# COLONY ACREAGE AND DISTRIBUTION OF THE BLACK-TAILED PRAIRIE DOG IN SOUTH DAKOTA, 2012.

**SOUTH DAKOTA DEPARTMENT OF GAME, FISH AND PARKS**
**PIERRE, SOUTH DAKOTA**

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## Table of Contents

List of Tables ..... ii
List of Figures ..... iii
Acronyms ..... v
Recommended Citation ..... v
Executive Summary ..... 1
Introduction ..... 1
Study Area ..... 2
Methods ..... 3
  Interpretation ..... 3
  Truthing Activities ..... 4
  Distribution and Ownership ..... 5
  Complex Analysis ..... 5
Results ..... 6
  Tribal ..... 6
  Non-tribal ..... 7
  Multi-state plan objectives ..... 7
  Truthing ..... 7
  Colony complex analysis ..... 8
Discussion ..... 8
  State management plan objectives ..... 8
  Multi-state management plan objectives ..... 8
  Trends in colony acreage and distribution ..... 9
  Trends in colony acreage-high density area only ..... 9
  Limitations to image interpretation ..... 10
  Black-tailed Prairie Dog Density ..... 11
Recommendations ..... 11
Acknowledgements ..... 11
References Cited ..... 12

## List of Tables

Table 1. Black-tailed prairie dog colony acreage and distribution in South Dakota, 2012. ..... 14

Table 2. Black-tailed prairie dog colony acreage and distribution on non-tribal (state-, federal- and privately-owned) lands in South Dakota, 2012. ..... 15

Table 3. Black-tailed prairie dog colony acreage and distribution on public lands in South Dakota, 2012..... 16

Table 4. Location, number and total county acreages of black-tailed prairie dog colonies greater than 1,000 acres in South Dakota, 2012. ..... 16

Table 5. Date and location of activities conducted to evaluate aerial image interpretation of black-tailed prairie dog colony acres in South Dakota, 2013. ..... 17

Table 6. Miles driven (a) and flown (b) to truth aerial image interpretation of black-tailed prairie dog colony acres in South Dakota, 2013. ..... 17

Table 7. Temporal comparison of black-tailed prairie dog colony acres and distribution in South Dakota. ..... 18

## List of Figures

Figure 1. Core (Northwestern Great Plains) and secondary (Nebraska Sandhills and North-central Great Plains) management areas within the historical range of the black-tailed prairie dog as delineated by Bailey's ecosections and a historical range map (Hall 1981, Bailey et al. 1994, Luce 2003, Cooper and Gabriel 2005). ..... 19

Figure 2. Counties and portions of counties evaluated for acreage and distribution of black-tailed prairie dog colonies in South Dakota, 2012. ..... 20

Figure 3. Example of aerial image interpretation using (a) presence of burrow-entrance mounds and (b) a combination of burrow-entrance mounds and contrasting land cover to indicate a black-tailed prairie dog colony (outlined in green). ..... 21

Figure 4. A prairie dog colony in Dewey County, South Dakota (a) before the image was enhanced using a GIS and (b) after enhancing the contrast in vegetation signatures (contrast increased 24%, brightness decreased 18%). This was done to aid in digitizing the colony boundary outlined in green. ..... 22

Figure 5. Illustration of a prairie dog complex. ..... 23

Figure 6. Distribution of black-tailed prairie dog colonies in South Dakota, 2012. ..... 24

Figure 7. Percent composition of black-tailed prairie dog colony acres by land ownership in South Dakota, 2012. State-, federal- and privately-owned lands are classified as non-tribal. ..... 25

Figure 8. Location of routes used to evaluate aerial image interpretation of the distribution and acreage of black-tailed prairie dog colonies in South Dakota, 2013. ..... 26

Figure 9. Temporal comparison of black-tailed prairie dog colony acres in South Dakota. Refer to (Stukel et al. 2004, Kempema 2007, Kempema et al. 2009) and the methods section of this report for detail on study area and methods used during each study. ..... 27

Figure 10. Stratification of counties or portions of counties based on black-tailed prairie dog colony acres in 2006. ..... 28

Figure 11. Temporal change in black-tailed prairie dog colony acres in high colony acreage South Dakota counties. Annual precipitation values from a weather station near Cottonwood, South Dakota. ..... 29

Figure 12. Predicted distribution of plague (*Yersinia pestis*) in South Dakota as of 2012. ..... 30

Figure 13. Black-tailed prairie dog complexes (≥2 colonies, ≥988 acres [400 ha]), and a maximum inter-colony distance of 3.73 miles (6 km) in South Dakota, 2012 ..... 31

Figure 14. Black-tailed prairie dog complexes (≥2 colonies, ≥988 acres [400 ha]), and a maximum inter-colony distance of 1.55 miles (3 km) in South Dakota, 2012. ..... 32

## Acronyms

| | |
|---|---|
| ArcGIS | A GIS used to work with maps and geographic information that is produced and supplied by the software company Environmental Systems Research Institute |
| GIS | Geographic Information System |
| GPS | Global Positioning System |
| NAIP | National Agriculture Imagery Program |
| SD | Standard Deviation |
| SDDA | South Dakota Department of Agriculture |
| SDGFP | South Dakota Department of Game, Fish and Parks |
| USDA | United States Department of Agriculture |

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## Executive Summary

We documented 526,641 acres (213,124.1 ha) of black-tailed prairie dog (*Cynomys ludovicianus*) colonies in thirty counties in South Dakota by visually interpreting aerial images with a GIS. Total colony acreage in 2012 was divided by landownership as follows: 222,173 acres (89,910.2 ha) on tribal lands and 304,468 acres (123,213 ha) on non-tribal land. The statewide (199,472 acres; 80,723.5 ha) and non-tribal (166,958 acres; 67,565.5 ha) colony acreage goals set forth in the state prairie dog conservation and management plan were achieved in 2012, thus no changes in current management action are required

## Introduction

In response to a petition to list the black-tailed prairie dog (*Cynomys ludovicianus*) in 1998, several states began a cooperative process to retain management of this species. *The Black-tailed Prairie Dog Conservation Assessment and Strategy* (Van Pelt 1999) and *A Multi-state Conservation Plan for the Black-tailed Prairie Dog*, *Cynomys ludovicianus*, *in the United States* (Luce 2003) were produced. Van Pelt (1999) identified the need for multi-state management of the black-tailed prairie dog and Luce (2003) proposed long-term conservation actions for a multi-state management approach. The goal of both the conservation assessment and strategy and the multi-state conservation plan is to assure long-term conservation of the species, precluding the need for Endangered Species Act protection.

Two of the proposed conservation actions outlined by Luce (2003) include the identification of specific colony acreage objectives at both the national and state levels and implementation of state-level management plans. Acreage goals were based on maintaining 1% and 0.1% of suitable habitat within core and secondary management areas, respectively as delineated by Bailey's ecoregions (Bailey et al. 1994). In South Dakota, the Northwestern Great Plains section was considered a core area, while the Nebraska Sandhills and North-central Great Plains sections were secondary management areas (Figure 1). South Dakota counties considered to be within the historic range of the species were within either the core or secondary management areas as delineated by the historical range of the species.

State-specific target acreage objectives outlined by Luce (2003) include maintaining:

1) a complex >5,000 acres (2,023.4 ha) in each state,
2) at least 10% of the total occupied acreage in colonies or complexes > 1,000 acres (404.7 ha) and
3) a species distribution within 75% or more of the counties in the historic range or historic geographic distribution.

The remaining three objectives apply to the range of the species within the United States and include:

1) maintaining at least the currently occupied acreage of black-tailed prairie dogs,
2) increase occupied black-tailed prairie dog acreage to at least 1,693,695 acres (685,414.0 ha) by 2011 and
3) maintaining at least the current black-tailed prairie dog occupied acreage in the two complexes greater than 5,000 acres (2,023.4 ha) that now occur on and adjacent to Conata Basin-Buffalo Gap National Grassland, South Dakota and Thunder Basin National Grassland, Wyoming.

The SDGFP and SDDA worked cooperatively to develop the *South Dakota Black-tailed Prairie Dog Conservation and Management Plan* (Cooper and Gabriel 2005). The plan was finalized and approved by the South Dakota legislature in 2005. One of the objectives in the state plan is to identify a state-specific acreage goal. The statewide black-tailed prairie dog colony acreage goal of 199,472 acres (80,723.5 ha) was set using those standards outlined by Luce (2003). To accommodate tribal management of black-tailed prairie dogs in South Dakota, the total state-wide colony acreage goal is divided by landownership with the goal of 166,958 acres (67,565.5 ha) on non-tribal land (state, federal, and private lands). Apportionment of the total state-wide acreage goal was done to recognize separate authority and management of black-tailed prairie dog acreage on tribal lands.

The strategy used to ensure the state meets minimum acreage levels is the implementation of administrative and management actions in response to colony acreage triggers (Cooper and Gabriel 2005). Actions are undertaken when the following non-tribal black-tailed prairie dog colony acreage triggers are met: 1) >160,000 acres (64,749.7 ha), 2) between 160,000 and 125,000 acres (64,749.7 and 50,585.7 ha), and 3) <125,000 acres (64,749.7 ha). Sales of prairie dog toxicant would cease, with limited exceptions if the state-wide colony acreage trigger of < 145,000 acres (58,679.4 ha) is reached. Refer to Cooper and Gabriel (2005) for details on specific administrative and management actions. SDGFP has committed to monitoring colony acreage and distribution of black-tailed prairie dogs approximately every three years to determine what changes in administrative and management actions are needed and to monitor trends in acreage of this keystone species.

## Study Area

We evaluated all or portions of 21 South Dakota counties west of the Missouri River excluding Lawrence County and portions of Pennington and Custer counties. We also included nine counties adjacent to and east of the river (Figure 2).

## Methods

One-meter resolution aerial imagery from the USDA's NAIP was obtained for each county in the study area from the USDA's Natural Resources Conservation Service Geospatial Data Gateway (http://datagateway.nrcs.usda.gov/). NAIP images of South Dakota were taken from 9 July through 6 August 2012 and made available in January 2013. Colony mapping began in January 2013.

*Interpretation*

Within ArcGIS 10.1, we laid a 3-mile by 2.25-mile (4.8-km by 3.6-km) grid over aerial imagery to provide a systematic approach to image analysis. An observer visually inspected each cell within this grid and digitized those areas determined to be colonies using the "freehand drawing tool". Two primary characteristics were used to detect black-tailed prairie dog colonies on aerial images. Mounds of excavated soil are created at black-tailed prairie dog burrow entrances. These mounds are typically one to three meters in diameter and are often void of vegetation (Hoogland 2006a). Size, lack of vegetation and differences in soil color make burrow-entrance mounds detectable on aerial images (Figure 3). Black-tailed prairie dog herbivory within a colony causes changes in vegetation composition and height between a colony and surrounding landcover (Dalsted et al. 1981, Detling 2006). Contrast in vegetation was often the first characteristic observed when scanning for colonies. Presence of burrow mounds helped to confirm the area was a colony. Vegetation contrast was used in combination with burrow presence to detect colonies and digitize polygons.

Observers began detecting colonies at scales approximately 1:9,000 to make colony characteristics easier to detect. Once observers became more familiar with image characteristics, scales of approximately 1:15,000 were more commonly used. To assist with digitizing, images were enhanced using the "adjust contrast" and "adjust brightness" options in the Effects Toolbar in ArcMap to increase the contrast between colonies and the surrounding landscape (Figure 4). The shapefile layer created from 2008 mapping efforts was used to assist in image interpretation confirming colony presence. It was never used to search for colonies. A colony that was intersected by major paved roads was digitized as two polygons. Minor paved roads, gravel and dirt roads and fence lines that intersected a colony were incorporated into one polygon. River and stream drainages were considered natural barriers and were used to digitize the boundary of a colony.

