NEVADA DEPARTMENT OF WILDLIFE

Projects 14 &15

Coyote Removal For Deer Enhancement

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Abstract

We quantified the effects of 5 years of coyote removal in Game Management Units 222 and 231, Lincoln Co., NV during fiscal years (FY) 2003-2008. We summarized trends in coyote age and population structure using data obtained from tooth-age analysis (cementum) of teeth taken from harvested coyotes by Wildlife Services. Mean age of coyotes declined throughout the experimental period in GMU 231 as a result of additively removing coyotes by aerial gunning and ground removals each year. Also, juvenile to adult ratios significantly increased by the end of the experimental period as well as the number of adult males to adult females in the population. Fawn:doe and fawn:adult ratios were not significantly different in years prior to coyote removal compared to years following coyote removal in the experimental areas. Similarly, fawn:doe and fawn:adult ratios were not significantly different in the experimental area (GMU's 222 and 231) compared to an adjacent population of mule deer in Utah (Unit 30a) during the same period. Other factors may have contributed to fawn survival in these areas.

Summary

Coyote Age Stucture

The results of 5 years of coyote removal in Game Management Unit (GMU) 231 and the northern portion of GMU 222 in Eastern Nevada appear to have had significant effects on the population dynamics of coyotes in those respective areas. Mean age of coyotes harvested through ground control measures (trapping, calling, and shooting) decreased in each subsequent year in GMU 231 starting in fiscal year (FY) 2004 and ending in FY 2008 for which the most recent data is available (Table 1, Figure 1). This trend was similar in GMU 222 up to FY 2007, however, age data from FY 2008 proved to be problematic and most likely biased to older aged coyotes due to a procedural mistake resulting in about one third of the harvested coyotes not being aged. Furthermore the pup: adult ratio was also impacted by the removal of coyotes in the experimental area with the average number of pups to adult females taken by ground measures increasing from 0.94 in FY 2004 to 2.92 by the end of FY 2008 (Table 1, Figure 2). A total of 1,124 coyotes of all sex and age class were removed in GMU's 222 and 231 during fiscal years 2004 -2008 (Table 1, Figure 3). The highest total number of coyotes removed in any given year occurred in FY 2007 for GMU 231 and FY 2008 for GMU 222. Density of coyote removal ranged from 0 – 3.47 coyotes/km^2 for the entire experimental area with the most concentrated efforts occurring in GMU 231 (Figures 8-10).

Table 1. Summary of age, sex ratios, and total number of coyotes removed using ground methods (trapping, calling, and shooting) and aerial gunning from fixed wing aircraft in Game Management Units 222 and 231, Lincoln Co. Nevada, for fiscal years (2004 – 2008).

	Fiscal Year				
Ground Removals	**2004**	**2005**	**2006**	**2007**	**2008**
Avg. Age all	2.70	2.73	2.64	1.39	1.90
Avg. Age Unit 231	2.85	2.84	2.56	1.39	1.36
Avg. Age Unit 222	2.47	2.48	2.76	2.21	2.90
Pups/Adult Female	0.94	0.57	1.02	3.50	2.92
Male/Female ratio	0.94	0.64	0.80	0.78	1.50
231 Ground Removals	60	40	97	89	84
222 Ground Removals	39	88	58	58	46
231 Air Removals	-	69	81	96	85
222 Air Removals	-	-	45	30	59
231 Total Removed	60	109	178	185	169
222 Total Removed	39	88	103	88	105
Grand Total	99	197	281	273	274

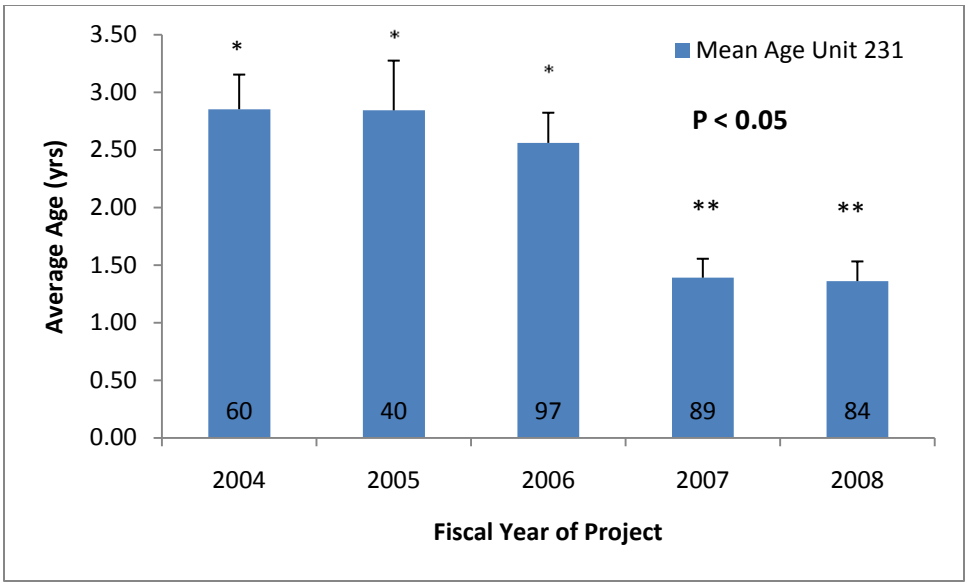

Figure 1. Mean age (+ SE) of coyotes harvested from predator removal experiment in Game Management Unit 231, Nevada for fiscal years (2004-2008). Sample sizes are displayed inside bars and stars above bars indicate significant differences in mean age of treatment year compared using ANOVA and Tukey's HSD for multiple comparisons ($\alpha = 0.05$).

