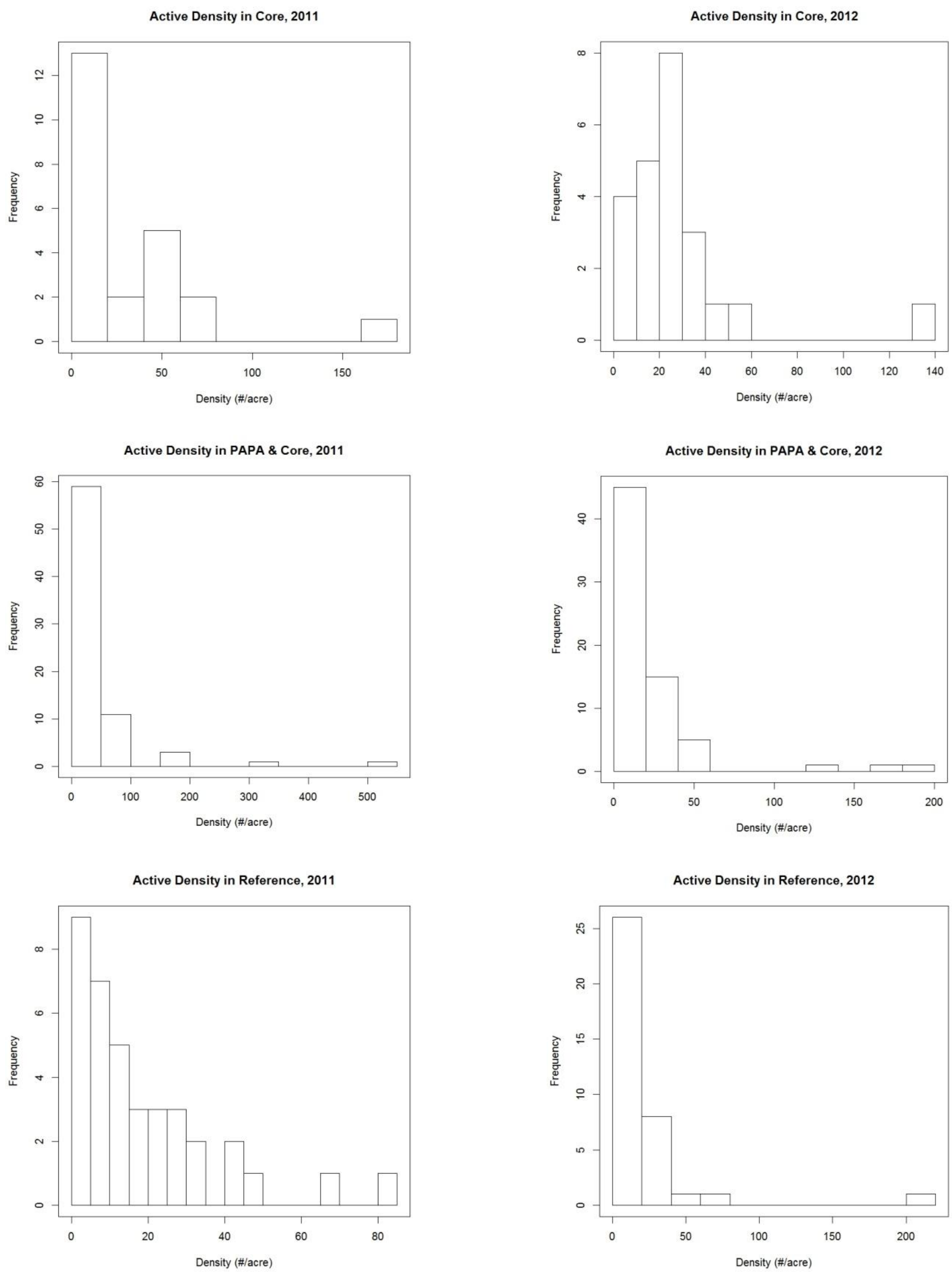


**Figure 3. Frequency of active burrow density values before the removal of outliers. Observations above 100 burrows per acre were considered outliers and removed from datasets when comparing year-to-year estimates of burrow density and population size.**

