Pronghorn Monitoring in the Pinedale Anticline Project Area: 2011 Annual Report

Prepared for:

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WEST Inc.
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NATURAL RESOURCES ◆ SCIENTIFIC SOLUTIONS

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SUGGESTED CITATION

Nielson, R. M., and H. Sawyer. 2013. Pronghorn monitoring in the Pinedale Anticline Project Area: 2011 Annual Report. Western EcoSystems Technology, Inc., Laramie, Wyoming, USA.

SECTION I: Wildlife monitoring and mitigation matrix

OVERVIEW

As part of the record of decision for gas development in the Pinedale Anticline Project Area (PAPA), the Bureau of Land Management (BLM) developed a Wildlife Monitoring and Mitigation Matrix (WMMM) that provides direction for development-phase wildlife monitoring (BLM 2008). For pronghorn (*Antilocapra americana*), the WMMM was intended to identify monitoring parameters that allow changes in pronghorn abundance to be quantitatively assessed. The WMMM specifies that mitigation measures will be triggered if a 15% decline in pronghorn abundance in the PAPA is detected in any year, or a cumulative change over all years beginning in the winter of 2009-10, relative to changes in the larger Sublette herd unit reference area. This threshold was not exceeded in the 2010-11 winter. Here, we report monitoring results for the winter of 2010-11.

METHODS

Abundance

We estimated pronghorn abundance in the PAPA in January, February, and March 2011 using aerial line transect surveys. The goal of each survey was to obtain a complete count of the number of pronghorn occupying each study area. Conducting multiple surveys allowed us to assess the variability in occupancy over time and estimate the average number of pronghorn occupying the study area during the winter period.

Line transects were spaced approximately ½-mile apart and were flown in an east-west orientation (Fig. 1) using fixed-wing aircraft flying at 300–400 feet above ground level (AGL) to minimize animal disturbance. Locations of all detected pronghorn groups were recorded using a Global Positioning System (GPS), and group sizes were visually counted. Groups with >50 animals were recorded with a hand-held video recorder (Sony HD Handycam HDR-CX100), so that group size could be determined by image analysis.

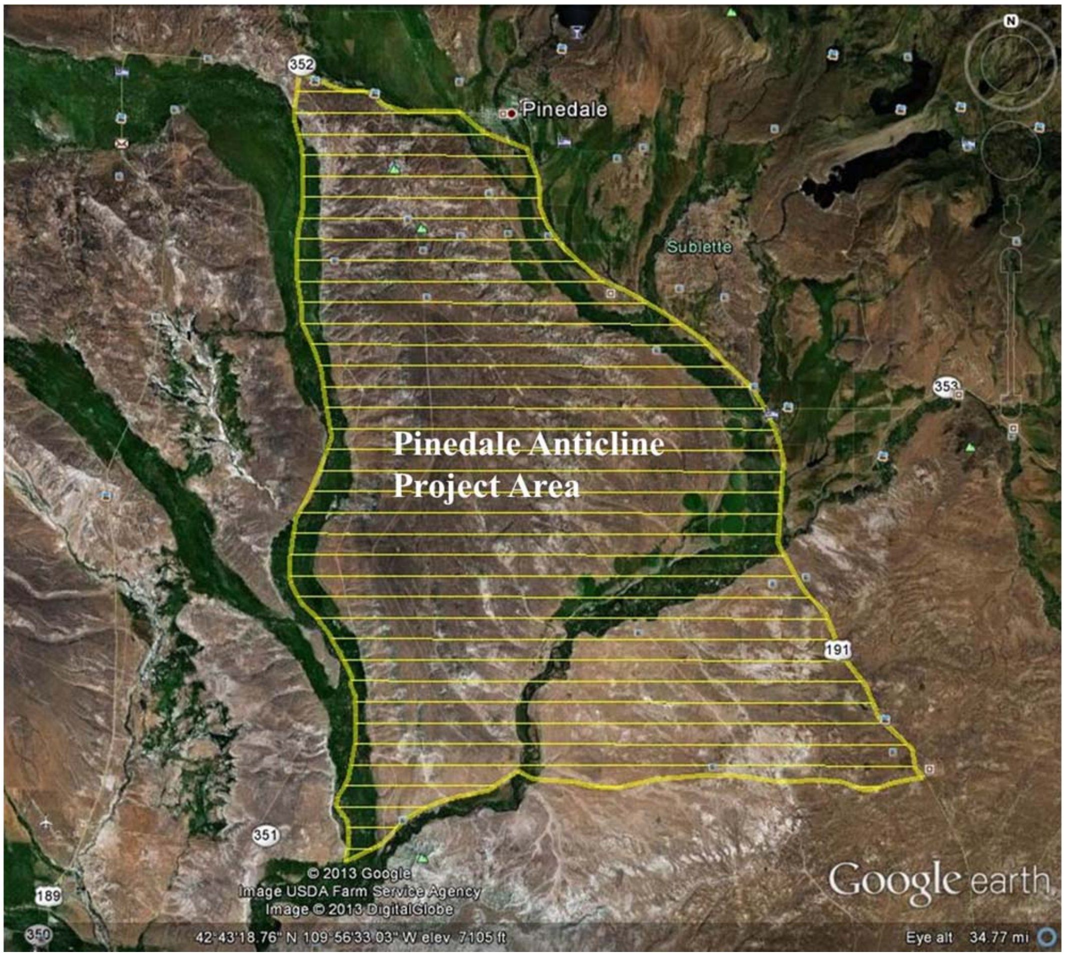

Figure 1. Survey transects over the Pinedale Anticline Project Area.

Video images were analyzed in the office by two independent observers. When a video clip could be reduced to one still image containing an entire pronghorn group, the two observers reviewed the image independently, and then collectively, until consensus was reached on the total group size (Fig. 2). When a video clip could not be reduced to a single image containing the entire group, we used the average of the two counts as the estimated group size. The sum totals of observed group sizes were considered estimates of the total number of pronghorn occupying the PAPA during each survey.

Figure 2. Example of a pronghorn group count (*n* = 165) based on a video clip from an aerial survey.

We calculated 90% confidence intervals (CIs) for each abundance estimate using a bootstrap procedure (Manly 2006) that involved randomly selecting one of the two observer counts for non-consensus counts and adding those to the sum of group sizes from the consensus counts. This process accounted for the variation between observers in counting large groups. A total of 200 bootstrap samples were used to calculate 90% CIs based on the central 90% of the bootstrap distribution (i.e., "Percentile Method") for each estimate.

Pronghorn abundance varied substantially during the 2009-10 and 2010-11 winters, so we calculated an average abundance for each winter. Ninety-percent CIs were calculated by randomly sampling with replacement 2 (2009-10; Nielson and Sawyer 2011) or 3 (2010-11) survey days from each winter, using the bootstrap procedure described above, and then averaging the new total counts. In addition, we calculated the percent change in abundance from the 2009-10 winter to the 2010-11 winter.

