NDOT Research Report

Report No. 342-18-803 TO 1

DATA COLLECTION AND ANALYSIS OF CROSSING STRUCTURES ALONG WEST I80 AND USA PARKWAY IN NEVADA

August 2019

Nevada Department of Transportation

1263 South Stewart Street

Carson City, NV 89712

NEVADA DOT
SAFE AND CONNECTED

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16. Abstract

Wildlife animals crossing road surface often cause wildlife-vehicle collisions (WVCs) and is a major concern of highway safety in rural and suburban areas. WVCs are dangerous for the motorists and the wildlife involved and cause millions of dollars in infrastructure damage. In this report, the Center for Advanced Transportation Education and Research (CATER) at the University of Nevada, Reno (UNR) collected data of wildlife using the six crossing structures along west I80 in the Pequop Mountains and two wild horses crossing underpasses along the USA Parkway in the migratory periods of 2018 fall and 2019 spring. The CATER team also obtained wildlife-crossing pictures at the five crossing structures collected by the Nevada Department of Transportation (NDOT) Environmental service in 2018 spring. A total of 140,009 effective pictures related to 3,686 wildlife and human records were captured in 2018 spring (3/21/2018 – 5/1/2018), 2018 fall (9/14/2018 – 12/31/2018), and 2019 spring (1/01/2019 – 5/13/19). Pictures were processed by renaming and grouping picture files based on event time. Wildlife approaching/crossing records were extracted by reviewing the recorded pictures, and the extracted records were stored into an Excel database. The major conclusions are:

1) Deer were the major wildlife species crossing the structures in the Pequop Mountains.
2) There were many deer using the west wildlife underpass and the west wildlife overpass.
3) Wild horses were the major wildlife species crossing the structures in the USA Parkway area.
4) There were much more wild horses approached the south wildlife underpass than the north wildlife underpass. Generally, the same groups crossed the structures twice every day, and there are more horse captured during 2018 fall period than 2019 spring period.

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Data Collection and Analysis of Crossing Structures along West I80 and USA Parkway in Nevada

FINAL REPORT

Prepared for the
SOLARIS Institute
Tier 1 University Transportation Center
and
Nevada Department of Transportation

Hao Xu, P.E., Ph.D.
Yuan Tian
Center for Advanced Transportation Education and Research,
University of Nevada, Reno

August 2019

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DISCLAIMER

SOLARIS PROJECT DTRT13-G-UTC55 and NDOT PROJECT P342-18-803/TO #1

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The research reported herein was performed under SOLARIS PROJECT DTRT13-G-UTC55 and NDOT PROJECT P342-18-803/TO #1by the Department of Civil and Environmental Engineering at the University of Nevada, Reno (UNR).

Dr. Hao Xu, P.E., Assistant Professor of Civil Engineering at UNR, was the Project Principal Investigator. The other author of this report is Yuan Tian, Research Assistant and Ph.D. Candidate at UNR.

ABSTRACT

Wildlife animals crossing road surface often cause wildlife-vehicle collisions (WVCs) and is a major concern of highway safety in rural and suburban areas. WVCs are dangerous for the motorists and the wildlife involved and cause millions of dollars in infrastructure damage. In this report, the Center for Advanced Transportation Education and Research (CATER) at the University of Nevada, Reno (UNR) collected data of wildlife using the six crossing structures along west I80 in the Pequop Mountains and two wild horses crossing underpasses along the USA Parkway in the migratory periods of 2018 fall and 2019 spring. The CATER team also obtained wildlife-crossing pictures at the five crossing structures collected by the Nevada Department of Transportation (NDOT) Environmental service in 2018 spring. A total of 140,009 effective pictures related to 3,686 wildlife and human records were captured in 2018 spring (3/21/2018 – 5/1/2018), 2018 fall (9/14/2018 – 12/31/2018), and 2019 spring (1/01/2019 – 5/13/19). Pictures were processed by renaming and grouping picture files based on event time. Wildlife approaching/crossing records were extracted by reviewing the recorded pictures, and the extracted records were stored into an Excel database. The major conclusions are:

1) Deer were the major wildlife species crossing the structures in the Pequop Mountains.
2) There were many deer using the west wildlife underpass and the west wildlife overpass.
3) Wild horses were the major wildlife species crossing the structures in the USA Parkway area.
4) There were much more wild horses approached the south wildlife underpass than the north wildlife underpass. Generally, the same groups crossed the structures twice every day, and there are more horse captured during 2018 fall period than 2019 spring period.

