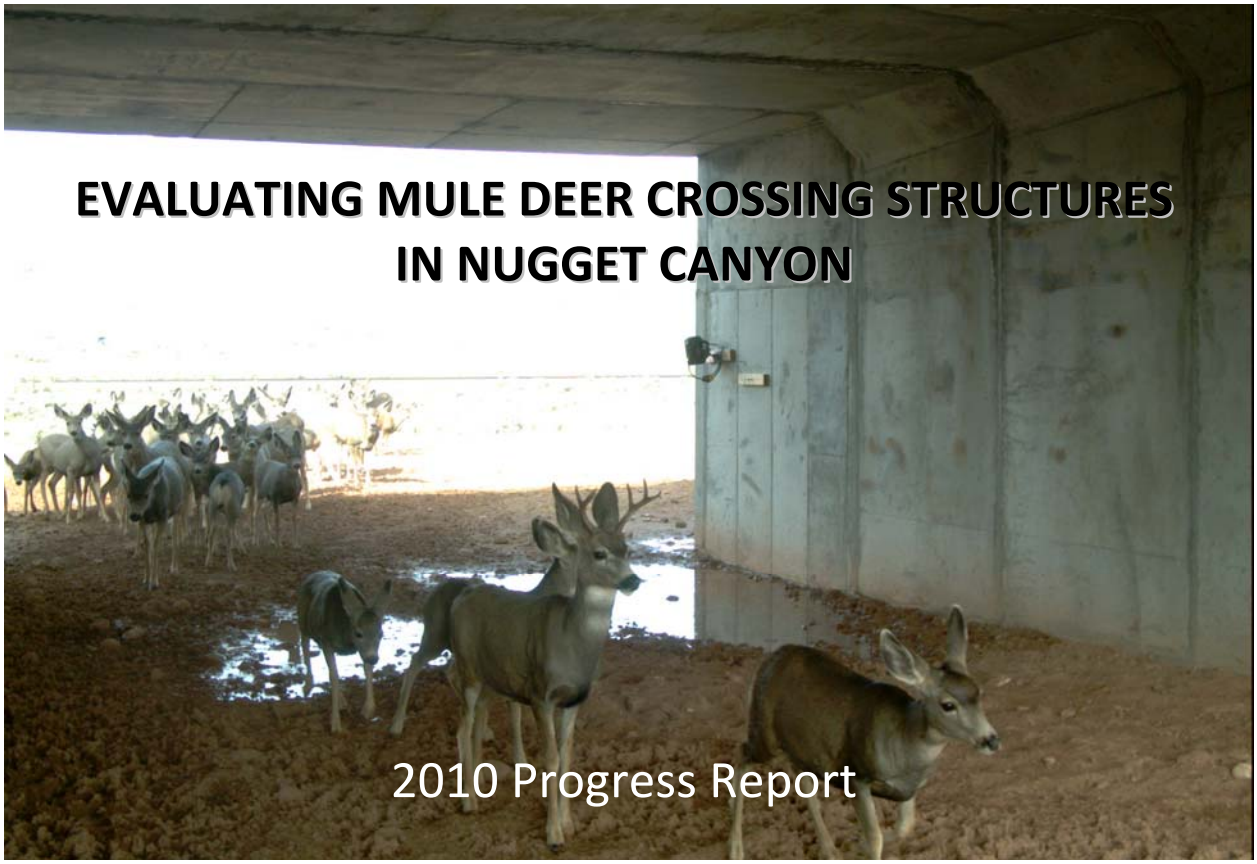

EVALUATING MULE DEER CROSSING STRUCTURES IN NUGGET CANYON

2010 Progress Report

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ACKNOWLEDGEMENTS

We thank T. Hart and J. Eddins for sponsoring this project. We appreciate the numerous Wyoming Department of Transportation personnel that have assisted with field logistics and data collection including T. Carpenter for providing collision data. N. Hymas, M. Zornes, S. Lockwood, B. Rudd and other Wyoming Game and Fish personnel have provided valuable assistance. This work was funded by the Wyoming Department of Transportation.

INTRODUCTION

The Nugget Canyon section of US 30 west of Kemmerer, Wyoming is located adjacent to mule deer winter range and bisects a migration route used by thousands of mule deer each spring and fall. Despite a variety of mitigation measures implemented during the 1990's aimed at slowing traffic and warning motorists of potential collisions with wildlife (e.g., signs, reflectors, flashing lights), dozens of vehicle-deer collisions continued to occur each year in this 12-mile segment (MP 30-42) of highway. The high rates of vehicle-deer collisions posed serious safety concerns for both motorists and mule deer. In an effort to move deer underneath the highway and reduce vehicle-deer collisions, the Wyoming Department of Transportation (WYDOT) installed seven miles of game fence (MP 28-35) and a concrete box crossing structure at MP 30.5 in 2001. This crossing structure was monitored for two years following construction and received high levels of deer use (i.e., hundreds), particularly during spring (March-April) and fall (November-December) migrations. The dimensions of this structure (20' x 60' x 10') had an openness ratio of approximately 1.12 and was determined to be adequate for mule deer use (Gordon and Anderson 2003). Although the underpass and associated fencing was successful at reducing vehicle-deer collisions around MP 30, remaining portions of the project area (i.e., MP 35-43) continued to have high levels of vehicle-deer collisions and it was apparent that additional crossing structures were needed. Accordingly, WYDOT approved construction of six new structures and seven additional miles of game fence to be completed in October 2008. The location of these structures generally corresponded with road segments that had high levels of vehicle-deer collisions and were installed at MP 35.25, 35.96, 37.44, 38.23, 39.00, and 40.62 (Fig. 1).

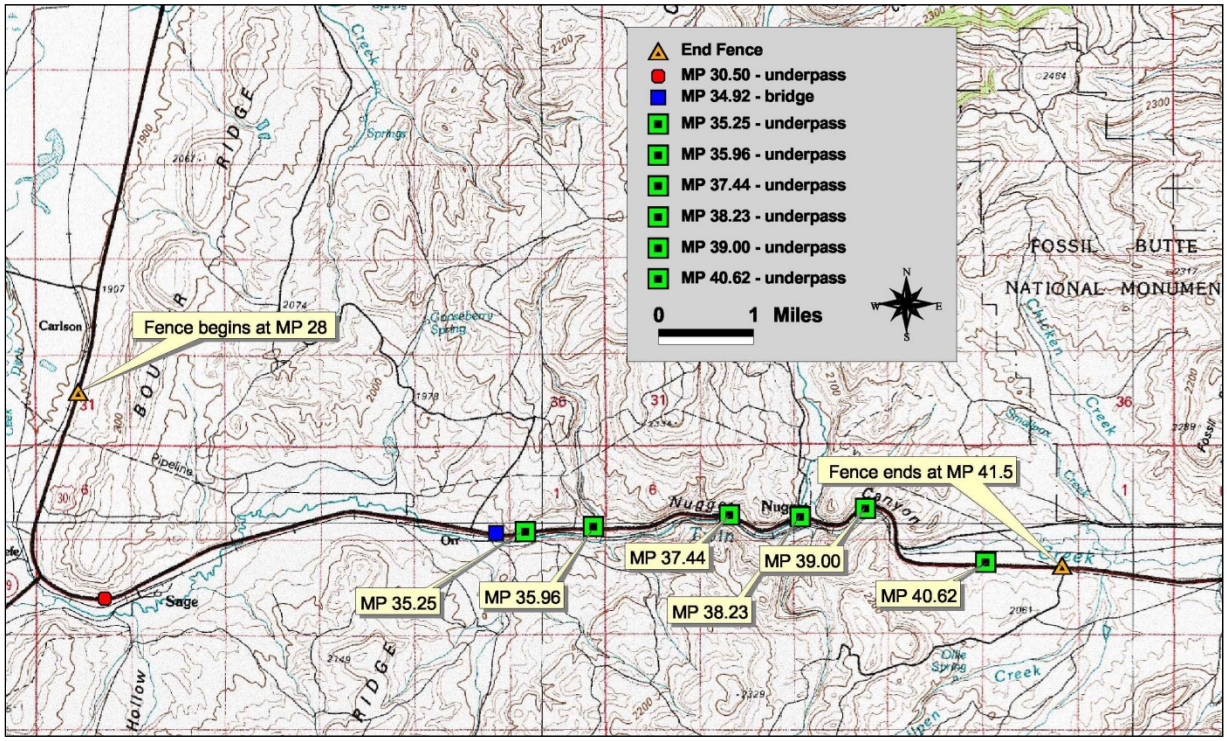

Figure 1. Approximate location of game-proof fencing, underpasses, and bridge along US 30 in Nugget Canyon.