Our intent was to detect and map all colonies within the study area. Each polygon created was considered a colony. Although aerial images have signatures to indicate a colony, typical field signs used to indicate status (active or inactive) of a colony (observation of prairie dogs, fresh diggings, feces and spider webs in burrows) could not be determined from the images.

*Truthing Activities*

We conducted observations from the field to confirm the presence of mapped colonies and determine colony activity status (active or inactive). Once digitizing colonies in a county was completed, the primary observer for that county was involved with the truthing activities. Truthing was completed on a county basis as soon as possible after digitizing was completed with the knowledge that some change would have occurred from the time the 2012 image was taken and the time truthing activities occurred in 2013.

Ground-truthing was conducted in areas that had adequate road coverage. Ground routes were developed in the office and were based upon road availability and condition. Routes were selected by targeting roads that provided access to the most colonies and that minimized travel distances. All colonies observed along the way were examined. Ground-truthing consisted of one driver/observer and one observer/data recorder with a Samsung tablet computer running ArcGIS 10.1 connected by Bluetooth to an external Trimble GPS unit. The tablet was loaded with a roads layer provided by the South Dakota Department of Transportation and the colony polygon file. Route modifications were made in the field due to impassable roads or restricted access. Route locations did not provide good coverage of isolated colonies.

In counties with limited road availability, we used a three-passenger fixed wing airplane (1982 Cessna 172 SkyHawk II) to conduct truthing activities. Length and placement of these routes was developed to provide approximately the same coverage of colony acres as the ground-truthing routes. We estimated that our effective observation distance from both the road and the air was 0.5 mile (0.80 km) on either side of the truthing route. Route coverage was calculated as the sum of the colony acres that intersected this 0.5-mile buffer. Aerial routes were drawn in ArcMap targeting clusters of colonies or large colonies. This resulted in some sharp corners along the route resulting from reaching an isolated colony to meet the coverage minimum. Aerial-truthing consisted of the pilot/observer and an observer/data recorder with a tablet computer running ArcGIS 10.1. The route was loaded onto a GPS unit. No major deviations were made from the route and no effort was made to observe the entire colony, only the portion that fell along the route. Aerial routes were flown at approximately 115 mph (185.1 km/h) at 250 to 300 feet (76.2 to 91.4 meters) above ground.

As each polygon was located, it was confirmed as a colony or as something other. If a polygon did not represent a colony, comments on identification were made directly on the shapefile using the “tablet tools” feature of ArcGIS 10.1. Colonies observed during truthing activities that were not digitized were also recorded for further inspection in the office. These new towns were considered omissions and could be towns that were missed while digitizing or newly formed from the time NAIP imagery was taken. Colonies were determined to be active if at least one visible prairie dog or signs of

recent activity such as fresh diggings and evidence of clipped vegetation was visible. Presence or absence of prairie dogs in each colony was determined by visual inspection and recorded on the shapefile using the “tablet tools” feature of ArcGIS 10.1. If any portion of the colony was active, the entire colony was classified as active.

After truthing activities, field data were compared with digitized polygons. Observers likely improved as they spent more time interpreting images and conducting truthing activities. Accuracy of interpretation was determined by comparing the digitized colony acreage within the 0.5-mile (0.80-m) buffer with that observed in the field within the 0.5-mile (0.80-m) buffer. If an image-interpreted colony was determined by truthing activities to be inactive or something other than a prairie dog colony (misidentification error), it was removed from the final GIS layer. Colonies not detected during image interpretation but spotted from the ground or the air were marked as well (omission error). These colonies were digitized and added to the final GIS layer. Acreage adjustments are suggested for misidentification and omission errors as well as inactive acres, but accurately reflect only those areas along the truthing routes.

*Distribution and Ownership*

County distribution and land ownership of colonies (tribal, state, federal, or private) were determined by using the “intersect tool” in ArcGIS 10.2 on layers containing county, tribal, state and federal land boundaries. Tribal lands are those lands that are held in trust status for individual Indians and federally recognized tribes. The total colony acreage on tribal lands was determined using a 2008 tribal land-ownership layer provided by the Bureau of Indian Affairs office in Aberdeen, South Dakota on 14 April 2009. Non-tribal lands are those under state, federal or private ownership. Privately-owned lands are those that were not identified as tribal, state or federal. To calculate county colony acres, the colony polygon layer was intersected with a county boundary shapefile. Polygons were dissolved according to county boundaries and acres calculated. Distribution and ownership information were calculated in North American Datum 1983, Universal Transverse Mercator projection (Zone 14) using the attribute table’s “statistics function” in ArcGIS 10.2. Spatial analysis was conducted in ArcGIS 10.1 and 10.2.

*Complex Analysis*

Monitoring the acreage and distribution of colonies provides only a part of what is happening on the landscape. The juxtaposition of each colony in relation to others provides information on ecological resilience of this species. A complex can be defined as a group of two or more colonies with a pre-defined maximum inter-colony distance (Figure 5; Hoogland 2006a). We defined a complex by size (both colony and non-colony area) and the number of colonies within a complex. All complexes less than 988.4 acres (400 ha) were removed from our analysis. This acreage was identified in the Multi-state

Conservation Plan as the minimum size for a colony or complex to provide the needs of multiple species (Luce 2003, Luce et al. 2006).

In the interest of providing information that is meaningful for the continued management and conservation of black-tailed prairie dog ecosystems, two sizes of complexes were generated in a GIS using different maximum inter-colony distances. The first and largest of the two was created by buffering colonies in our final colony layer by 1.86 miles (3 km). This provided a maximum inter-colony distance of 3.73 miles (6 km) between any colony boundaries defined by our digitizing. This distance represents a maximum distance traveled by inter-colonial dispersers (Hoogland 2006b). The second and smaller of the two complex sizes was similarly generated in a GIS, but had a 0.78 mile (1.25 km) colony buffer distance. This provided a maximum inter-colony distance of 1.55 miles (2.5 km). This inter-colony distance increases the eventual probability of recolonization should a colony die out (Hoogland 2006b).

## Results

Four observers were used during image interpretation. Each county was interpreted by a single observer. One observer digitized colonies in 16 of the 30 (53.3%) counties evaluated. Colonies were detected in all 30 counties. Image interpretation resulted in 9,708 digitized polygons representing prairie dog colonies (Figure 6). Polygons ranged in size from less than one acre (0.40 ha) to 11,093 acres (4,489.2 ha). Average polygon size was 54.2 acres (SD = 185.4 [21.9 ha, SD=75.0]). A total of 526,641 colony acres (213,124.1 ha) were mapped in the study area. This accounts for almost 1.7% of the 30,198,808 acre (12,221,024.0 ha) study area. Only a small percent of all colony acres mapped occurred east of the Missouri River (1.5% or 7,685 acres [3,110.0 ha]). Colony acres in Shannon, Pennington, Todd and Corson counties made up almost half (49.1%) of the total colony acreage in the study area (Table 1).

Total colony acreage was divided by landownership as follows: 222,173 colony acres (89,910.2 ha) on tribal lands and 304,468 colony acres (123,213 ha) on non-tribal lands (Table 1). Shannon County had the most colony acres on tribal lands (84,791 acres; 34,313 ha). Pennington County had the most colony acres on non-tribal lands (69,287 acres; 28,039.5 ha). Refer to Table 1 for total colony acres in each county or partial county in the study area.

*Tribal*

Colony acreage on tribal lands (222,173 acres; 89,910.2 ha) accounted for 42.2% of the total colony acres mapped in 2012 (Figure 7). Shannon, Todd, Dewey, Corson and Ziebach counties have almost half (48.4%) of all the colony acres found on tribal land.

*Non-tribal*

Colonies on non-tribal lands (state-, federal- and privately-owned lands) accounted for 57.8% (304,468 acres; 123,213 ha) of the total colony acreage in 2012 (Table 2). This was broken down further into 76,821 acres (31,088.4 ha) on public lands and 227,647 acres (92,125.5 ha) on privately-owned lands. Pennington County had the most colony acres on publicly-owned lands (45,096 acres; 18,249.7 ha). Meade County had the most colony acres on private lands (28,847 acres; 11,674.0 ha) (Table 2). State and federal agencies own or manage lands with colonies that accounted for 1.5% (7,699 acres) and 13.1% (69,122 acres; 27,972.7 ha) of all colony acres mapped, respectively (Table 3, Figure 7). Private lands had the highest percent of all colony acres (43.2% [227,647 acres; 92,125.5 ha]).

*Multi-state plan objectives*

We digitized thirty-three colonies in nine counties that are at least 1,000 acres (404.7 ha; Table 4). South Dakota has two colonies greater than 5,000 acres (2,023 ha), one each in Pennington and Shannon counties. The total acreage of colonies greater than 1,000 acres (404.7 ha) accounts for 12.5% of the 526,641 colony acres (213,124.1 ha) mapped. Thirty of the 38 historical counties were included in the study area. At least one colony is present in all 30 counties surveyed within the historic range of this species.

*Truthing*

The same two observers conducted truthing activities from a vehicle along 1,992 miles (3,205.8 km) of road for 12 days from 12 February through 6 August 2013 (Tables 5 and 6a, Figure 8). Ground-truthing routes covered an average of 17% of colony acres per county. One observer and the pilot/observer flew 1,553 miles over eight counties in July (Tables 5 and 6b). Aerial-truthing routes covered an average of 19% of colony acres in the counties that were flown.

We attempted to observe 76,366 colony acres (30,904.2 ha) or 15% of all colony acres mapped within this 0.5-mile (0.8 km) buffer. We categorized digitized polygons that intersected the buffer as colonies, misidentified areas (interpreted as a colony and digitized, but determined to not be a colony from the field) or areas that were omitted (a colony was present, but not detected on the aerial images). We also determined colony activity status while in the field. Some areas we attempted to evaluate were not observable during our truthing activities (out of our viewshed or the status could simply not be determined due to distance from the road or vegetative growth). Of the 76,366 colony acres (30,904.2 ha) we attempted to truth, 22,804 acres (9,228.5 ha) could either not be determined or the area could not be observed. Of the remaining 53,562 acres (21,675.8 ha), 52,861 (21,392.1 ha) were correctly interpreted colony acres, 540 acres

(218.5 ha) were misinterpreted, and 161 acres (65.2 ha) were omitted. Thus, based on our truthing efforts, we correctly interpreted 98.7% of the colony acres observed by truthing activities and misidentified 1.0%. Less than 1% of colony acres were missed during image interpretation. Of the 52,861 acres (21,392.1 ha) confirmed as colonies, 43,791 acres (82.8%; 17,721.6 ha) were active and 9,070 acres (3,670 ha) inactive (17.2%).

*Colony complex analysis*

Seventy-six complexes were generated with a 3.73 mile (6km) maximum inter-colony distance (Figure 13). Complex size ranged from 7,785 acres (3,150.5 ha) to over 15,000,000 acres (6,070,284.6 ha) and averaged 226,853 acres (SD = 1,730,582; 91,804.2 ha, SD = 700,341.7). The average number of colonies a complex contained was 126.8 (SD = 1,046.8). Fifty-nine percent of the complexes contained either 2 or 3 colonies; 25% contained 4, 5, or 6 colonies. The largest complex contained 9,191 colonies. Average colony size within a complex ranged from to 1.4 to 191 acres (0.57 to 77.3 ha). At most, 3.6% of a complex was comprised of colony acres.

