Area of black-tailed prairie dog colonies in eastern Colorado

Gary C. White, James R. Dennis, and Frances M. Pusateri

Abstract In 2001 the Colorado Division of Wildlife (CDOW) began writing a conservation plan for shortgrass prairie species including the black-tailed prairie dog (*Cynomys ludovicianus*), partly in response to a petition filed to list the black-tailed prairie dog as a Threatened Species and a finding made by the United States Fish and Wildlife Service (USFWS) that a listing was warranted but precluded. To determine the status of the species in Colorado, acreage of active black-tailed prairie dog colonies was estimated in eastern Colorado during June-August 2002, using aerial line intercept methods. We stratified the survey by county boundaries based on imperfect prior knowledge of colony areas by county and computed the proportion of each line intersecting active prairie dog colonies. Active colonies were defined as colonies with prairie dogs observed from the air or fresh digging at burrow entrances. For 131,615 km^2 surveyed, estimated area of active colonies was 255,398 ha, with a 95% confidence interval of ±9.5%, indicating that 1.94% of the surveyed range was occupied. This estimate may be biased low because some active colonies might have been misclassified as inactive or because some active colonies might not have been spotted when flown over. In contrast, this estimate may be biased high because some active colonies included in the survey may be active in only a portion of the colony considered as intersecting the survey line. However, our estimate for Colorado was consistent with the estimated area of active black-tailed prairie dog colonies in Wyoming from Sidle et al. (2001), where 2.02% of 66,085 km^2 was estimated to be occupied.

Key words aerial surveys, black-tailed prairie dog, *Cynomys ludovicianus*, line intercept sampling, monitoring, optimal allocation

In Colorado the black-tailed prairie dog (*Cynomys ludovicianus*) occurs in the plains and grasslands east of the foothills and historically was found in all eastern counties except the County of Denver (Lechleitner 1969) up to an elevation of about 1,850 m (Armstrong 1972). In 2001 the Colorado Division of Wildlife (CDOW) began writing a conservation plan for shortgrass prairie species including the black-tailed prairie dog, partly in response to a petition filed to list the black-tailed prairie dog as a Threatened Species and a finding made by the United States Fish and Wildlife Service (USFWS) that a listing was warranted but precluded (USFWS 2000). As part of the conservation plan, CDOW needed information on the area occupied by black-tailed prairie dogs in eastern Colorado. The estimate ranged widely, depending on the interest group making the estimate and the methods used. A 1978 and 1979 survey of 12 counties in eastern Colorado mapped 9,955 ha of black-tailed prairie dog towns (Bissell et al. 1979). Van Pelt (1999) extrapolated from this to estimate the size of the species' entire range in Colorado and estimated 36,000 ha of occupied black-tailed prairie dog colonies in the state. Using a survey mailed to landowners, the Colorado Agricultural

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Statistics Service (1990) surveyed 9,046 farmers and ranchers and obtained nearly 3,000 responses to estimate that 628,500 ha of occupied prairie dog (all species) range existed in Colorado. Adjusting this estimate for only black-tailed prairie dogs, the Department of Agriculture estimated 376,500 ha of occupied range. Knowles (1998) estimated only 17,800 ha for Colorado, based on mapping information available at the time. The EDAW (2000) estimated 86,740 ha of active prairie dog colonies in eastern Colorado, based on historical records and updated information on a portion of the historical colonies with site visits. In response to the controversy created by these vastly different estimates, CDOW conducted an intensive aerial survey of eastern Colorado to determine the area of active black-tailed prairie dog colonies.