This study was designed to evaluate the effectiveness of the newly constructed underpasses and associated fencing. Specifically, we provide a quantitative assessment of how many mule deer (and other wildlife) actually use the underpasses, and to what degree the underpasses reduced vehicle-deer collisions. The study will also provide insight as to how mule deer (and other wildlife) habituate to the crossing structures and what habitat characteristics (e.g., topography, vegetation, etc.) may influence the levels of deer use at each of the structures. Ultimately, information provided by this study is intended to improve the ability of wildlife and transportation agencies to sustain migratory ungulate populations and maintain public safety on roadways.

OBJECTIVES

1) Evaluate the number of vehicle-deer collisions across 3 time periods, including: 1990-2000 (before underpass construction), 2002-2007 (following construction of 1 underpass), and 2009-2010 (following construction of 6 additional underpasses). The analysis area included a 17-mi corridor (MP 27-43) that extended approximately 1.5 miles beyond each side of the game-proof fencing, such that we could evaluate whether or not mule-deer vehicle collisions increased in areas immediately adjacent to the fencing.

2) Quantify the number of deer that use each of the 7 structures during spring and fall migrations.

    a. Evaluate the temporal patterns in deer use across the 7 structures, including 1) seasonal (e.g., November and March), 2) daily (day or night), and 3) annual (2008-2010) patterns. Determine when peak levels of use occur and if the level of use at structures changes over time.

3) Evaluate the success of deer crossings by comparing the number of deer that approach the underpass and move through, versus those that approach and do not cross.

METHODS

Wildlife-vehicle collision data was obtained from WYDOT and analyzed by mile post across the entire 13-mi corridor (MP 28-41). We compared the number of deer-vehicle collisions in 3 time periods: 1) January 1, 1990 – October 1, 2001, (total of 141 months) prior to construction of the underpass at MP 30.5, 2) October 1, 2001 – October 1, 2008, (total of 82 months) following construction of the underpass at MP 30.5, and 3) October 1, 2008 – May 1, 2010, (total of 19 months) following construction of 6 additional underpasses. To make comparisons between the three periods that differed in temporal length, we standardized the number of wildlife-vehicle collisions by the number of months in each period.

We used high-speed digital photos collected from Reconyx cameras to calculate the number of deer that used each underpass. Three cameras were mounted in each of the 7 underpasses, including one at the entrance, one in the middle, and one at the exit (Fig. 2). This

camera configuration allowed us to count the number of deer that approached and/or passed through the underpass from either direction. Additionally, we placed a camera underneath the open-span bridge at MP 34.92. The underpasses were not equipped with camera systems until December 16, 2008, after a considerable portion of mule deer had already completed the fall migration. The camera at the open-span bridge was installed on January 26, 2009. We examined seasonal temporal patterns by plotting the number of deer that passed through each structure each day, across the entire monitoring period. We examined the daily temporal patterns by calculating the number of deer that moved through structures each hour of the day, for a 10-day sampling period that corresponded with the peak levels of use during fall and spring migrations.

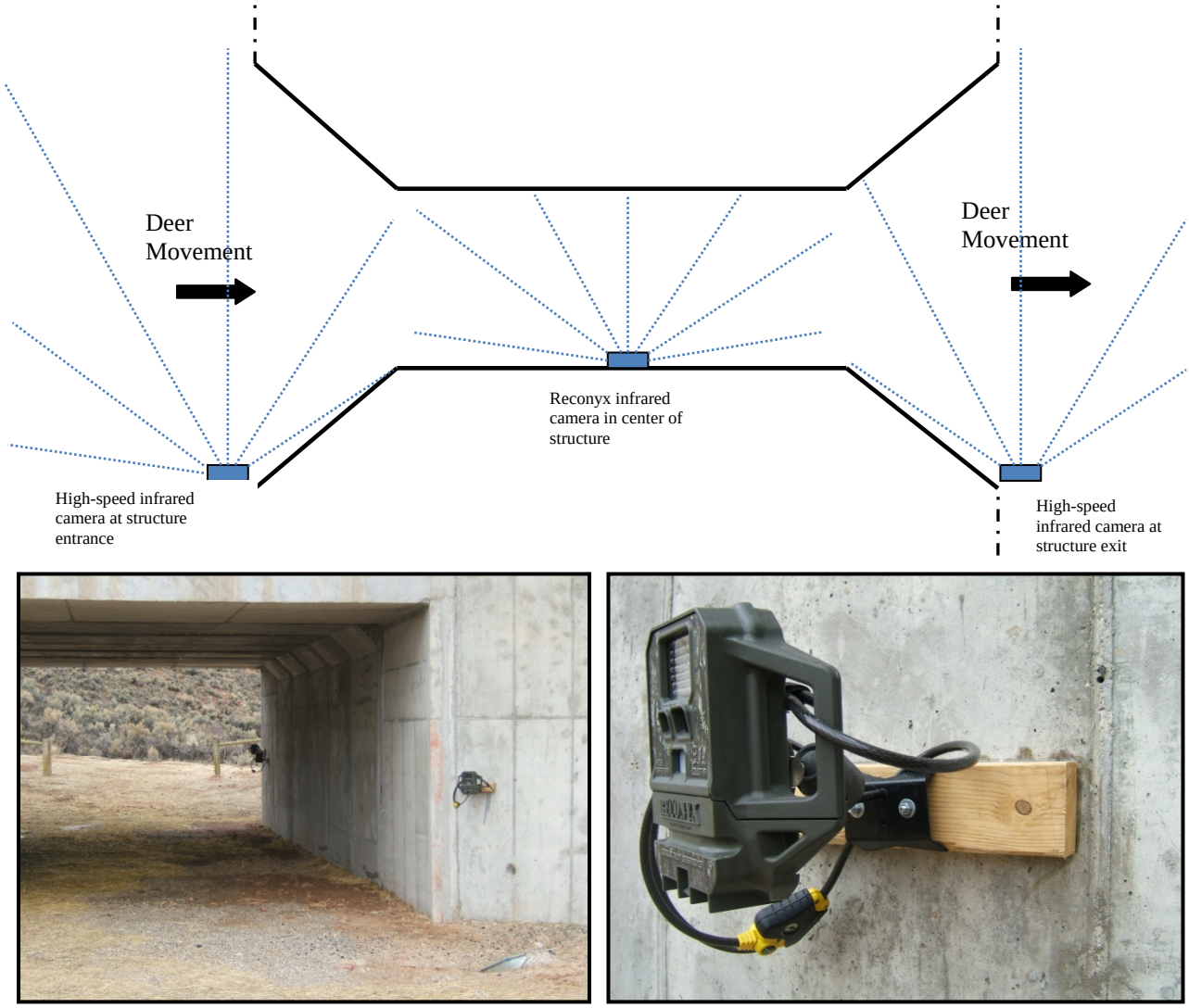

Figure 2. Placement configuration of three cameras on each of the seven underpasses.

We evaluated the success of deer crossings by comparing the number of deer that approached each underpass and moved through, versus the total number that approached. This metric was intended to quantify the effectiveness of each crossing structure and evaluate

whether mule deer acclimate to the new underpasses over time. Using estimates of how many deer approached each structure and how many passed through, we calculated the success rate of each structure. For example, a structure that had 100 deer approach it and 75 of them moved through, would indicate that 75% of animals that approached the structure successfully crossed. We calculated efficiency ratios during the 10-day peak migration period of each season (fall 2008, Dec. 17-26; fall 2009, Dec. 8-17; spring 2009, April 23- May 02; and spring 2010, April 17-26).

PRELIMINARY RESULTS

Mule Deer-Vehicle Collisions

Before the underpass at MP 30.5 was built in the summer of 2001 (1990-2001 [141 months]), the average number of mule deer-vehicle collisions between MP 28-41 per month was 0.75. Road segments with the highest collision rates occurred near MP 30, 35, 36, 37, and 38 ranging from 3.06 to 0.89 mule deer fatalities per month (Fig. 3). Following construction of the underpass at MP 30.5, the average number of mule deer- vehicle collisions between 2001-2008 (82 months) was 0.66 per month (Fig. 3). Although the total number of mule deer-vehicle collisions did not decline considerably, the number of collisions near MP 30 dropped by 79% (from 1.81 to 0.39 per month; Fig. 3). The total number of mule deer-vehicle collisions was similar in both time periods because the number of collisions in the eastern segment (MP 39-43) increased following construction of the underpass at MP 30.5. However, after the six new underpasses and seven additional miles of game fencing were constructed in 2008, an average of 0.14 mule deer – vehicle collision per month was recorded from October 2008 to May 2010 (19 months; Fig. 3). To date, the underpass construction and game-proof fencing have effectively reduced mule deer-vehicle collisions throughout the project area, except between MP 32-34. The amount of mule deer-vehicle collisions at this segment may be due to deer occasionally crossing cattle guards at MP's 33.00 and 34.90. Additional camera monitoring at these cattle guards may provide insight as to how deer are bypassing the game fence. Importantly, mule deer-vehicle collisions have not increased in areas immediately adjacent to the fencing (i.e., MP 27 and 43), where deer are free to move across US 30 at grade-level.

