Pronghorn Monitoring in the Pinedale Anticline Project Area

2015 Annual Report

Prepared for:

Pinedale Anticline Project Office (PAPO)

PO BOX 768
Pinedale, WY 82941

Prepared by:

Chad LeBeau, Ryan Nielson, and Hall Sawyer

Western EcoSystems Technology, Inc.
415 West 17th Street, Suite 200
Cheyenne, Wyoming 82001

November 2015

Draft Pre-Decisional Document for review

SUGGESTED CITATION

LeBeau, C. W., R. M. Nielson, and H. Sawyer. 2015. Pronghorn monitoring in the Pinedale Anticline Project Area: 2015 Annual Report. Western EcoSystems Technology, Inc., Cheyenne, Wyoming, USA.

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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. Here, we report monitoring results for the winter of 2014-15, where estimates indicate an increase in pronghorn abundance of the PAPA since 2009-10.

Methods

We estimated pronghorn abundance in the PAPA in January, February, and March 2015 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 abundance 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 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.

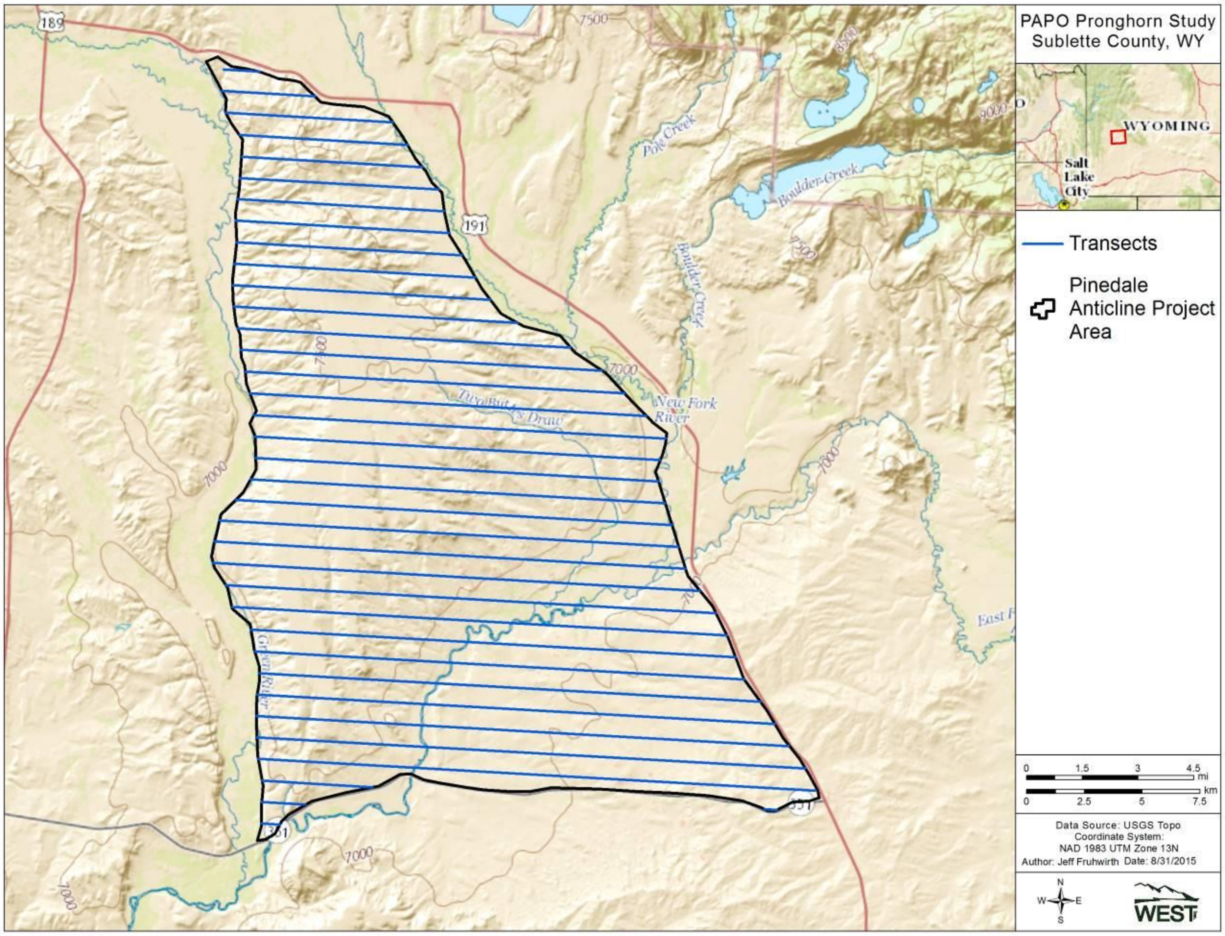

Figure 1. Survey transects over the Pinedale Anticline Project Area.

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 from independent observers viewing the same video clip 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, 2010-11, 2011-12, 2012-13, 2013-14, and 2014-15 winters, so we calculated an average abundance for each winter. Ninety-percent CIs were calculated by randomly sampling, with replacement, 2 survey days (for 2009-10 monitoring period; Nielson and Sawyer 2011) or 3 survey days (for 2010-11 through 2014-15 monitoring periods; Nielson and Sawyer 2012, Nielson et al. 2013a, Nielson et al. 2014) 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 2014-15 winter.

Results

Pronghorn abundance in the PAPA was highly variable. We counted 3,657 pronghorn in 26 groups on January 8, 5160 pronghorn in 39 groups on February 13, and 7,224 pronghorn in 118 groups on March 10 (Table 1, Fig. 3). Based on these 3 surveys, the estimated average number of pronghorn occupying the PAPA during 2014-15 winter was 5,347 (90% CI: 4,096 – 6,561), compared to 1,533 (90% CI: 772 – 2,305) in the 2009-10 winter. This represents a 3-fold increase in average abundance on the PAPA from 2009-10 to 2014-15 winters (90% CI: 1.02-fold increase to 6.85-fold increase).

In contrast, WGFD population estimates for the entire Sublette herd unit reference area were 59,000 in 2010 and 31,300 in 2014, representing a 47% decline (Table 2).

Table 1. Abundance estimates for the Pinedale Anticline Project 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 (indicated by 90% CI = 'NA').

Area	Month	Winter 2009-10		Winter 2010-11		Winter 2011-12		Winter 2012-13		Winter 2013-14		Winter 2014-15	
		Estimate	90% CI	Estimate	90% CI	Estimate	90% CI	Estimate	90% CI	Estimate	90% CI	Estimate	90% CI
PAPA	Jan	775	782 767	1,420	1,425 1,415	2,200	NA NA	1,492	1,505 1,480	2,022	2,179 1,852	3,657	3,823 3,496
	Feb	2,290	2,323 2,256	505	NA NA	1,126	1,142 1,109	605	610 600	2,975	3,056 2,884	5,160	5,358 4,949
	Mar	NA	NA NA	1,184	NA NA	2,258	2,263 2,253	2,604	2,609 2,599	2,232	2,261 2,201	7,224	7,280 7,163
	Avg.	***1,533***	***2,305 772***	***1,036***	***1,344 731***	***1,861***	***2,242 1,473***	***1,567***	***2,239 895***	***2,409***	***2,774 2,050***	***5,347***	***6,561 4,096***

Table 2. Wyoming Game and Fish Department pronghorn population estimates for the entire Sublette herd unit.