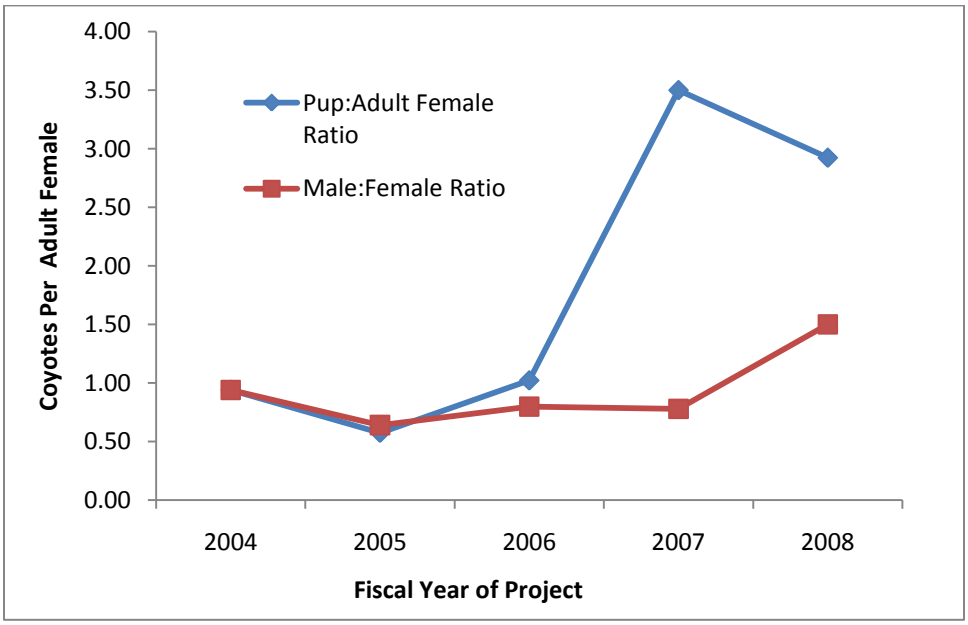

Figure 2. Mean pup to adult female ratio (blue line) and mean male to adult female ratio of coyotes harvested from predator removal experiment in Game Management Unit 231, Nevada for fiscal years (2004-2008).

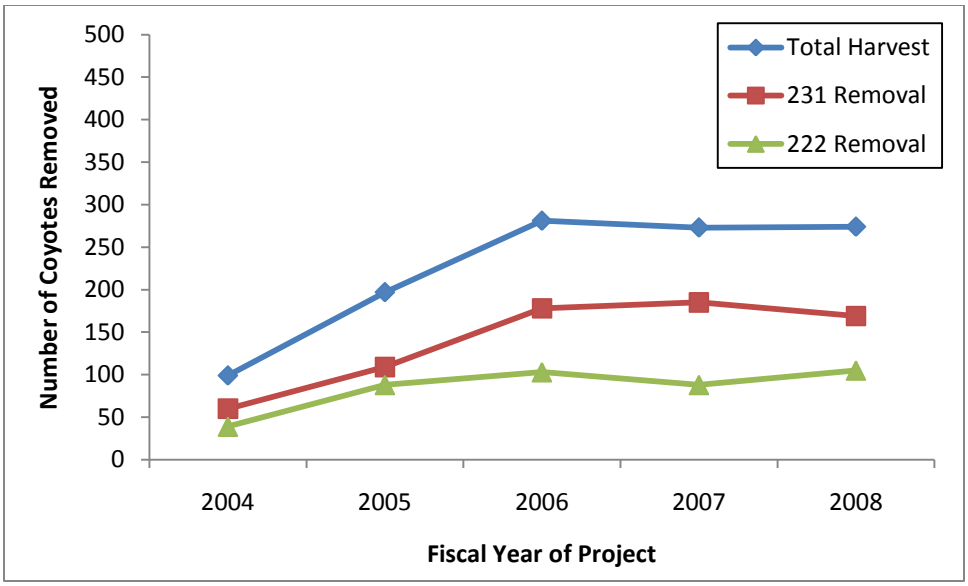

Figure 3. Total number of coyotes removed by ground trapping and aerial gunning in experimental areas of Game Management Unit 222 (green line), GMU 231 (red line), and the total number removed in both areas (blue line) for fiscal years (2004-2008).