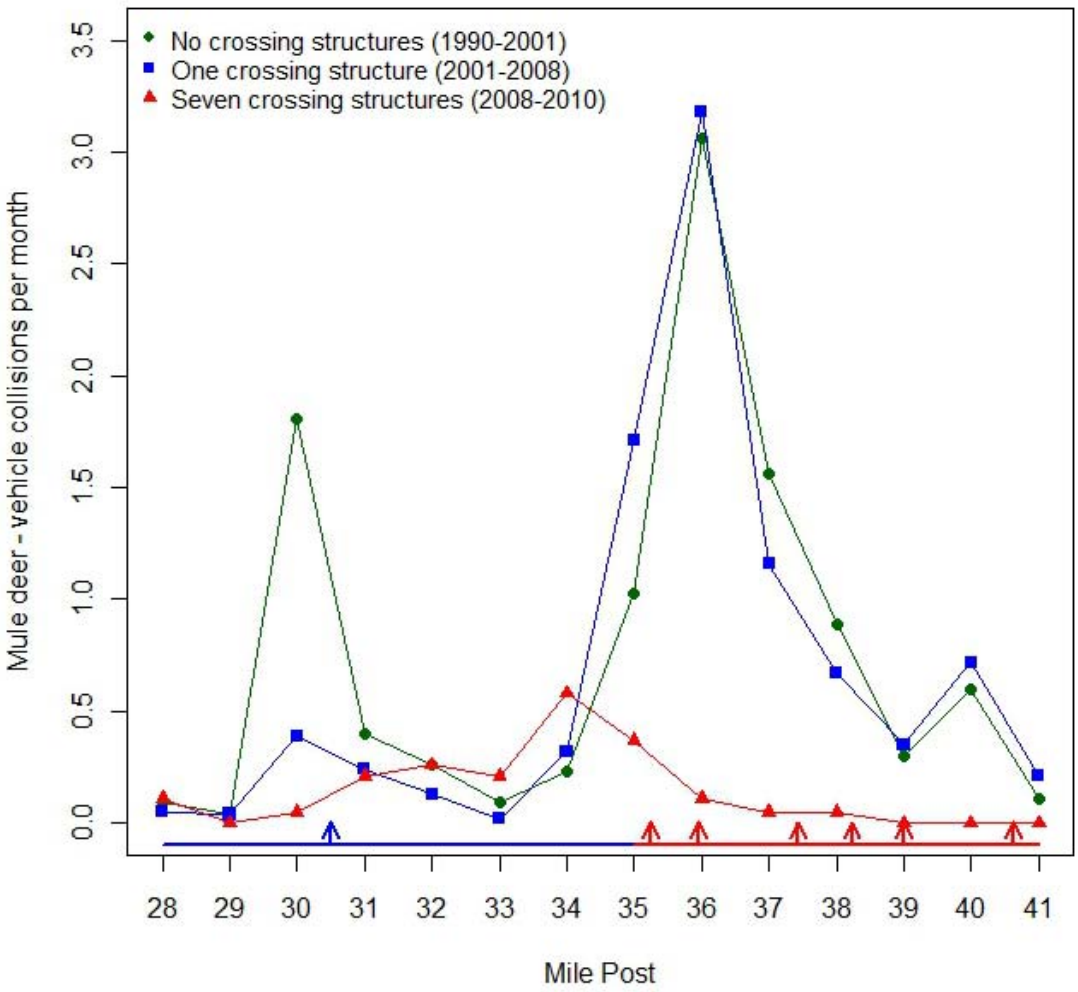

Figure 3. Average number of mule deer-vehicle collisions per month before underpass construction (1990-2001), after one underpass was constructed at MP 30.50 (2001-2008), and after all seven underpasses were constructed (2008-2010). Vertical arrows at bottom of graph depict location of underpasses. Horizontal lines below the arrows depict fencing associated with underpasses.

Underpass Use by Mule Deer

We documented 14,362 mule deer pass through the eight crossing structures (7 underpasses and one bridge during the 2009-10 monitoring season (October 1, 2009 through May 31, 2010; Table. 1). These numbers were higher than the 2008-09 monitoring season (13,025 [December 16, 2008-May 30, 2009]) because cameras were not installed until December 16, 2008, after the fall migration had already started (Table 2). Across both seasons, we recorded 27,387 mule deer pass through the structures during spring and fall migrations (Table 2). Of the 13,025 mule deer documented during the 2008-09 season, 38% (*n*=4,929) moved north to south and 62% (*n*=8,096) moved south to north. During the 2009-10 season, 58% (*n*=8,309) moved north to south and 42% (*n*=6,053) moved south to north. Again, the proportion of north to south movement was smaller during the 2008-09 season because cameras were not installed until mid-way through the fall migration. Most deer movement occurred at MP 30.50 (55%; *n*=7,160 [2008-09] and 48%; 6,834 [2009-10]) and MP 35.96 (29%; *n*=3,828 [2008-09] and 19%; *n*=2,775 [2009-10]; Figs. 4A&B). Combined, the 5 other underpasses and bridge accounted for the remaining 16% of deer use and recorded approximately 200-600 mule deer each during the 2008-09 season. Deer use during the 2009-10 season was distributed more evenly between the 5 other structures and accounted for 33% of total deer use. Most underpass activity occurred during spring and fall migrations, but crossings occurred on a regular basis throughout the winter period (January and February) as well (Tables 1 & 2).

The amount of mule deer use at underpasses varied between fall and spring migrations, especially at MP 30.5 and 35.96 (Figs. 4A&B). During the 2008 fall migrations (Fig. 4A), 90% of all deer crossings occurred at MP 30.50 (73%) and MP 35.96 (17%). During the 2009 fall migrations, 64% of all deer crossings were recorded at MP 30.50 (52%) and MP 35.96 (12%). However, during the 2009 spring migration, MP 30.50 accounted for 44% of deer crossings, while 37% occurred at MP 35.96 underpass (Fig. 4B). We observed similar trends during the 2010 spring migration, with MP 30.50 and 35.96 recording 41% and 29% of all deer crossings, respectively. The remaining 5 structures recorded a higher percentage use during the 2009-10 migration seasons (23% fall 2009 and 30% spring 2010) than during the 2008-09 season (10% fall 2008 and 19% spring 2009; Figs. 4A&B).

The timing of peak movements during the fall 2008 migration was approximately December 17-29 and ranged from 62 to 276 individuals per day. Peak movements during the fall 2009 migration occurred from December 4-17 and ranged from 44 to 284 individuals per day (Fig. 5A). Spring migrations were characterized by multiple peaks of deer movement that were consistent between 2009 and 2010 (Fig. 5B). The spring 2009 migration peaked in March (18-24), April (7-13), and May (1-11) and ranged from 77 to 358 individuals per day. The peaks of the 2010 spring migration were similar (i.e., March 13-18, April 17-27, and May 5-10) and ranged from 73 to 195 individuals per day (Fig. 5B). Although peak levels of deer use across all structures were consistent across years, the timing of peak deer movements varied at the individual crossing structures (Figs. 6-13). On a daily basis, peak levels of underpass use occurred in the mornings and evenings (Fig. 14). However, morning use was more prominent in the spring compared to the fall.

We evaluated the success of deer crossings by comparing the number of deer that approached each underpass and moved through, versus the total number that approached. The success rate of deer passing through the underpasses averaged 54% among all seven structures during the 2008-09 monitoring season. This success rate increased to 72% during the 2009-10 seasons with all 7 structures showing an increase in successful passes versus the number of repels (Fig. 15). The average success rate for each crossing structure during both monitoring seasons ranges from 50% (MP 35.25) to 86% (MP 30.50).