Methods

Sampling scheme

We conducted line intercept surveys following the protocol of Sidle et al. (2001). We took a stratified simple random sample of lines. Potential black-tailed prairie dog habitat in eastern Colorado was stratified by the 28 counties to disperse the sample across the sampling frame and to allocate sampling intensity. The EDAW (2000) report summarized then-available data on area and location of prairie dog colonies in eastern Colorado. From the area of each county and the estimated area of prairie dog towns within the county provided by the EDAW (2000) survey, we predicted the proportion of lines in each county i that would intersect dog towns (r_i) as

$$r_i = \frac{\text{Area of active towns in County } i}{\text{Area of County } i} = \frac{C_i}{A_i}.$$

From 8 data points in Table 1 of Sidle et al. (2001), we estimated an approximate relationship between the standard deviation of r [SD(r)] and the value of r as a linear relationship of $\text{SD}(r) = 0.0087 + 1.0804r$. With this relationship and an estimate of r for each county, hence an estimate of SD(r) for each county, we used the theory from Cochran (1977) on optimal allocation of a sample to best estimate the total for the sampling frame to allocate the number of lines to fly in each county. We assumed counties to be square, so that length of lines flown in each county, given the number of lines allocated, could be used to determine cost. Cost of the survey for a county was computed as length of line to be flown plus 2 times the square root of county area in km^2 (to account for ferry time), all divided by flight speed of 145 km/hour, times \$180 (U.S.) per hour of flight time. We estimated flight costs of the survey as \$60,000 to achieve a precision of ±20%.

Aerial surveys

Black-tailed prairie dog colonies are conspicuous from the air because most burrow entry mounds, 2-3 m in diameter, are barren of vegetation and because of the contrast between excavated soil and undisturbed areas surrounding the mound (Cincotta 1989, Hoogland 1995). Herbivory by black-tailed prairie dogs causes significant zonation and other changes in plant cover near burrows (Koford 1958, Bonham and Lerwick 1976, Gold 1976, Garrett et al. 1982, Cincotta 1985, Whicker and Detling 1993). Bare ground and erosion increase in colonies, and vegetative structure decreases, resulting in a markedly different appearance between colonies and adjacent areas undisturbed by prairie dogs (Munn 1993, Whicker and Detling 1993). Areas of pocket gopher (*Geomys bursarius* and *Thomomys talpoides*) activity do not show the loss of vegetation characteristic of black-tailed prairie dog colonies, and their mounds of pushed-up dirt are smaller and lack a burrow entrance, making these areas distinguishable from prairie dog colonies (Sidle et al. 2001). Likewise, mounds of harvester ants (*Pogonomyrmex occidentalis*) were distinguished from mounds of prairie dogs by a ring of vegetation around the mound, absence of a burrow hole, and lack of a grazed appearance (Sidle et al. 2001). Ground squirrel colonies, such as the Richardson's (*Spermophilus richardsonii*) and Wyoming (*S. elegans*), do not occur in eastern Colorado (Fitzgerald et al. 1994), and thus would not be confused with black-tailed prairie dog colonies. Two other ground squirrels commonly occur in eastern Colorado: spotted (*S. spilosoma*) and thirteen-lined (*S. tridecemlineatus*) ground squirrels. Neither species is colonial. Spotted ground squirrels occupy habitat associated with sandy soil typical of the sand sage mid-grass areas. Thirteen-lined ground squirrel habitat overlaps with prairie dogs; they can occupy prairie dog towns but are considered to be solitary, and their single burrow entrances have little soil deposited around them, making them difficult to find.

We flew east-west aerial survey lines in each county, except that we flew north–south lines in El

Table 1. Results of aerial line intercept stratified simple random sample of black-tailed prairie dogs in eastern Colorado, 2001-2002.