As requested by PAPO, we compared abundance estimates for the PAPA with those estimated by the Wyoming Game and Fish Department (WGFD) for the entire Sublette herd unit reference area. We note that using the herd unit as a reference area is of limited value because the reference area should not contain the PAPA, as the treatment will affect what is observed in the reference. Thus, the comparison does not allow potential treatment effects (e.g., gas development) to be discerned from the reference area. Additionally, the WGFD herd unit estimates were based on POPII models that estimate population size from doe to fawn ratios, hunter success, winter severity, and adult survival. The WGFD herd estimates were not based on actual counts and do not have any measure of precision.

RESULTS

Abundance

Pronghorn abundance in the PAPA was highly variable. We counted 1,420 pronghorn in 16 groups on January 14th, 505 pronghorn in 11 groups on February 10th, and 1,184 pronghorn in 23 groups on March 11th (Table 1, Fig. 3). Based on these 3 surveys, the estimated average number of pronghorn occupying the PAPA during 2010-11 winter was 1,036 (90% CI: 731 – 1,344), compared to 1,533 (90% CI: 772 – 2,305) in the 2009-10 winter. This represents a 32% decline in average abundance on the PAPA from 2009-10 to 2010-11 winters. However, this decline was not statistically significant at an alpha level of $\alpha = 0.10$ (90% CI: 68% decline to 63% increase).

In contrast, WGFD population estimates for the entire Sublette herd unit reference area were 59,000 in 2010 and 37,800 in 2011, representing a 36% decline. We note that the WGFD estimates were modeled from POPII software and have no confidence intervals associated with them.

Table 1. Abundance estimates from winter aerial surveys over the Pinedale Anticline Project Area. Ninety percent confidence intervals are to the right of each total count, unless a consensus was reached on all group sizes (indicated by 90% CI = 'NA').

	Winter			
	2009-10		2010-11	
Month	Estimate	90% CI	Estimate	90% CI
January	775	782 767	1,420	1,425 1,415
February	2,290	2,323 2,256	505	NA NA
March	NA	NA NA	1,184	NA NA
Average	1,533	2,305 772	1,036	1,344 731

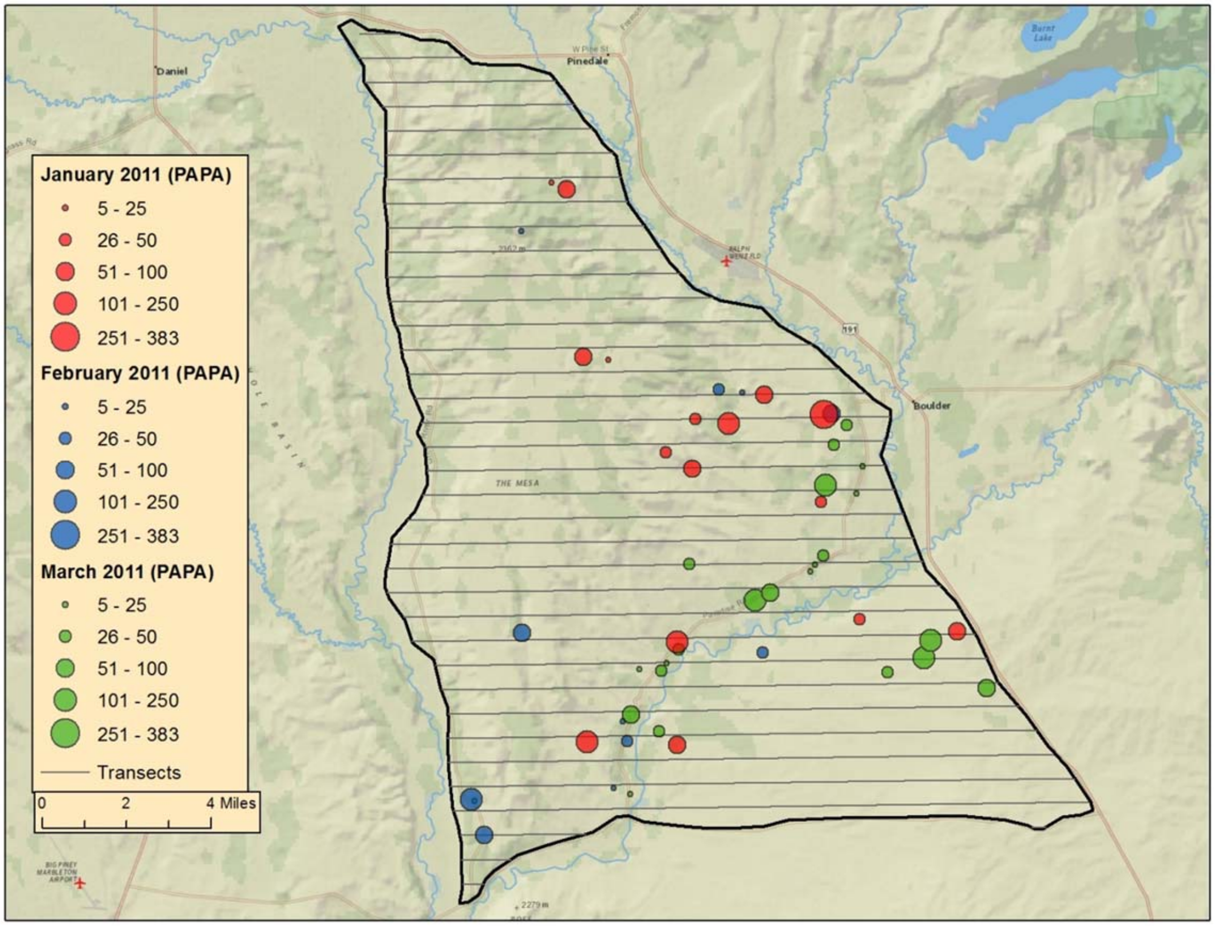

Figure 3. Location and relative size of pronghorn groups observed during aerial surveys over the Pinedale Anticline Project Area.

DISCUSSION

The current methodology for estimating pronghorn abundance does not adhere to common line transect distance methodology (Buckland et al. 2001), but instead is based on a 'complete count' technique (Seber 2002), that accounts for differences in observers viewing each video segment, and variability across surveys. Current application of the complete count technique involves flying a dense sample of line transects (spaced ½-mile apart), attempting to locate every group of pronghorn in the study area, and using high-definition video images to determine group size. A key assumption of this method is that few, if any pronghorn groups were missed or incorrectly counted.

The problem with application of traditional line transect distance methodology (Buckland et al. 2001) for pronghorn during the winter is the assumption that animals do not move in response to observers. Obviously, pronghorn are very mobile and react quickly to nearby aircraft, which would likely violate this assumption and result in observers detecting groups after movement and further from the transect line.

At this time, we believe the 'complete count' approach is the preferred method and that surveying line transects ½-mile apart using HD video to determine group size is likely the most efficient and reliable method of estimating pronghorn abundance. However, it should be recognized that this technique can only produce an index, and not a complete count, unless we are confident that all pronghorn were detected and none were double-counted. Regardless of whether the estimate is considered a complete count or an index of abundance, this approach should provide a reliable means to monitor trends in pronghorn abundance through time. It is our opinion that the winter surveys provide accurate estimates of abundance when snow conditions are optimal – when pronghorn congregate in large groups and probability of detection is high.