Six hundred and forty-two complexes were generated with a 1.55 mile (2.5 km) maximum inter-colony distance (Figure 14). Complex size ranged from 1,356 to 1,625,016 acres (548.8 to 657,620.4 ha). Average complex size was 11,708.3 acres (SD = 83,249.6; [4,738.2 ha, SD = 33,690]). The average number of colonies a complex contained was 14.2 (SD = 120.6). Fifty-seven percent of the complexes contained 2 or 3 colonies; 22% contained 4, 5, or 6 colonies. The largest complex contained 2,324 colonies. Average colony size within a complex ranged from less than one acre (0.40 ha) to 374.8 acres (151.7 ha). At most, 17.3% of a complex was comprised of colony acres.

## Discussion

*State management plan objectives*

The statewide (199,472 acres; 80,723.5 ha ) and non-tribal (166,958 acres; 67,565.5 ha) colony acreage goals set forth by Cooper and Gabriel (2005) were achieved in 2012. Thus, there is no required change in state management actions. Tribal colony acreage in 2012 exceeds the apportionment (16.3%) of the state-wide acreage goal set to accommodate tribal management of black-tailed prairie dogs.

*Multi-state management plan objectives*

South Dakota has met the three state-specific target acreage and distribution objectives outlined in the multi-state management plan (Luce 2003). South Dakota has at least one colony (and many complexes) >5,000 acres (2,023.4 ha). At least 10% of the total

mapped and estimated occupied acreage is in colonies >1,000 acres (404.7 ha). Black-tailed prairie dog colonies are present in at least 30 of the 38 counties (79%) found within the historic range of the species in South Dakota.

*Trends in colony acreage and distribution*

This report summarizes the fourth colony monitoring effort conducted by SDGFP. Total colony acreage in 2012 decreased 16.5% (104,208 fewer acres; 42,171.5 ha) from 2008 (Figure 9). Total acreage in 2012 was still 27.8% higher than colony acreage mapped in 2003. Statewide colony distribution remains similar to previous mapping efforts with the majority of colonies found west of the Missouri River. Since our mapping efforts began, slightly less than half of the colony acres mapped occurred on non-tribal lands. In 2012, slightly over half (58.6%) of the colony acres were on non-tribal lands. Note that the tribal landownership layer used was based on information from 2009, the most recent available to us. Acreage calculations based on updated information may differ from what is reported here. Refer to Table 7 for trends in colony acres for each county. Please refer to Stukel et al. (2004), Kempema (2007) and Kempema et al. (2009) for details on previous survey efforts.

*Trends in colony acreage-high density area only*

In 2006, counties or portions of counties were classified as having high or low colony acreage (Figure 10). High acreage counties included Bennett, Corson, a portion of Custer, Dewey, Fall River, Jackson, Mellette, a portion of Pennington, Shannon, Todd and Ziebach counties. A census of these counties has been conducted among all four monitoring efforts making a temporal comparison of colony acreage within this area useful. In 2006, transects were used to sample the colony acreages within the counties considered low acreage (Kempema 2007).

Over the four survey years, colony acres in high acreage counties represented an average of 84.0% of total colony acres mapped in South Dakota. In 2012, there were 419,224 colony acres mapped in these counties. This was 21% less (110,998 fewer acres; 44,919 ha) than in 2008. Despite this recent decrease, there are still 68,505 more acres in these counties than the acreage mapped in 2002-2003. This 21% decrease in the high acreage counties alone would not trigger any changes in state management actions and both state-wide and non-tribal colony acreage goals are met.

A combination of below average annual precipitation and the presence of plague may help to explain fewer colony acres in western South Dakota. Archived weather data were downloaded from South Dakota State University's Climate and Weather website (http://climate.sdstate.edu/climate_site/climate.htm). We used data from the Cottonwood Automated Weather Station # 391972 (northwestern Jackson County; Latitude 43.9599, Longitude -101.8539) as the best representative location for our

analysis area and because it provided a complete data set. In 2011 and 2012, annual precipitation was below the 30-year average (Figure 11).

The first documented plague epizootic in black-tailed prairie dogs in South Dakota occurred in 2005 in Shannon County (Mann-Klager 2005, Smith 2009). In 2007, a colony in Dewey County was confirmed to have been affected by plague. In 2008, a plague epizootic affected 10,823 colony acres (4,380 ha) in the Conata Basin (Griebel 2008). Effects of this zoonotic disease are still being documented in this basin (Griebel 2013a). Based on available information (plague positive animals, flea samples or confirmed reports of prairie dog die-offs), plague has a likely distribution across much of western South Dakota (Figure 12). This does not mean that an epizootic is or has occurred in these areas, but that the bacterium *Yersinia pestis* that causes plague is present.

*Limitations to image interpretation*

The ability to detect active colonies through aerial imagery interpretation is limited if a colony has undergone an abrupt change in activity status (Biggins et al. 2006). This abrupt change can be caused by plague or poisoning.

There is currently no intensive, state-wide plague monitoring effort in South Dakota. On a smaller scale, efforts to monitor the movement of the disease on the Pine Ridge Indian Reservation and on Forest Service and National Park Service lands in and around the Conata Basin have been thorough (Ecoffey, personal communication, Griebel 2014). Monitoring elsewhere has been limited in scope or consistency or nonexistent. Plague-causing bacterium likely occurs in most if not all counties west of the Missouri River in South Dakota. Severe outbreaks of plague in prairie dog colonies (epizootics) are known to occur under certain environmental conditions. We know from our mapping efforts in 2008 that without specific information on the location and movement of a plague epizootic, a colony can be considerably impacted by plague while still leaving the signature of a colony on an aerial image (Kempema et al. 2009).

Zinc phosphide is used to control prairie dog acres in South Dakota by both public and private entities. In 2012, SDGFP poisoned 3,591 acres of unwanted colony acres that encroached from public onto private lands. In that same year, the Wall Ranger District, Buffalo Gap National Grassland, U.S. Forest Service treated a total of 295 colony acres (119.4 ha) with rodenticide (Griebel 2013b). The area of colony acres poisoned on other public, tribal trust and private lands is unknown. Comprehensive information on the number of colony acres poisoned on private lands remains limited.

One indication of the potential amount of acres treated in South Dakota is the sale of zinc phosphide bait by South Dakota Bait Station, a part of the SDDA. A total of 70,650 lbs (32,046.3 kg) of bait was sold from the bait station during calendar year 2012. Of

this total, 60% (42,550 lbs; 19,300.4 kg) was sold to in-state entities. Government entities purchased 37,050 lbs (16,805.6 kg). Sales to non-government entities totaled 33,600 lbs (15,240.7 kg). Unfortunately, sales represent the demand, but do not accurately reflect how much is applied, location of application or effectiveness. In addition to zinc phosphide, chlorophacinone (Rozol) can now be legally used to control prairie dogs in South Dakota. It is unknown how many acres are controlled using this pesticide, where these control efforts are occurring and what is treatment effectiveness. Given our lack of information on exactly when and where plague outbreaks occurred or even if they occurred in 2012 as well as the location and size of poisoned colonies, the total colony acreage presented in this report is likely an overestimate.

Based on our limited truthing efforts, we estimated that 17.2% of the mapped polygons was inactive, 1% was not colonies and 0.3% was missed in 2012. Using these estimates (although biased) as a correction factor on the acreage of the polygons initially mapped before ground truthing was conducted (536,412 acres; 217, 078.2 ha), there would be 438,388.5 active colony acres (177,409.5 ha) within the surveyed area in 2012.

*Black-tailed Prairie Dog Density*

We did not estimate the number or density of individual prairie dogs or their burrows in South Dakota. The density of black-tailed prairie dogs varies with location as well as temporally and with management (Biggins et al. 2006).

## Recommendations

McDonald et al. (2011) provides the states within the black-tailed prairie dog range the opportunity to move towards a standardized monitoring methodology. SDGFP should continue to work with other states and researchers towards that objective. However, state agency needs should not be ignored in the process.

Improvements to ground- and aerial-truthing methodology should be made to allow for development of a correction factor to address interpretation errors and inactive colony status. This would improve statewide colony acreage estimates. Development of this correction factor would likely require a more intensive on-the-ground effort.

## Acknowledgements

We'd like to acknowledge John Green, Keith Fisk, Doug Jones, Tom Kirschenmann, Chris Marsh, Eileen Dowd Stukel and Chad Switzer with SDGFP and Diane Mann-Klager with Bureau of Indian Affairs for their assistance in this mapping effort. Thank you to Lyman McDonald, WEST Inc. for providing a review. Funding for this project was provided by SDGFP.

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## Tables

Table 1. Black-tailed prairie dog colony acreage and distribution in South Dakota, 2012.

| County | | Colony Acres | | | |
|---|---|---|---|---|---|
| **Name** | **Area (ac)[a]** | **Tribal** | **Non-Tribal** | **Total** | **% Total** |
| Bennett | 762,200 | 2,888 | 5,186 | 8,074 | 1.5 |
| Brule | 541,315 | 0 | 1,207 | 1,207 | 0.2 |
| Buffalo | 311,908 | 446 | 744 | 1,190 | 0.2 |
| Butte | 1,453,902 | 0 | 5,129 | 5,129 | 1.0 |
| Campbell | 493,025 | 0 | 300 | 300 | 0.1 |
| Charles Mix | 735,594 | 52 | 365 | 417 | 0.1 |
| Corson | 1,618,898 | 22,056 | 20,478 | 42,534 | 8.1 |
| Custer | 642,089 | 0 | 26,181 | 26,181 | 5.0 |
| Dewey | 1,564,586 | 23,570 | 13,940 | 37,510 | 7.1 |
| Fall River | 1,122,275 | 0 | 16,495 | 16,495 | 3.1 |
| Gregory | 673,729 | 29 | 2,027 | 2,056 | 0.4 |
| Haakon | 1,169,494 | 0 | 2,686 | 2,686 | 0.5 |
| Harding | 1,717,825 | 0 | 2,063 | 2,063 | 0.4 |
| Hughes | 512,136 | 189 | 917 | 1,106 | 0.2 |
| Hyde | 553,907 | 437 | 710 | 1,147 | 0.2 |
| Jackson | 1,198,002 | 9,551 | 11,526 | 21,077 | 4.0 |
| Jones | 621,159 | 0 | 4,591 | 4,591 | 0.9 |
| Lyman | 1,091,672 | 5,159 | 5,621 | 10,780 | 2.0 |
| Meade | 2,232,084 | 2 | 30,782 | 30,784 | 5.8 |
| Mellette | 838,711 | 17,181 | 18,066 | 35,246 | 6.7 |
| Pennington | 1,257,168 | 0 | 69,287 | 69,287 | 13.2 |
| Perkins | 1,851,473 | 6 | 12,547 | 12,553 | 2.4 |
| Potter | 574,772 | 0 | 270 | 270 | 0.1 |
| Shannon | 1,343,454 | 84,791 | 10,904 | 95,695 | 18.2 |
| Stanley | 970,679 | 216 | 9,769 | 9,984 | 1.9 |
| Sully | 684,579 | 0 | 1,275 | 1,275 | 0.2 |
| Todd | 889,822 | 37,238 | 13,925 | 51,163 | 9.7 |
| Tripp | 1,034,554 | 635 | 6,440 | 7,075 | 1.3 |
| Walworth | 476,255 | 0 | 772 | 772 | 0.1 |
| Ziebach | 1,261,543 | 17,726 | 10,268 | 27,994 | 5.3 |
| **Totals** | 30,198,808 | **222,173** | **304,468** | **526,641** | 100 |

[a]County area includes both land and water.