County	County area (ha)	Active colony area (ha)	SE	95% CI	Distance flown (km)	Lines flown
Adams	310,838	3,873	582	29.5%	1,665	15
Arapahoe	208,052	4,341	1,385	62.5%	608	6
Baca	662,919	29,132	3,108	20.9%	2,847	31
Bent	392,107	32,563	5,629	33.9%	2,088	36
Boulder	194,527	7,191	1,390	37.9%	929	18
Cheyenne	461,272	8,641	881	20.0%	1,750	18
Crowley	207,370	9,080	1,726	37.3%	1,092	24
Douglas	217,934	1,528	841	107.8%	695	15
Elbert	478,657	1,719	1,007	114.8%	961	15
El Paso	551,421	6,739	2,006	58.4%	1,296	21
Fremont	396,818	3,454	1,288	73.1%	872	11
Huerfano	412,448	0	0	0.0%	781	15
Jefferson	201,160	2,089	813	76.3%	556	24
Kiowa	462,372	18,908	6,128	63.5%	1,796	15
Kit Carson	560,223	7,327	1,211	32.4%	1,911	20
Larimer	681,543	6,378	1,325	40.7%	1,688	20
Las Animas	1,235,797	13,132	3,758	56.1%	3,959	29
Lincoln	669,603	6,821	1,681	48.3%	2,084	36
Logan	477,920	6,822	1,244	35.7%	1,599	21
Morgan	335,261	2,035	653	62.9%	864	15
Otero	328,111	9,417	2,954	61.5%	742	16
Phillips	178,345	0	0	0.0%	259	5
Prowers	425,938	27,071	3,574	25.9%	1,907	31
Pueblo	620,954	18,406	2,923	31.1%	3,011	42
Sedgwick	142,036	767	360	92.1%	253	5
Washington	655,131	1,342	532	77.7%	1,612	24
Weld	1,040,301	21,302	2,318	21.3%	5,745	61
Yuma	612,087	5,320	1,173	43.2%	1,653	26
Total	13,121,145	255,398	12,420	9.5%	45,223	615

Paso County. We flew lines parallel at county-specific equal intervals from a starting point on the north edge (east edge in El Paso County) of the county in a Cessna 185 (Cessna Aircraft Co., Wichita, Kans.). Because the interval between lines was not a multiple of the land survey system (i.e., the interval between lines was not exactly 1.6 km), this semi-systematic sampling procedure would not be expected to incur biases. We computed the offset between lines to provide number of lines needed as estimated by the optimal allocation procedure. We used two Global Positioning System (GPS) units in the aircraft: 1) a panel-mounted unit for aircraft navigation (Garmin 150 and later Garmin 250 XL; Garmin International Incorporated, Olathe, Kans.), and 2) a yoke-mounted unit for recording colony boundaries and county boundaries (Garmin 295). The navigational GPS was capable of flying parallel offsets of a predetermined distance or a "ladder search." We used a personal computer and mapping software (*Terrain Navigator V5.03* and *MapSource V4.09*; Garmin International Incorporated, Olathe, Kans.) to create maps of county boundaries prior to flights and to download data after the flights.

During the survey the pilot flew the aircraft at about 55 m above ground level (AGL) and approximately 160 km/hour. The pilot and observer would watch ahead of the aircraft for colonies. When they detected a colony, the aircraft continued its path along the transect line over the colony. We counted the colony only if burrows occurred on both sides of the aircraft. We designated colonies as active if we observed prairie dogs, or if we observed fresh diggings around burrows, as per Sidle et al. (2001). Few (<5%) colonies were determined to be active solely by seeing diggings, however. When a colony was to be counted, the observer entered a waypoint in the yoke-mounted GPS as the aircraft reached the proximal edge of the colony. Occasionally the observer required the aircraft to travel back over the proximal edge of the colony for colonies initially classified as inactive that were then determined to be active based on overflight inspection. The observer entered the next waypoint as the aircraft passed over the distal edge of the colony, although colonies <200 m in length often required the aircraft to circle to allow the GPS to process the waypoint for the proximal edge of the colony. The observer did not enter inactive colonies into the GPS. If time allowed before reaching the next colony, the observer edited the pair of waypoint names to couple them for the observed colony. As the aircraft traveled along the transect line, the observer operating the yoke-mounted GPS would watch the GPS screen for the approaching county boundary. As the aircraft passed over the county boundary, the observer entered a waypoint in the yoke-mounted GPS to mark the end of the current transect. The pilot then flew to the start of the next transect, where the observer entered a new waypoint as the plane passed the county boundary. We flew Larimer, Logan, Morgan, Phillips, Sedgwick, Washington, Weld, and Yuma counties during summer and fall, 2001. By August 2002 we flew all counties except Boulder, Denver, El Paso, Fremont, Huerfano, Jefferson, and Lincoln, which we flew during autumn 2002.