Deer Population Response

The results from predator removal in GMU's 222 and 231 appear to have had minimal effects on the population structure of mule deer in those respective units. We compared fawn:doe ratios from post-season surveys conducted in early winter (December) and fawn:adult deer ratios in spring (April) for GMU's 222 and 231 in Nevada using 5 years of pre-removal survey data (1998-2003) and 5 years of post-removal survey data for years (2003-2008). We also compared deer survey data (fawn:doe and fawn:adult ratios) from experimental areas in Nevada (GMU 231 and northern GMU 222) with an adjacent population of mule deer in Utah (GMU 30a) where no predator removal projects occurred (although removal of some coyotes may have occurred for livestock depredation by US Wildlife Services and to enhance survival of neonate mule deer after years of poor fawn recruitment).

No significant differences occurred in fawn:doe ratios post-season (December) prior to start of predator removal between experimental area GMU 231 Nevada and control area GMU 30a Utah (ANOVA $_{unit}$ $F_{1,9}$ = 1.30, P = 0.291). A similar result occurred comparing Spring ratios (fawn:adult) from treatment area (GMU 231) with control area (UT GMU 30a) prior to predator removal (ANOVA $_{unit}$ $F_{1,9}$ = 0.69, P = 0.432).

Fawn to doe and fawn to adult ratios did not significantly differ between treatment area (NV GMU 231) and control area (UT GMU 30a) after predator removal experiment began (2003-2008) (Table 2). Post-season fawn:doe ratios did not significantly differ between control and treatment (ANOVA $_{unit}$ $F_{1,9}$ = 0.005, P = 0.941) nor did Spring fawn:adult ratios (ANOVA $_{unit}$ $F_{1,9}$ = 1.37, P = 0.274, Table 2, Figure 4).

Similarly, when comparing young:adult ratios for pre-treatment years (1997-2002) with post-treatment years (2003-2008) for the treatment area in Nevada (GMU's 222 and 231), no significant differences were found in both post-season data and spring survey data (Table 2, Figures 5,6). Although, when comparing just survey data in GMU 231, where a significant amount of coyote removal occurred

throughout the entire study area, December fawn:doe ratios do approach significance (ANOVA $_{unit}$ $F_{1,9}$ = 4.51, P = 0.066)(Figure 5). However, spring ratios during the same time periods (an indicator of fawn recruitment), do not appear to be significantly different (ANOVA $_{unit}$ $F_{1,9}$ = 1.31, P = 0.281)(Table 2, Figure 5). The same was true when comparing survey data from combined units 222 and 231 for pre-treatment years (1997-2002) with post-treatment survey data (2003-2008) (Table 2, Figure 6).

Although the results from 5 years of coyote removal in experimental areas (GMU's 231 and 222) do not appear to have significantly impacted the recruitment of mule deer fawns, coyote predation on mule deer is likely occurring. Several reasons could explain why the desired results from predator removal were not obtained. First, the deer data collected is very course in nature and lacks statistical power. Deer data are collected only twice per year (post-season and spring) and much variation can occur when surveying mule deer from a helicopter depending on the weather conditions and timing of mule deer migration patterns. Furthermore no survival data exits on mule deer fawns from the time they are born (mid to late June) to the first six months, when coyote predation is most likely to occur. Although mean fawn:doe ratios do appear to be higher overall during years of coyote removal (Table 2) compared to years of pre-treatment, other compounding factors could be affecting fawn survival and recruitment. For instance, the highest number of fawns per 100 does were observed during a post-season survey in year 2005 (87 fawns per 100 does) only 61 fawns per 100 does were observed the following year (post-season), and spring recruitment numbers were the lowest observed in 10 years during years 2004 and 2008 near the beginning and end of the coyote removal project. Other factors such as annual snowpack and spring/summer precipitation may have also confounded the results from the predator removal experiment. For example the high numbers of fawns observed during spring surveys in years 2005-2006 corresponded to record high precipitation for GMU's 222 and 231 in eastern Nevada (Figure 7). The subsequent decline in precipitation for GMU's 222 and 231 following years 2005-2006 corresponded to a drop in population estimate, numbers of fawns observed, and fawn:doe ratios (Figure 7). Coyote predation in this system may have been compensatory mortality rather than additive for years during which coyote removal was applied.

Table 1. Counts of mule deer before and after coyote removal experiment for post-season (December, Fawn:doe) and spring (Fawn:adult) surveys of Nevada game management units 222, 231, and control area in Southwest Desert, Utah (limited removal of coyotes).