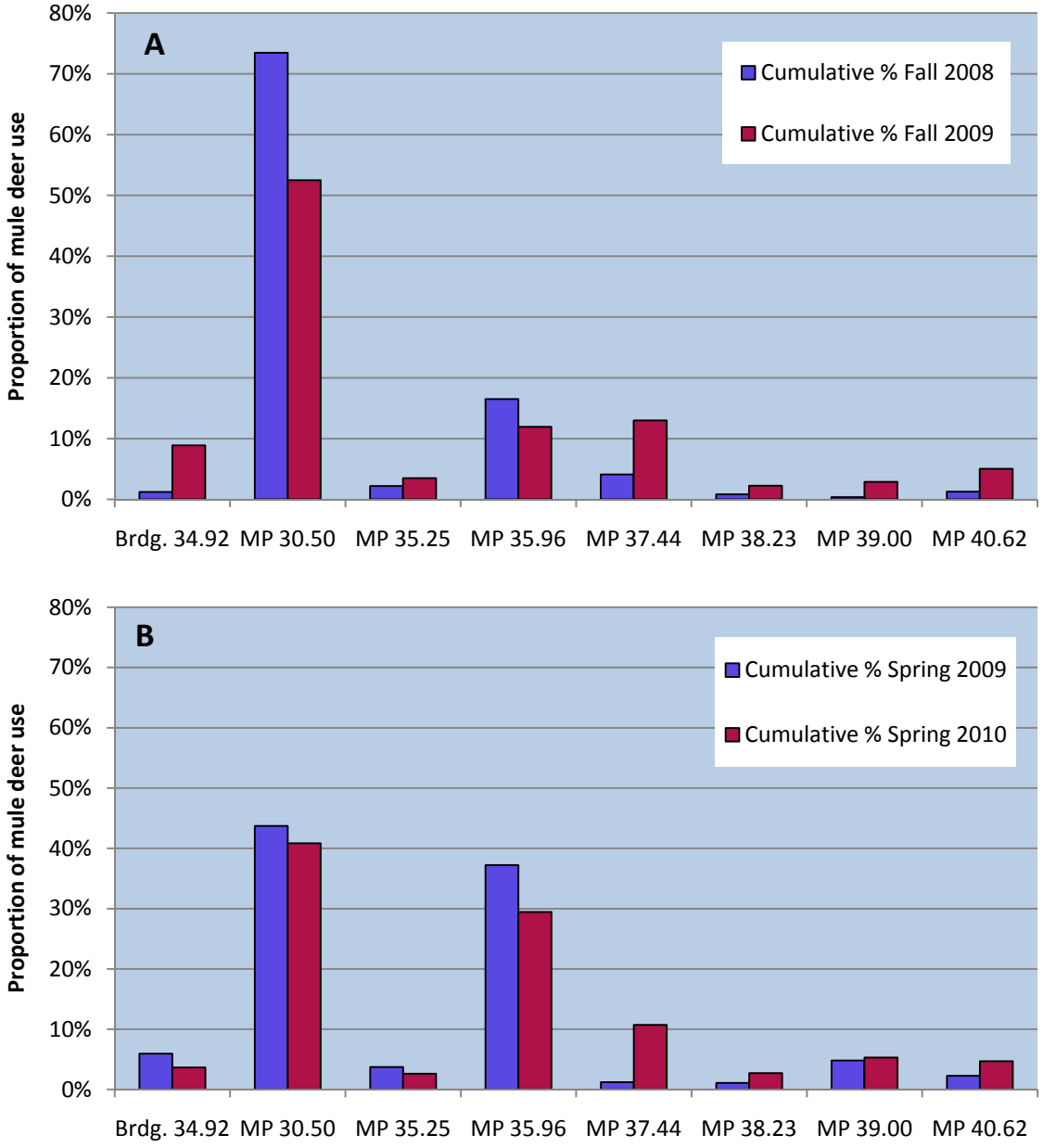

Figure 4. (A) Proportional use of mule deer at each underpass and bridge during the fall 2008 and 2009 migrations. (B) Proportional use of mule deer at each underpass and bridge during the spring 2009 and 2010 migrations.

Table 1. Number of mule deer that moved through Nugget Canyon underpasses, October 2009 – May 2010.

	Fall Migration						Winter				Spring Migration							
	October		November		December		January		February		March		April		May		Total	
Movement Direction	North-South	South-North	North-South	South-North	North-South	South-North	North-South	South-North	North-South	South-North	North-South	South-North	North-South	South-North	North-South	South-North	North-South	South-North
Brdg.34.92	43	0	277	35	368	16	29	1	12	3	5	33	4	18	0	115	738	221
MP 30.50	472	16	712	29	2,008	71	591	92	312	233	242	1,330	17	340	8	361	4,362	2,472
MP 35.25	155	3	54	9	45	8	17	3	11	9	1	46	6	41	2	40	291	159
MP 35.96	232	24	197	45	368	19	45	13	30	16	46	541	66	616	9	508	993	1,782
MP 37.44	422	35	315	56	203	31	49	11	36	14	10	50	4	180	41	272	1,080	649
MP 38.23	95	10	17	6	22	1	13	5	4	0	7	5	16	60	13	78	187	165
MP 39.00	128	6	24	8	30	3	11	6	19	12	11	26	0	43	17	217	240	321
MP 40.62	147	9	74	12	106	26	31	17	16	11	33	54	7	19	4	136	418	284
Sub-totals	1,694	103	1,670	200	3,150	175	786	148	440	298	355	2085	120	1317	94	1727	8,309	6,053
Totals	**1,797**		**1,870**		**3,325**		**934**		**738**		**2,440**		**1,437**		**1,821**		**14,362**	

Table 2. Number of mule deer that moved through Nugget Canyon underpasses, December 2008 – May 2010.

	Fall Migration						Winter				Spring Migration							
	October		November		December[2]		January		February		March		April		May		Total	
Monitoring Season[1]	2009	2010	2009	2010	2009	2010	2009	2010	2009	2010	2009	2010	2009	2010	2009	2010	2009	2010
Brdg. 34.92	n/a	43	n/a	312	n/a	384	11	30	58	15	50	38	224	22	199	115	542	959
MP 30.50	n/a	488	n/a	741	1,552	2,079	1,072	683	1,040	545	1,879	1,572	1,157	357	460	369	7160	6834
MP 35.25	n/a	158	n/a	63	83	53	41	20	28	20	23	47	82	47	153	42	410	450
MP 35.96	n/a	256	n/a	242	638	387	129	58	104	46	383	587	1,186	682	1,388	517	3828	2775
MP 37.44	n/a	457	n/a	371	149	234	17	60	39	50	2	60	11	184	83	313	301	1729
MP 38.23	n/a	105	n/a	23	18	23	6	18	10	4	1	12	13	76	81	91	129	352
MP 39.00	n/a	134	n/a	32	3	33	3	17	2	31	8	37	89	43	303	234	408	561
MP 40.62	n/a	156	n/a	86	47	132	25	48	12	27	9	87	5	26	149	140	247	702
Totals	**n/a**	**1,797**	**n/a**	**1,870**	**2,490**	**3,325**	**1,304**	**934**	**1,293**	**738**	**2,355**	**2,440**	**2,767**	**1,437**	**2,816**	**1,821**	**13,025**	**14,362**

[1] The 2009 monitoring season consisted of the fall and spring migrations during 2008 and 2009. 2010 monitoring season consisted of the 2009-2010 fall and spring migrations. [2] Monitoring began December 16, 2008 for the 2009 season.