Data analysis

After all transect lines for a particular county had been flown, the observer removed the yoke-mounted GPS from the aircraft and downloaded all waypoints from the GPS to a computer. From the waypoint file, we computed the length of each transect and the length of that transect intersecting active prairie dog towns to provide a ratio (r_i) of active colonies to total length for transect i. The mean ($\bar{r}$) across the n transects in the county times the county area (A) gives an estimate of the area of active prairie dog colonies in county j ($\hat{C}_j$). We computed the variance of $\hat{C}_j$ from the n transects in the county, following Sidle et al. 2001, as

$$\hat{\text{Var}}(\hat{C}_j) = \frac{A^2 \sum_{i=1}^{n} (r_i - \hat{r})^2}{n(n-1)}.$$

We computed the estimated total area of prairie dog towns ($\hat{C}_T$) in eastern Colorado as the sum of the county estimates, with the variance computed as the sum of the variances across the counties, i.e.,

$$\text{SE}\left(\hat{C}_T\right) = \left(\sum_j \hat{\text{Var}}(C_j)\right)^{1/2}.$$

We computed the 95% confidence interval for C_T as percentage of C_T as $\pm 100 \times 1.96 \times \text{SE}(\hat{C}_T)/\hat{C}_T$.

Results

The number of colony intersections measured was 1,596, with a range of 27–5,788 m. The estimated area of active prairie dog colonies in eastern Colorado was $\hat{C}_T = 255{,}398$ ha, with a 95% confidence interval of ±9.5% (Table 1). Precision of the estimate was considerably better than the ±20% designed for because the estimate was about 2.9× larger than the values from EDAW (2000) used in the design process. Cost of flight time in the survey was approximately $70,000 for 475 total hours.

Although the EDAW (2000) survey was useful for design of our survey, the correlation between our results by county and their estimates was not strong: $r = 0.71$, meaning that their results only explained 50% of the variation between our county estimates. The correlation between line length and length of the line intersecting active colonies was only 0.148. Thus, we are justified in using the simple average-density estimator of Sidle et al. (2001) because the ratio estimator would not provide improved performance with this low correlation.

Discussion

Sidle et al. (2001) found the correlation between line length and length of line intersecting active colonies to be higher for the 4 high-density strata (>0.48) than observed here, although they found a negative correlation for one of the low-density strata. They recommend using the average-density estimator for surveys with low correlation, as we have done here. The number of lines flown per stratum was considerably less than the 175–287 flown in their high-density strata. Hence, we did not consider computing a composite estimator as Sidle et al. (2001) did because of the generally low sampling intensity per stratum in our survey.

Counties provided a useful instrument for stratification for 3 reasons. First, a reason specific to this study was that rough estimates of the active colony area were available from EDAW (2000). Second, a more general reason was that we expected differences between counties because of differences in the philosophies of county extension agents about prairie dog control. County agents emphasizing prairie dog control would assist landowners with obtaining state and federal monies for poisoning prairie dogs, whereas other agents might actually de-emphasize prairie dog control. Therefore, given an expected difference in the proportion of counties in prairie dog colonies, stratification by county improved the precision of the statewide estimate. Third, counties provided an appropriate level of stratification in Colorado in that much of the reporting and investigation (and perhaps management) of plague (*Yersinia pestis*) is done at the county level, so that, again, we might presume differences between counties.

We believe our estimate of 255,400 ha to be a reliable estimate of prairie dog active colony area in eastern Colorado, for several reasons. Primarily, the survey was based on a replicable, rigorous survey sampling approach (Miller and Cully 2001, Sidle et al. 2001), and conducted according to a precise protocol. All of eastern Colorado was included in the sampling frame, and the sample was allocated to optimize the variance of the statewide estimate. However, multiple sources of bias may affect the estimate; we discuss 5 possible sources of bias here and consider their impacts on the estimate presented.