The WMMM specifies that mitigation measures will be triggered if a 15% decline in pronghorn abundance in the PAPA is detected in any year compared to the first year of abundance monitoring (2009-10 winter), or a cumulative change over all years since the first year, relative to the larger Sublette herd unit reference area. Although we estimated a 32% decline in occupancy of the PAPA in 2010-11 compared to 2009-10, this decline was not statistically significant at an alpha level of $\alpha = 0.10$ based on overlapping CIs, and was similar to the estimated 36% decline for the larger Sublette herd unit reference area.

SECTION II: RESOURCE SELECTION MODELING

OVERVIEW

As part of the pronghorn monitoring effort we attempt to maintain a sample (~30 animals) of GPS-collared pronghorn in both the Pinedale Anticline Project Area (PAPA) and Bench Corral Study Area to document movements and help ensure abundance estimates were not influenced by movements of animals between the two areas (i.e., marked animals occupy their respective winter ranges when we conduct counts). The GPS data provide additional opportunity to examine winter habitat use patterns and update migration routes for the PAPA and Bench Corral Study Area sub-populations.

METHODS

Capture and Collaring

We captured 31 adult female pronghorn on January 24, 2011 and equipped them with store-on-board GPS collars (Generation 4; Telonics, Inc., Mesa, AZ) that were programmed to collect locations every 3 hours and drop off November 1, 2011. Capture efforts were split between the PAPA ($n = 17$) and Bench Corral Study Area $(n = 14)$. We attempted to sample pronghorn in proportion to their relative abundance across both winter ranges (Fig. 4).

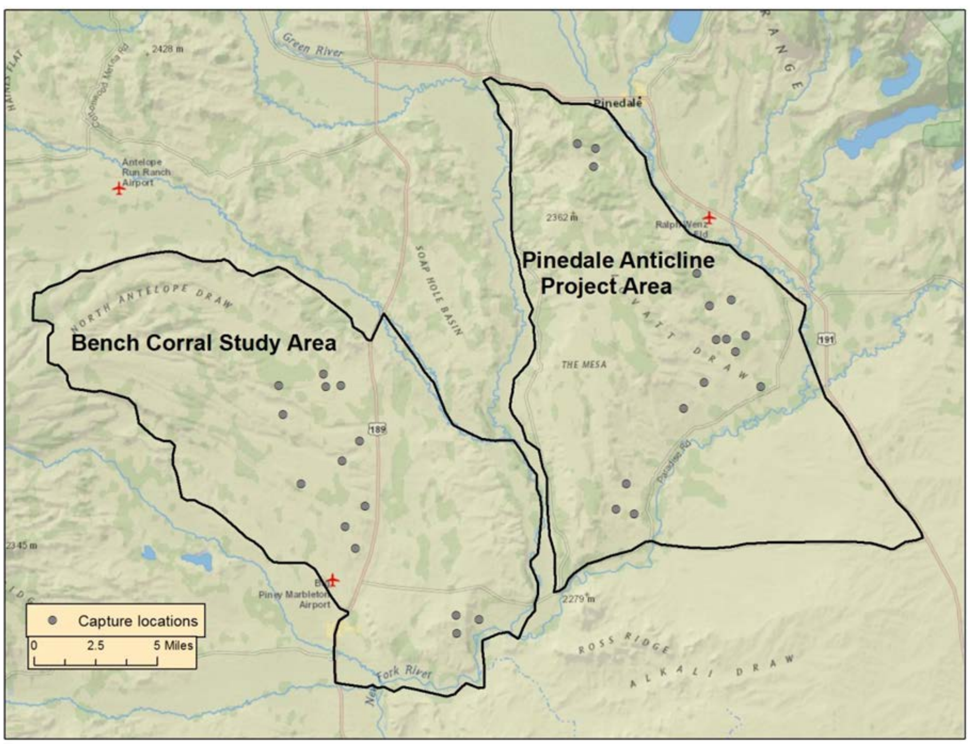

Figure 4. Capture locations of pronghorn in the Pinedale Anticline Project Area and Bench Corral Study Area on January 24, 2011.

Habitat Use

We developed a habitat (resource) use model for pronghorn in the PAPA during the winter of 2010-11 (January 24th – March 31st). Average GPS fix success was high (>99%), so our approach to habitat use analysis generally followed that of Sawyer et al. (2006, 2007, 2009*a*), where a generalized linear model (McCullagh and Nelder 1989) was used to estimate the probability of use as a function of habitat variables with an error term following a negative binomial distribution (Hilbe 2008). However, instead of estimating probability of use for each individual animal and averaging the habitat use model coefficients across animals (Nielson and Sawyer 2011), we combined data from all GPS-collared animals to estimate the population-level model and bootstrapped individual animals to estimate standard errors (SEs) and 90% confidence intervals (CIs) for model coefficients. This modeling approach weights the location data from each animal appropriately (Thomas and Taylor 2006), treats the animal as the primary sampling unit (Thomas and Taylor 2006), and simplifies use of standard approaches for model selection (Burnham and Anderson 2002).

Our modeling approach consisted of 5 basic steps where we: 1) measured habitat variables at 4,353 randomly selected circular sampling units with 100-m radii, 2) counted the number of pronghorn GPS locations in the sampling units, 3) used the relative number of pronghorn locations as the response variable in a multiple regression analysis to model the probability of use as a function of habitat variables, 4) bootstrapped (Manly 2007) the individual pronghorn to estimate SEs and 90% CIs for model coefficients, and then 5) mapped predictions of the final habitat use model.

We considered the following variables in the habitat use analysis: slope (%), elevation (m), distance (km) to well pad, distance (km) to infrastructure (well pad, road or other infrastructure), and aspect. Additionally, we considered two vegetation variables, including the proportion of low-density (<25% canopy cover) Wyoming big sagebrush and the proportion of high-density (>25% canopy cover) Wyoming big sagebrush. The proportion of low-density and high-density sagebrush within each circular sampling unit was based upon a vegetation layer developed by Thomas (2010). This vegetation layer did not cover the entire PAPA (Figs. 1 – 4) so we limited our habitat use analysis to the extent of the vegetation layer within the PAPA boundary. All other variables were based on the center point values of each sampling unit. We considered south and east facing slopes to be preferred by pronghorn in winter, so we combined these two aspects into one category.

Before modeling habitat use, we conducted a Pearson's pairwise correlation analysis to identify possible multicollinearity issues and determine whether we should exclude any variables from our modeling $(|r| \geq 0.60)$. Not surprisingly, distance to well pad and distance to infrastructure were highly correlated $(r = 0.77)$, so we did not allow both variables in the same model. In addition, proportions of low-density and high-density sagebrush were correlated $(r = -0.61)$. Due to this correlation, we chose to drop proportion of high-density sagebrush from the analysis because we believed, *a priori*, that pronghorn were more likely associated with areas containing low-density sagebrush.