	Unit 231 NV Pre Removal (1997-2002)		Unit 30a UT Pre Removal (1997-2002)		
Fawn:doe ratio	Mean	SD	Mean	SD	*P*-value
Post-Season (December)	47.36	8.64	55.5	12.81	**0.291**
Spring (April)	35.39	3.66	39.25	9.64	**0.432**

	Unit 231 NV Predator Removal (2003 -2008)		Unit 30a UT Control (Limited Removal) (03-08)		
Fawn:doe ratio	Mean	SD	Mean	SD	*P*-value
Post-Season (December)	62.9	13.92	63.5	8.34	**0.941**
Spring (April)	42.00	12.34	49.50	6.85	**0.274**

	Unit 231 Nevada Pre-Removal (1997-2002)		Unit 231 Nevada Post-Removal (2003-2008)		
Fawn:doe ratio	Mean	SD	Mean	SD	*P*-value
Post-Season (December)	47.36	8.64	62.94	13.93	**0.066**
Spring (April)	35.40	3.66	42.00	12.35	**0.284**

	Units 222, 231 NV Pre-Removal (1997-2002)		Units 222, 231 NV Post-Removal (2003-2008)		
Fawn:doe ratio	Mean	SD	Mean	SD	*P*-value
Post-Season (December)	50.64	7.32	57.87	11.78	**0.116**
Spring (April)	36.77	3.35	40.3	11.25	**0.354**

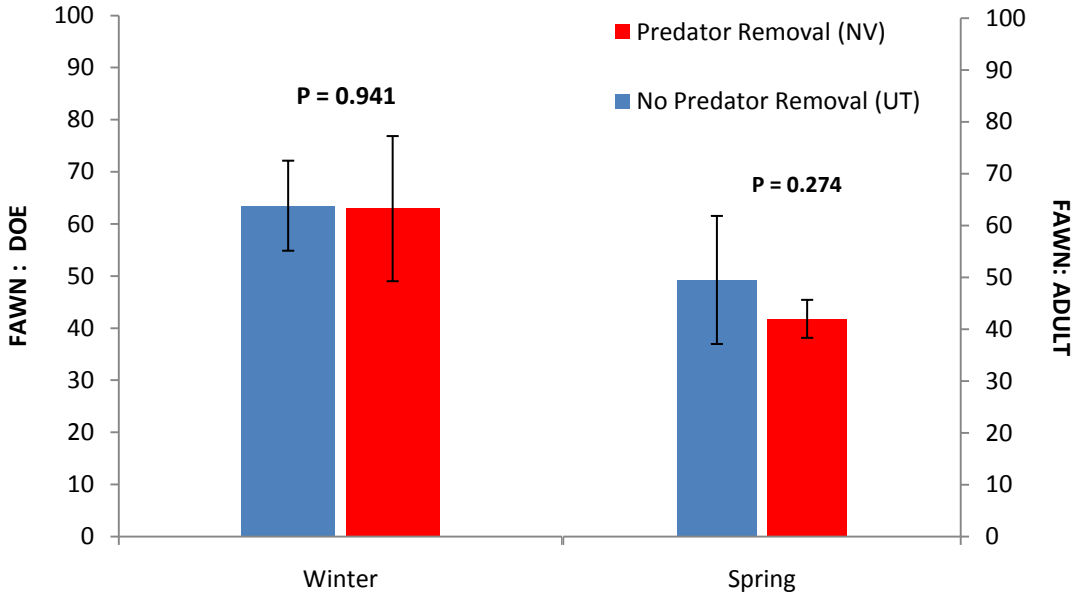

Figure 4. Mean ratio of mule deer fawns per 100 adult does (Winter), and mule deer fawns per 100 adults (Spring). P-values are results from ANOVA comparing fawn: doe (or fawn: adult) ratios in treatment area (Unit 231, NV) with an adjacent area of no predator removals (Unit 30a, UT). Error bars indicate +/- 1 standard deviation.