Year	Estimate	% Change from 2010
2010	59,000	NA
2011	37,800	-36
2012	40,000	-32
2013	34,000	-42
2014	31,300	-47

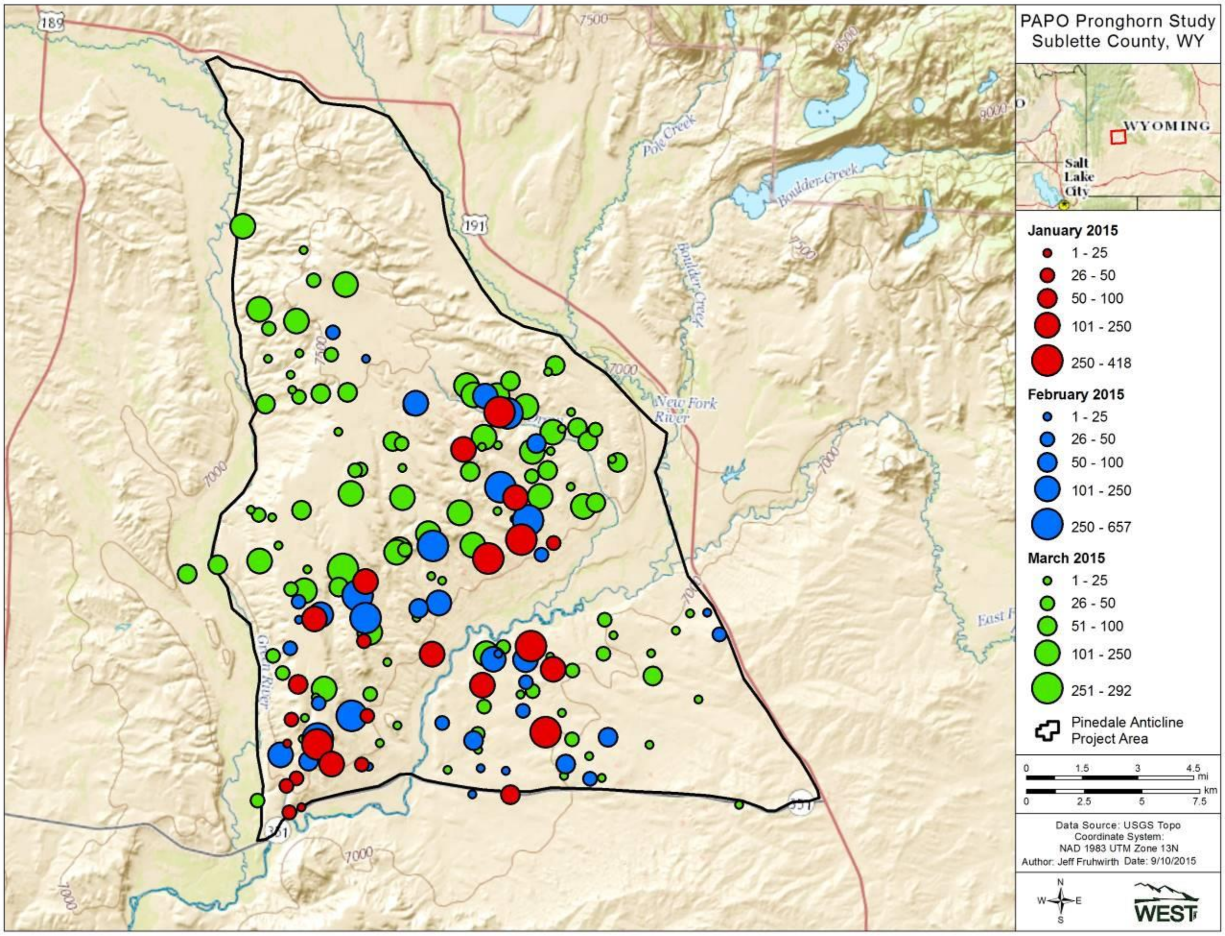

Figure 3. Location and relative size of pronghorn groups observed during aerial surveys over the Pinedale Anticline Study Area.

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 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.

However, we also recognize that marked animals are moving in and out of the study area within the winter period (see migration supplement). For example, during the winter (December 15 – March 15) of 2014-15, half of the marked pronghorn spent some time outside of the PAPA boundary. Importantly, our GPS data indicate that a substantial portion of animals utilize areas outside the study area boundary during the winter months (Fig. 4). The proportion of time spent on the PAPA decreased over time but the proportion of pronghorn that left the PAPA during the winter increased overtime. Such movements make estimating abundance difficult and could explain much of the variation observed between surveys. In addition, the high pronghorn estimates during the month of March are likely due to pronghorn from the south migrating through the PAPA.

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. We estimated a significant 3-fold increase in abundance of the PAPA in 2014-15 compared to 2009-10.

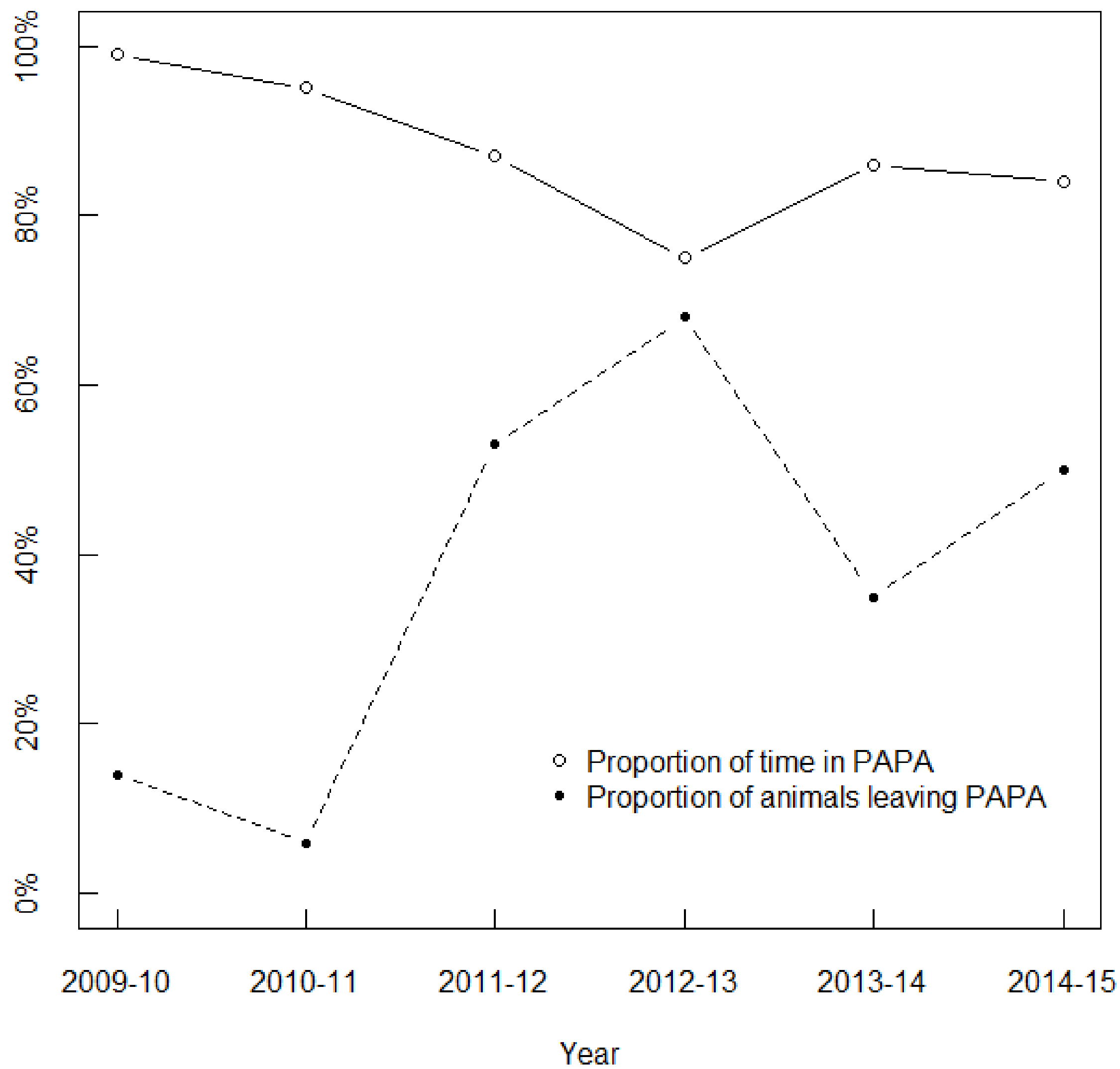

Figure 4. The proportion of total time pronghorn spent on the Pinedale Anticline Project Area and the proportion of pronghorn that left the Pinedale Anticline Project Area during the winter period.