Table 2. Black-tailed prairie dog colony acreage and distribution on non-tribal (state-, federal- and privately-owned) lands in South Dakota, 2012.

| | Public | | | | |
|---|---|---|---|---|---|
| **County** | State | Federal | **Total** | **Private** | **Total** |
| Bennett | 106 | 393 | 499 | 4,687 | 5,186 |
| Brule | 89 | 0 | 89 | 1,119 | 1,207 |
| Buffalo | 0 | 0 | 0 | 744 | 744 |
| Butte | 118 | 1,063 | 1,181 | 3,948 | 5,129 |
| Campbell | 0 | 0 | 0 | 300 | 300 |
| Charles Mix | 23 | 0 | 23 | 342 | 365 |
| Corson | 313 | 900 | 1,214 | 19,264 | 20,478 |
| Custer | 911 | 8,443 | 9,354 | 16,826 | 26,181 |
| Dewey | 420 | 0 | 420 | 13,520 | 13,940 |
| Fall River | 366 | 3,824 | 4,190 | 12,305 | 16,495 |
| Gregory | 1 | 0 | 1 | 2,026 | 2,027 |
| Haakon | 34 | 0 | 34 | 2,651 | 2,686 |
| Harding | 614 | 130 | 745 | 1,318 | 2,063 |
| Hughes | 20 | 0 | 20 | 897 | 917 |
| Hyde | 0 | 0 | 0 | 710 | 710 |
| Jackson | 100 | 1,553 | 1,653 | 9,873 | 11,526 |
| Jones | 134 | 171 | 305 | 4,287 | 4,591 |
| Lyman | 320 | 207 | 527 | 5,094 | 5,621 |
| Meade | 1,236 | 699 | 1,935 | 28,847 | 30,782 |
| Mellette | 332 | 0 | 332 | 17,733 | 18,066 |
| Pennington | 922 | 44,175 | 45,096 | 24,190 | 69,287 |
| Perkins | 763 | 1,705 | 2,468 | 10,079 | 12,547 |
| Potter | 0 | 0 | 0 | 270 | 270 |
| Shannon | 0 | 3,610 | 3,610 | 7,294 | 10,904 |
| Stanley | 317 | 2,250 | 2,567 | 7,202 | 9,769 |
| Sully | 176 | 0 | 176 | 1,099 | 1,275 |
| Todd | 0 | 0 | 0 | 13,925 | 13,925 |
| Tripp | 28 | 0 | 28 | 6,412 | 6,440 |
| Walworth | 54 | 0 | 54 | 718 | 772 |
| Ziebach | 303 | 0 | 303 | 9,966 | 10,268 |
| **Total** | 7,699 | 69,122 | **76,821** | **227,647** | **304,468** |

Table 3. Black-tailed prairie dog colony acreage and distribution on public lands in South Dakota, 2012.

| State | Colony Acres |
|---|---|
| School and Public Lands | 6,244 |
| Game, Fish and Parks | |
| Game Production Areas | 642 |
| Parks and Recreation Areas | 813 |
| Total | 7,699 |
| **Federal** | |
| National Park Service | 18,141 |
| U.S. Forest Service | 48,312 |
| U.S. Fish and Wildlife Service | 394 |
| Bureau of Land Management | 2,275 |
| Total | 69,122 |
| **Total** | **76,822** |

Table 4. Location, number and total county acreages of black-tailed prairie dog colonies greater than 1,000 acres in South Dakota, 2012.

| County | # Colonies | Colony Acres |
|---|---|---|
| Corson | 1 | 1,214 |
| Custer | 1 | 1,172 |
| Dewey | 1 | 1,105 |
| Lyman | 1 | 1,453 |
| Meade | 3 | 3,530 |
| Mellette | 1 | 1,159 |
| Pennington[a] | 8 | 21,338 |
| Shannon[b] | 15 | 32,014 |
| Todd | 2 | 2,722 |
| **Total** | **33** | **65,706** |

[a] One colony is greater than 5,000 acres (11,093 acres; 4,489.2 hectares)
[b] One colony is greater than 5,000 acres (7,993 acres; 3,234.7 hectares)

Table 5. Date and location of activities conducted to evaluate aerial image interpretation of black-tailed prairie dog colony acres in South Dakota, 2013.

| County | Date |
|---|---|
| Lyman | February 12 |
| Tripp | April 26 |
| Jones | April 30 |
| Bennett | May 3 |
| Haakon, Jackson, Custer, Fall River, Pennington | May 14-16 |
| Shannon | May 17 |
| Dewey, Ziebach | July 9* |
| Ziebach, Corson | July 10* |
| Perkins, Meade | July 16* |
| Butte, Harding | July 17* |
| Mellette, Todd | July 29 |
| Stanley | July 30 |
| Sully, Hughes, Hyde | July 31 |
| Brule, Buffalo | August 6 |

*Truthing activities completed by airplane.

Table 6. Miles driven (a) and flown (b) to truth aerial image interpretation of black-tailed prairie dog colony acres in South Dakota, 2013.

| a | County | Miles |
|---|---|---|
| | Bennett | 111 |
| | Brule | 30 |
| | Buffalo | 31 |
| | Custer | 100 |
| | Fall River | 152 |
| | Haakon | 141 |
| | Hughes | 73 |
| | Hyde | 41 |
| | Jackson | 168 |
| | Jones | 157 |
| | Lyman | 149 |
| | Mellette | 90 |
| | Pennington | 142 |
| | Shannon | 178 |
| | Stanley | 166 |
| | Sully | 34 |
| | Todd | 48 |
| | Tripp | 181 |
| | **Total** | 1,992 |

| b | County | Miles |
|---|---|---|
| | Sully | 12 |
| | Harding | 185 |
| | Perkins | 194 |
| | Butte | 200 |
| | Ziebach | 204 |
| | Dewey | 210 |
| | Meade | 271 |
| | Corson | 277 |
| | **Total** | 1,553 |

Table 7. Temporal comparison of black-tailed prairie dog colony acres and distribution in South Dakota.

| County | 2003[a] | 2006[b] | 2008[c] | 2012[d] |
|---|---|---|---|---|
| Bennett | 6,511 | 10,742 | 10,456 | 8,074 |
| Brule | 1,277 | na | 1,158 | 1,207 |
| Buffalo | 1,983 | na | 2,888 | 1,190 |
| Butte | 2,009 | 4,400 | 5,052 | 5,129 |
| Campbell | 0 | na | 136 | 300 |
| Charles Mix | 245 | na | 535 | 417 |
| Corson | 26,213 | 40,646 | 41,081 | 42,534 |
| Custer | 13,213 | 18,936 | 26,518 | 26,181 |
| Dewey | 48,342 | 58,720 | 80,655 | 37,510 |
| Fall River | 9,291 | 16,855 | 22,367 | 16,495 |
| Gregory | 1,131 | 1,457 | 1,715 | 2,056 |
| Haakon | 1,483 | 2,965 | 2,582 | 2,686 |
| Hand | 252 | na | 3 | na |
| Harding | 2,976 | 4,235 | 4,110 | 2,063 |
| Hughes | 1,449 | na | 2,283 | 1,106 |
| Hyde | 729 | na | 2 | 1,147 |
| Jackson | 11,586 | 25,550 | 22,864 | 21,077 |
| Jones | 2,536 | 2,967 | 5,682 | 4,591 |
| Lyman | 5,781 | 10,853 | 10,749 | 10,780 |
| Meade | 18,116 | 23,115 | 27,091 | 30,784 |
| Mellette | 37,960 | 65,578 | 56,261 | 35,246 |
| Pennington | 36,804 | 57,909 | 63,489 | 69,287 |
| Perkins | 8,093 | 12,690 | 18,735 | 12,553 |
| Potter | 162 | na | 598 | 270 |
| Shannon | 90,736 | 144,336 | 119,483 | 95,695 |
| Stanley | 5,813 | 8,140 | 9,439 | 9,984 |
| Sully | 815 | na | 1,272 | 1,275 |
| Todd | 49,884 | 76,250 | 50,009 | 51,163 |
| Tripp | 3,360 | 8,708 | 4,813 | 7,075 |
| Walworth | 538 | na | 0 | 772 |
| Ziebach | 22,834 | 30,357 | 38,820 | 27,994 |
| **Totals** | **412,122** | **625,410** | **630,849** | **526,641** |

[a] See Stukel et al. (2004) for a description of the study area and methods used.
[b] See Kempema (2007) for a description of the study area and methods used. Not applicable (na) indicates these counties were not included in the study area in 2006.
[c] See Kempema et al. (2009) for a description of the study area and methods used. Note that in 2008 a complete survey of Hand and Hyde counties was not conducted.
[d] See the methods section of this report.

## Figures

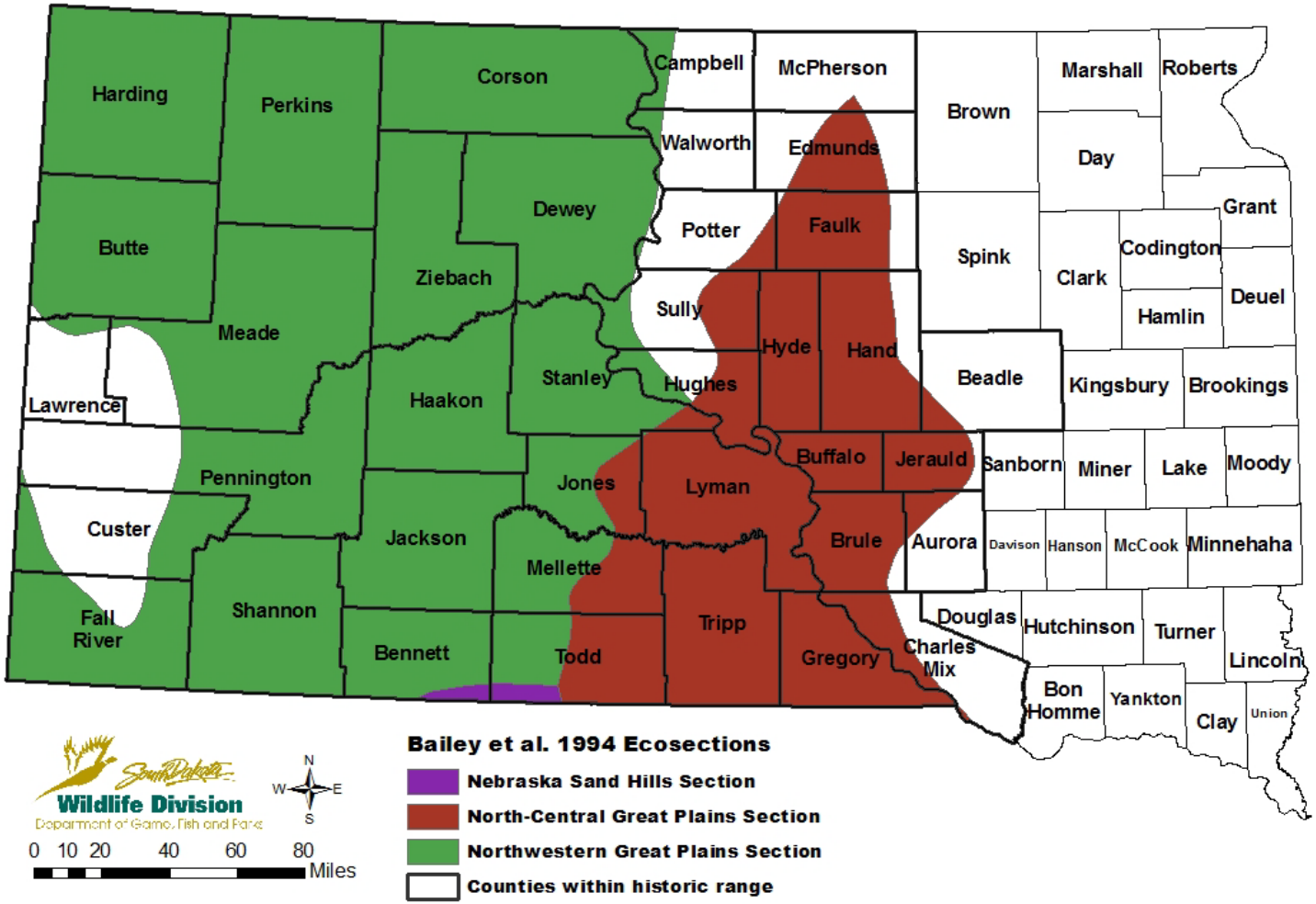


Figure 1. Core (Northwestern Great Plains) and secondary (Nebraska Sandhills and North-central Great Plains) management areas within the historical range of the black-tailed prairie dog as delineated by Bailey's ecosections and a historical range map (Hall 1981, Bailey et al. 1994, Luce 2003, Cooper and Gabriel 2005).