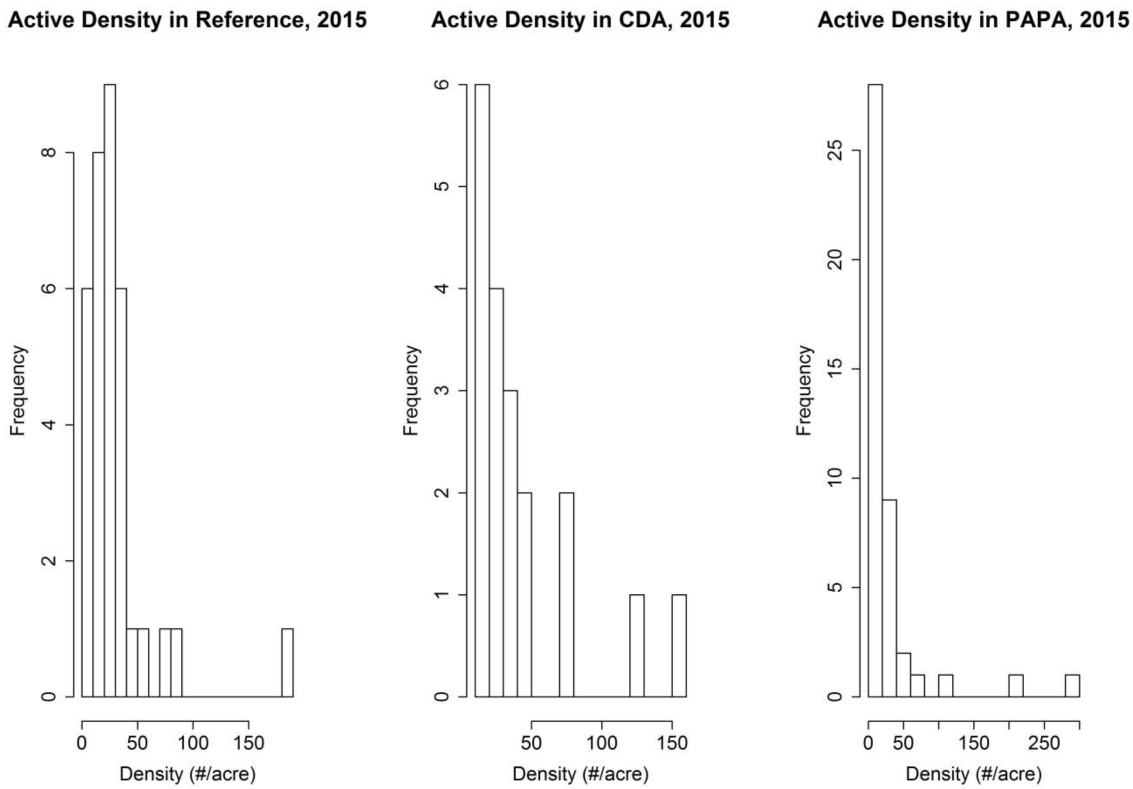


**Figure 4. Frequency of active burrow density values before the removal of outliers. Observations above 100 burrows per acre were considered outliers and removed from datasets when comparing year-to-year estimates of burrow density and population size for 2015.**