SECTION II: Resource selection modeling

Overview

As part of the pronghorn monitoring effort we attempted to maintain a sample (~30 animals) of GPS-collared pronghorn in both the Pinedale Anticline Project Area (PAPA) and Bench Corral Study Area (BC) to document movements and understand whether abundance estimates were 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 document migration routes for the PAPA and BC study area sub-populations.

Methods

Capture and Collaring

We captured 30 adult female pronghorn on January 12, 2012 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 April 1, 2013. These were the first collars used in this long-term monitoring effort that collected data on individual pronghorn for consecutive years. Capture efforts were split between the PAPA (*n*=13) and BC (*n*=17; Fig. 5). We attempted to sample pronghorn in proportion to their relative distribution across both winter ranges (Fig. 5). On December 12, 2012 we captured 6 additional animals, including 4 in the PAPA (*n*=17) and 2 in BC (*n*=19), to put out collars from animals that died during 2012.

We captured 29 adult female pronghorn on December 16, 2013 and equipped them with store-on-board GPS collars that were programmed to collect locations every 2 hours and drop off April 1, 2015. Capture efforts were split between the PAPA (*n*=17) and BC (*n*=13; Fig. 5). Three additional pronghorn were captured on the PAPA on February 17 and December 11, 2014.

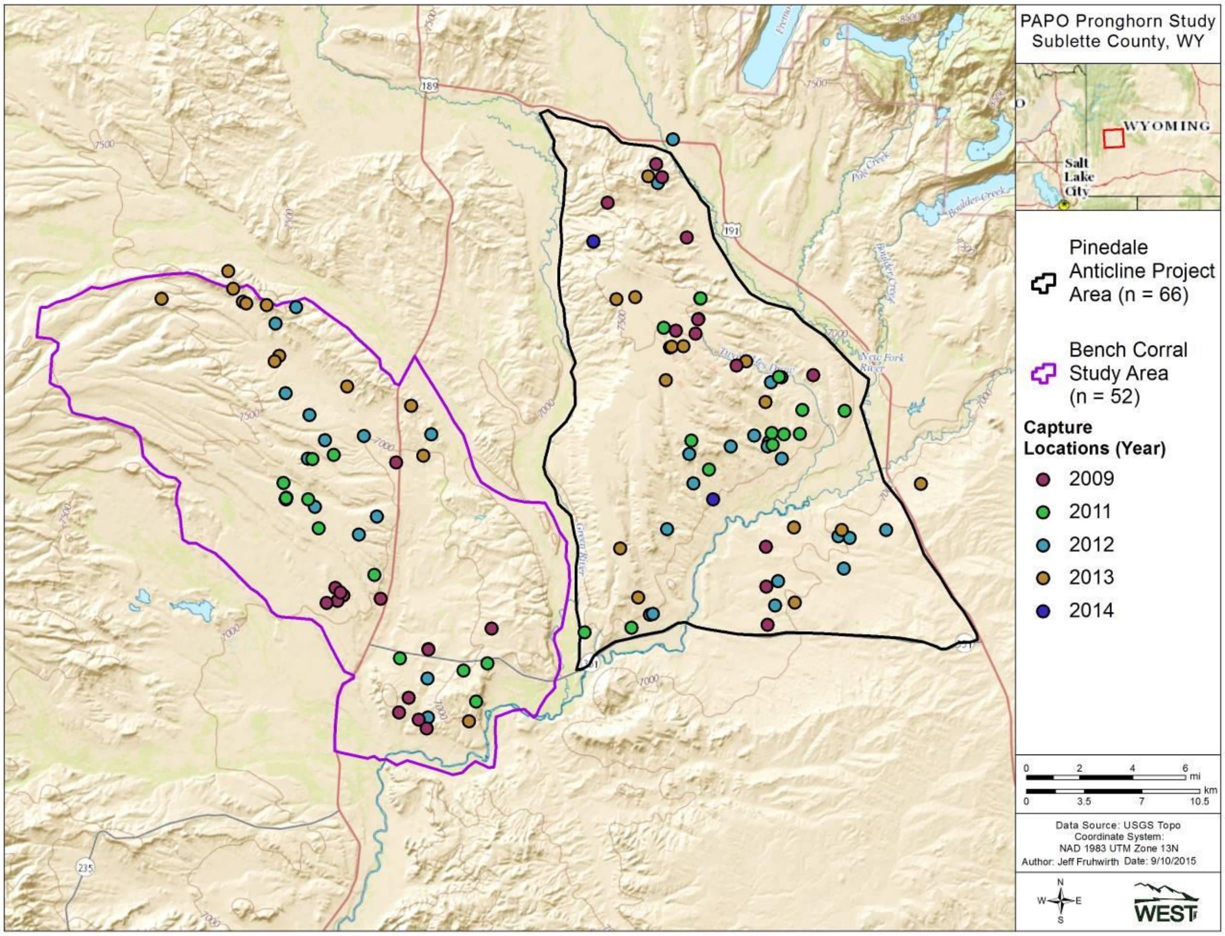

Figure 5. Capture locations of pronghorn in the Pinedale Anticline Project Area and Bench Corral Study Area in January and December, 2009-2014.

Habitat Use Modeling

We developed a habitat use model for pronghorn in the PAPA during the winters of 2011-12, 2012-13, 2013-14, and 2014-15 (January 1 – March 31). Average GPS fix success was high (>99%), so our approach to habitat use analysis generally followed that of Nielson and Sawyer (2013), 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 (e.g., Sawyer et al. 2009), 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 allows for information-theoretic approaches to 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) used AIC to evaluate a set of five candidate models 5) bootstrapped (Manly 2007) the individual pronghorn to estimate SEs and 90% CIs for the top model coefficients, and then 6) 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 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 3) and used Akaike's Information Criterion AIC (Burnham and Anderson 2002) to rank the models. Habitat use models were fit using R v2.14.1 (R Development Core Team 2013). Model selection was performed on the 2011-12 data. The best approximating model from the 2011-12 data was then used to estimate selection patterns for subsequent years to identify changes in selection patterns over time.

Table 3. 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 19 of the 21 GPS collars from pronghorn in the PAPA during the 2011-12 and 2012-13 study period. The two unrecovered collars (collar IDs: 69 and 77) were last detected during flights on October 8 and August 23, 2012, respectively, and the fate of these animals is unknown. Two of the 19 collars recovered were from pronghorn that died of natural causes and one collar was retrieved from a harvested pronghorn.

During the 2013-14 and 2014-15 study period, we recovered all 20 GPS collars from pronghorn in the PAPA. No data was recorded for one individual that died as a result of capture. Two of the 20 collars recovered were from pronghorn that died of natural causes and one collar was retrieved from a harvested pronghorn.

We recovered all 16 GPS collars from pronghorn in the BC during the 2011-12 and 2012-13 study period and 12 of the 13 GPS collars during the 2013-14 and 2014-15 study periods. Six pronghorn died between February 2, 2012 and March 11, 2013 and one died shortly after capture during the 2011-12 and 2013-14 study periods. One individual pronghorn died in the BC during the 2013-14 and 2014-15 study periods.

Habitat Use

We used 5,847 locations collected from 15 GPS-collared pronghorn in the PAPA to estimate a habitat use model for the winter of 2011-12. In addition, we used 6,835 locations from 17 individuals for the winter 2012-13, 9,556 locations from 16 individuals for the winter 2013-14, and 9,722 locations from 17 individuals for the winter 2014-15 habitat use models. The model containing elevation, elevation^2, slope, slope^2, aspect (S & E), proportion of low-density sagebrush, and distance to well was the top model based on the lowest AIC value for the winter 2011-12 habitat use model.

This model was applied to subsequent years use data and the coefficients from the final model for all winters (Table 4-7) suggest that pronghorn selected for areas with low-density sagebrush at moderate elevations, with moderate slopes facing south or east, and closer to wells. Plots in Fig. 6 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 2011-12 winter (January-March).