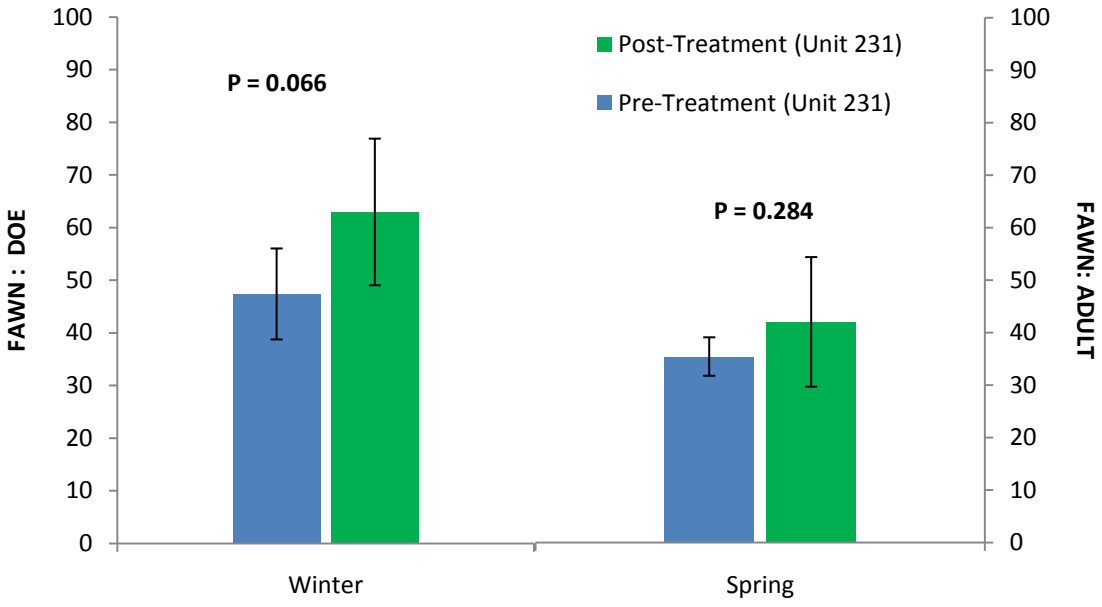

Figure 5. Mean ratio of mule deer fawns per 100 adult does (Winter), and mule deer fawns per 100 adults (Spring) in Game Management Unit 231. P-values are from ANOVA comparing fawn: doe (or fawn: adult) ratios during years before treatment (1998-2003) with years after predator control of coyotes was initiated (2003-2008). Error bars indicate +/- 1 standard deviation.

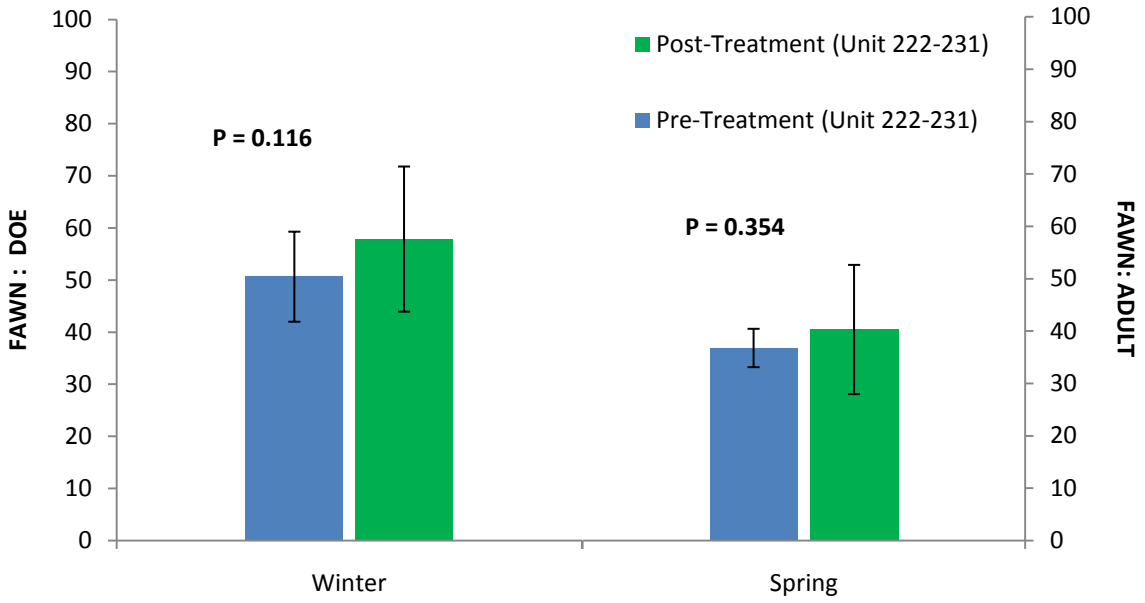

Figure 6. Mean ratio of mule deer fawns per 100 adult does (Winter), and mule deer fawns per 100 adults (Spring) in Game Management Units 222 and 231. P-values are from ANOVA comparing fawn: doe (or fawn: adult) ratios during years before treatment (1997-2002) with years after predator control of coyotes was initiated (2003-2008). Error bars indicate +/- 1 standard deviation.