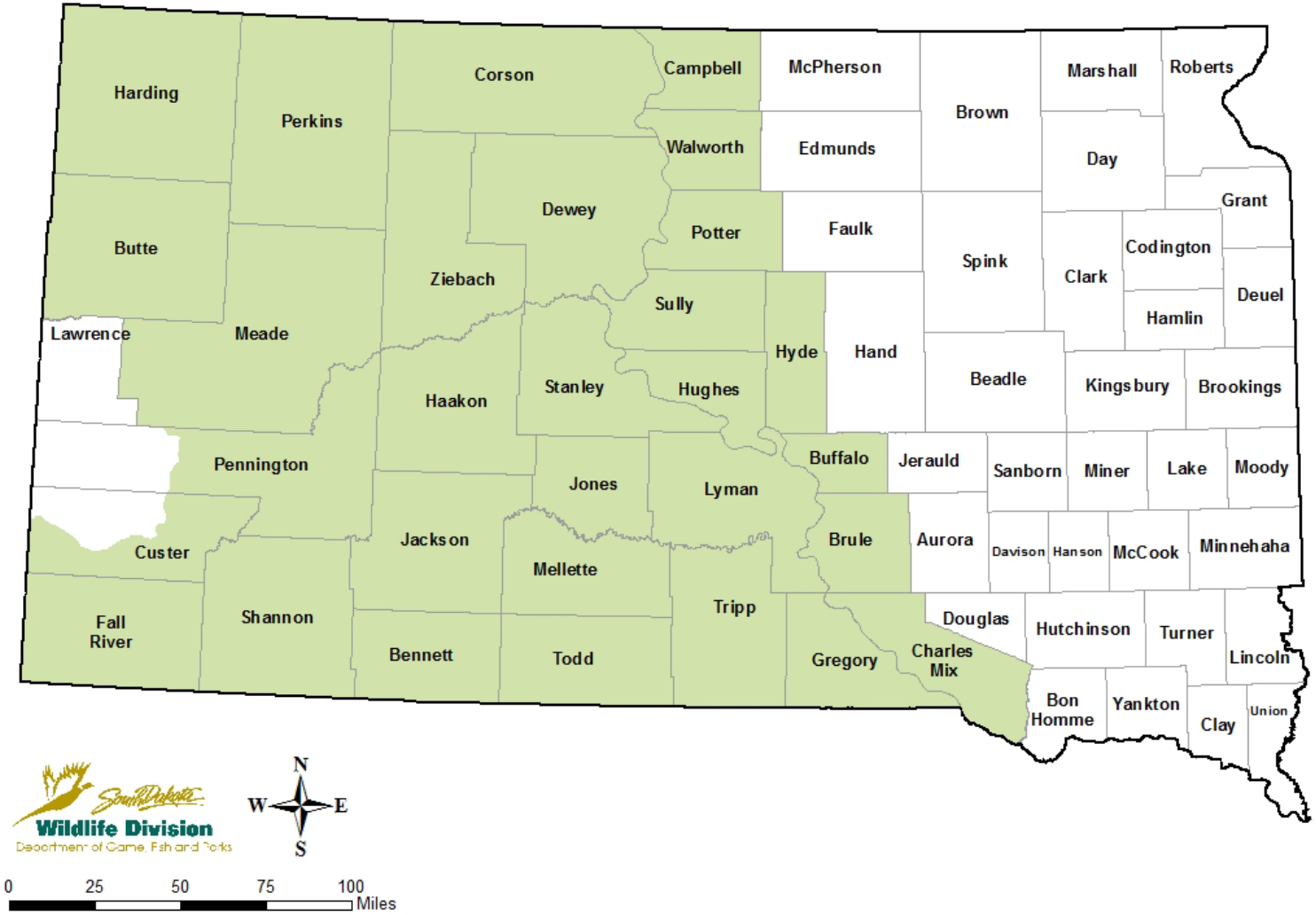


Figure 2. Counties and portions of counties evaluated for acreage and distribution of black-tailed prairie dog colonies in South Dakota, 2012.

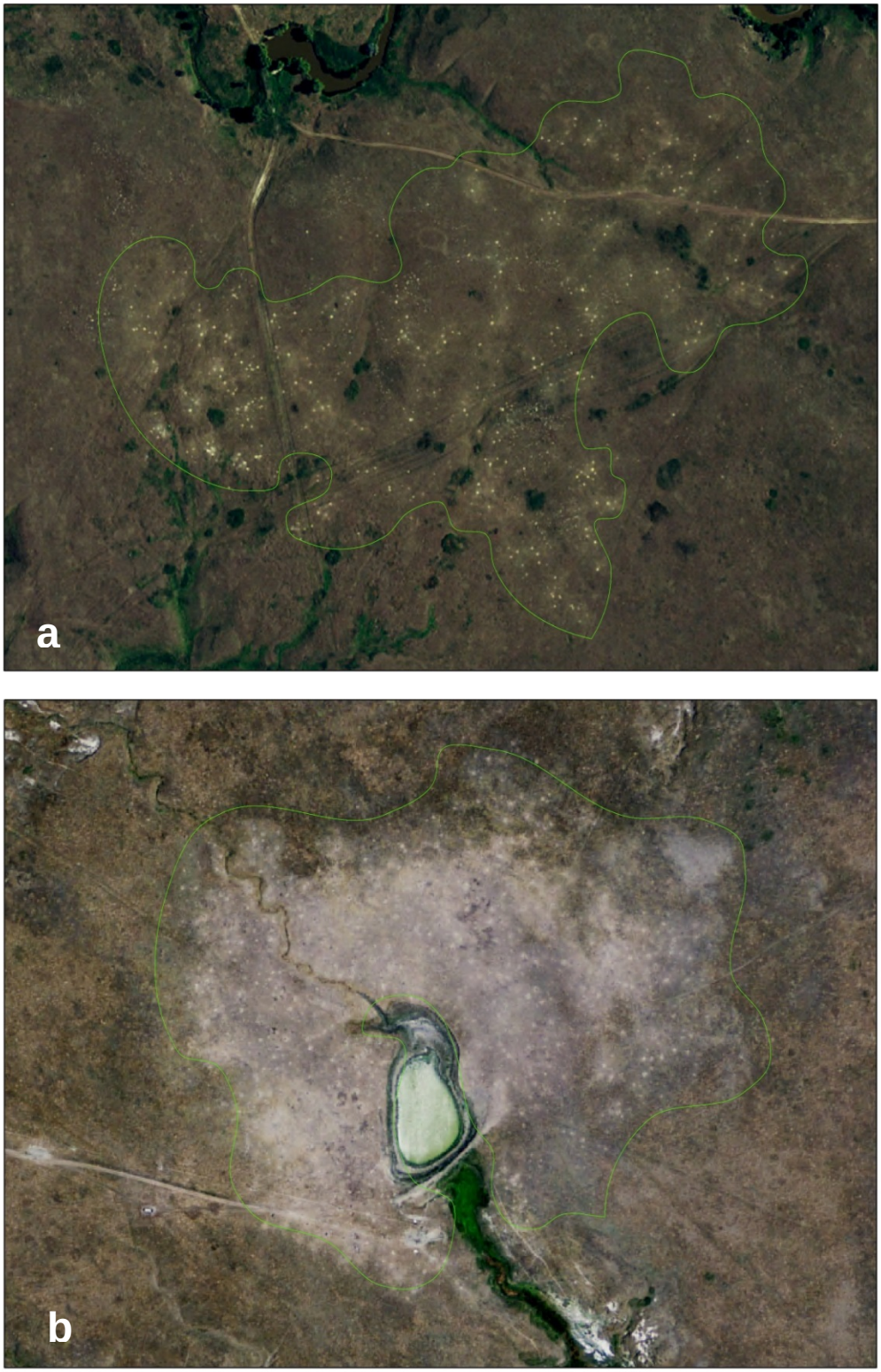


Figure 3. Example of aerial image interpretation using (a) presence of burrow-entrance mounds and (b) a combination of burrow-entrance mounds and contrasting land cover to indicate a black-tailed prairie dog colony (outlined in green).