Covariate	Estimated Coefficient	90% Confidence Interval	
		Lower Limit	Upper Limit
Intercept	-793.3252	NA	NA
Elevation (m)	0.7185	0.4817	1.0490
$Elevation^2$	-0.0002	-0.0002	-0.0001
Slope (%)	-0.0122	-0.0855	0.0723
$Slope^2$	-0.0063	-0.0156	0.0007
% Low-density Sagebrush	1.0629	0.8411	1.3259
Aspect (S & E)	0.3807	0.0928	0.6548
Dist. (km) to Well	-0.7243	-0.9337	-0.5062

Table 5. Coefficients with 90% confidence intervals for the final habitat use model for pronghorn in the Pinedale Anticline Project Area during the 2012-13 winter (January-March).

Covariate	Estimated Coefficient	90% Confidence Interval	
		Lower Limit	Upper Limit
Intercept	-558.2528	NA	NA
Elevation (m)	0.4993	0.1138	1.0384
$Elevation^2$	-0.0001	-0.0002	-0.00003
Slope (%)	0.0671	-0.0062	0.1468
$Slope^2$	-0.0120	-0.0192	-0.0067
% Low-density Sagebrush	1.1686	0.9870	1.3555
Aspect (S & E)	0.4381	0.2587	0.5980
Dist. (km) to Well	-0.2335	-0.5346	0.0079

Table 6. Coefficients with 90% confidence intervals for the final habitat use model for pronghorn in the Pinedale Anticline Project Area during the 2013-14 winter (January-March).

Covariate	Estimated Coefficient	90% Confidence Interval	
		Lower Limit	Upper Limit
Intercept	-796.5602	NA	NA
Elevation (m)	0.7186	0.4870	0.9739
Elevation^2	-0.0002	-0.0002	-0.0001
Slope (%)	0.0811	0.0003	0.1847
Slope^2	-0.0135	-0.0240	-0.0067
% Low-density Sagebrush	0.8979	0.6599	1.2097
Aspect (S & E)	0.6553	0.5843	0.7249
Dist. (km) to Well	-0.2251	-0.3930	-0.0878

Table 7. Coefficients with 90% confidence intervals for the final habitat use model for pronghorn in the Pinedale Anticline Project Area during the 2014-15 winter (January-March).

Covariate	Estimated Coefficient	90% Confidence Interval	
		Lower Limit	Upper Limit
Intercept	-291.9408	NA	NA
Elevation (m)	0.2616	-0.14787	0.60149
Elevation^2	-0.0001	-0.00014	0.00003
Slope (%)	0.0429	-0.08520	0.15715
Slope^2	-0.0165	-0.02677	-0.00627
% Low-density Sagebrush	1.3472	1.09337	1.59711
Aspect (S & E)	0.4058	0.13599	0.60174
Dist. (km) to Well	-0.1924	-0.35454	-0.01351

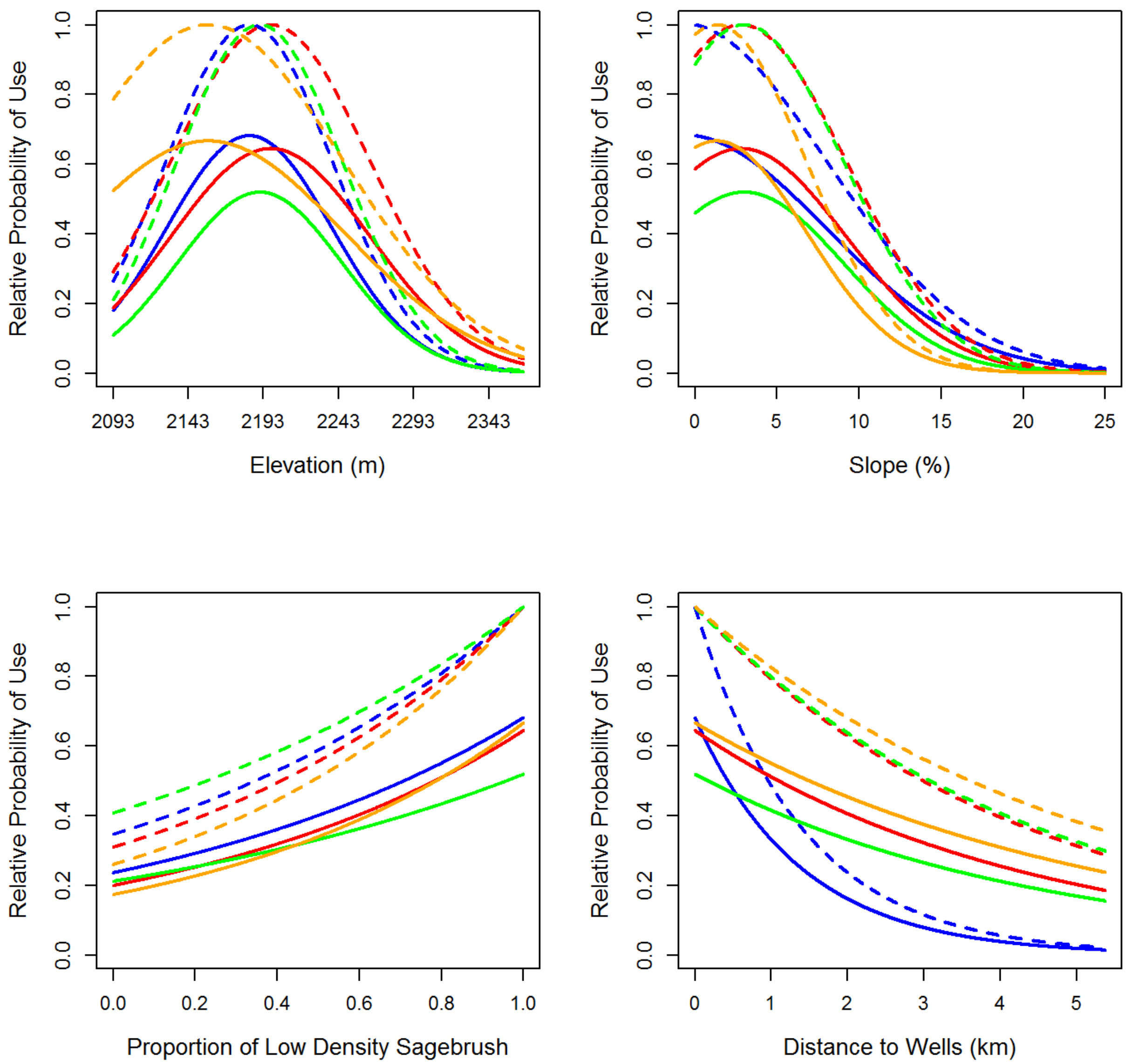

Figure 6. Predicted levels of use by pronghorn in the Pinedale Anticline Project Area during the winters of 2011-12 (blue lines), 2012-13 (red lines), 2013-14 (green), and 2014-15 (orange), as a function of variables in the top habitat use model. Dashed lines represent predictions for south and east facing slopes and solid lines represent predictions for areas facing north or west. Levels of variables not plotted were held constant.

Areas with the highest predicted level of use (i.e., dark blue areas in Appendix A) had an average elevation range between 2,148 m (2014-15) and 2,176 m (2013-14). Average slope ranged between 2.1% (2014-15) and 3.0% (2013-14). Average Low-density sagebrush ranged between 79% (2011-12) and 92% (2014-15). Average distance to wells ranged between 0.41 km (2011-12) and 0.81 km (2013-14).

Most (62% in 2011-12, 79% in 2012-13, 93% in 2013-14, and 70% in 2014-15) of the areas with the highest predicted level of use had south or east facing slopes. The predictive maps indicated that pronghorn use was highest in areas relatively close to wells during all winters (Appendix A).

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. We found that pronghorn used areas relatively close (< 1 km) to infrastructure. This is in sharp contrast to mule deer that have avoided well pads in the same study area (Sawyer et al. 2009). Our data suggest that when pronghorn occupied the PAPA during the winter of 2011-12 2012-13, 2013-14, and 2014-15, they did not avoid gas field infrastructure. Importantly, our GPS data indicate that a substantial portion of animals utilize areas outside the study area boundary during the winter months (see Fig. 4). The proportion of time spent on the PAPA decreased over time but the proportion of pronghorn that left the PAPA during the winter increased overtime. Thus, our habitat use model only reflects use of marked animals when they were in the study area. 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.