We developed an *a priori* list of habitat use models (Table 2). Each model was fit using the location data and Akaike's Information Criterion (Burnham and Anderson 2002) was used to rank the models. A model with a lower AIC value was considered to be a better fit to the data. Habitat use models were fit using R v2.14.1 (R Development Core Team 2011).

Table 2. List of *a priori* pronghorn winter habitat use models.

Model	Variables
1	elevation + elevation^2 + slope + slope^2 + % low-density sagebrush + aspect (S & E)
2	Model (1) + distance to well
3	Model (1) + distance to well + distance to well^2
4	Model (1) + distance to infrastructure
5	Model (1) + distance to infrastructure + distance to infrastructure^2

RESULTS

Capture and Collaring

We recovered 15 of the 17 GPS collars from pronghorn in the PAPA (Table 3). The two unrecovered collars (collar IDs: 43 and 45) were last detected during flights on September 11 and June 23, 2011, respectively, and the fate of these animals is unknown. Of the remaining 15 pronghorn, one survived the winter of 2009-10 but died on May 8 of natural causes. The other mortality occurred on March 4 adjacent to Boulder South Road.

We recovered 13 of the 14 GPS collars from pronghorn in the Bench Corral Study Area (Table 3). One collar (collar ID 56) failed to drop on the scheduled release date and was last detected near Annie Draw in December 2011. The fate of this animal is unknown. Four pronghorn died between March 26 and October 22, 2011 (Table 3).

A map of all pronghorn locations recorded from January 24 through October 31, 2011 is provided in Appendix A.

Table 3. Summary of GPS collars placed on pronghorn January 24, 2011 in the Pinedale Anticline Project Area (PAPA) and Bench Corral (BC) Study Area. The summary includes the collar ID, the area the pronghorn was captured and collared, whether the collar was recovered, whether the animal was considered migratory and the fate of the animal through November 1, 2011.

Collar ID	Area	Recovery	Migratory	Survival
37	PAPA	Yes	Yes	Yes
39	PAPA	Yes	n/a	Died 3/4/11 (New Fork River Rd - roadkill)
41	PAPA	Yes	Yes	Yes
43	PAPA	No	?	Unknown
45	PAPA	No	?	Unknown
47	PAPA	Yes	Yes	Yes
49	PAPA	Yes	Yes	Yes
51	PAPA	Yes	Yes	Yes
53	PAPA	Yes	Yes	Yes
55	PAPA	Yes	Yes	Yes
57	PAPA	Yes	Yes	Yes
59	PAPA	Yes	No	Yes
61	PAPA	Yes	Yes	Yes
31	PAPA	Yes	n/a	Died 5/8/11 (natural causes)
33	PAPA	Yes	Yes	Yes
35	PAPA	Yes	Yes	Yes
36	PAPA	Yes	Yes	Yes
38	BC	Yes	Yes	Yes
40	BC	Yes	Yes	Yes
42	BC	Yes	Yes	Yes
44	BC	Yes	Yes	Yes
46	BC	Yes	No	Yes
48	BC	Yes	Yes	Died 10/22/11 (harvested)
50	BC	Yes	No	Yes
52	BC	Yes	No	Yes
54	BC	Yes	No	Died 9/10/11 (unknown cause)
56	BC	No	?	Unknown
58	BC	Yes	n/a	Died 3/26/11 (Billy Canyon)
60	BC	Yes	n/a	Died 3/28/11 (Alkali Creek)
32	BC	Yes	Yes	Yes
34	BC	Yes	No	Yes

Habitat Use

We used 5,550 locations collected from 13 GPS-collared pronghorn in the PAPA to estimate a habitat use model for the winter of 2010-11. Two GPS-collared pronghorn (collar IDs: 47 and 53) were excluded because most locations were outside the habitat use modeling area. The model containing elevation, elevation^2, slope, slope^2, aspect (S & E), proportion of low-density sagebrush, and distance to infrastructure was the top model (model 4) based on the lowest AIC value.

Coefficients from the final model (Table 4) suggest that pronghorn selected for areas with low-density sagebrush at moderate elevations, with moderate slopes facing south or east, and closer to infrastructure. Plots in Fig. 5 show how predicted levels of use vary in relation to each variable.

Table 4. Coefficients with 90% confidence intervals for the final habitat use model for pronghorn in the Pinedale Anticline Project Area during the 2010-11 winter.

		90% Confidence Interval	
Covariate	Estimated Coefficient	Lower Limit	Upper Limit
Intercept	-707.8782	NA	NA
Elevation (m)	0.6474	0.1683	1.8154
Elevation^2	-0.0001	-0.0004	-0.00001
Slope (%)	0.3969	0.2786	0.5218
Slope^2	-0.0286	-0.0373	-0.0185
% Low-density Sagebrush	0.0065	0.0034	0.0096
Aspect (S & E)	0.6229	0.4378	0.8106
Dist. (km) to Infrastructure	-0.4517	-0.7404	-0.2886