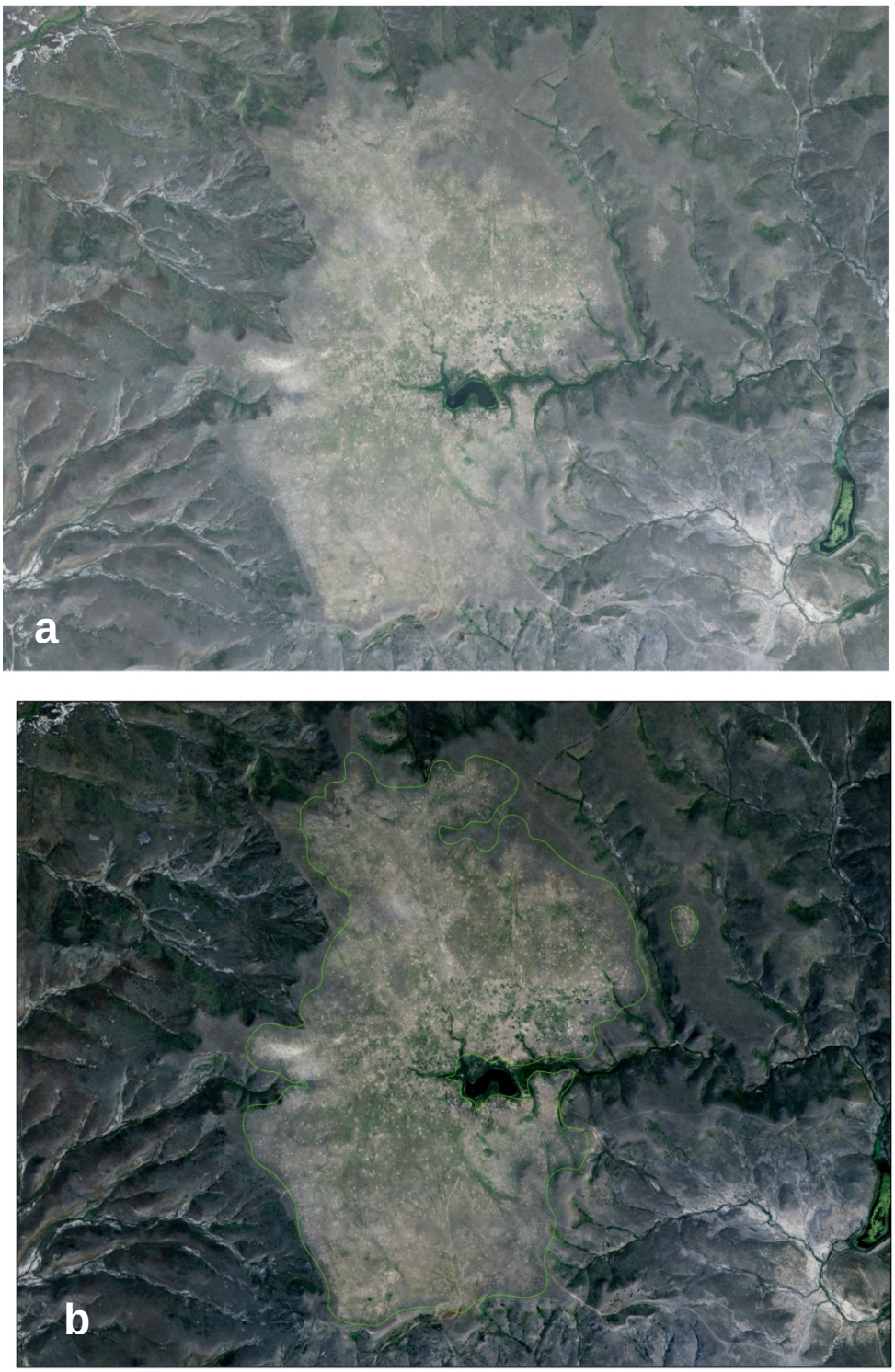


Figure 4. A prairie dog colony in Dewey County, South Dakota (a) before the image was enhanced using a GIS and (b) after enhancing the contrast in vegetation signatures (contrast increased 24%, brightness decreased 18%). This was done to aid in digitizing the colony boundary outlined in green.

Figure 5. Illustration of a prairie dog complex.

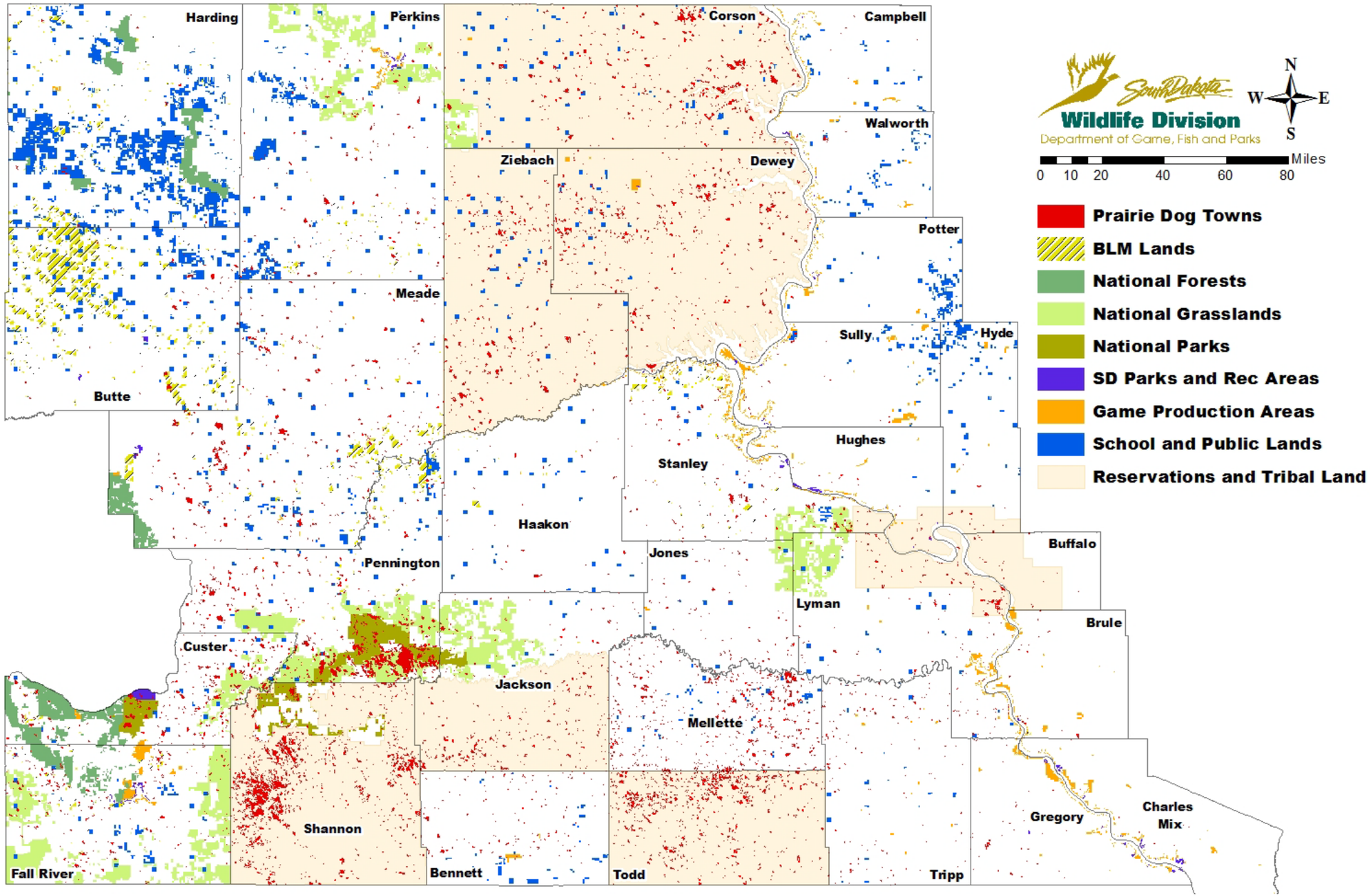


Figure 6. Distribution of black-tailed prairie dog colonies in South Dakota, 2012.

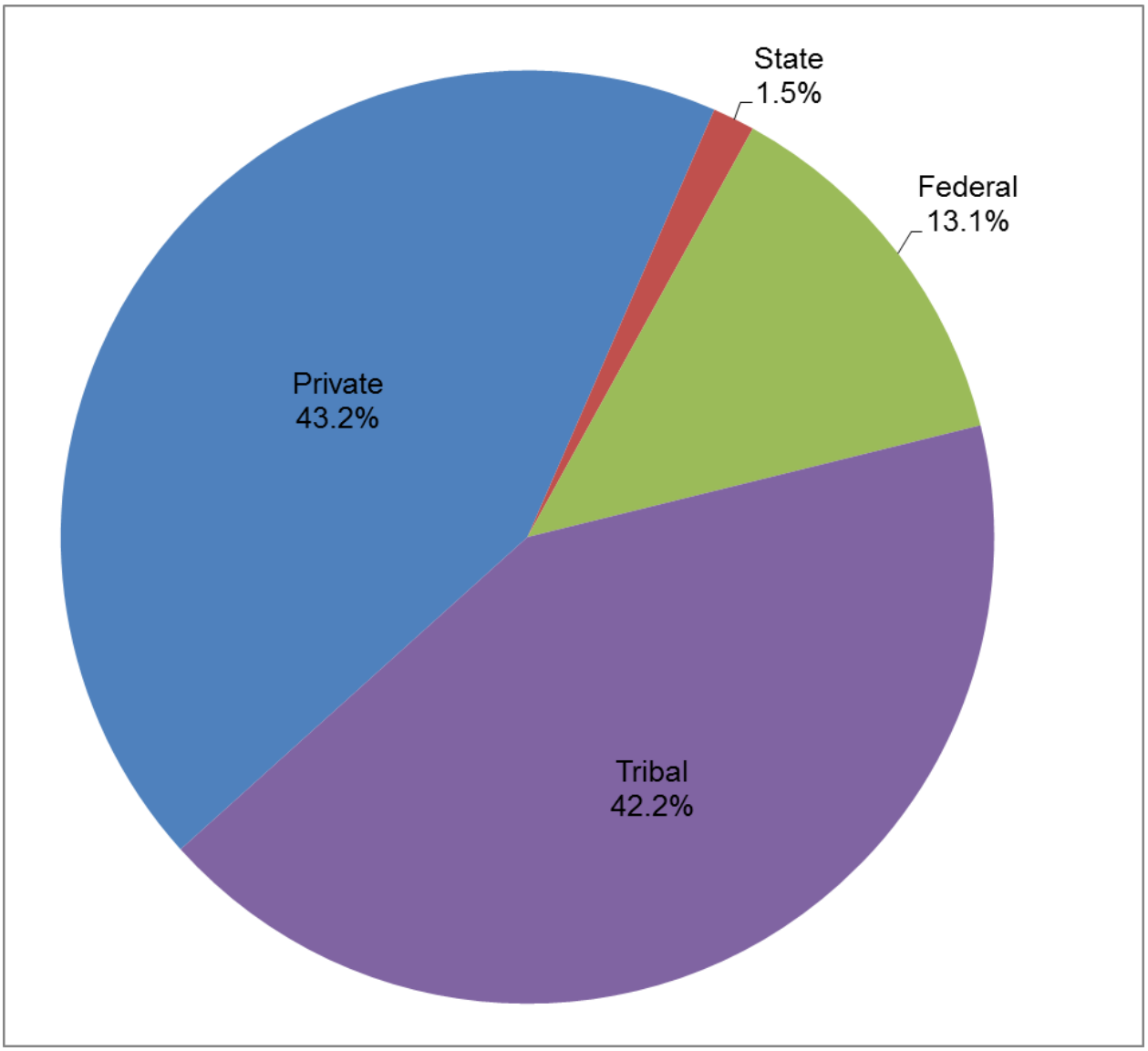


Figure 7. Percent composition of black-tailed prairie dog colony acres by land ownership in South Dakota, 2012. State-, federal- and privately-owned lands are classified as non-tribal.