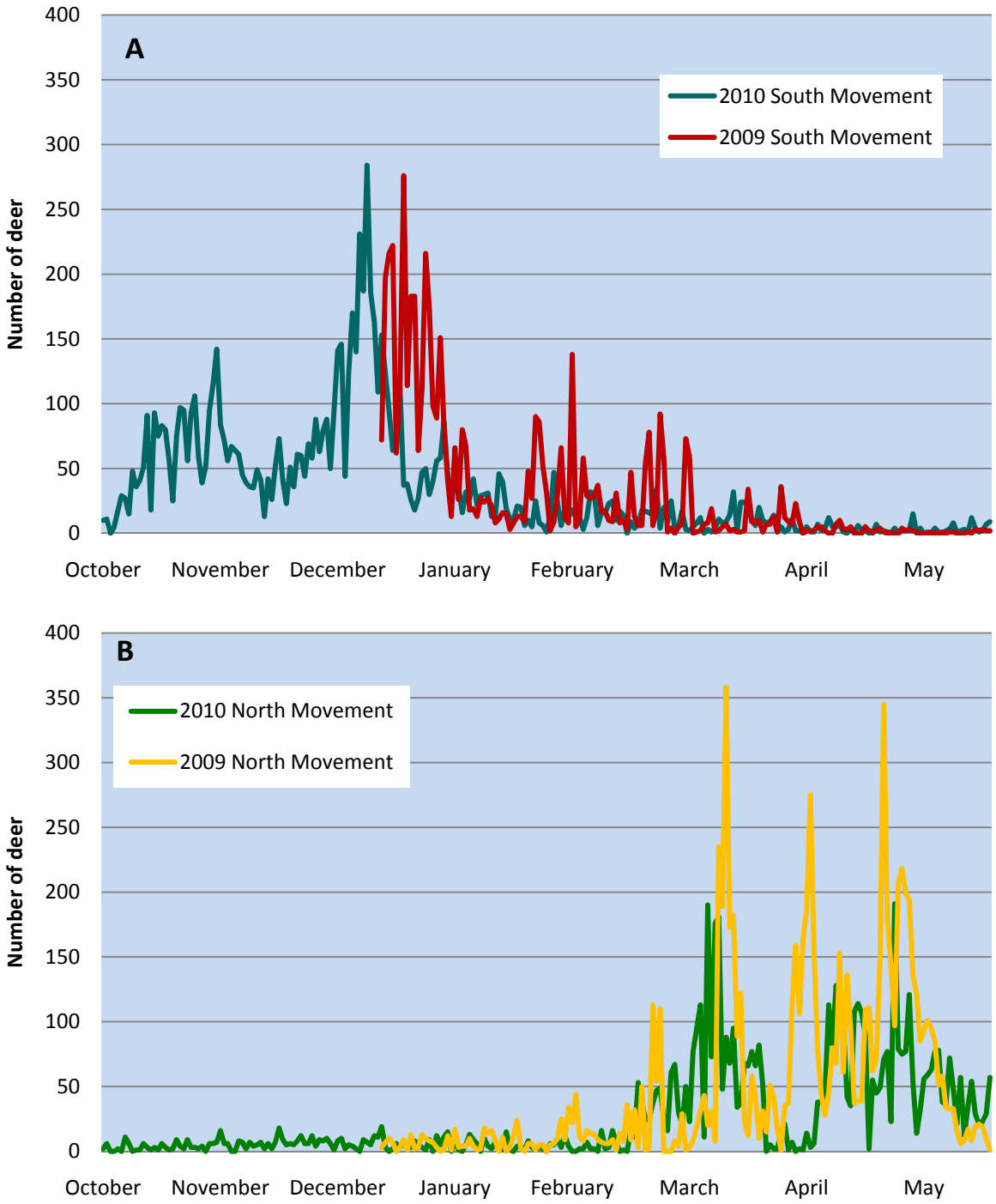

Figure 5. (A) Total number of mule deer moving north to south through crossing structures during the 2009 and 2010 monitoring seasons. Peak southerly movements occur in mid- to late-December. (B) Total number of mule deer moving south to north through crossing structures during the 2009 and 2010 monitoring seasons. Peak northerly movements occur late-March to early-May.

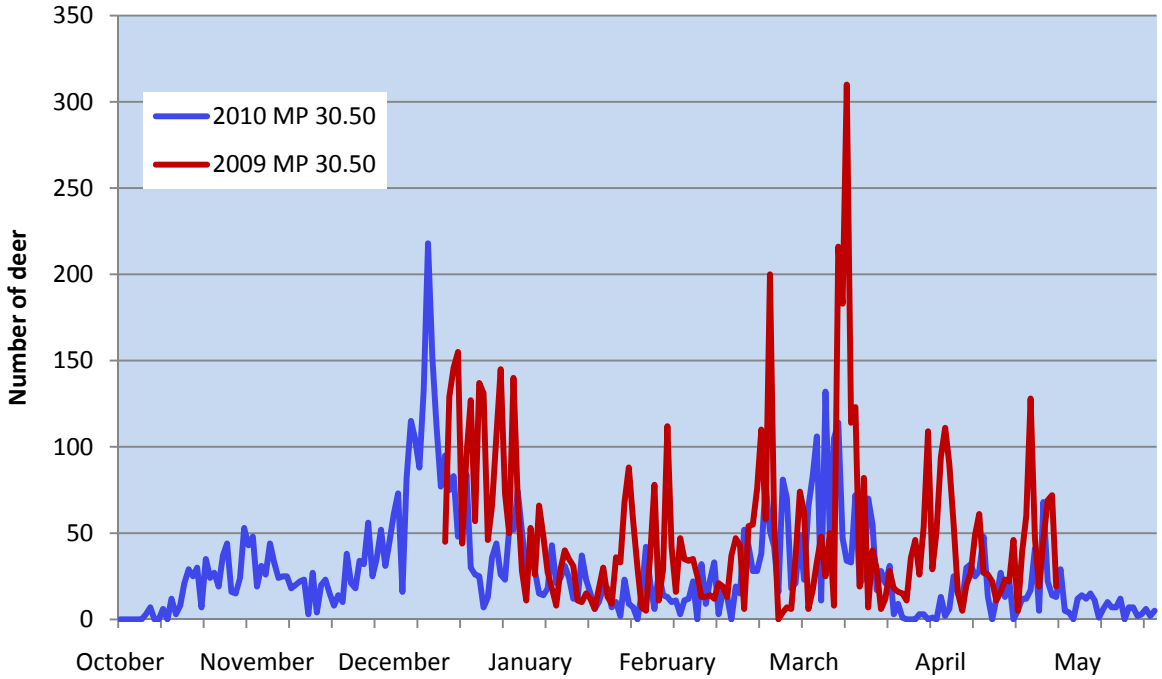

Figure 6. Number of deer passing through MP 30.50 crossing structure during the 2009 (fall 2008-spring 2009) and 2010 (fall 2009-spring 2010) monitoring seasons.

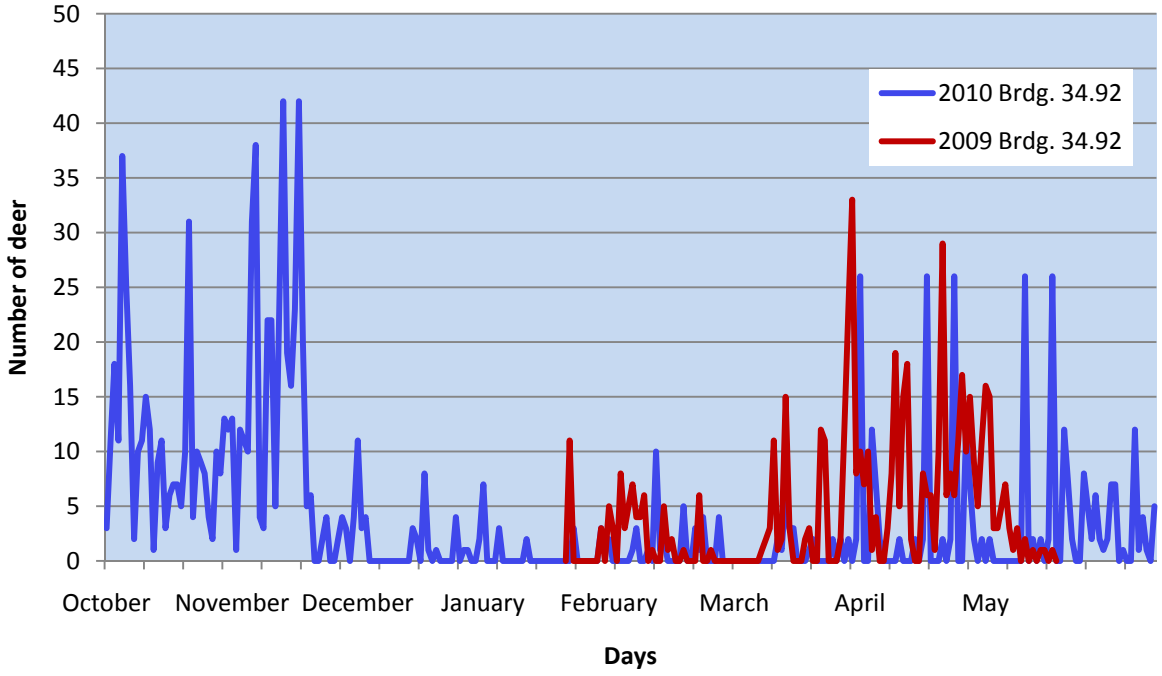

Figure 7. Number of deer passing through the bridge at MP 34.92 during the 2009 (fall 2008-spring 2009) and 2010 (fall 2009-spring 2010) monitoring seasons.