SECTION III: Trends in Pronghorn Abundance in the Pinedale Anticline Project Area and the Bench Corral Study Area

Overview

As part of the pronghorn monitoring effort we estimated pronghorn abundance in the Bench Corral (BC) Study Area in January, February, and March 2015 in addition to the Pinedale Anticline Project Area (PAPA) 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 abundance over time and estimate the average number of pronghorn occupying the area during the winter period.

Methods

Pronghorn abundance in the PAPA and BC 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 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.

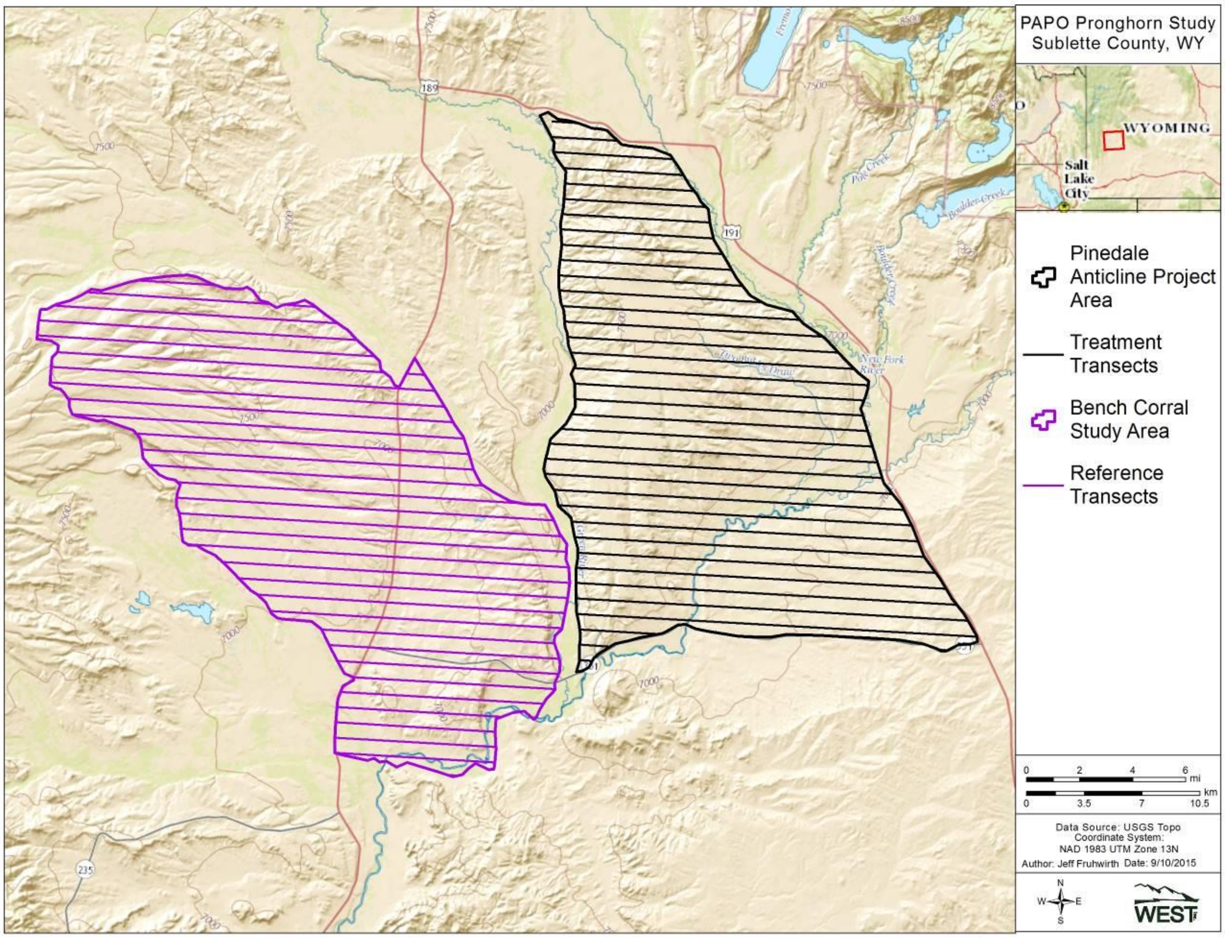

Figure 7. Survey transects used to estimate pronghorn abundance within the Pinedale Anticline Project Area and the Bench Corral Study Area.

Results

Pronghorn abundance in the PAPA was highly variable. We counted 3,657 pronghorn in 26 groups on January 8, 5160 pronghorn in 39 groups on February 13, and 7,224 pronghorn in 118 groups on March 10 (Table 8). Based on these 3 surveys, the estimated average number of pronghorn occupying the PAPA during 2014-15 winter was 5,347 (90% CI: 4,096 – 6,561), compared to 1,533 (90% CI: 772 – 2,305) in the 2009-10 winter. This represents a 3-fold increase in average abundance on the PAPA from 2009-10 to 2014-15 winters (90% CI: 1.02 to 6.85-fold increase; Fig. 8).

Pronghorn abundance was less variable in the BC across the three surveys during the winter of 2014-15. We counted 4,486 pronghorn in 26 groups on January 7, 4,963 pronghorn in 37 groups on February 14, and 3,998 pronghorn in 92 groups on March 12 (Table 8, Fig. 8, Fig. 9). The average number of pronghorn occupying in the BC during the three surveys was 4,482 (90% CI: 4,024 – 6,648), compared to 2,742 (90% CI: 2,808 – 2,670) in the 2009-10 winter. This represents a statistically significant 59% increase in the average abundance in the BC from 2009-10 to 2014-15 winters (90% CI: 49 to 69% increase).

Table 8. Abundance estimates for the Pinedale Anticline Project Area and Bench Corral 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.

Area	Month	Winter 2009-10		Winter 2010-11		Winter 2011-12		Winter 2012-13		Winter 2013-14		Winter 2014-15	
		Estimate	90% CI	Estimate	90% CI	Estimate	90% CI	Estimate	90% CI	Estimate	90% CI	Estimate	90% CI
PAPA	Jan	775	782 767	1,420	1,425 1,415	2,200	NA NA	1,492	1,505 1,480	2,022	2,179 1,852	3,657	3,823 3,496
	Feb	2,290	2,323 2,256	505	NA NA	1,126	1,142 1,109	605	610 600	2,975	3,056 2,884	5,160	5,358 4,949
	Mar	NA	NA NA	1,184	NA NA	2,258	2,263 2,253	2,604	2,609 2,599	2,232	2,261 2,201	7,224	7,280 7,163
	Avg.	***1,533***	***2,305 772***	***1,036***	***1,344 731***	***1,861***	***2,242 1,473***	***1,567***	***2,239 895***	***2,409***	***2,774 2,050***	***5,347***	***6,561 4,096***
BC	Jan	2,682	2,713 2,656	1,307	1,318 1,294	1,856	1,871 1,840	510	533 487	495	503 487	4,486	4,626 4,352
	Feb	2,802	2,817 2,785	2,088	2,094 2,082	1,528	1,561 1,494	231	NA NA	1,336	1,469 1,154	4,575	4,728 4,427
	Mar	NA	NA NA	1,524	NA NA	1,772	1,787 1,756	840	NA NA	2,536	2,606 2,466	3,998	4,046 3,958
	Avg.	***2,742***	***2,808 2,670***	***1,640***	***1,902 1,375***	***1,718***	***1,837 1,591***	***527***	***743 316***	***1,456***	***2,190 713***	***4,353***	***4,627 4,090***