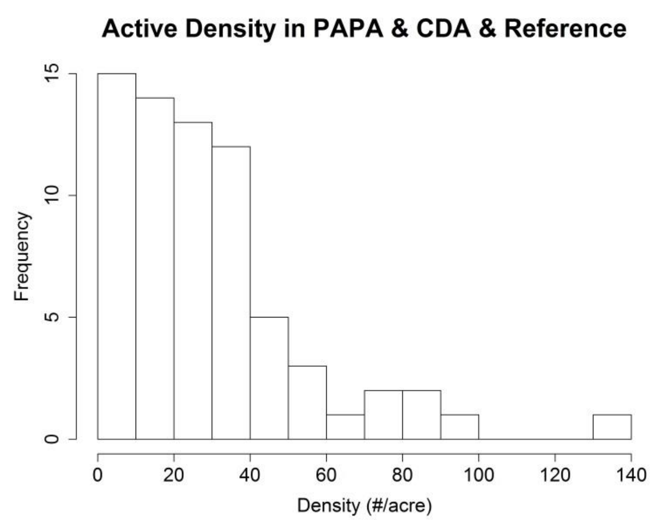


**Figure 5. Frequency of active burrow density values in 2016 within the PAPA, CDA and Reference Areas.**

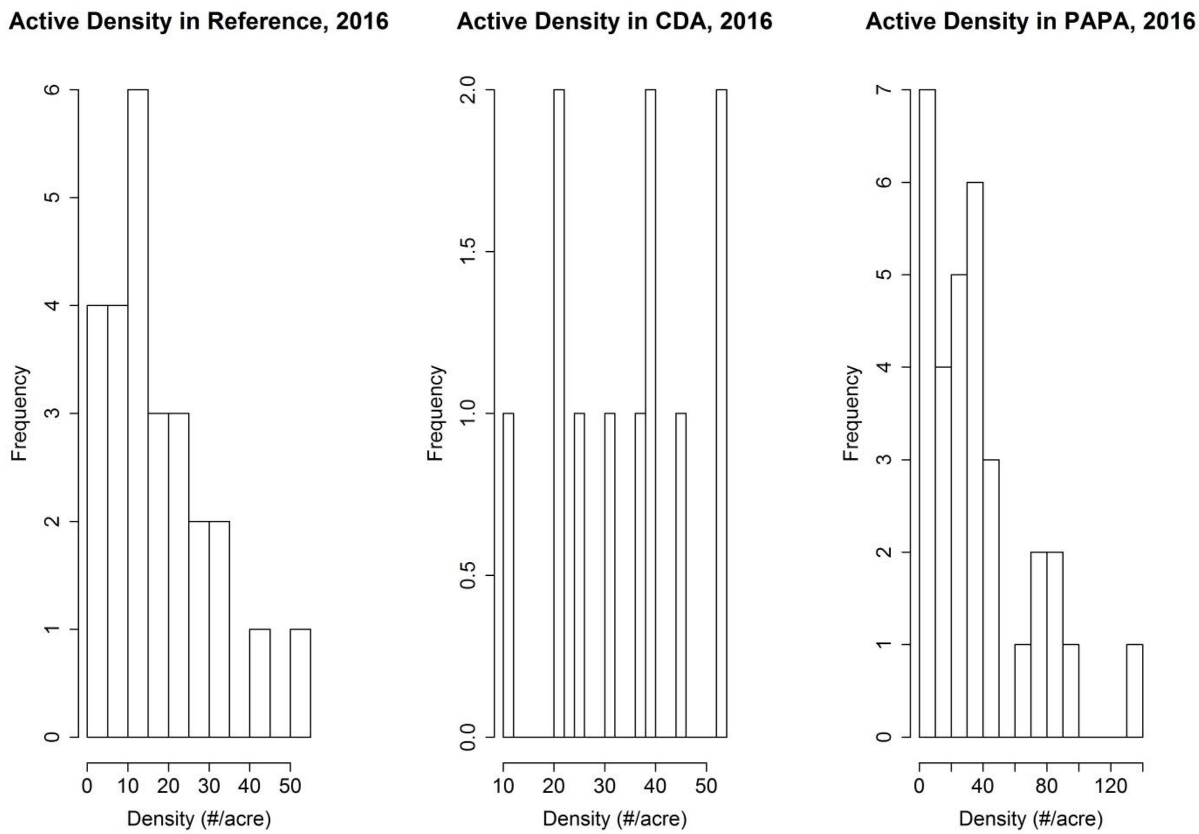


**Figure 6. Frequency of active burrow density values before the removal of outliers. Observations above 100 burrows per acre were considered outliers and removed from datasets when comparing year-to-year estimates of burrow density and population size for 2016.**

Based on the data excluding outliers, point estimates for active burrow density increased from 2015 to 2016 in all three areas (Table 12). In addition, estimated number of active burrows and estimated number of prairie dogs decreased from 2015 to 2016 within the Reference Area but increased in the other two areas (Tables 13 and 14). Changes in the estimated number of prairie dogs within each area between years varied from a decrease by 33% in the Reference Area (2014-2016) to an increase of 246% in the CDA (2012-2016; Table 15). Year to year changes in abundance were statistically significant within the CDA between 2012 and 2016; however, no year to year changes in abundance relative to 2015 were significant in the PAPA or Reference Area (Table 15; Figure 7).