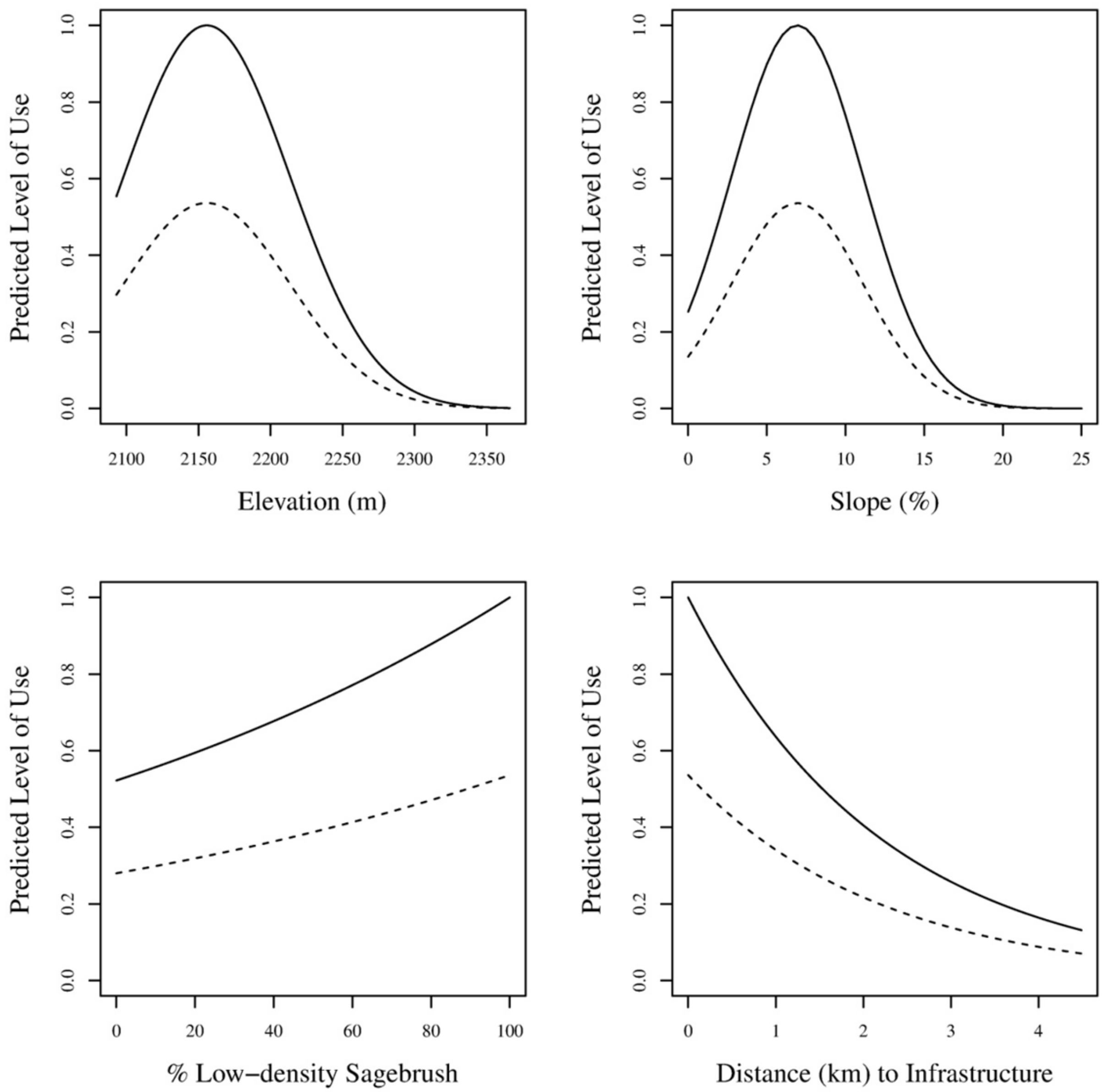

Figure 5. Predicted levels of use by pronghorn in the Pinedale Anticline Project Area during the winter of 2010-11, as a function of variables in the top habitat use model. Predictions in each panel were scaled to have a maximum value of 1.0. Solid lines represent predictions for south and east facing slopes and dashed lines represent predictions for areas facing north or west. Levels of variables not plotted were held constant at their median values.

Areas with the highest predicted level of use (i.e., dark blue areas in Fig. 6) had an average elevation of 2,157 m, 3.4% slope, 63% low-density sagebrush, and were 0.46 km from infrastructure. Most (86%) of the areas with the highest predicted level of use had south or east facing slopes. The predictive map indicated that pronghorn use was highest in areas relatively close to infrastructure (Fig. 6).

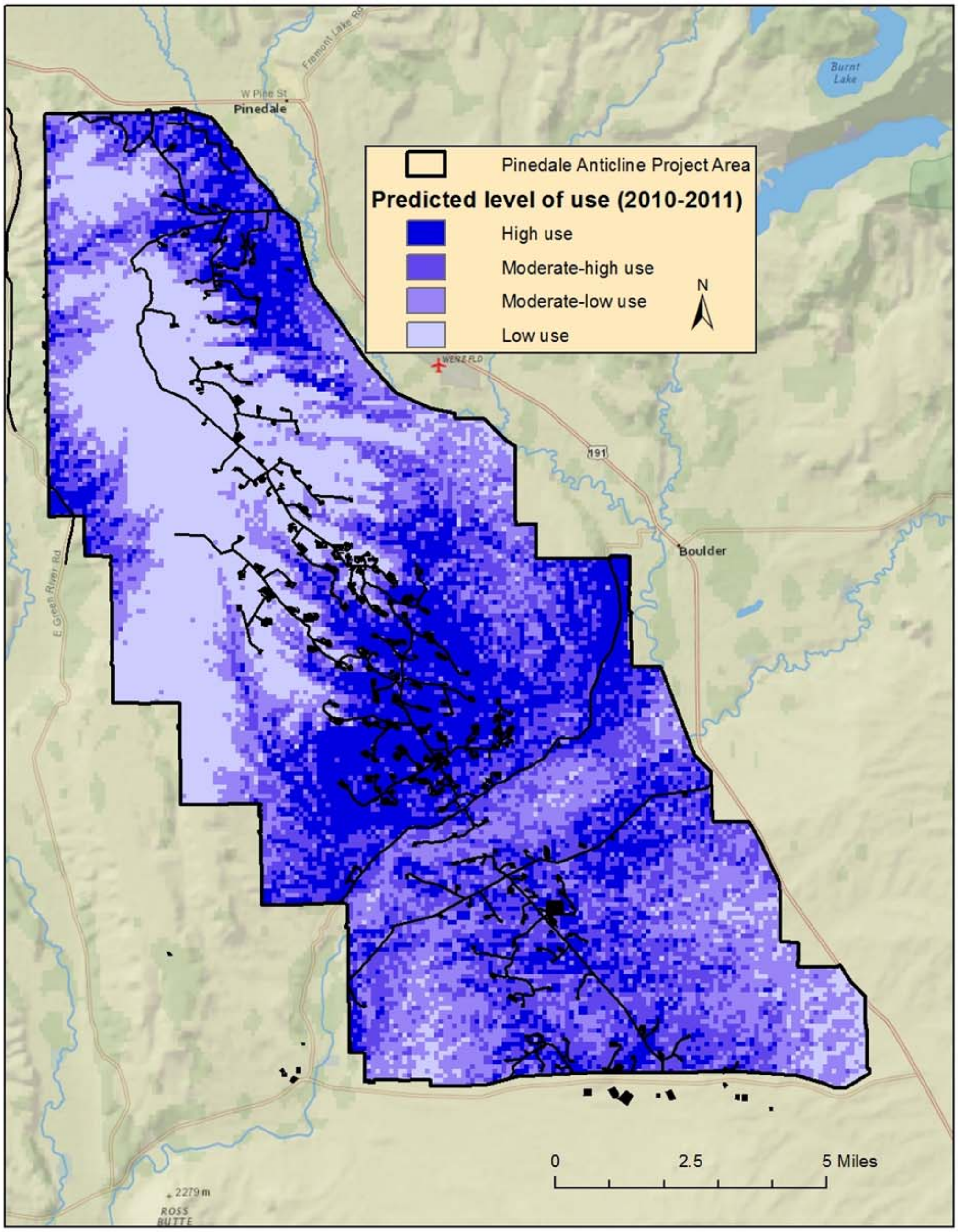

Figure 6. Predicted level of pronghorn habitat use in a portion of the Pinedale Anticline Project Area (PAPA) that included available vegetation data developed by Thomas (2010) during the winter of 2010-11. This vegetation layer did not cover the entire PAPA so we limited our habitat use analysis to the extent of the vegetation layer within the PAPA boundary.