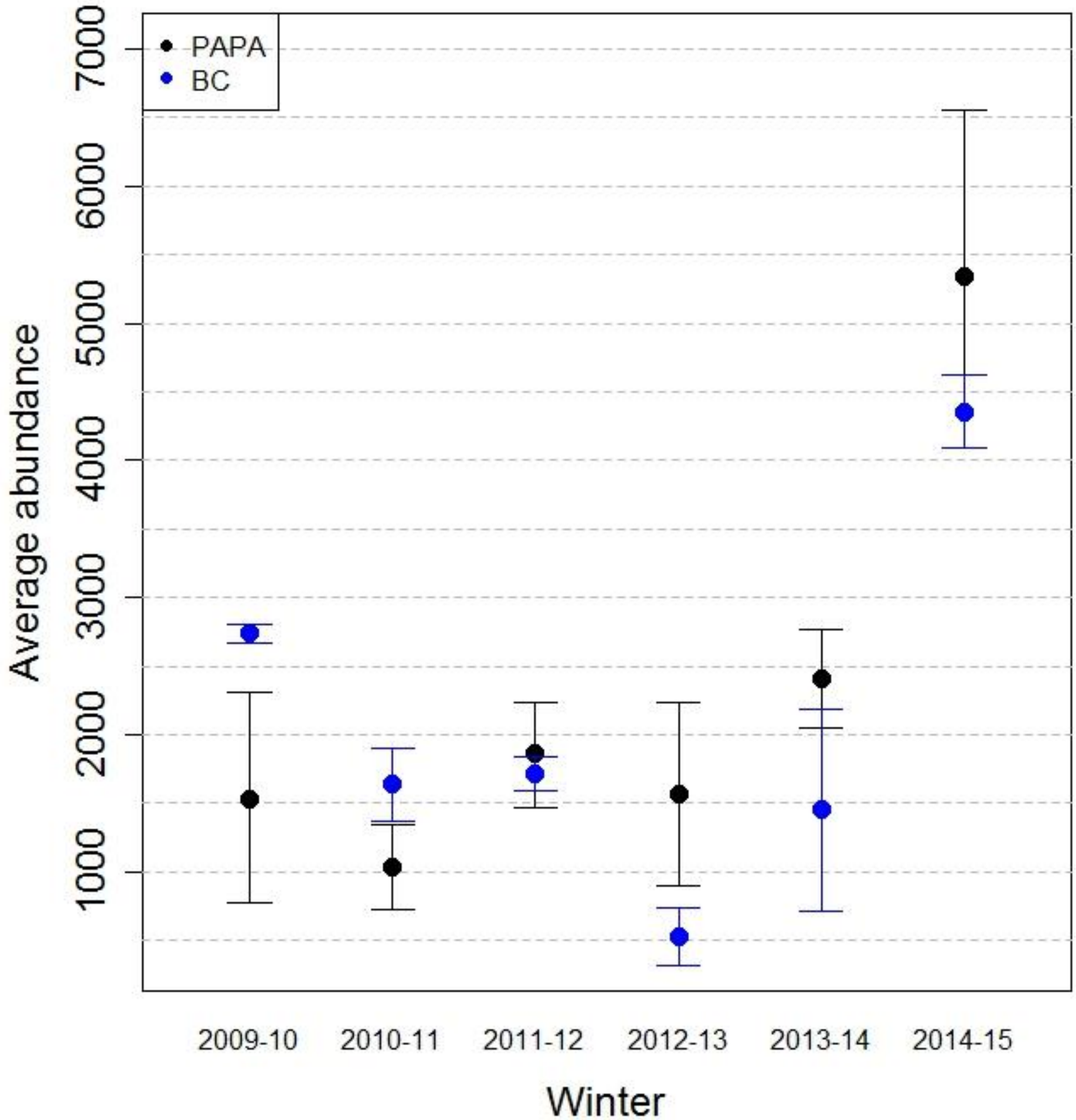

Figure 8. Average pronghorn abundance within the Pinedale Anticline Project Area and Bench Corral Study area during winter aerial surveys.

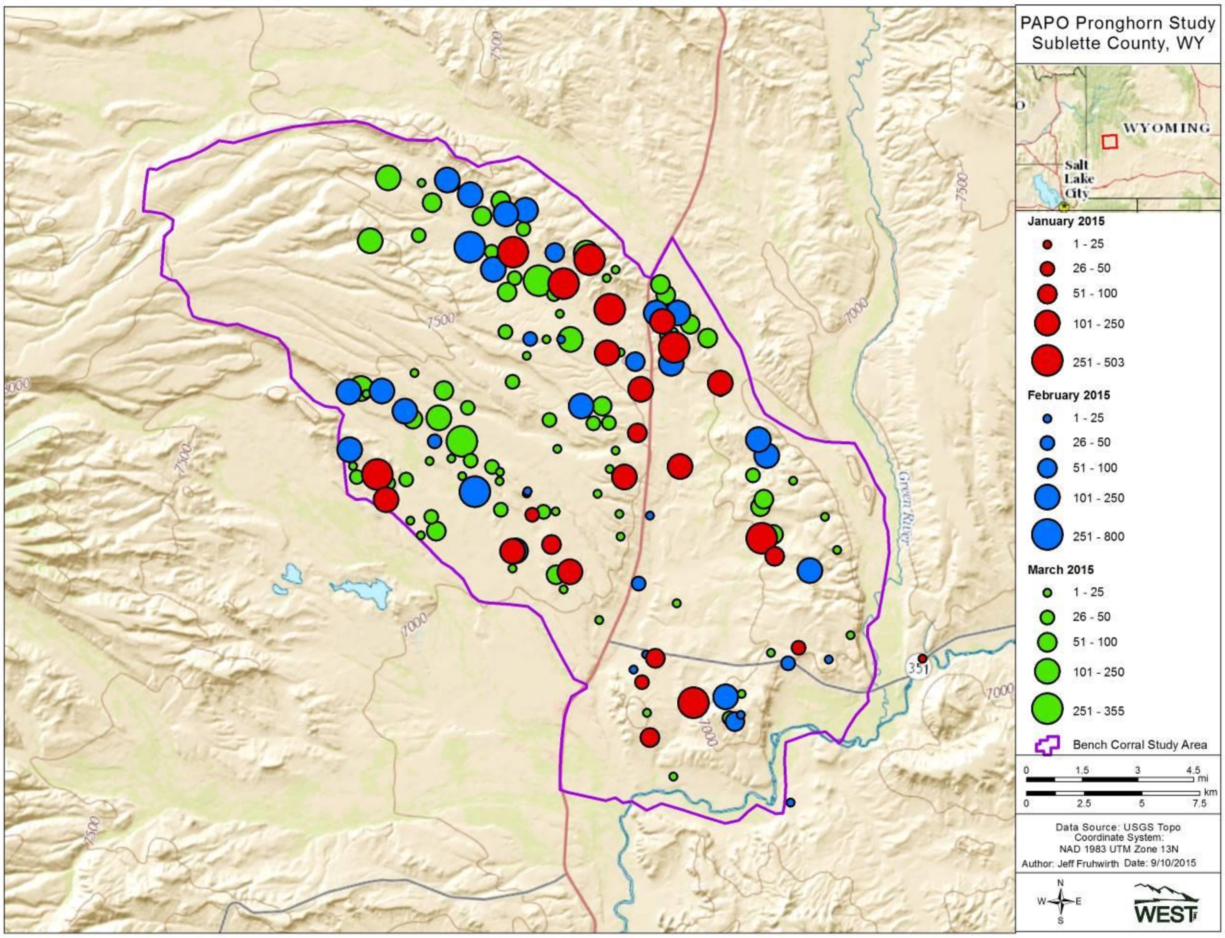

Figure 9. Location and relative size of pronghorn groups observed during aerial surveys over the Bench Corral Study Area.

Discussion

We estimated a 3-fold increase in abundance of the PAPA in 2014-15 compared to 2009-10. Similarly, we detected a significant increase (59%) in the average abundance in the BC from 2009-10 to 2014-15. The high variability in the estimates of pronghorn abundance in the PAPA could be the result of changing snow conditions and probability of detection. However, we believe a more likely explanation is movement of animals outside of the designated study areas. Specifically, the southern boundaries of both study areas appear to be fluid. Pronghorn in the Sand Draw or Duke's Triangle region of the PAPA often move south of highway 351 and occupy a range that extends 10-20 miles south of the study area (Nielson et al. 2013b). Pronghorn that winter east of HWY 189 in the BC area appear to move south beyond the Green River another 10-15 miles (Nielson et al. 2013b).