**Table 12. Average active burrow density (number per acre) based on dataset excluding outliers in each area with 95% bootstrap confidence interval (D = density; CI = confidence interval; U = upper; L = lower).**

| Area | 2011 | | | 2012 | | | 2013 | | | 2014 | | | 2015 | | | 2016 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | D | CI | | D | CI | | D | CI | | D | CI | | D | CI | | D | CI | |
| | | U | L | | U | L | | U | L | | U | L | | U | L | | U | L |
| CDA | 23.92 | 14.22 | 33.85 | 20.83 | 15.22 | 25.52 | 13.38 | 7.69 | 19.84 | 35.84 | 30.33 | 41.35 | 43.03 | 21.81 | 82.38 | 152.00 | 32.90 | 486.64 |
| PAPA | 20.99 | 15.32 | 26.89 | 14.94 | 12.40 | 18.74 | 8.33 | 3.96 | 14.03 | 18.01 | 16.56 | 19.46 | 18.23 | 12.38 | 26.42 | 47.83 | 25.56 | 93.79 |
| Ref. | 17.98 | 11.96 | 24.13 | 14.10 | 9.28 | 19.15 | 12.06 | 7.69 | 17.76 | 28.95 | 26.75 | 31.16 | 25.34 | 19.27 | 32.71 | 21.46 | 13.91 | 32.51 |

**Table 13. Total number of active burrows in each area with 95% bootstrap confidence interval (dataset excluding outliers).**

| Area | 2011 | | | 2012 | | | 2013 | | | 2014 | | | 2015 | | | 2016 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | D | CI | | D | CI | | D | CI | | D | CI | | D | CI | | D | CI | |
| | | U | L | | U | L | | U | L | | U | L | | U | L | | U | L |
| CDA | 25,589 | 15,026 | 40,705 | 21,636 | 12,361 | 29,947 | 19,511 | 5,883 | 39,037 | 61,806 | 23,088 | 110,719 | 52,160 | 22,773 | 90,811 | 74,942 | 36,675 | 125,399 |
| PAPA | 72,262 | 58,191 | 90,986 | 63,130 | 52,158 | 76,796 | 32,121 | 12,467 | 60,084 | 75,838 | 35,113 | 134,112 | 52,172 | 21,704 | 89,285 | 79,858 | 27,941 | 150,729 |
| Ref. | 31,951 | 21,651 | 44,696 | 21,187 | 16,367 | 26,978 | 28,377 | 12,115 | 50,348 | 60,670 | 25,700 | 103,949 | 60,883 | 30,221 | 101,478 | 41,216 | 14,932 | 73,782 |

**Table 14. Total number of white-tailed prairie dogs in each area (dataset excluding outliers), based on the Biggins conversion, with 95% bootstrap confidence interval.**

| Area | 2011 | | | 2012 | | | 2013 | | | 2014 | | | 2015 | | | 2016 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | # | CI | | # | CI | | # | CI | | # | CI | | # | CI | | # | CI | |
| | | L | U | | L | U | | L | U | | L | U | | L | U | | L | U |
| CDA | 1,868 | 1,097 | 2,971 | 1,579 | 902 | 2,186 | 1,424 | 429 | 2,850 | 4,429 | 1,876 | 7,588 | 3,808 | 1,662 | 6,629 | 5,471 | 2,677 | 9,154 |
| PAPA | 5,275 | 4,248 | 6,642 | 4,608 | 3,808 | 5,606 | 2,345 | 910 | 4,386 | 5,536 | 2,563 | 9,790 | 3,809 | 1,584 | 6,518 | 5,830 | 2,040 | 11,003 |
| Ref. | 2,332 | 1,581 | 3,263 | 1,547 | 1,195 | 1,969 | 2,072 | 884 | 3,675 | 4,512 | 1,685 | 8,082 | 4,444 | 2,206 | 7,408 | 3,009 | 1,090 | 5,386 |

**Table 15. Percent change of total number of white-tailed prairie dogs in each area (dataset excluding outliers), based on the conversion, with 95% bootstrap confidence interval.**

| Area | 2011 to 2016 | 2012 to 2016 | 2013-2016 | 2014-2016 | 2015-2016 |
|---|---|---|---|---|---|
| CDA | 193 | 246 | 284 | 24 | 44 |
| PAPA | 11 | 27 | 149 | 5 | 53 |
| Reference | 29 | 95 | 45 | -33 | -32 |