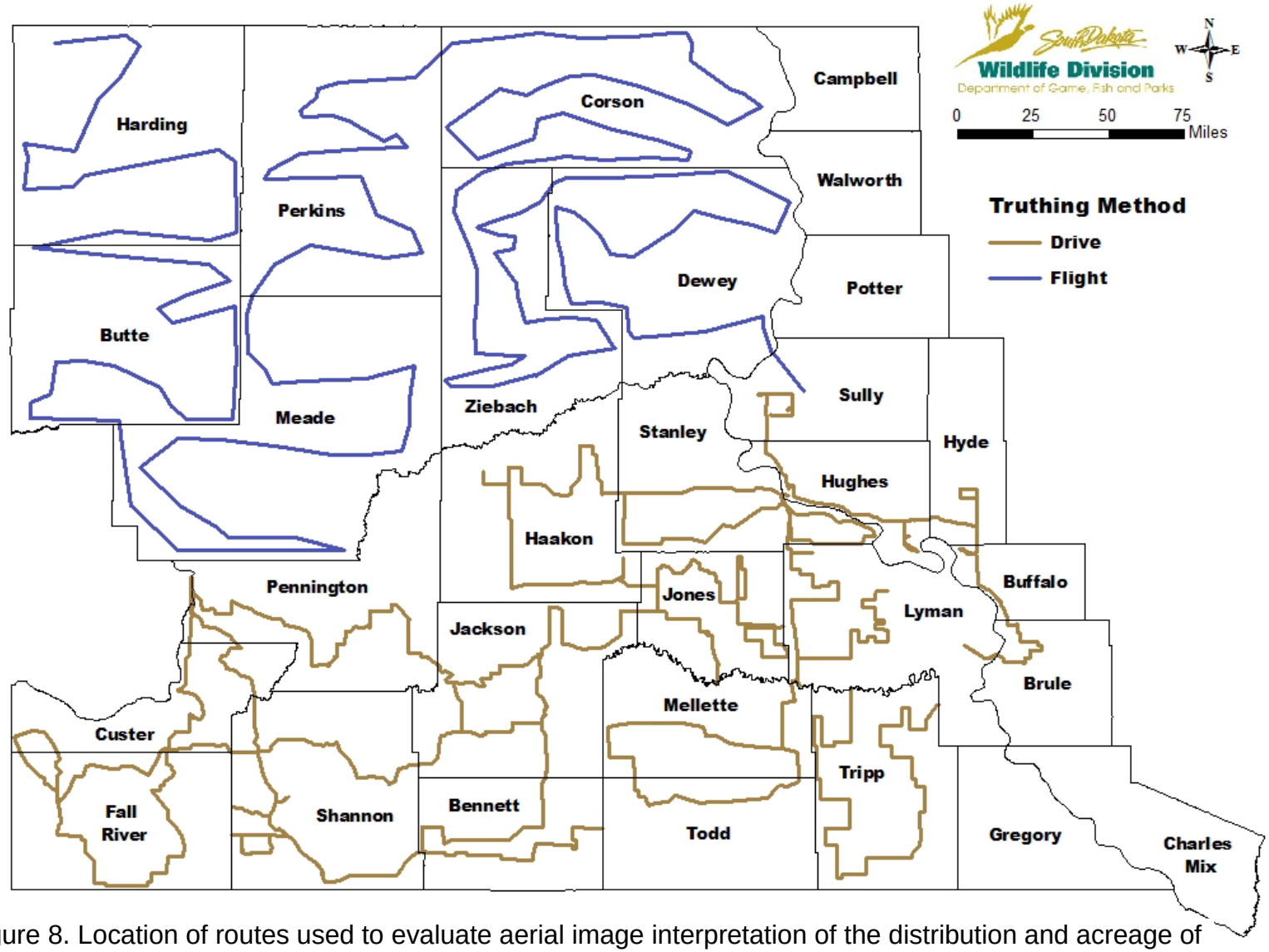


Figure 8. Location of routes used to evaluate aerial image interpretation of the distribution and acreage of black-tailed prairie dog colonies in South Dakota, 2013

Figure 9. Temporal comparison of black-tailed prairie dog colony acres in South Dakota. Refer to (Stukel et al. 2004, Kempema 2007, Kempema et al. 2009) and the methods section of this report for detail on study area and methods used during each study.

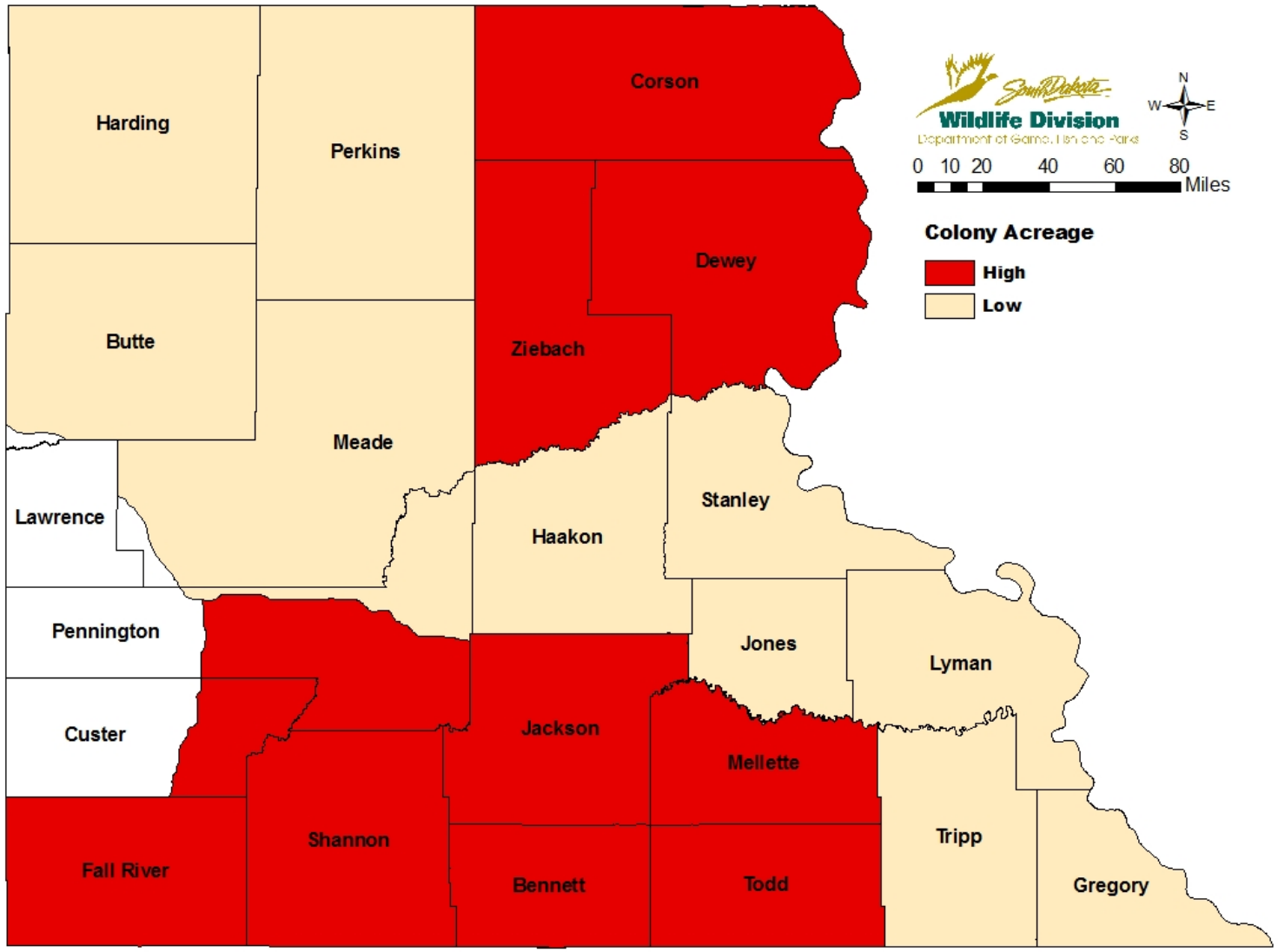


Figure 10. Stratification of counties or portions of counties based on black-tailed prairie dog colony acres in 2006.

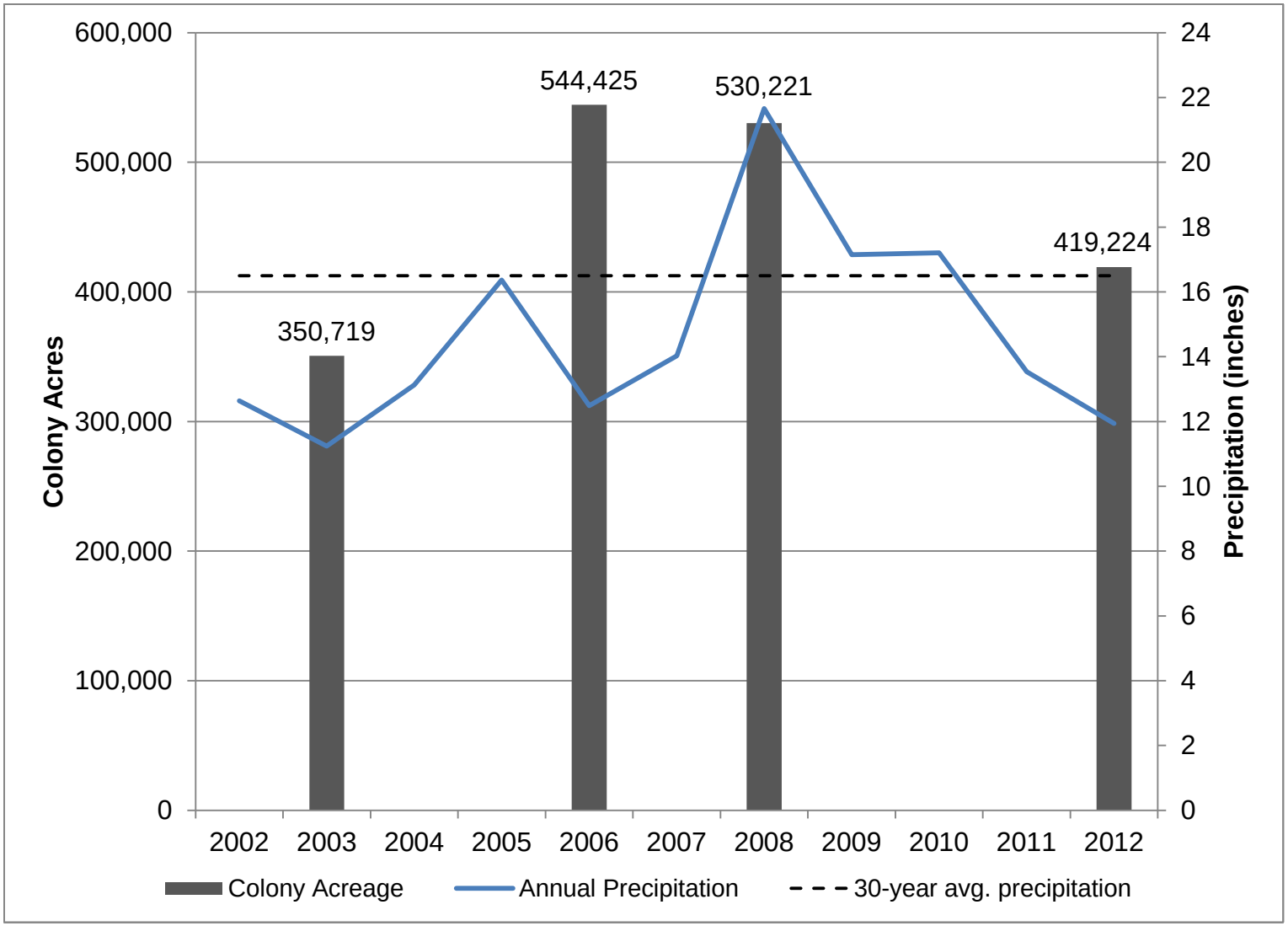


Figure 11. Temporal change in black-tailed prairie dog colony acres in high colony acreage South Dakota counties. Annual precipitation values from a weather station near Cottonwood, South Dakota.