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EXECUTIVE SUMMARY

Wildlife crossing road surface is a major concern of highway safety in rural and suburban areas. Wildlife-vehicle collisions (WVCs) are dangerous for the motorists and the wildlife involved, and cause millions of dollars in infrastructure damage. The Nevada Department of Transportation (NDOT) implemented various mitigation facilities, such as wildlife fencing and wildlife-crossing structures, along highways to reduce WVCs. Monitoring wildlife animals' use of crossing structures is important for evaluating the effect of existing structures and understanding wildlife-crossing patterns, which is valuable for future mitigation strategies.

In a previous NDOT traffic safety task order, the Center for Advanced Transportation Education and Research (CATER) at the University of Nevada, Reno (UNR) collected, processed and analyzed pictures of wildlife/human activities near the seven crossing structures along I80 in the Pequop Mountains and the Toano Range. Wildlife animals and humans crossing data were collected in 2015 fall (8/11/2015 – 12/20/2015), 2016 spring (1/24/2016 – 6/2/2016), and 2016 fall (9/8/2016 – 12/23/16). In this project, UNR CATER continued the data collection to monitor how wildlife animals and humans using highway-crossing structures. The monitored structures include two 10' x 10' wildlife-underpasses, two vehicle-underpasses and two wildlife-overpasses in the Pequop Mountains along I80, and two wild horse underpasses along the State Route 439 (SR 439, USA Parkway). The project team installed 21 motion-activated-wildlife cameras at the total eight crossing structures to automatically capture pictures of human and wildlife activities in 2018 fall (9/14/2018 – 12/31/2018), and 2019 spring (1/01/2019 – 5/13/19). The data processing and analysis included pictures of 2018 spring (3/21/2018 – 5/1/2018) that were captured for the Pequop Mountains structures by the NDOT Environmental Services. A total of 140,009 pictures related to 3,686 wildlife and human records were captured in the three migration terms. Pictures were renamed and processed based on activities time; wildlife approaching/crossing records were extracted by reviewing all the pictures.

Wildlife animals crossing/approaching the I80 structures are deer, rabbit, and coyotes, in which deer were the majority. Horses, cattle and coyotes were observed at the two USA Parkway structures. Vehicles and pedestrians crossing highway through the I80 vehicle underpasses were also recorded. The numbers of deer approaching, crossing, and retracting at the Pequop Mountain crossing structures are summarized in Table 4-1. The numbers of wild horses approaching, crossing, and retracting at the USA Parkway underpasses are listed in Table 4-2.

Table 1 Summary of Deer Activities at the Pequop Mountain Area

	Deer Groups	**Deer Approaching**	**Deer Crossing**	**Deer Retracting**
Southbound	816	2,753	1,901	852
Northbound	876	2,927	1,742	1,185
Unknown	59	171	Unknown	Unknown

Table 2 Summary of Wild horses Activities at the USA Parkway Area

	Horse Groups	**Horse Approaching**	**Horse Crossing**	**Horse Retracting**
Southbound	73	509	493	16
Northbound	93	566	511	55
Unknown	10	31	Unknown	Unknown

CHAPTER 1 BACKGROUND

Wildlife-vehicle collisions (WVCs) are a major concern of highway safety, which are caused by wildlife crossing highway surfaces. A data study (Huijser, et al., 2007) revealed that 725,000 to 1,500,000 wildlife-vehicle collisions happened yearly in the United States. From May 2015 through May 2016, 399 wildlife-vehicle crashes were reported in Nevada, including one human fatality and 69 injuries. It is estimated that U.S. roads influence at least one-fifth of the natural ecology of the country (Forman, et al., 2000). Roads increase wildlife deaths, reduce habitat, prevent wildlife from accessing natural resources, and isolate wildlife populations into vulnerable subpopulations (Clevenger, et al., 2011). Wildlife-crossing structures are built with the wildlife-friendly design to reduce vehicle-wildlife collision occurrence. Monitoring wildlife's use of structures is an effective approach to evaluating the effect of the different structures and understanding of wildlife-crossing patterns.