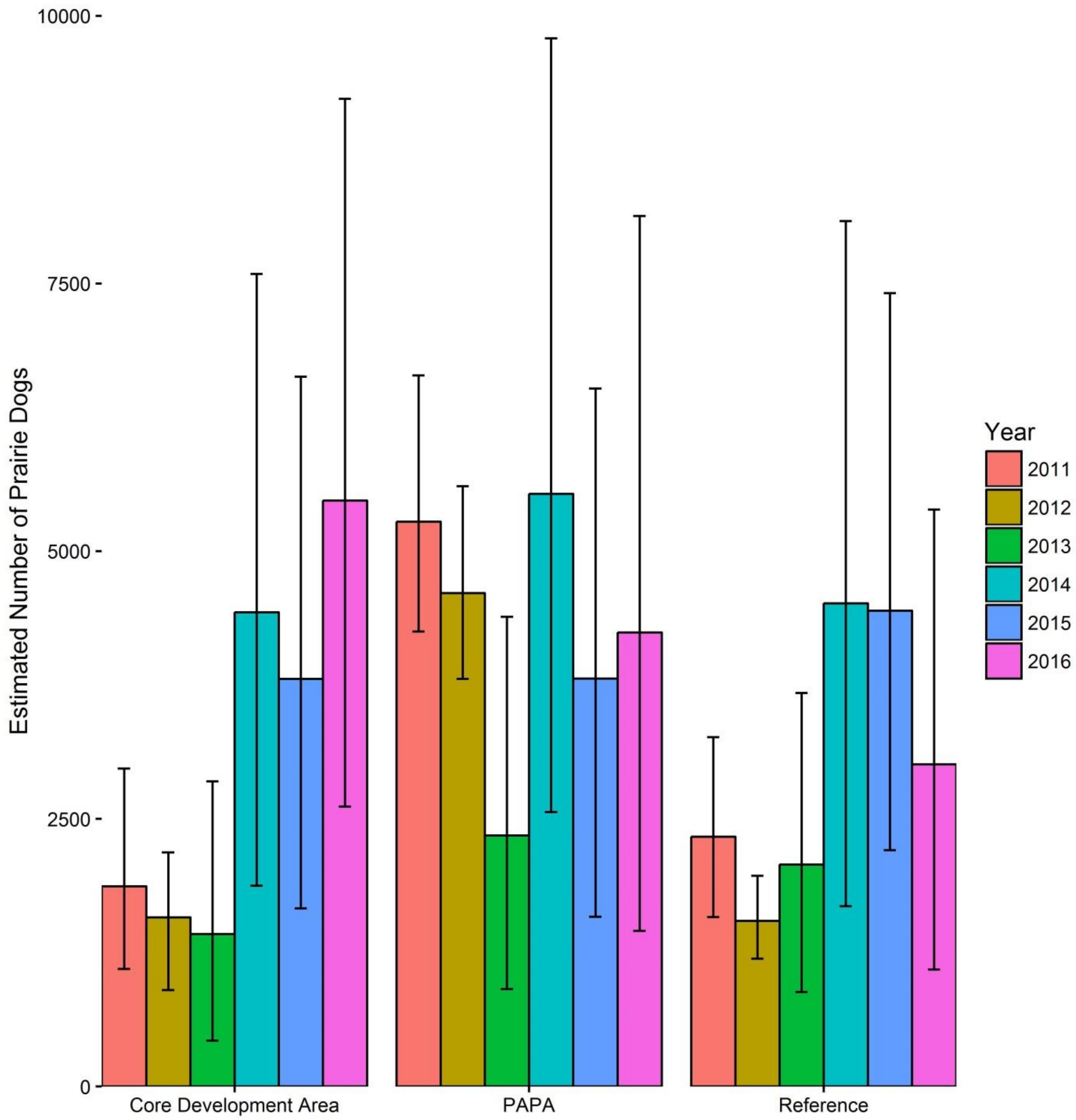


**Figure 7. Estimated number of white-tailed prairie dogs from dataset excluding outliers documented in 2011, 2012, 2013, 2014, 2015, and 2016 on the Core Development Area, PAPA, and Reference areas. Vertical lines represent 95% bootstrap confidence intervals.**

# DISCUSSION

Six years of data have now been collected, which allows for five consecutive years (and six periods if including 2009 data) of comparisons of burrow densities and populations sizes to address the requirements of the Wildlife Monitoring and Mitigation Matrix. From 2009 to 2016, the total amount of prairie dog town acres decreased by 29% within the PAPA, but increased within the

Reference Area and CDA. Subsequently, there was a decrease in acreage in the PAPA from 2015 to 2016 by 17%.