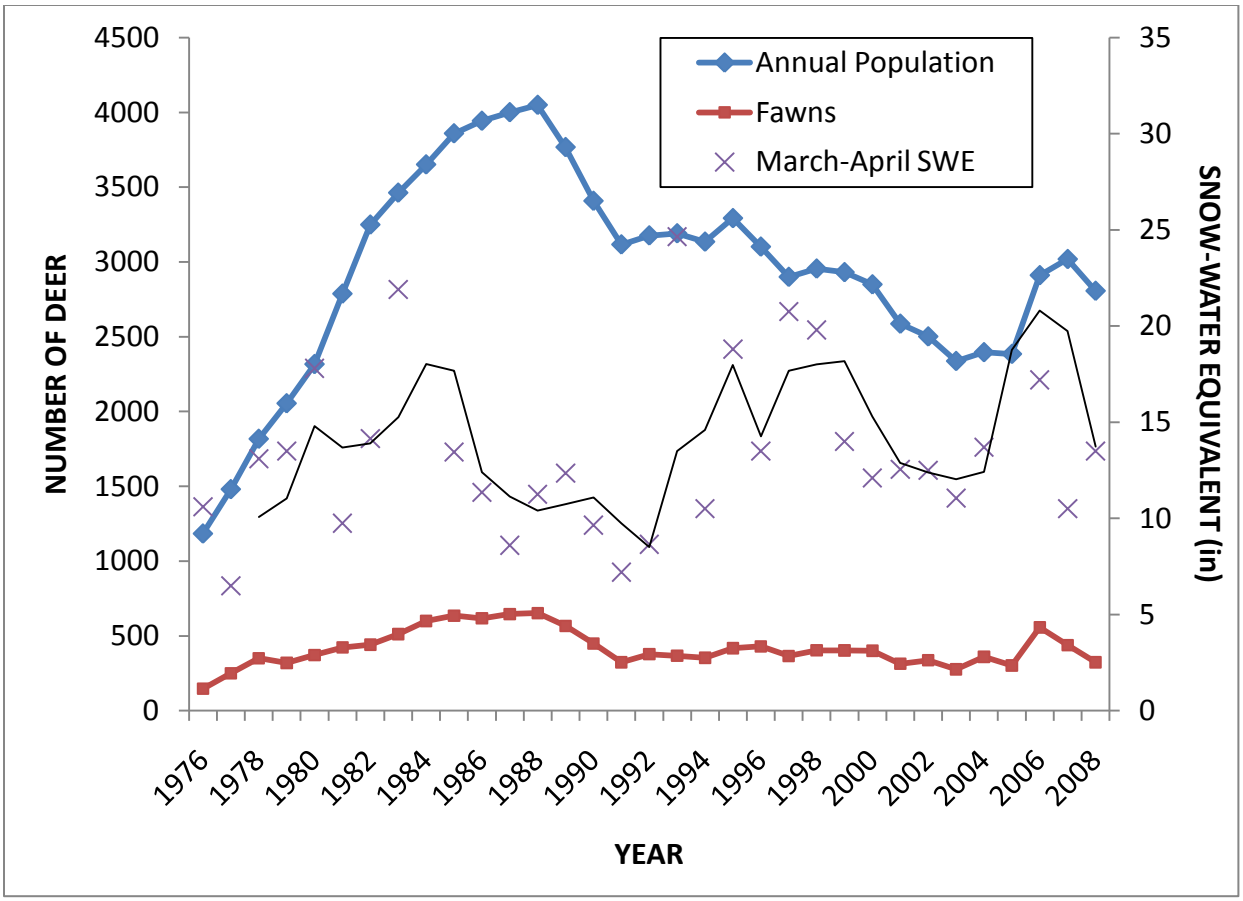

Figure 7. Population estimate of mule deer (blue line) and number of fawns (red line) for surveys in Game Management Unit 231, Nevada, during years 1976-2008. Late winter (March-April) precipitation (snow water equivalent in inches) from Snotel site on Ward Mtn. (39^{o} 8', -114^{o} 57') is plotted on secondary axis during years (1976-2008).