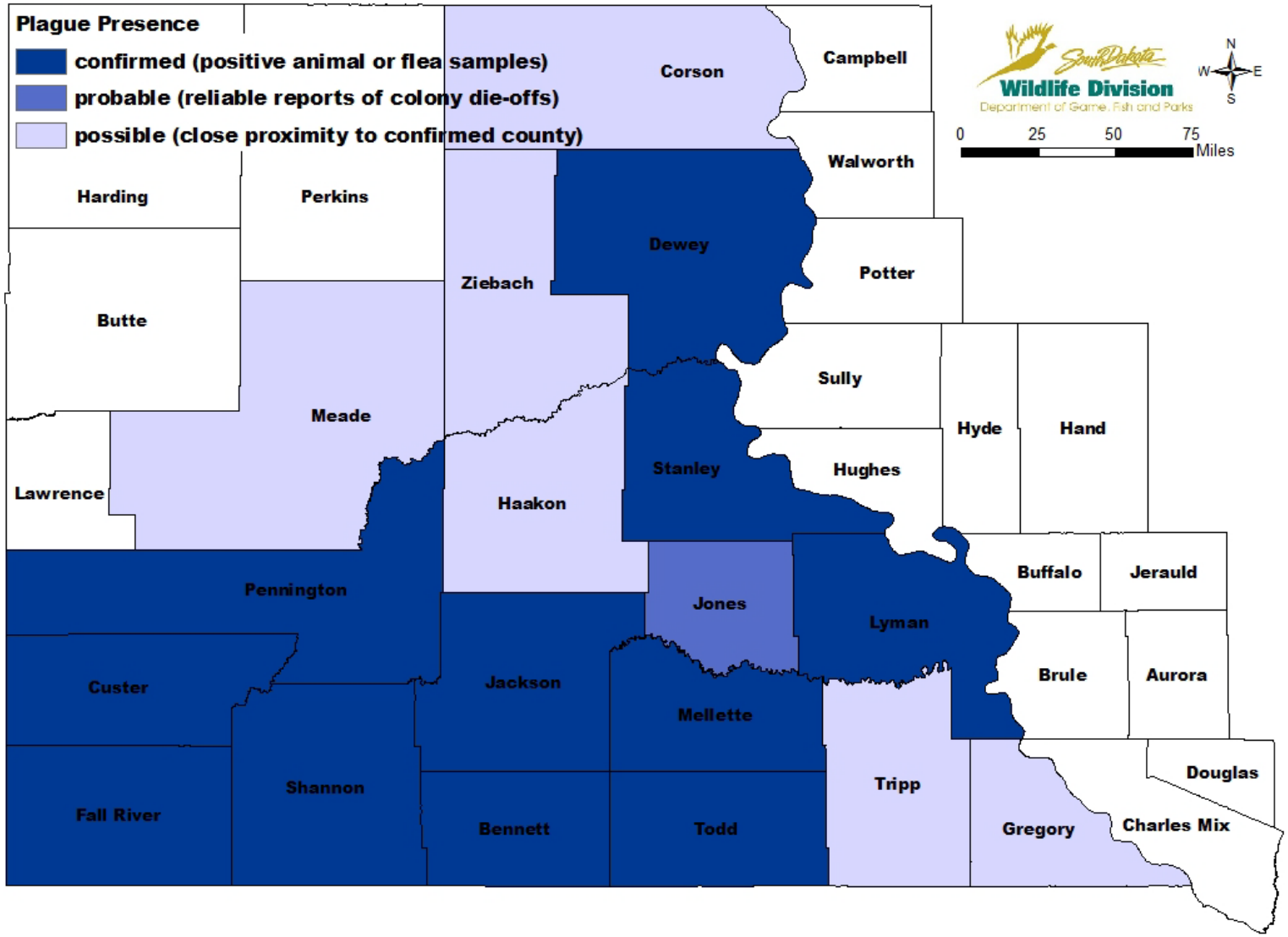


Figure 12. Predicted distribution of plague (*Yersinia pestis*) in South Dakota as of 2012.

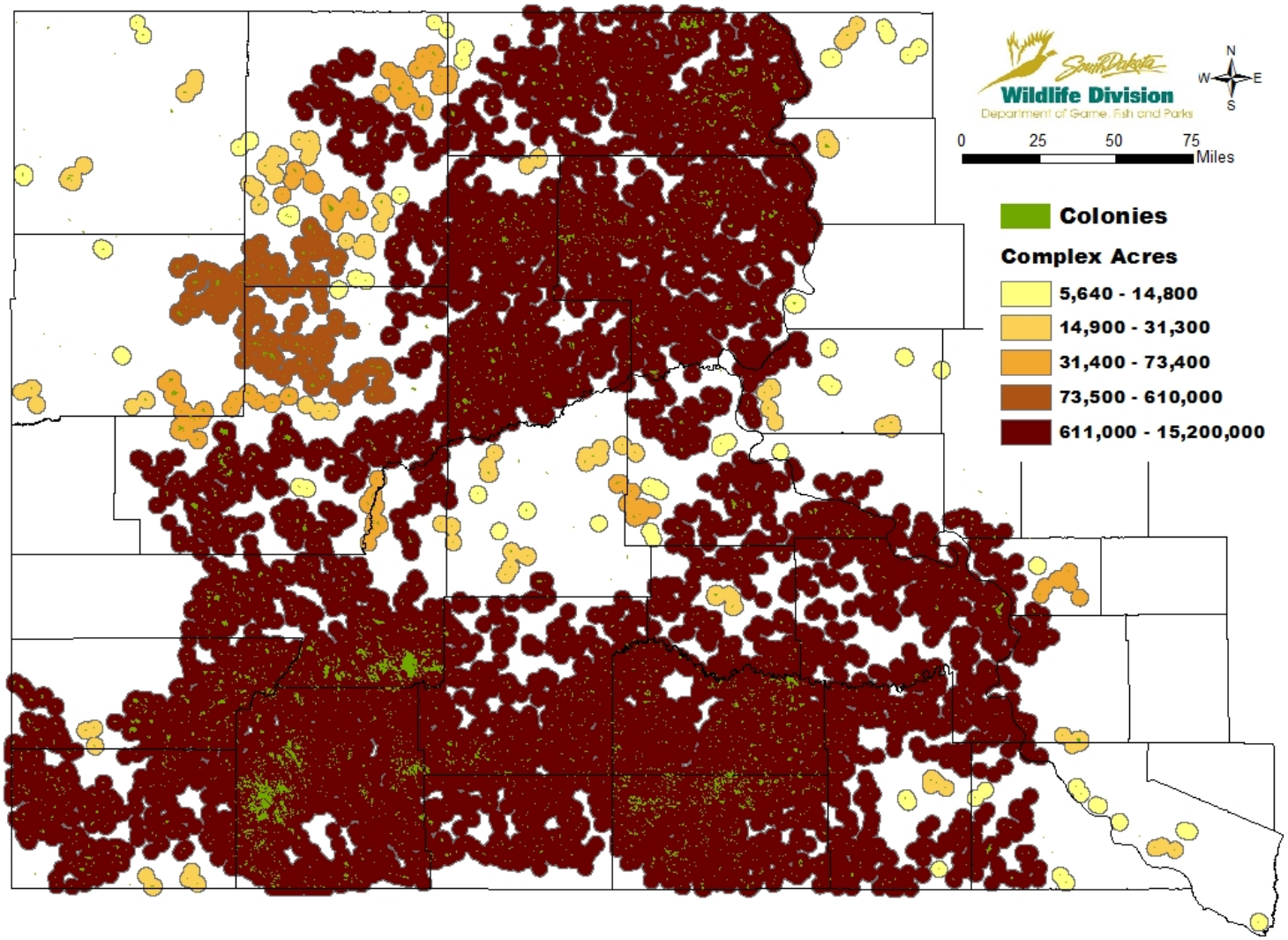


Figure 13. Black-tailed prairie dog complexes (≥2 colonies, ≥988 acres [400 ha]), and a maximum inter-colony distance of 3.73 miles (6 km) in South Dakota, 2012

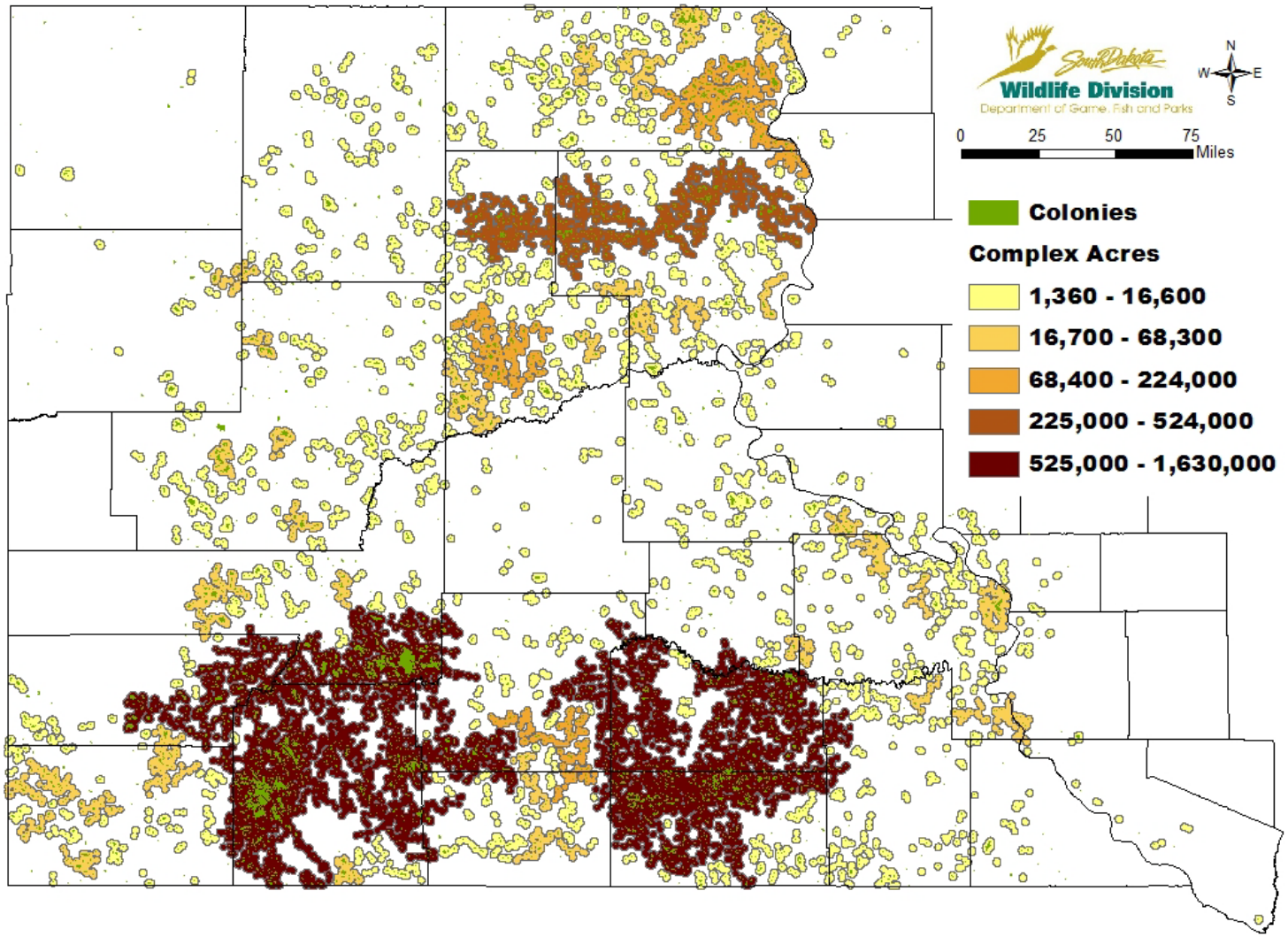


Figure 14. Black-tailed prairie dog complexes (≥2 colonies, ≥988 acres [400 ha]), and a maximum inter-colony distance of 1.55 miles (3 km) in South Dakota, 2012.