DISCUSSION

Consistent with previous big game monitoring in the PAPA, data from GPS-collared pronghorn were used in a habitat use analysis to determine how or if gas field infrastructure affected pronghorn distribution in the PAPA. Consistent with Beckmann et al. (2008) and Nielson and Sawyer (2011), we found that pronghorn used areas close to infrastructure. This is in sharp contrast to mule deer that have avoided well pads in the same study area (Sawyer et al. 2009*a*). Our data suggest pronghorn distribution during the winter of 2010-11 was not negatively affected by gas field infrastructure. Although pronghorn did not avoid infrastructure, it is possible that their vigilance and foraging was affected (Gavin and Komers 2006), but measuring that level of behavioral response was beyond the scope of this study. Pronghorn and other herding animals may alleviate the effects of disturbance or perceived risk by aggregating in large groups (Lima 1995, Gavin and Komers 2006), so it is possible that the large group sizes observed in the PAPA allow pronghorn to effectively utilize areas close to infrastructure.

SECTION III: Sex and age classification surveys and trends in pronghorn abundance in the Pinedale Anticline Project Area (PAPA) and the Bench Corral Study Area.

OVERVIEW

As part of the pronghorn monitoring effort we conducted ground-based surveys to estimate the number of fawns and buck per 100 does within the PAPA and Bench Corral Study Area during each winter. Age and sex ratios from the two study areas were compared to ratios developed by the WGFD for the entire Sublette herd unit reference area based on surveys conducted August 2010. In addition, we estimated pronghorn abundance in the Bench Corral Study Area in January, February, and March 2011 using aerial line transect surveys. The goal of each survey was to obtain a complete count of the number of pronghorn occupying the study area. Conducting multiple surveys allowed us to assess the variability in occupancy over time and estimate the average number of pronghorn occupying the area during the winter period.

METHODS

Sex and age classification surveys

Ground surveys were conducted within 24 hours of each aerial survey. The PAPA and Bench Corral Study Area were surveyed on consecutive days. We attempted to classify a minimum of 400 animals in each area during each survey. Ninety-percent CIs were calculated for each estimate using a bootstrap procedure (Manly 2007). The bootstrap process involved taking 200 simple random samples with replacement of individual groups observed during the ground surveys, and re-calculating the age/sex ratios to produce 200 new estimates. The 5 and 95% percentiles of the bootstrap distribution were used as lower and upper 90% confidence limits, respectively.

Abundance

Pronghorn abundance in each study area was estimated for each winter, beginning in 2009-10, using the same methods described in Section I. Again, line transects were spaced approximately ½-mile apart and were flown in an east-west orientation (Fig. 7) using fixed-wing aircraft flying at 300–400 feet above ground level (AGL) to minimize animal disturbance. Locations of all detected pronghorn groups were recorded using a GPS, and group sizes were visually counted. Groups with >50 animals were recorded with a hand-held video recorder (Sony HD Handycam HDR-CX100), so that group size could be determined by image analysis.

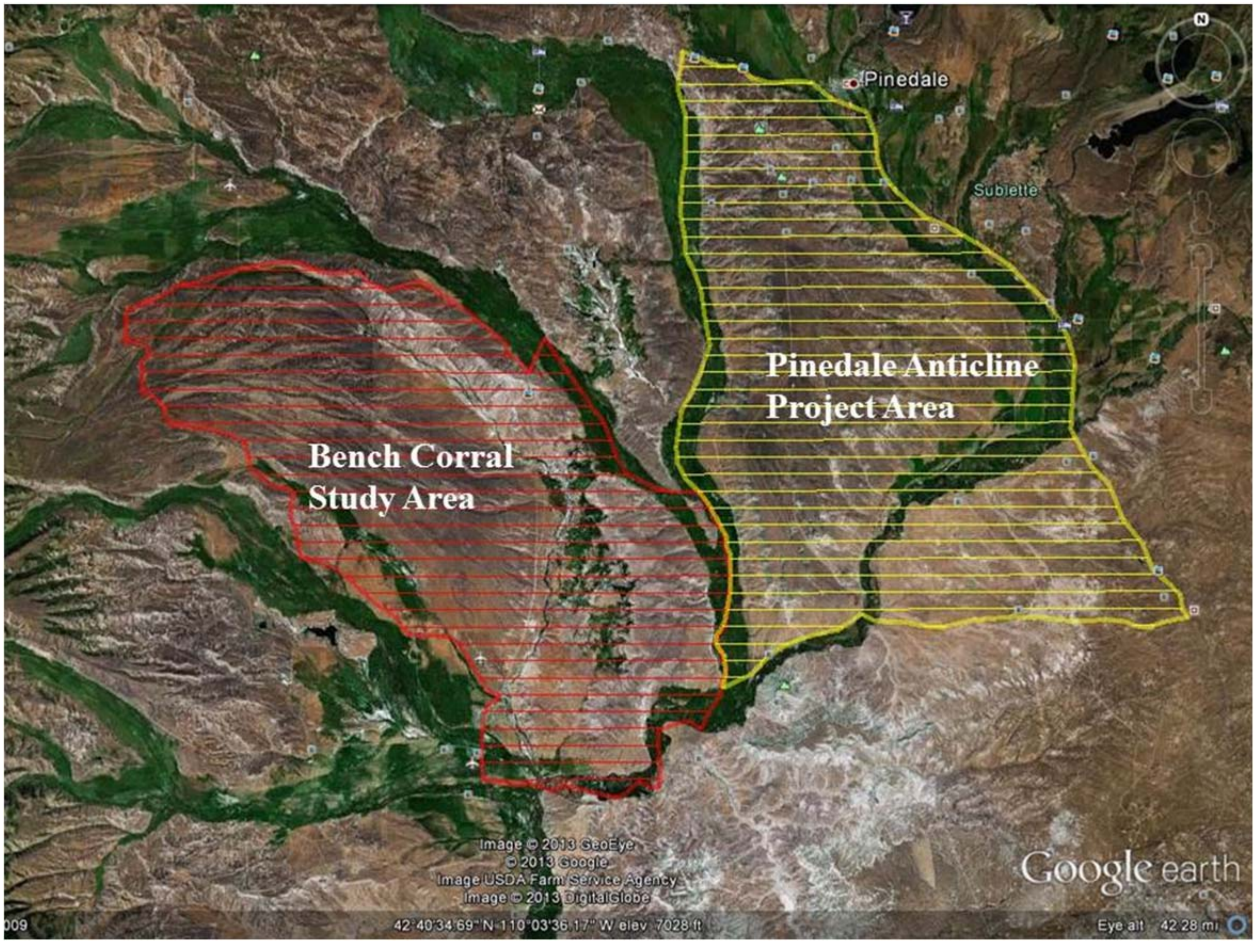

Figure 7. Survey transects in the Pinedale Anticline Project Area and the Bench Corral Study Area.

RESULTS

Sex and age classification surveys

The average number of fawns per 100 does was 38.3 (90% CI: 33.0 to 43.4) in the PAPA and 34.3 (90% CI: 28.0 to 39.2) in the Bench Corral Study Area (Table 5). The WGFD estimate for the entire Sublette herd unit reference area based on surveys conducted August 2010 was 63 fawns per 100 does.