Prairie dog towns are dynamic in that boundaries change with every new burrow dug or old burrow that collapses. Even though town sizes may change from year to year, prairie dog populations may not change in a parallel fashion, as prairie dog densities may vary within towns (especially within larger towns) such that some portions of a large town may have relatively high densities of prairie dogs, while other areas are mostly devoid of activity. Areas devoid of activity can deteriorate such that they are eliminated from towns during future mapping efforts, while high density areas may persist, thereby increasing the density of active burrows while overall town size may decrease. There is also potential for year-to-year variation due to differences in field personnel and the ability to access towns, especially those located on private lands. However, consistency among field personnel in 2011, 2012, 2013, 2014, 2015, and 2016 and adherence to protocols should have helped to minimize this potential annual variation.

It is unknown what may be responsible for the changes in mapped acreages, but after six years of mapping prairie dog colonies, the data shows a consistent pattern of increasing presence/occupancy (i.e., acreage of prairie dog towns) within the Reference Areas; while presence/occupancy in the CDA and PAPA have been slightly more variable (Figure 2). While the acreage of mapped towns has steadily increased within the Reference Area, within the PAPA acreages increased the first two years (2011 and 2012), followed by a decline in 2013 before rebounding slightly in 2014 and, finally, decreasing slightly in 2015 and 2016 (Table 2). The mitigation trigger in the Wildlife Monitoring and Mitigation Matrix is three consecutive years of decline in presence/absence, which has not occurred; therefore, the PAPA mitigation trigger has not been exceeded.

The total number of active burrows was transformed using the methods of Biggins et al. (1993) to estimate the number of prairie dogs residing within each of the three study areas. The Reference Area showed an increase in the estimated number of prairie dogs from 2011 to 2016 and slightly decreased from 2015 to 2016. The estimated number of prairie dogs within the CDA declined from 2011 to 2013, increased dramatically in 2014, and decreased in 2015 before increasing in 2016. This trend was similar with the PAPA as the estimated number of prairie dogs declined from 2011 to 2013 before returning to 2011 baseline levels in 2014 and, finally, dropping substantially in 2015 and 2016. Additionally, a decrease in acreage and a concurrent increase in total active burrows in the PAPA was a likely driver of the slight increase in average active burrow density. In the Reference Area, the average active burrow density and total active burrows was lower in 2016 compared to 2015. Within the CDA, abundance increased from 2015 to 2016 and was attributed to an increase in the total number of active burrows. The PAPA and CDA area supported the largest estimated prairie dog population. The mitigation trigger for abundance that is identified in the Monitoring and Mitigation Matrix is an average 15% decline in numbers of individuals each year over three years. Because there was a lack of statistical difference in year-to-year estimates of active burrow density and population estimates, there is no support for implementation of mitigation based on the relative abundance data collected to date.

If annual prairie dog monitoring continues in 2017 then the recommendation for implementing aerial surveys to identify potential newly colonized areas is warranted. To improve upon the methods being used for this long term monitoring effort, it is recommended that an aerial survey of the study areas be conducted to search for newly established towns which could be added to the dataset. Without the aerial survey effort, documentation of the expansion or contraction of prairie dogs within the study areas will be limited to the expansion/contraction of existing towns and reduce the potential for documenting newly colonized towns. If prairie dogs are expanding in areas through colonization of new towns, then not attempting to document those newly colonized areas may negatively bias the results and interpretation of this monitoring plan, as it would likely make it more difficult to document expansion than to document contraction of prairie dog towns within the study areas. In 2011, 2012, 2013, 2014, 2015, and 2016 new towns were only mapped if they were observed incidentally during the course of other surveys, leaving large portions of the study areas unsurveyed since 2009. Since the Monitoring and Mitigation Matrix bases its mitigation triggers on a rolling 3-year time period (i.e., three consecutive years of decline), it makes sense to conduct a complete survey of the study areas at least once every three years to allow for newly colonized towns to be identified, thereby increasing the opportunity to document increases in presence/occupancy and abundance.

Continued monitoring will make it possible to compare annual variations in both prairie dog abundance and presence/absence (i.e., acreage of towns). Additional data will help to clarify potential impacts from ongoing activities within the areas of interest and address the specific monitoring components outlined by the PAPO in the Wildlife Monitoring and Mitigation Matrix. Due to the variability in the estimates of active burrow density and population numbers, it will take several years to document trends with a relatively high level of statistical confidence.

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