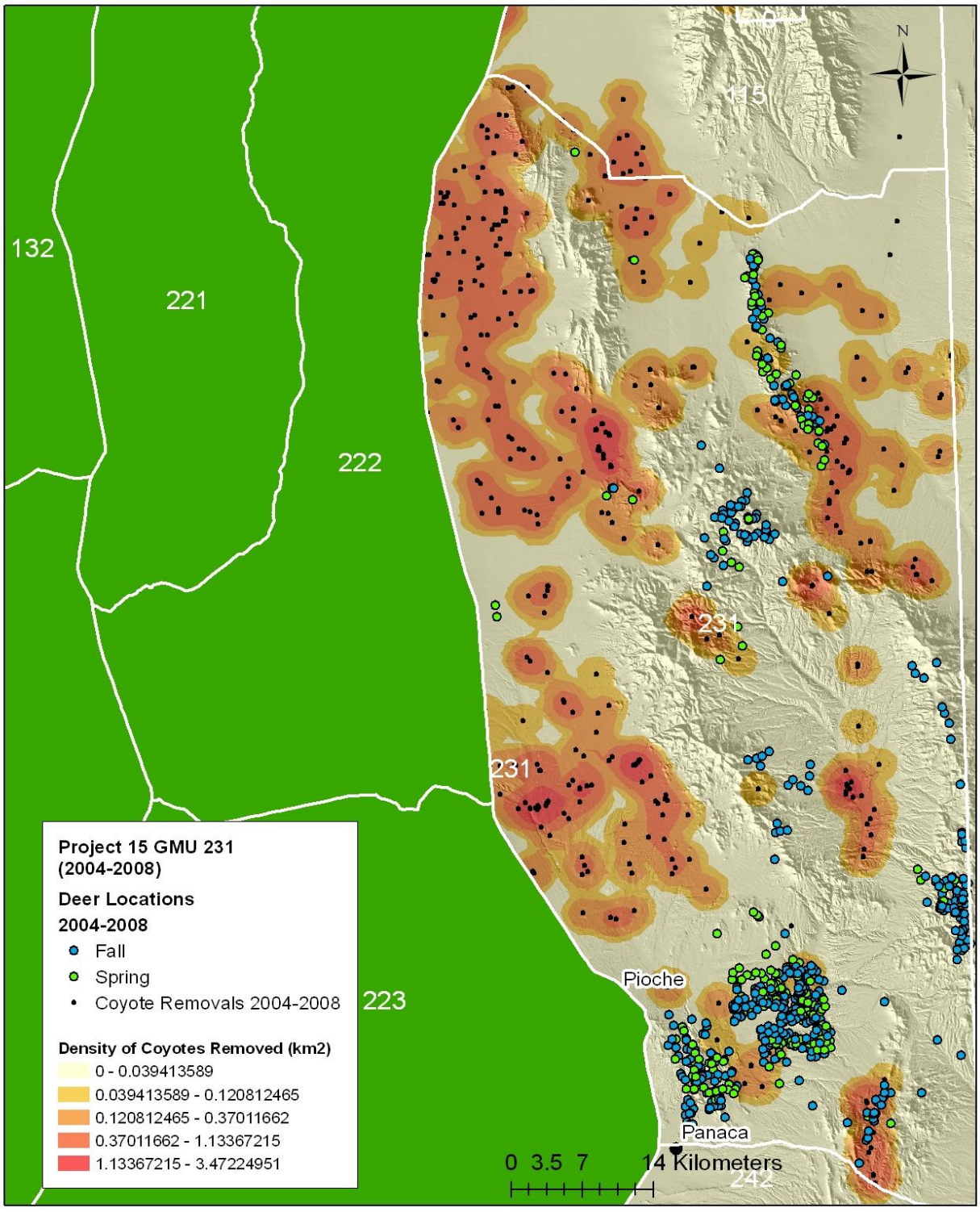

Figure 8. Map showing the experimental treatment area (GMU 231) in Lincoln Co., NV for years 2004-2008. Deer locations are from Fall helicopter surveys (blue dots) and Spring helicopter surveys (green dots). Shaded-polygons are density of coyotes removed (km^2) based on Kriging of coyote points (black dots) and number of coyote removed using both ground and aerial methods.