First, some small colonies likely were missed because of observer fatigue. Long hours of flying, constantly looking at the ground, will result in fatigue and observers missing the objects of interest. As a result, active colony area will be underestimated. However, as shown below, the impact of small colonies on the estimate was nearly negligible, so bias from observer fatigue was not likely to have greatly affected our estimate. One referee speculated that observer fatigue would make observers disinclined to subdivide a line segment into active and inactive segments within a colony, causing our estimate to be biased high. We suspect just the opposite in that, when a colony is finally encountered after a period of no prairie dog activity, the opportunity to "do something" is irresistible. Alternatively, observers may have been overzealous in classifying low-activity colonies as inactive.

A second source of bias concerns inaccuracy of the GPS to exactly record locations and the ability of the observer to activate the GPS at the exact instant that the aircraft traverses the edge of an active colony. Although the exact intercepts of colonies likely are different than the recorded intercept, the bias caused by this inaccuracy is negligible for our estimate. That is, we expect that observers consistently would be too fast or too slow in activating the GPS, so that even though the endpoints of the colony intercept would be biased, the difference between these endpoints, and hence the length of the colony intercept, would be unbiased. A similar phenomenon would have occurred with the estimates provided by Sidle et al. (2001).

A third source of bias concerns lag time of the GPS in recording 2 consecutive waypoints. The GPS system used in the CDOW aircraft to measure length of the intersection of the flight line and a black-tailed prairie dog colony had a time delay of 1-2 seconds between consecutive waypoints. The effect of this delay is to overestimate the length of the intersection, causing positive bias in the estimate of colony area. That is, the entry point into a colony is correctly recorded, but the exit point is beyond the colony because the GPS is unable to process the entry point before the exit point is reached. To address this issue, we performed an analysis of intersection lengths to evaluate the potential bias of this problem. We assumed a flight speed of 44.7 m seconds^{-1} and have summarized data for colonies with a time of intersection of 10 seconds or less (Table 2).

Note that in at least some instances the aircraft circled back over the colony to record a second point at the exit of the colony because flight speed precluded recording both points in a single pass. However, the frequency of occurrence of this procedure was not recorded when data were collected, and this procedure was not performed for all colonies with distances <89.4 m. Hence, there was potential for the GPS delay to bias data and overestimate colony acreage.

To evaluate the potential bias, we assumed a worse-case scenario. Suppose that all of the colony intersections with a flight time of ≤5 seconds were too large by a factor of 2. That is, the GPS actually had a delay time of up to 5 seconds, and the result was that each of the colonies observed was recorded with a length of $2L$, instead of the true value of L. This assumption affected 10.8% of the data (Table 1). The effect of this assumption was to change the cumulative length of colony intersection from 1,059.8 km to 1,044.8 km, which was only a 1.4% change in the total length of colonies

Table 2. Cumulative percent of colony intersections with a time of flight over the colony of ≤10 seconds for eastern Colorado, 2002.

Flight time (sec)	Intersection length (m)	Percent of colonies
≤1	44.7	0.1
≤2	89.4	0.6
≤3	134.1	1.7
≤4	178.8	4.6
≤5	223.5	10.8
≤6	268.2	18.1
≤7	312.9	26.9
≤8	357.6	34.6
≤9	402.3	41.5
≤10	447.0	47.9

intersected. A crude estimator of the proportion of eastern Colorado in prairie dog towns that ignores the county stratification was the length of colony intersection divided by length of flight line, or 1,059.8/45,221.9 = 2.34%. With the reduction due to GPS delay, the estimate would be 1,044.8/45,221.9 = 2.31%. This example illustrates that reduction of 1.4% in the cumulative length of colony intersection was directly reflected in the estimate of area. Thus, the effect of the GPS delay was effectively negligible.

To take an even more Draconian assumption, assume that all the colonies with a 10-second intersection time were bogus (i.e., had a length of zero). Then the cumulative length of colony intersection would drop by only 226.1 km, from 1,059.8 to 883.7, a 21% reduction. Thus, the estimate of acreage in eastern Colorado would be 21% too high if this second assumption were true. This second assumption is totally unreasonable but illustrates the robustness of the estimator of prairie dog colony size to the contribution of the colony lengths ≥447.0 m. Effectively, colony area was determined by the large colonies, not by the numerous small colonies.