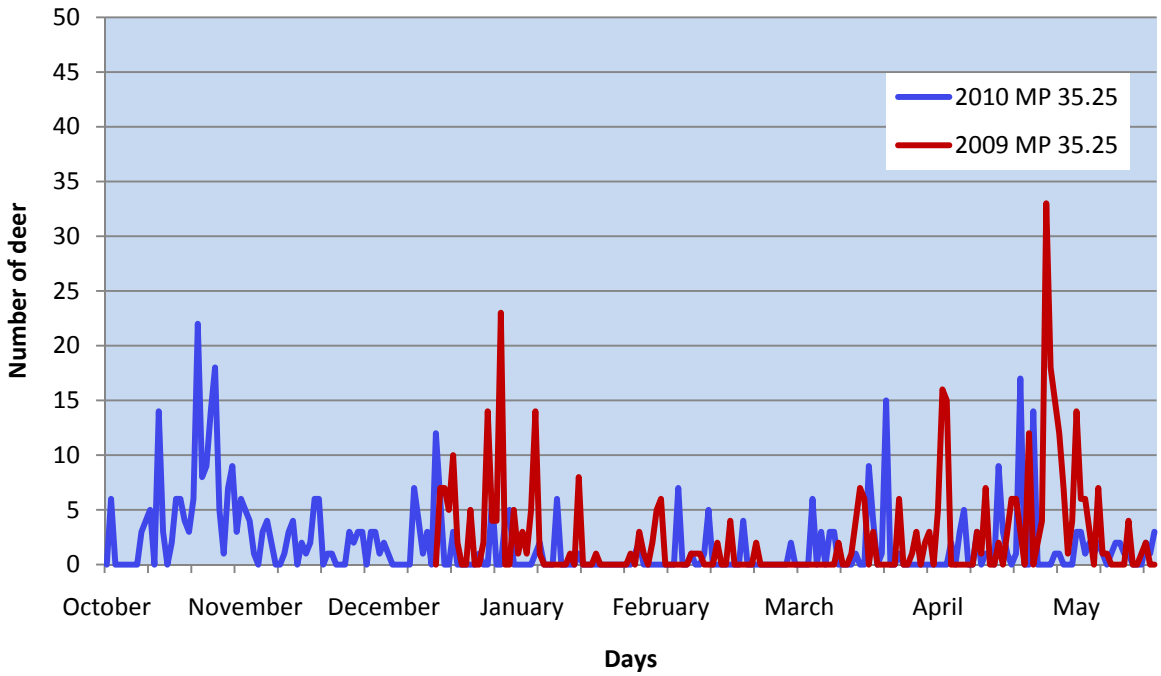

Figure 8. Number of deer passing through MP 35.25 crossing structure during the 2009 (fall 2008-spring 2009) and 2010 (fall 2009-spring 2010) monitoring seasons.

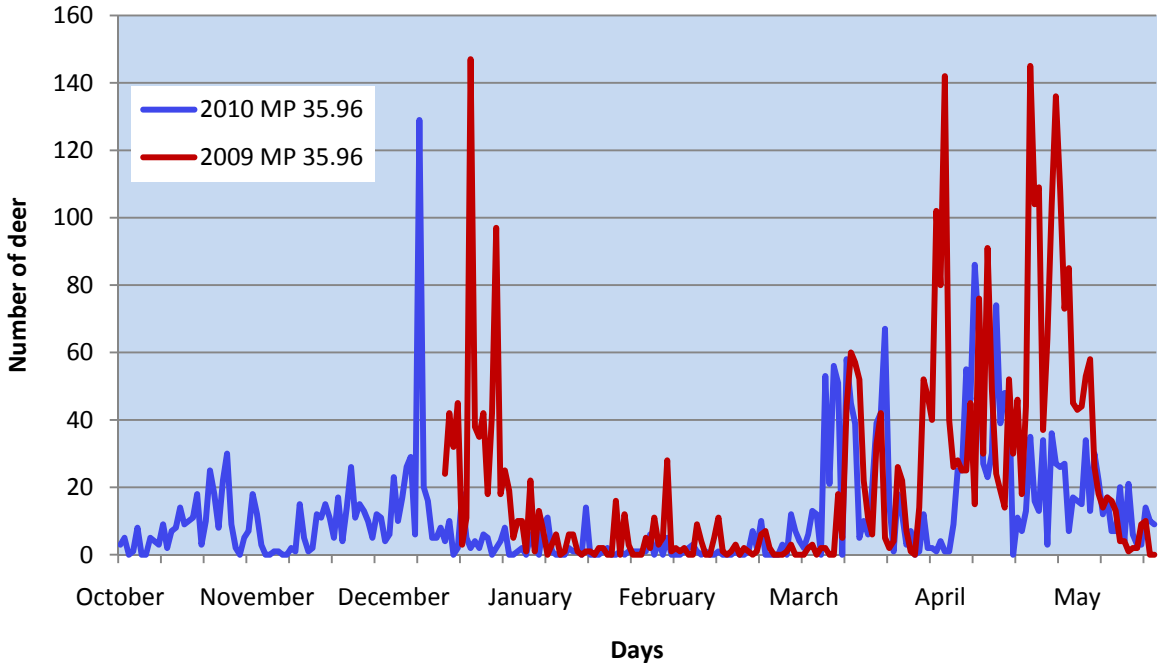

Figure 9. Number of deer passing through MP 35.96 crossing structure during the 2009 (fall 2008-spring 2009) and 2010 (fall 2009-spring 2010) monitoring seasons.

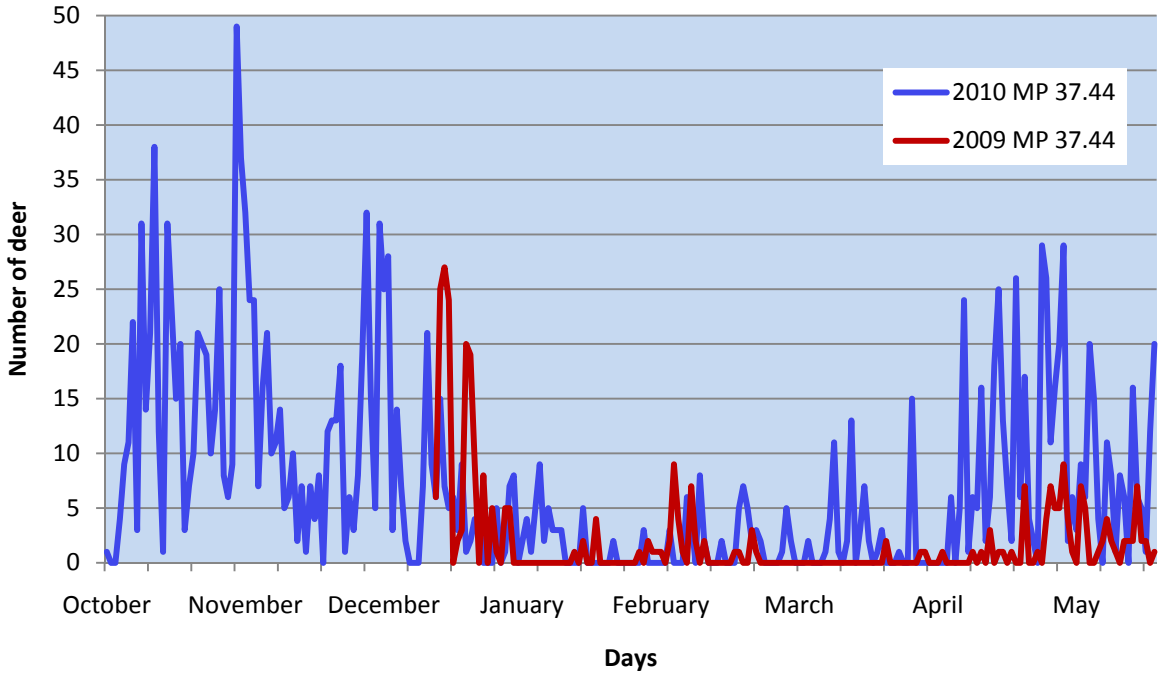

Figure 10. Number of deer passing through MP 37.44 crossing structure during the 2009 (fall 2008-spring 2009) and 2010 (fall 2009-spring 2010) monitoring seasons.