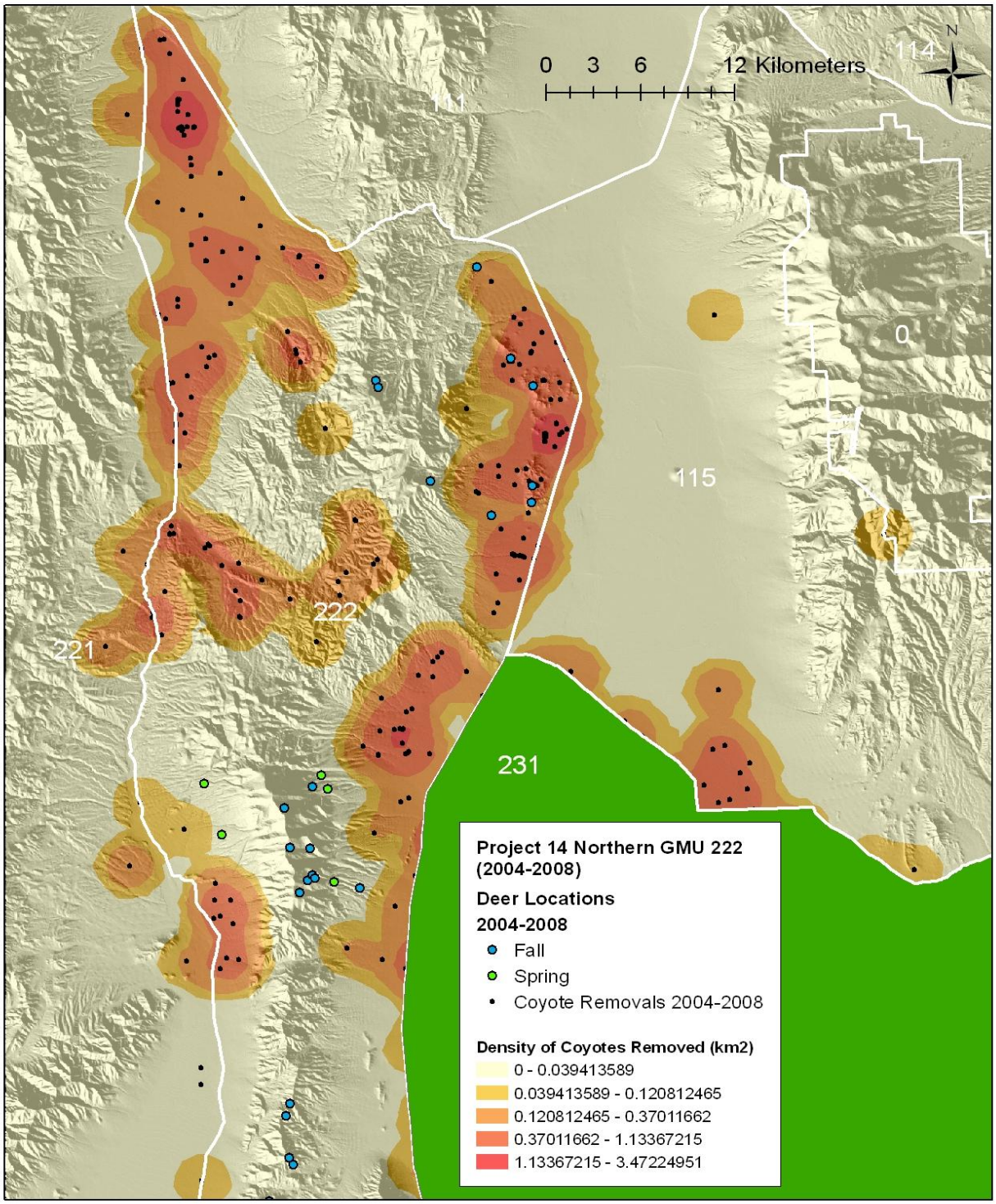

Figure 9. Map showing the experimental treatment area (GMU 222) in Lincoln Co., NV for years 2004-2008. Deer locations are from Fall helicopter surveys (blue dots) and Spring helicopter surveys (green dots). Shaded-polygons are density of coyotes removed (km^2) based on Kriging of coyote points (black dots) and number of coyote removed using both ground and aerial methods.

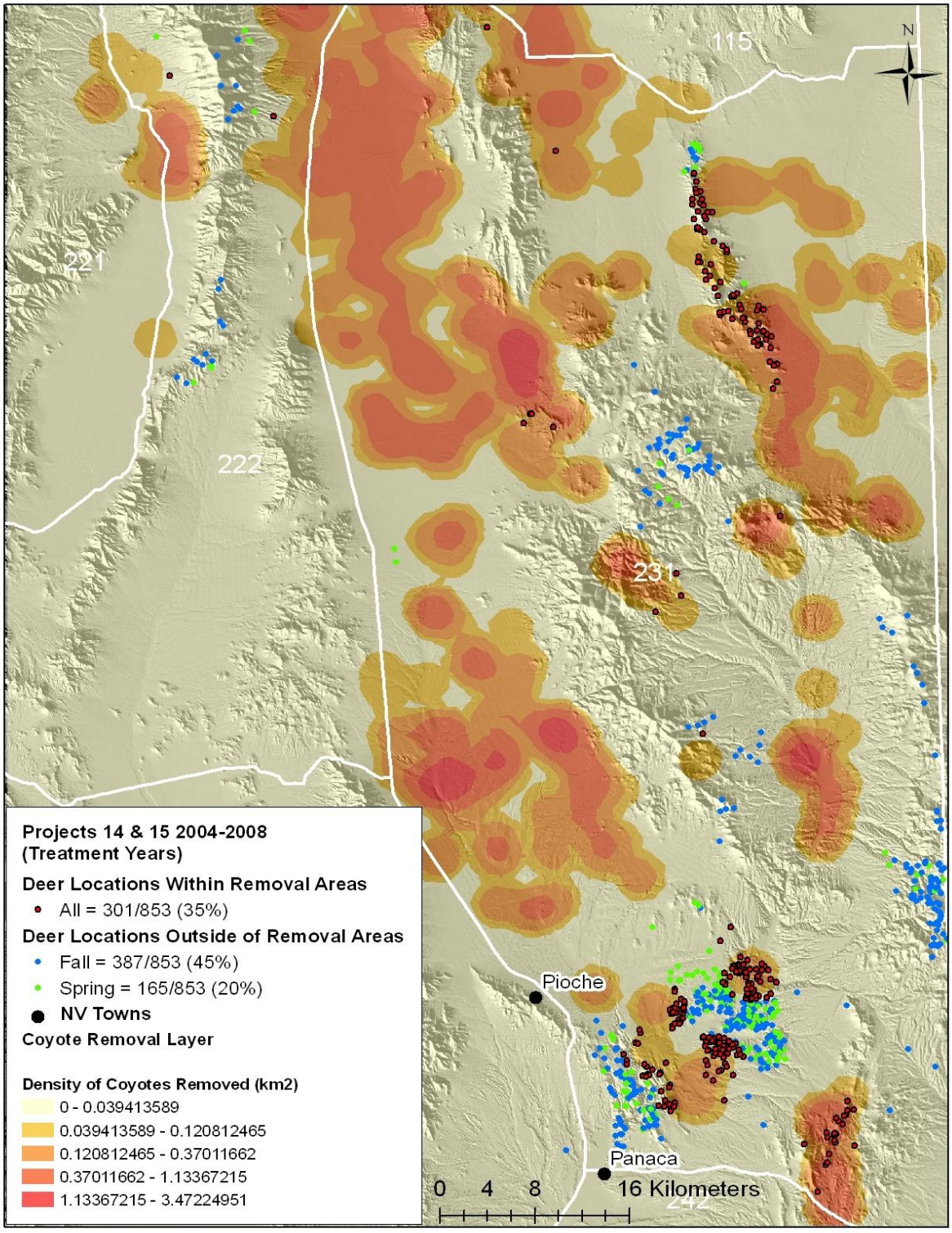

Figure 10. Map showing the effective rate of coyote removals in treatment area (GMU 231) in Lincoln Co., NV for years 2004-2008. Deer locations are from Fall helicopter surveys (blue dots) and Spring helicopter surveys (green dots). Red dots indicate deer locations where greater than 0.12 coyotes per square mile were removed.