A fourth source of potential bias concerns classification of colonies as active or inactive. We believe our aerial survey protocol was conservative in classifying a colony as active or inactive. Either prairie dogs were observed, or fresh active digging was noted, as was done by Sidle et al. (2001). In general, observers likely erred on the conservative side in calling a colony active because of the difficulty in judging colony activity from the air, (i.e., probably some colonies with few prairie dogs were not included in this survey because no animals were observed and no fresh digging was present). Such misclassification would result in our estimate being biased low, with a similar bias expected for the Sidle et al. (2001) estimates.

Unfortunately, the area of inactive colonies was not recorded in our survey, something that can be rectified in follow-up surveys to monitor black-tailed prairie dogs. Lack of an estimate of inactive colony area weakens the credibility of our estimate of active colony area because we cannot present a ratio of active to inactive colony sizes. The EDAW (2000) estimated a ratio of 0.134 ha of inactive colony per 1 ha of active colony, giving 11.8% inactive of all black-tailed prairie dog colony area in Colorado. Sidle et al. (2001) estimated a ratio of inactive to active of 0.236, giving 19.1% of all colony area as inactive. Based on these values and assuming that all inactive colonies were misclassified as active, a highly unlikely scenario, we might expect our estimate to be biased high by 11.8 or 19.1% because of incorrect classification of active and inactive colonies.

A fifth source of bias concerns degree of activity of colonies. We considered colonies active and recorded their intercepts in the survey, or classified them as inactive and not recorded, as was done by Sidle et al. (2001). However, some portions of the active colonies included in the survey may have had inactive sectors, resulting in an overestimate of the active colony area. Possible reasons for inactive sectors in otherwise active colonies include poisoning and plague. Prairie dogs are highly susceptible epizootic hosts and suffer high mortality, often >99% (Cully 1997, Cully et al. 1997, Antolin et al. 2002). We do not expect that plague would leave a significant number of colonies with portions of a contiguous colony active and other portions inactive, but certainly recent poisoning of a portion of a colony by a single landowner could create such a scenario. Given our criterion of calling a colony active or inactive based on observing prairie dogs or fresh diggings as done by Sidle et al. (2001), the bias in our estimate resulting from inactive portions in otherwise active colonies is linearly related to the proportion of the line length that overlaid inactive colonies. That is, if 10% of the line length classified as active was actually inactive, then our estimate of active colony size is 10% too high.

Considerable logistic difficulty exists with objectively classifying prairie dog colonies as active or inactive from the air. As soon as a gradient in activity is recognized, categories of activity can be defined (e.g., 10% active, 20% active, etc.). Our approach was to classify a colony as active or inactive based on prairie dog observations and occasionally only fresh digging. Although our criterion was objective, we may have overestimated the area of active colonies because of inactive segments within active colonies.

As demonstrated above, the estimate of colony area is driven by the large colonies, some with intercept lengths of 4-5 km. Additional evidence that these large colonies were not largely inactive is provided by graphical evidence from mapping the colony intersections. Almost all of the large intersections (the one exception being a 4.2-km intersection in Boulder County) occurred in parallel lines. That is, the distance between survey lines was less than the intercept distances so that, effectively, the plotted intercepts for large colonies delineated the colony's edge in a rudimentary fashion. The visual pattern thus observed suggests that these large colonies were consistently classified as active colonies according to the criteria of this survey.

Our estimate provides the basis of a long-term monitoring program for black-tailed prairie dogs in eastern Colorado, although at this time only the single estimate is available, with a second survey planned to begin in 2005. The relatively tight confidence interval we achieved in this survey means that future surveys can have adequate statistical power to detect a change in the area of active colonies. However, an issue that will require multiple surveys to address is the amount of temporal variation in the area of active colonies. Plague may cause substantial declines in active colony area during short time periods (<1 year) in localized areas, whereas colonies might expand at other locales during the same time period. The combination of growth and contraction of existing colonies, plus extinction and settlement of new colonies, creates a potentially highly variable temporal process. The variation in this stochastic process should be considered in determining the amount of decline to consider "normal" before the current estimate of active prairie dog colony area is used to justify intervention or other required management practices to promote prairie dog colony areas (Thompson et al. 1998). Because of this variable temporal process, the trend in acreage through time is the variable of most interest.