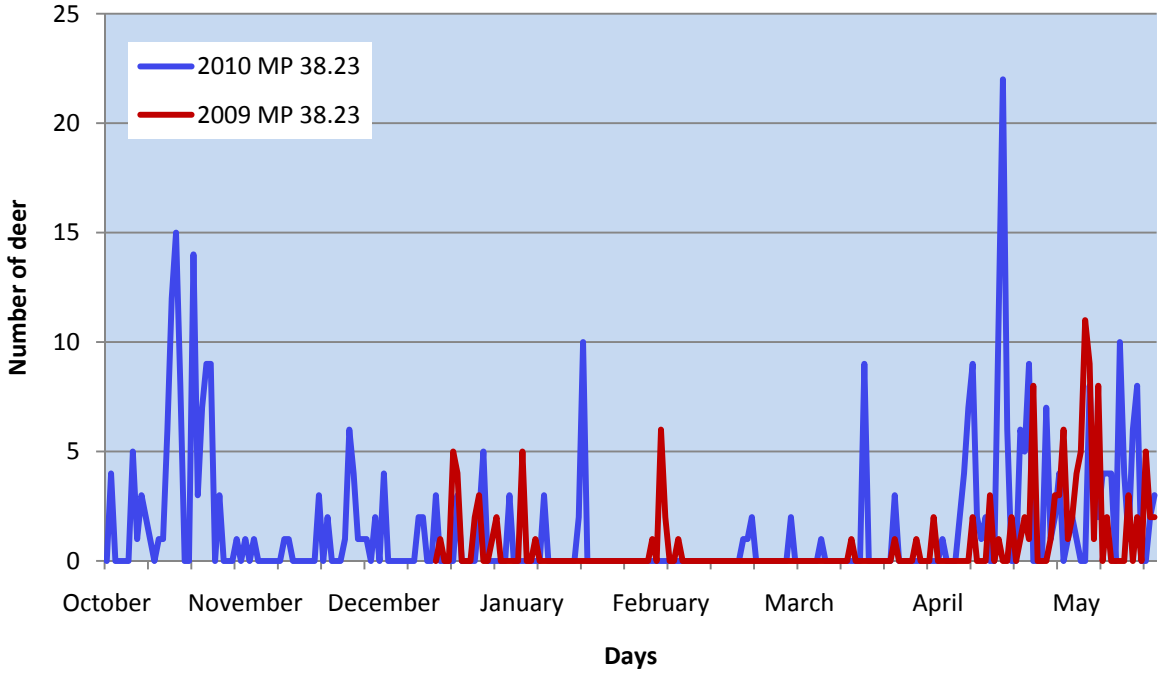

Figure 11. Number of deer passing through MP 38.23 crossing structure during the 2009 (fall 2008-spring 2009) and 2010 (fall 2009-spring 2010) monitoring seasons.

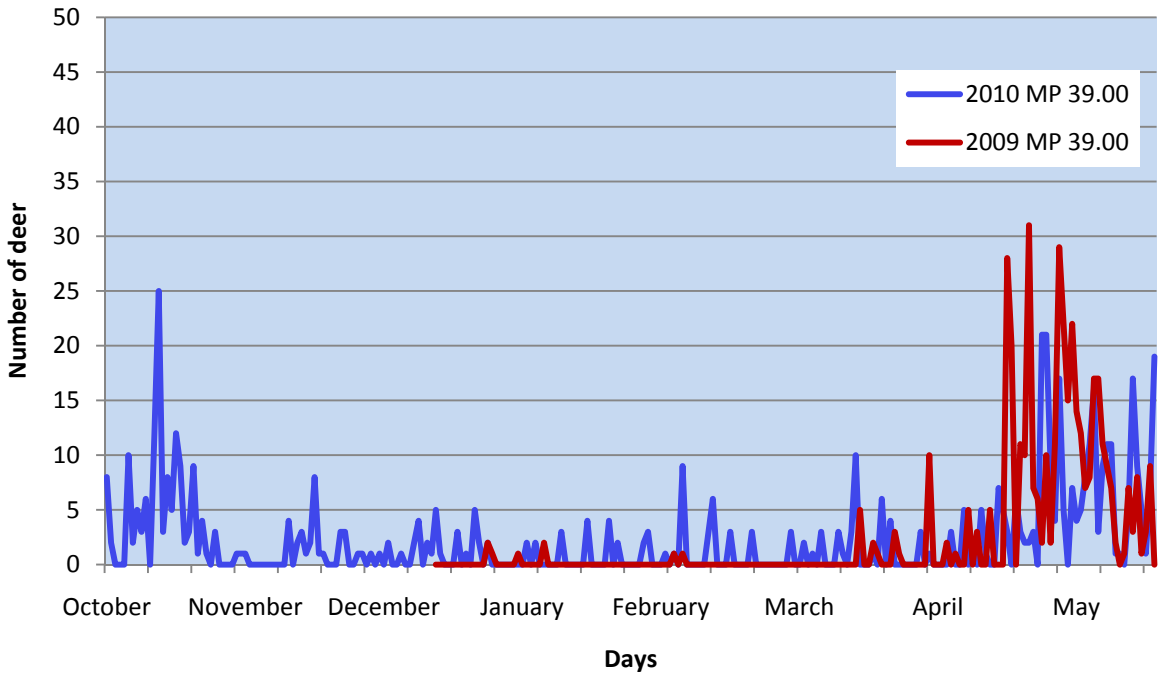

Figure 12. Number of deer passing through MP 39.00 crossing structure during the 2009 (fall 2008-spring 2009) and 2010 (fall 2009-spring 2010) monitoring seasons.

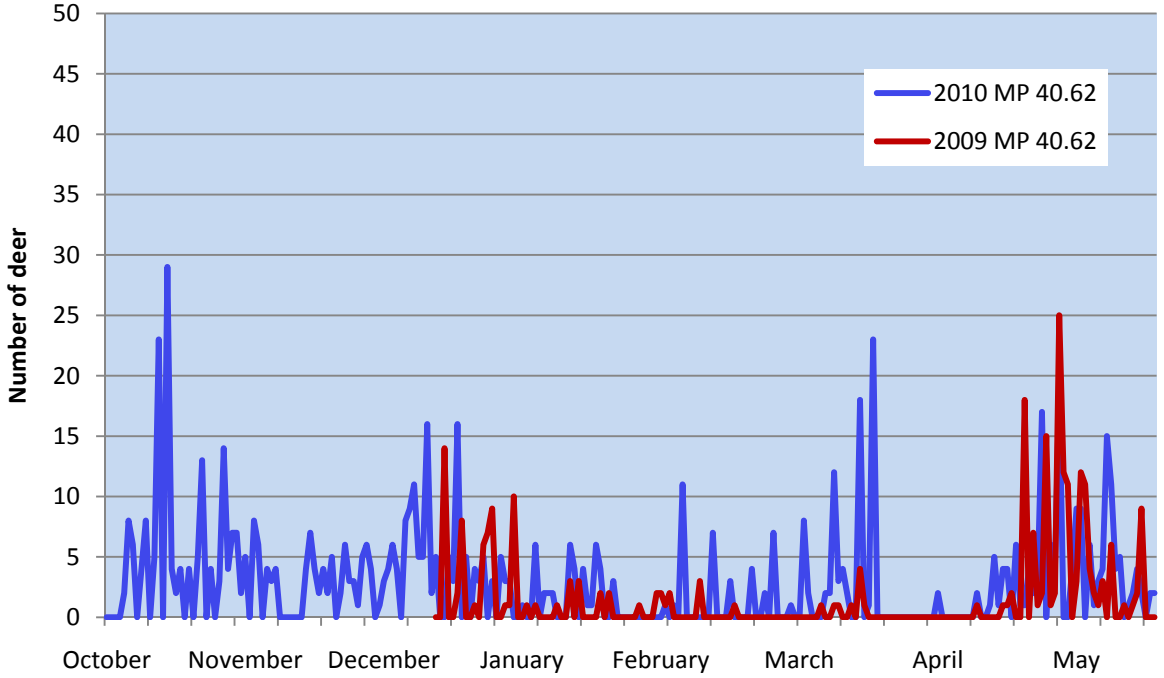

Figure 13. Number of deer passing through MP 40.62 crossing structure during the 2009 (fall 2008-spring 2009) and 2010 (fall 2009-spring 2010) monitoring seasons.