The average number of bucks per 100 does was 47.3 (90% CI: 41.4 to 54.2) in the PAPA and 47.2 (90% CI: 33.5 to 59.5) in the Bench Corral Study Area (Table 6). The WGFD estimate for the entire Sublette herd unit reference area based on surveys during the summer of 2010 was 53 bucks per 100 does.

Table 5. The number of fawns observed per 100 does, along with 90% confidence intervals, based on ground surveys in January, February and March of 2011, for the Pinedale Anticline Project Area (PAPA) and the Bench Corral (BC) Study Area.

Area (Survey)	# Groups	Fawns per 100 Does	90% Confidence Interval Lower Limit	90% Confidence Interval Upper Limit
PAPA (Jan)	6	36.6	27.2	45.8
PAPA (Feb)	9	34.9	29.0	40.0
PAPA (Mar)	13	44.7	33.7	56.8
PAPA (Jan, Feb & Mar)	28	38.3	33.0	43.4
BC (Jan)	7	29.5	20.1	40.6
BC (Feb)	5	39.8	32.6	44.5
BC (Mar)	5	30.9	27.3	33.3
BC (Jan, Feb, & Mar)	17	34.3	28.0	39.2
PAPA and BC (Jan)	13	33.7	25.8	41.4
PAPA and BC (Feb)	14	37.1	32.8	40.5
PAPA and BC (Mar)	18	40.2	32.8	49.4
PAPA and BC (Jan, Feb & Mar)	45	36.7	33.3	40.1

Table 6. The number of bucks observed per 100 does, along with 90% confidence intervals, based on ground surveys in January, February and March of 2011, for the Pinedale Anticline Project Area (PAPA) and the Bench Corral (BC) Study Area.

Area (Survey)	# Groups	Bucks per 100 Does	90% Confidence Interval Lower Limit	90% Confidence Interval Upper Limit
PAPA (Jan)	6	43.0	32.9	52.8
PAPA (Feb)	9	45.9	35.6	55.4
PAPA (Mar)	13	54.3	41.3	74.2
PAPA (Jan, Feb & Mar)	28	47.3	41.4	54.2
BC (Jan)	7	27.7	18.4	39.5
BC (Feb)	5	64.1	60.0	64.9
BC (Mar)	5	44.7	24.5	77.5
BC (Jan, Feb, & Mar)	17	47.2	33.5	59.5
PAPA and BC (Jan)	13	36.7	29.1	44.7
PAPA and BC (Feb)	14	54.0	45.2	60.7
PAPA and BC (Mar)	18	51.2	37.8	67.2
PAPA and BC (Jan, Feb & Mar)	45	47.3	41.1	53.5

Abundance

Pronghorn abundance in the PAPA was highly variable. We counted 1,420 pronghorn in 16 groups on January 14th, 505 pronghorn in 11 groups on February 10th, and 1,184 pronghorn in 23 groups on March 11th (Table 7, Fig. 3). Based on these 3 surveys, the estimated average number of pronghorn occupying the PAPA during 2010-11 winter was 1,036 (90% CI: 731 – 1,344), compared to 1,533 (90% CI: 772 – 2,305) in the 2009-10 winter. This represents a 32% decline in the average abundance on the PAPA from 2009-10 to 2010-11 winters. However, this decline was not statistically significant at an alpha level of $\alpha = 0.10$ (90% CI: 68% decline to 63% increase).

In contrast, pronghorn abundance was less variable in the Bench Corral Study Area across the three surveys during the winter of 2010-11. We counted 1,307 pronghorn in 18 groups in on January 15th, 2,088 pronghorn in 20 groups on February 11th, and 1,524 pronghorn in 17 groups on March 12th (Table 7, Fig. 8). The average number of pronghorn occupying in the Bench Corral Study Area during the three surveys was 1,640 (90% CI: 1,375 – 1,902), compared to 2,742 (90% CI: 2,670 – 2,808) in the 2009-10 winter. This represents a statistically significant 40% decline in the average abundance in the Bench Corrals Study Area from 2009-10 to 2010-11 winters (90% CI: 29% decline to 50% decline).

Table 7. Abundance estimates for the Pinedale Anticline Project Area (PAPA) and Bench Corral (BC) Study Area from winter aerial surveys. Ninety percent confidence intervals are to the right of each total count, unless a consensus was reached on all group sizes.

		Winter			
		2009-10		2010-11	
	Month	Estimate	90% CI	Estimate	90% CI
PAPA	January	775	782 767	1,420	1,425 1,415
	February	2,290	2,323 2,256	505	NA NA
	March	NA	NA NA	1,184	NA NA
	Average	1,533	2,305 772	1,036	1,344 731
Bench Corral	January	2,682	2,713 2,656	1,307	1,318 1,294
	February	2,802	2,817 2,785	2,088	2,094 2,082
	March	NA	NA NA	1,524	NA NA
	Average	2,742	2,808 2,670	1,640	1,902 1,375