In summary, we believe our estimate is relatively unbiased because the biases described above likely cancel each other out and because our estimate was consistent with previous estimates of black-tailed prairie dog colony area in eastern Colorado. We would expect the estimate from the Colorado Agricultural Statistics Service (1990) of 376,500 ha to be biased high because of nonresponse bias by farmers and ranchers who did not have prairie dogs inhabiting their property. In contrast, we would expect the Knowles (1998) estimate, which was "speculative" (his description) based only on available mapping information, to be biased low. Thus we find his estimate highly suspect, clearly lacking any rigorous sampling frame. The EDAW (2000) recognized that its estimate was biased low because it only verified colonies from roads and did not obtain access to private property. One of EDAW's (2000:25) recommendations for further work was to "Attempt to obtain landowner cooperation in order to expand this study's baseline beyond what is easily viewable from public roadsides," thus recognizing their estimate was biased low. Not only is our estimate based on a rigorous statistical sampling frame, it is consistent with the expected bias of these previously reported estimates for Colorado. Finally, Sidle et al. (2001) reported an estimate of 1,332.3 km^2 of black-tailed prairie dog colony area for Wyoming, with 66,085 km^2 surveyed (2.02% active colonies). Their Figure 1 suggested that the black-tailed prairie dog range in Colorado was nearly 2 times that of Wyoming, consistent with the areas surveyed by Sidle et al. (2001) in Wyoming and this study in Colorado. Thus, our estimate of 2,554.0 km^2 with 131,615 km^2 surveyed (1.94% active colonies) appears completely consistent with the Sidle et al. (2001) estimate for Wyoming, particularly given the ecological and sociological similarities of eastern Colorado and eastern Wyoming.

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Dr. Gary C. White (right), The Wildlife Society's 51st Aldo Leopold Memorial Award recipient, was born in 1948 (the year of Aldo Leopold's death), growing up on a farm in central Iowa. He graduated with a B.S. (1970) from the Department of Fisheries and Wildlife at Iowa State University, an M.S. (1972) in wildlife biology from the University of Maine at Orono, and a Ph.D. (1976) in zoology from the Ohio State University. He spent 1976–1977 as a post-doctoral researcher with the Utah Cooperative Wildlife Research Unit at Utah State University. From 1977–1984 he was a scientist in the Environmental Science Group at Los Alamos National Laboratory, and in 1984 moved to the Department of Fishery and Wildlife Biology at Colorado State University, where he is currently a professor with half-time support from the Colorado Division of Wildlife. Dr. White's research on ungulate population dynamics while at Los Alamos National Laboratory, and later the Colorado Division of Wildlife, has focused on some of the most fundamental concepts in wildlife population dynamics, such as density-dependent and compensatory responses. Experimental field research for 17 years in northwestern Colorado has demonstrated cause-and-effect relationships between mule deer density and winter fawn survival. From 1993 to present, he has served on the Mexican Spotted Owl Recovery Team, and is currently designing a monitoring scheme for this species. His research and teaching have benefited from collaboration with others to contribute to the techniques of statistical modeling, population estimation, and survival analysis for wildlife research and management. Dr. White has co-authored more than 100 refereed scientific papers, 2 books, and 40 technical papers. He also is the architect of the software programs CAPTURE, SURVIV, RELEASE, NOREMARK and MARK. ***Jim Dennis*** (left) recently retired from the Colorado Division of Wildlife after 32 years of service. The last 23 years were spent as regional wildlife biologist in the Fort Collins office. He earned a B.S. in zoology from Colorado State University in 1971. Present interests include conservation and management of marine game fish and promotion of sound ecotourism practices. ***Frances M. Pusateri*** (center) currently is the grassland species coordinator in the Species Conservation Section of the Colorado Division of Wildlife. She received her B.S. in wildlife management from Colorado State University. Her professional interests include grassland ecology and management, eco-regional planning, and public outreach for grassland species issues. She is past president of the Colorado Chapter of TWS.

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