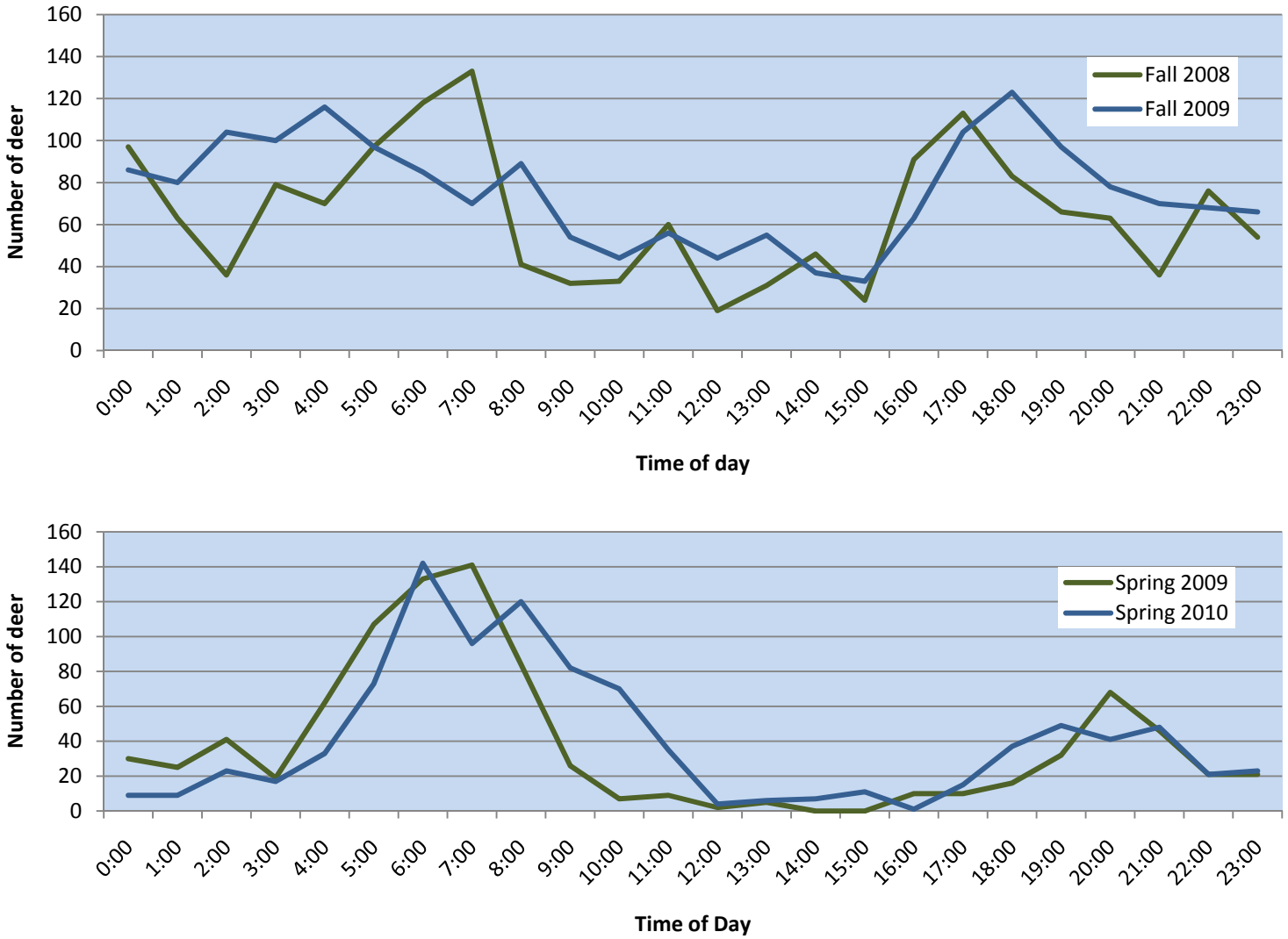

Figure 14. Number and time of day that mule deer moved through underpasses during a 10-day peak sample period during the 2009 and 2010 monitoring periods (fall 2008, Dec. 17-26; fall 2009, Dec. 8-17; spring 2009, April 23-May 02; and spring 2010, April 17-26).

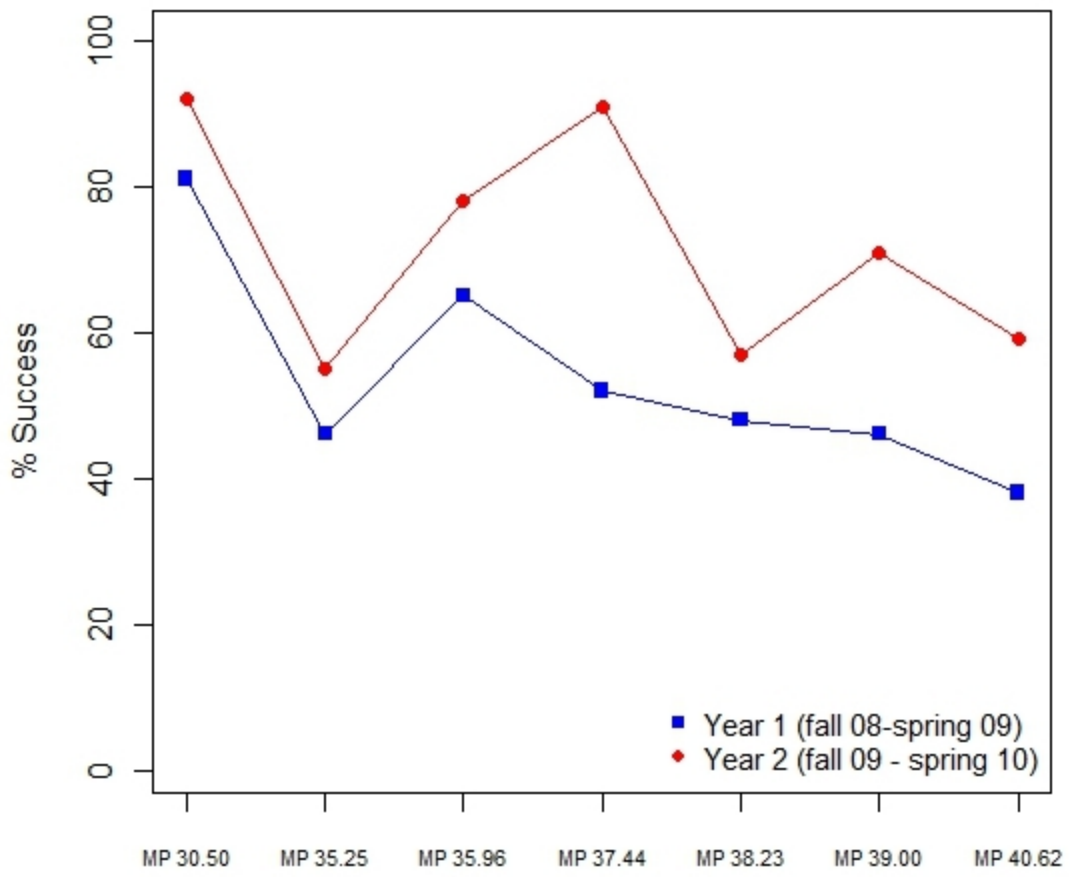

Figure 15. Success rates of mule deer passing through each underpass during the first two years of study. Crossing success was higher at all seven underpasses in Year 2.

Underpass Use by Other Wildlife

Between December 2008 and May 2010, we recorded 500 elk, 39 pronghorn, 13 coyotes, 44 bobcats, 6 badgers, 8 moose, and 1 mountain lion, raccoon, and red fox move through the underpasses (Table 3; Photos 1-4). Elk movement was restricted to the existing underpass at MP 30.50 during the fall 2008 migration; however three of the new structures (MP 39.00, MP 38.23, MP 35.96) were used in subsequent migrations. Most pronghorn movement was restricted to MP 30.50, however one was recorded at MP 38.23. Similarly, most moose crossings occurred at MP 30.50, but MP 37.44 and MP 40.62 each had one crossing.

Table 3. Number of other wildlife species that moved through the Nugget Canyon crossing structures during the first 2 years of study.

Other Wildlife Crossings																		
Underpass	**Badger**		**Bobcat**		**Coyote**		**Elk**		**Moose**		**Mountain Lion**		**Pronghorn**		**Raccoon**		**Red Fox**	
	2009	**2010**	**2009**	**2010**	**2009**	**2010**	**2009**	**2010**	**2009**	**2010**	**2009**	**2010**	**2009**	**2010**	**2009**	**2010**	**2009**	**2010**
Brdg. 34.92	0	1	0	6	0	0	1	0	0	0	0	0	0	0	1	0	0	1
MP 30.50	0	2	0	6	0	2	343	144	0	6	0	0	35	3	0	0	0	0
MP 35.25	0	0	0	18	1	0	0	0	0	0	0	0	0	0	0	0	0	0
MP 35.96	0	0	2	9	2	2	0	5	0	0	0	0	0	0	0	0	0	0
MP 37.44	0	1	0	2	0	2	0	0	0	1	0	0	0	0	0	0	0	0
MP 38.23	0	0	0	0	0	0	3	1	0	0	0	1	0	1	0	1	0	0
MP 39.00	0	0	0	1	1	0	3	0	0	0	0	0	0	0	0	0	0	0
MP 40.62	1	1	0	0	3	0	0	0	0	1	0	0	0	0	0	0	0	0
Sub-total:	1	5	2	42	7	6	350	150	0	8	0	1	35	4	1	1	0	1
Total:	6		44		13		500		8		1		39		1		1	

Photo 1. Elk crossing through underpass at MP 38.23.

Photo 2. Moose crossing through underpass at MP 30.50.

Photo 3. Mule deer and pronghorn move through underpass at MP 30.50.

Photo 4. Bobcat and kittens move through underpass at MP 35.96.

WORK SCHEDULE

This work schedule is designed to collect movement data for 3 full migration cycles (spring and fall). We maintain one camera operating at each underpass during the summer period.

<u>2010</u>

June-August	Spring migration analysis, annual report to WYDOT
October -	Install cameras and begin structure monitoring of fall migration
November -	Camera checks and structure monitoring
December -	Camera checks and structure monitoring

<u>2011</u>

January -	Camera checks and structure monitoring
February -	Fall migration analysis
March -	Begin structure monitoring of spring migration
April -	Camera checks and structure monitoring
May -	Camera checks and structure monitoring
June-August	Remove cameras and complete data analysis
September -	Submit final report to WYDOT