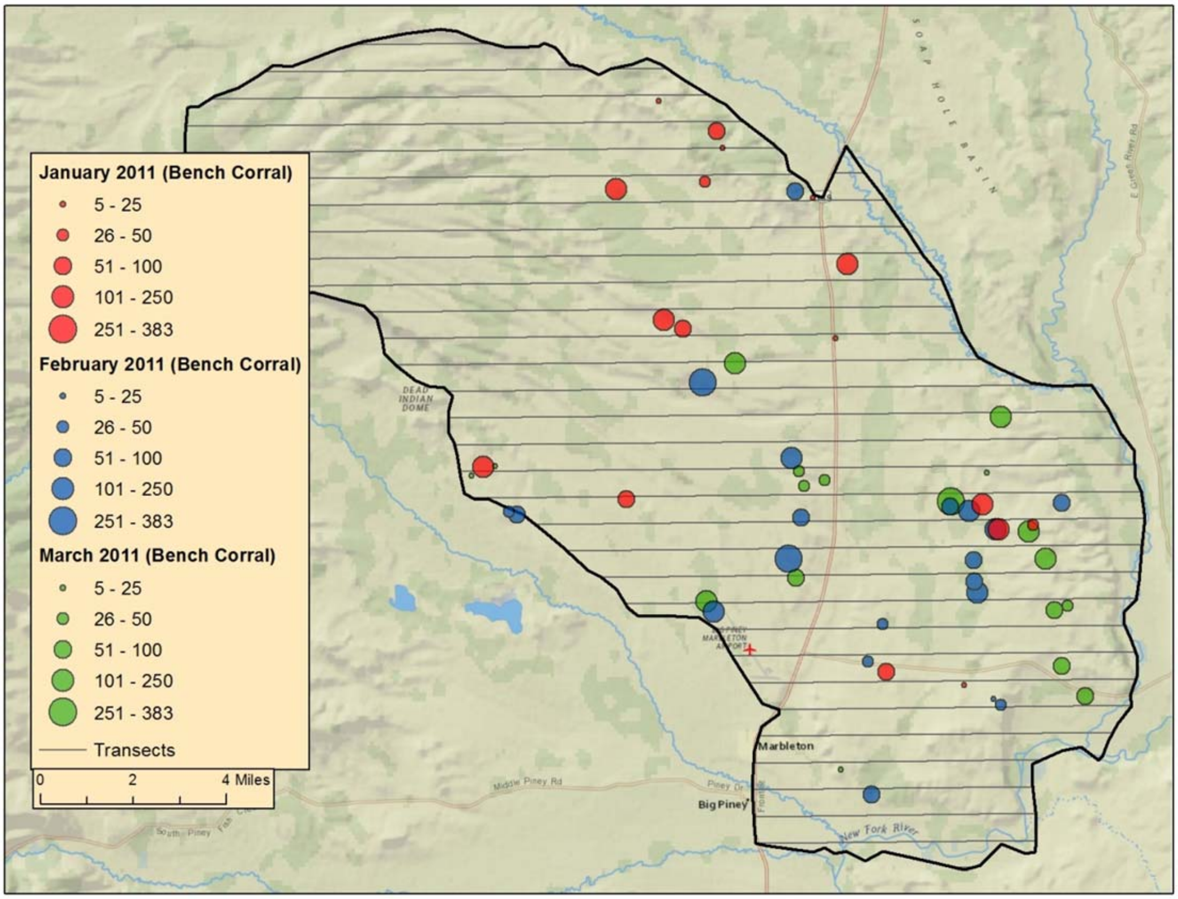

Figure 8. Location and relative size of pronghorn groups observed during aerial surveys over the Bench Corral Study Area.

DISCUSSION

Although we estimated a 32% decline in occupancy of the PAPA in 2010-11 compared to 2009-10, this decline was not statistically significant at an alpha level of $\alpha = 0.10$ based on overlapping CIs, and was less than the decline in occupancy of the Bench Corral Study Area for the same time period.

Only 4 of the collared pronghorn (1 from the PAPA and 3 from Bench Corral Study Area) were recorded outside of the PAPA and Bench Corral Study Area during the winter of 2010-11, and those locations were recorded during March of 2011. In addition, there was no evidence of movement of collared pronghorn between the two areas during the winter of 2010-11.

The high variability in the estimates of pronghorn occupancy of the PAPA in both 2009-10 and 2010-11 could be the result of changing snow conditions and probability of detection. However, the region within the PAPA and south of the New Fork River seems to contain a portion of the larger population whose movements are fluid across highway 351 and occupy a range that extends south of the study area. Thus, we believe the lack of precision for abundance of the PAPA is largely due to inclusion of the area south of the New Fork River.

The winter of 2009-10 was the first attempt to estimate pronghorn abundance in the PAPA and Bench Corral Study Area. In 2009-10 we tested two different HD video cameras, and we did not conduct a March survey due to a lack of snow and early detected migration of pronghorn from the study areas. Thus, we recommend considering the winter of 2009-10 to be a 'pilot' year, and winter of 2010-11 as the baseline to which future abundance estimates will be compared to determine if the WMMM trigger has been met.

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APPENDIX

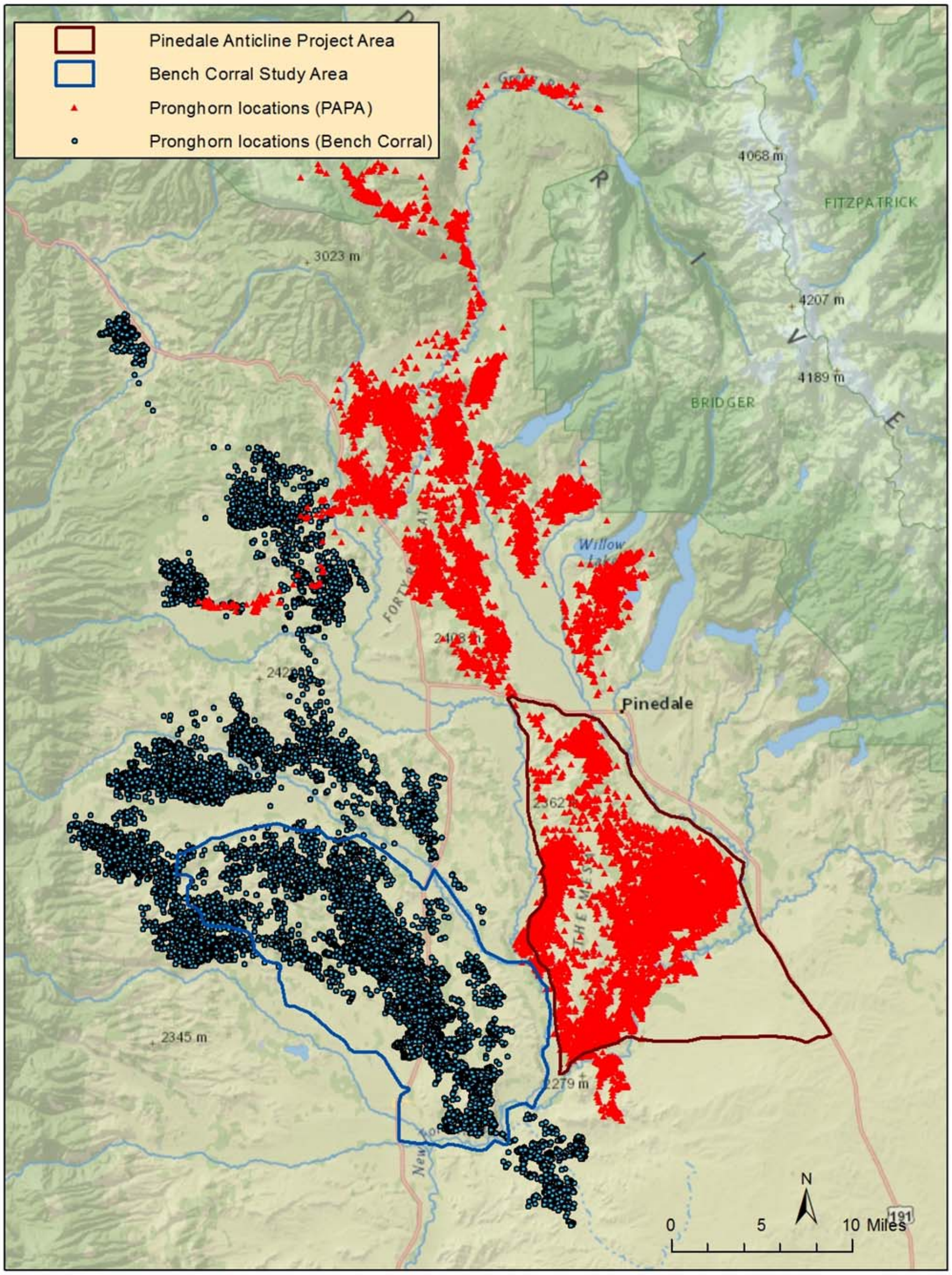

Figure A. 1. Locations obtained January 24 through October 31, 2011, from 28 Global Positioning System collars fitted to sampled pronghorn in the Bench Corral Study Area (left; blue) and the Pinedale Anticline Project Area (right; red).