The winter of 2009-10 was the first attempt to estimate pronghorn abundance in the PAPA and BC. 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. If the 2010-11 winter is considered the baseline for calculating future changes in abundance, there was an estimated 4.69-fold increase in abundance of the PAPA in 2014-15 (90% CI; 2.43-fold increase to 7.89-fold increase). Change in abundance from 2010-11 to 2014-15 increased 1.68-fold within the BC (90% CI; 1.12-fold increase to 2.22-fold increase).

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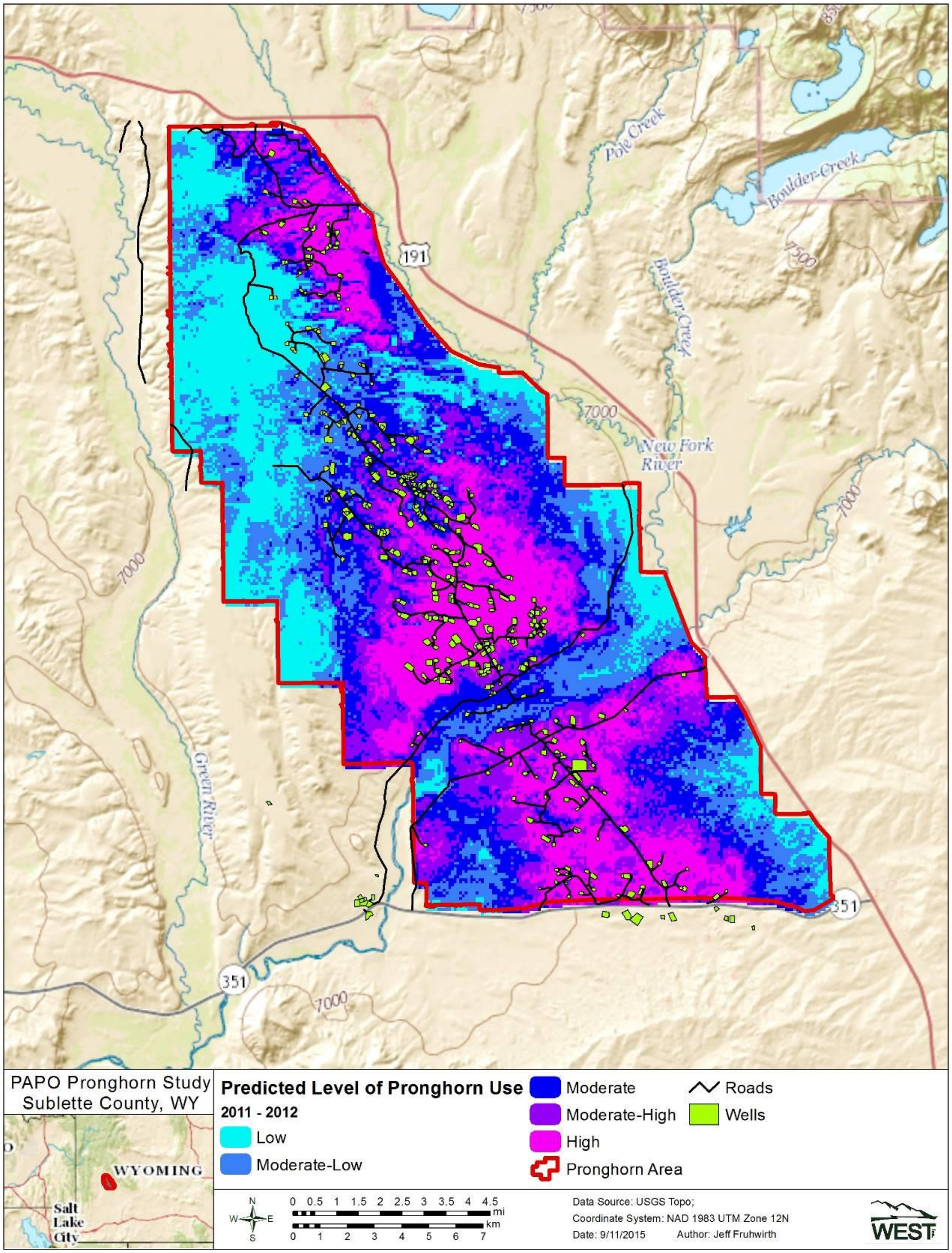
Appendix A.

Predicted level of pronghorn habitat use in a portion of the Pinedale Anticline Project Area that included available vegetation data developed by Thomas (2010) during the winter of 2011-12, 2012-13, 2013-14, and 2014-15. 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.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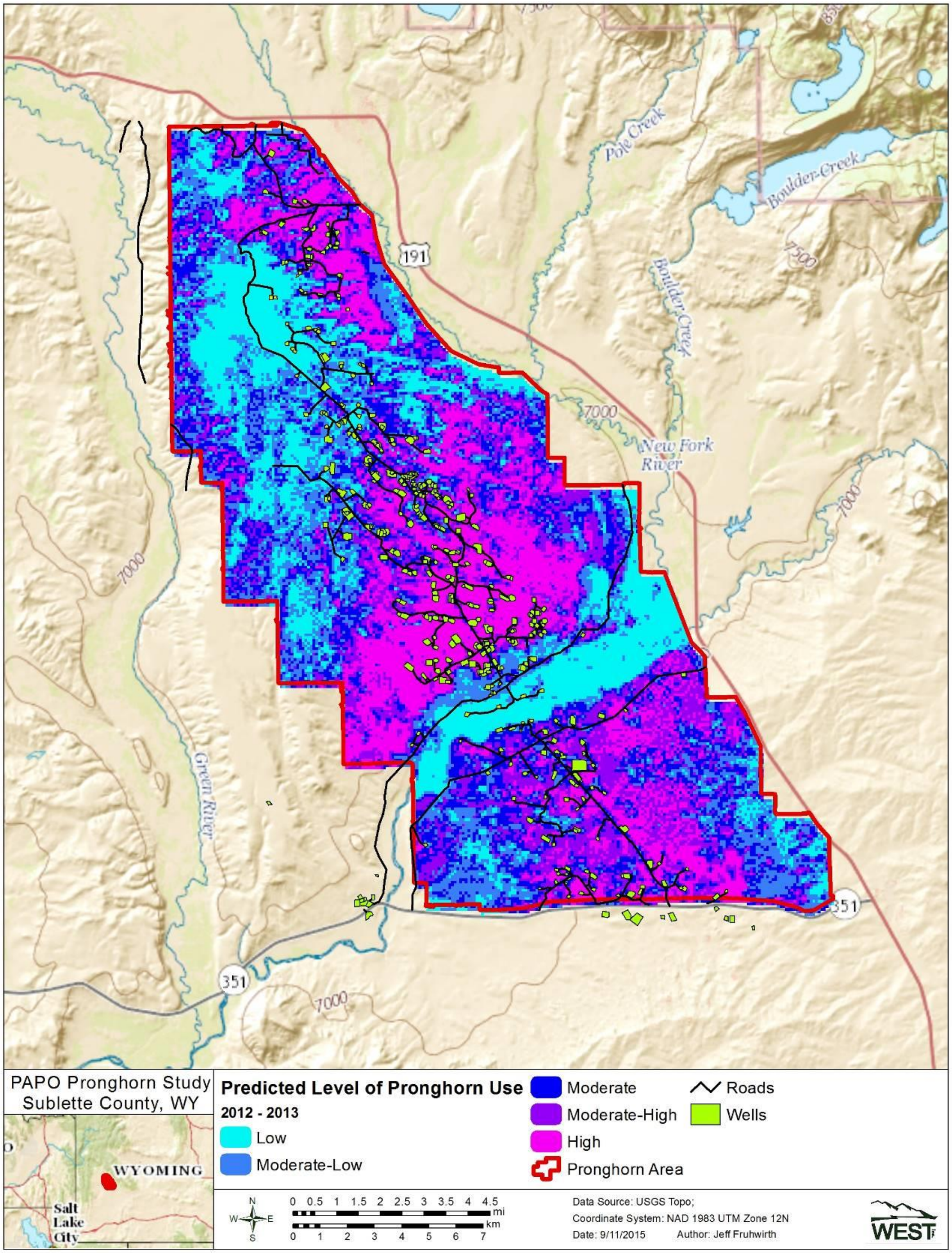
PAPO Pronghorn Study
Sublette County, WY
Predicted Level of Pronghorn Use
2011 - 2012
Low
Moderate-Low
Moderate
Moderate-High
High
Pronghorn Area
Roads
Wells
WYOMING
Salt Lake City
0 0.5 1 1.5 2 2.5 3 3.5 4 4.5 mi
0 1 2 3 4 5 6 7 km
Data Source: USGS Topo;
Coordinate System: NAD 1983 UTM Zone 12N
Date: 9/11/2015 Author: Jeff Fruhwirth
WEST



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Moderate-Low
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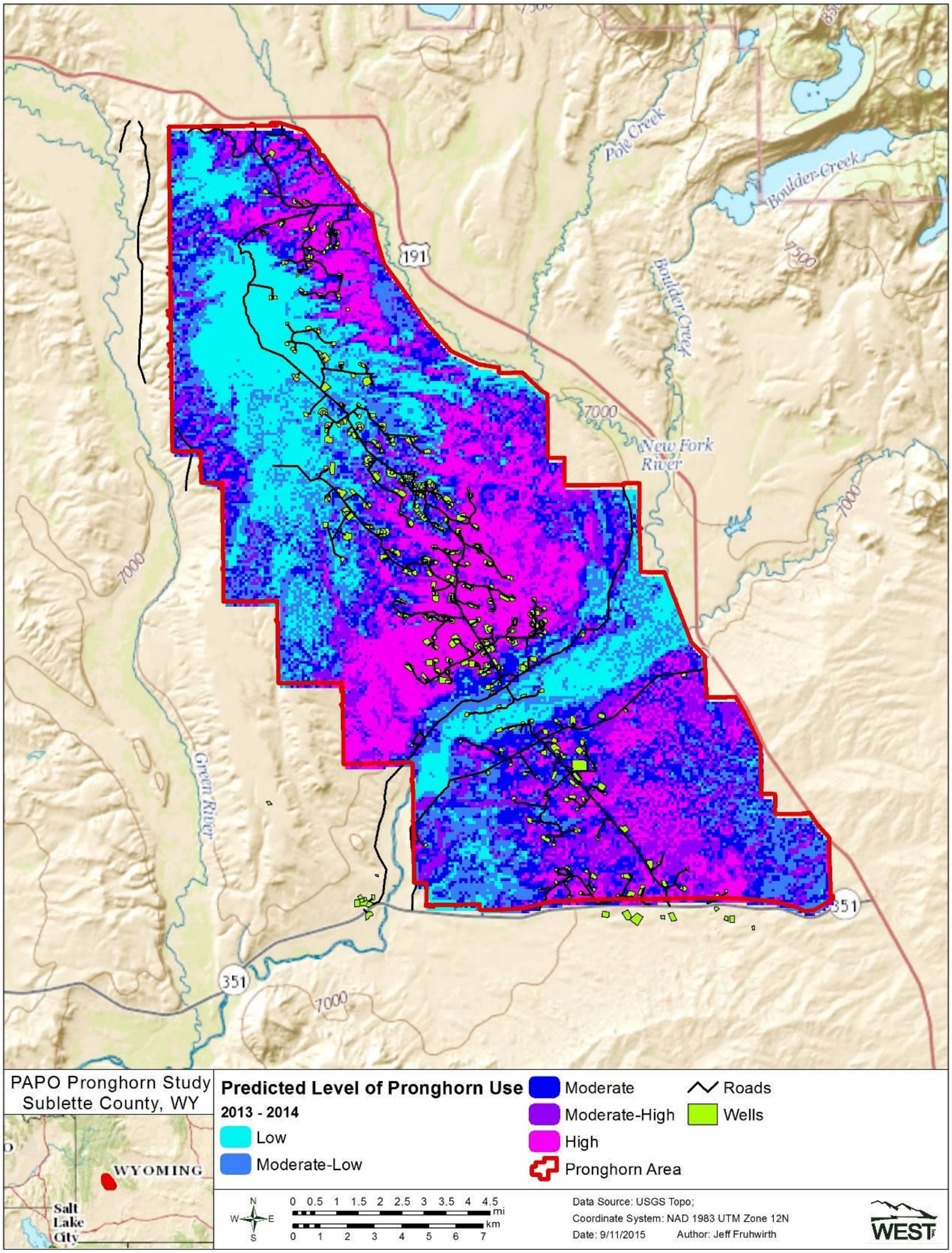
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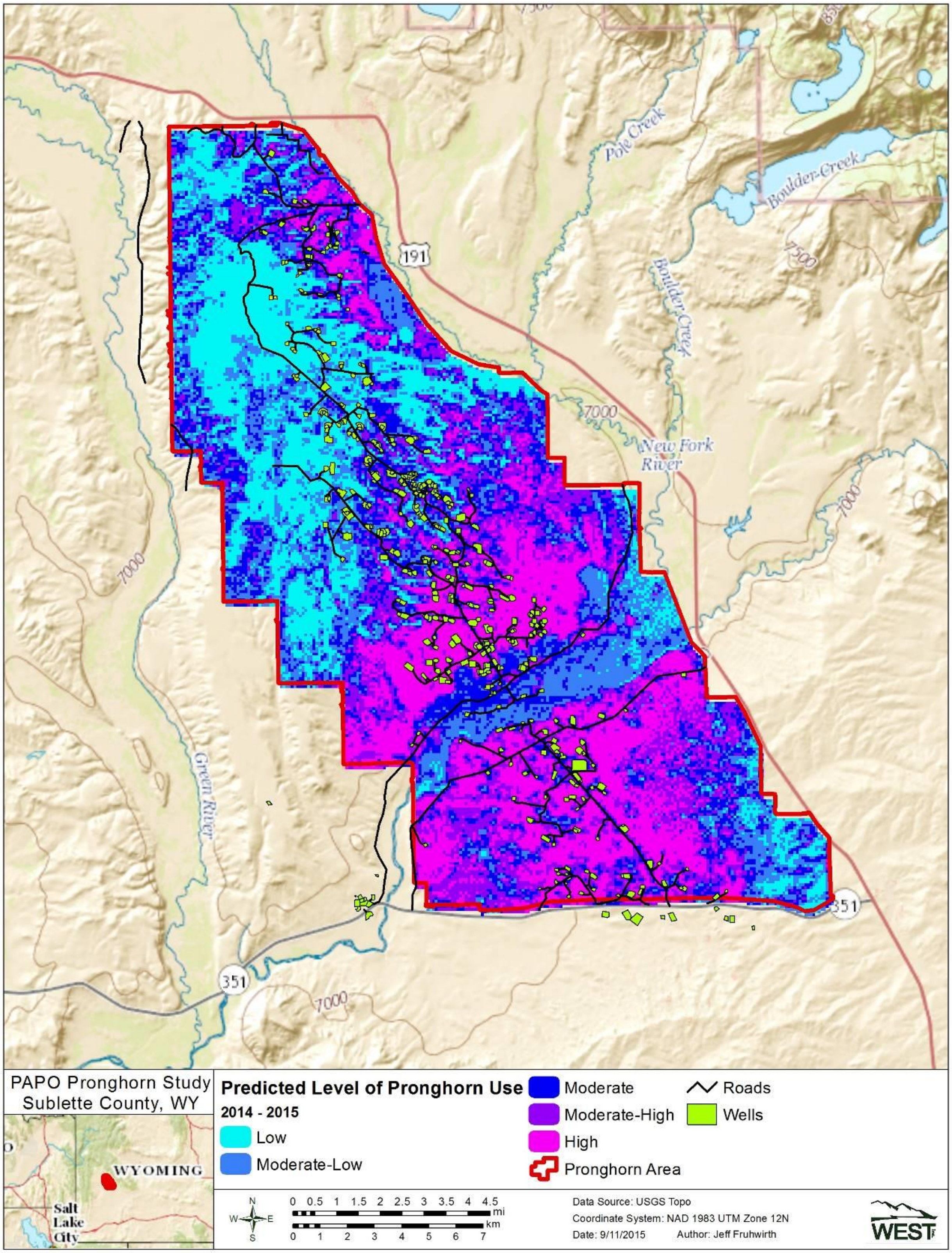
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