The Nevada Department of Transportation (NDOT) collaborates with the Nevada Department of Wildlife (NDOW) to improve highway safety and wildlife ecology in Nevada, especially in areas where wildlife-vehicle crashes are concentrated. NDOT constructs wildlife fencing and wildlife crossing structures to reduce WVCs. One focal area in Nevada is between Wells and Wendover along I80 in Elko County. Crash data of 2015-2016 shows that Elko has the highest frequency of wildlife-vehicle crashes in Nevada counties, as shown in Figure 1-1. Figure 1-2 shows the highest number of wildlife bodies that were found and removed by NDOT District engineers in Elko. The Pequop Mountains area is problematic with many deer crossing I80 while high-density wild horses live in the USA Parkway area and horses crossing the highway very often. NDOT built two 10' x 10' wildlife underpasses, two vehicle-underpasses and two wildlife-overpasses along I80 in the Pequop Mountains as located in Figure 1-3. And there are two wildlife underpasses in along the USA Parkway as located in Figure 1-4.

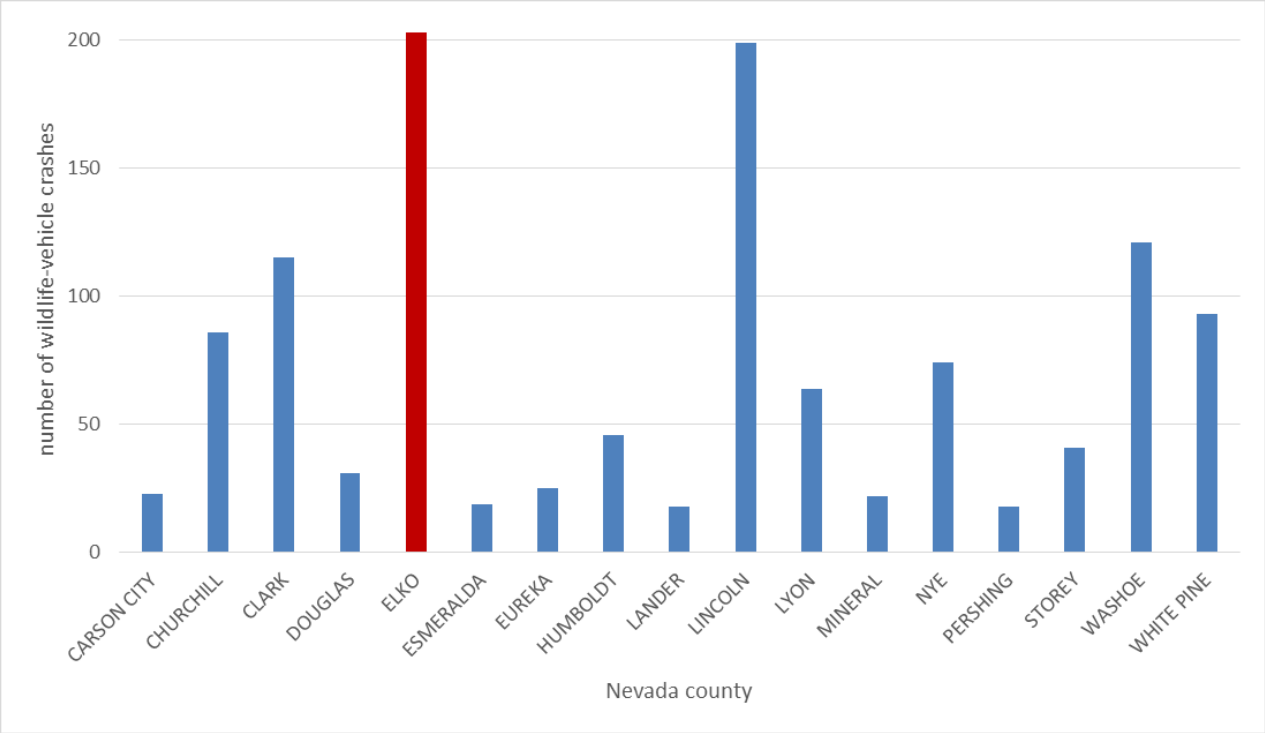

Figure 1-1 Wildlife-vehicle crashes of Nevada counties in 2016-2017

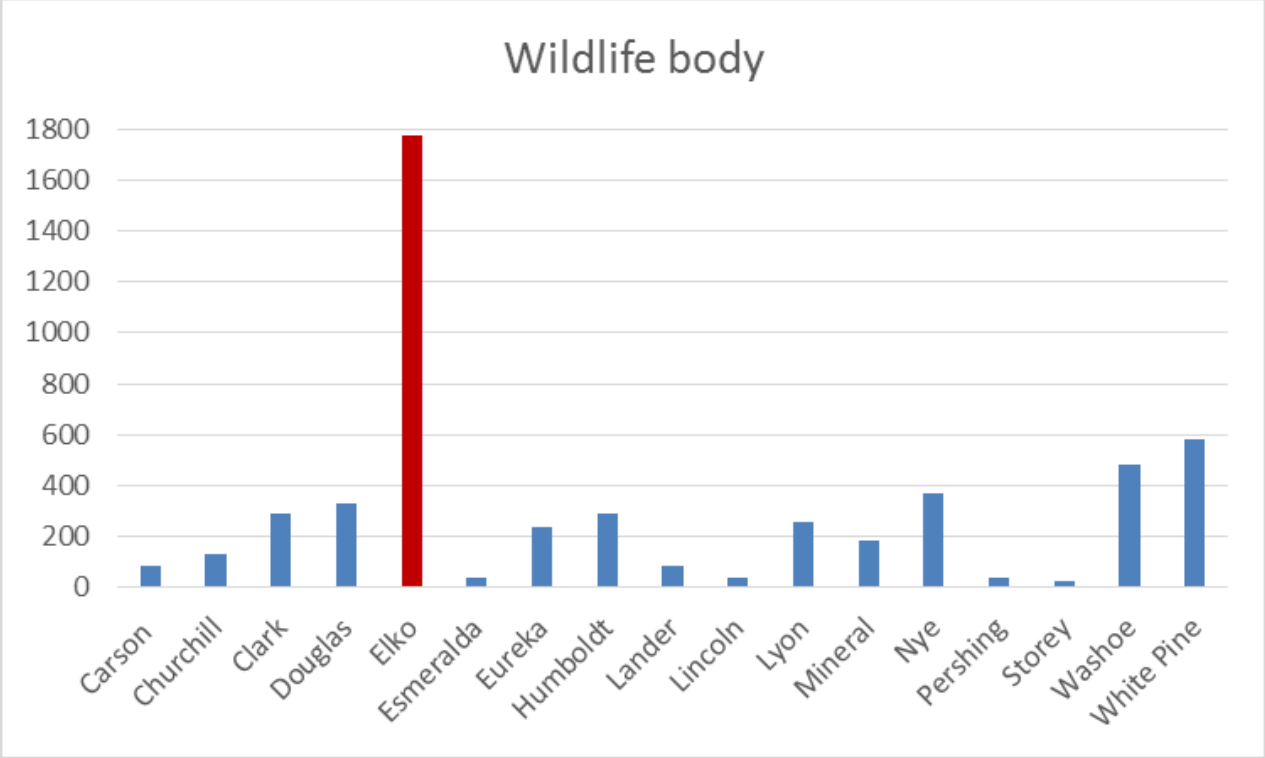

Figure 1-2 Wildlife body removal number in 2009-2016

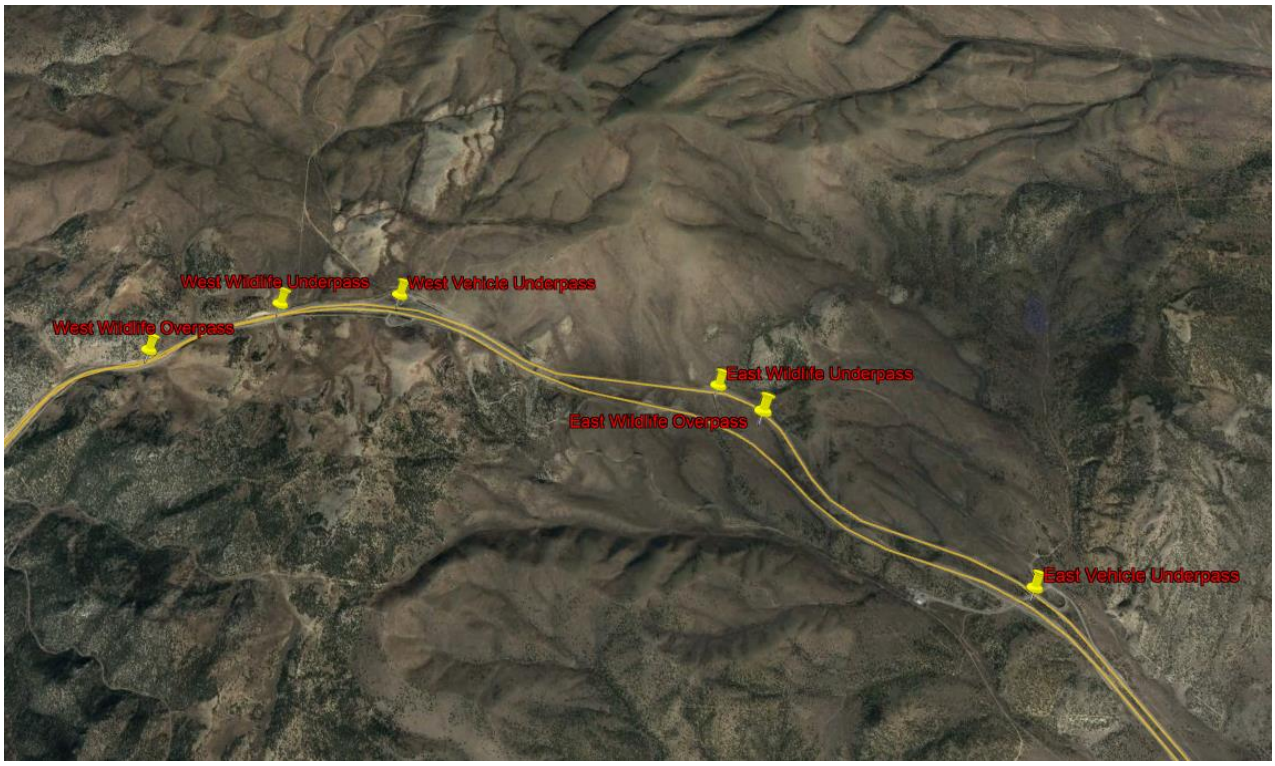

Figure 1-3 I80 crossing structures in the Pequop Mountains

Figure 1-4 USA Parkway crossing structures[1]

In this project, the Center for Advanced Transportation Education and Research (CATER) at the University of Nevada, Reno (UNR) collected data of wildlife crossings at the eight structures in the migratory periods of 2018 fall and 2019 spring and obtained pictures of

[1] The USA Parkway satellite map was not recently updated so USA Parkway is not visible on the map.

wildlife-crossing structures in the Pequop Mountain in 2018 spring from NDOT. The collected data help to understand how wildlife use different crossing facilities for migration.

This report is organized as the following: Section 2 introduces the wildlife-crossing structures where data collection was performed. Details about camera installation, picture collection and camera maintenance are in Section 3. Section 4 documents data analysis results of wildlife crossing I80 and USA Parkway. At the end of this report, Section 5 summarizes research findings from the data of 2018 spring, 2018 fall, and 2019 spring.

CHAPTER 2 CROSSING STRUCTURES

2.1 West wildlife underpass at the Pequop Mountain

A 10'x10' wildlife underpass in the Pequop Mountains is to the west of the vehicle underpass at the I80 milepost EL 95.25 (latitude 41.077589^{o} and longitude -114.579315^{o}) as shown in Figure 2-1. The camera labeled as NDOT01 was installed at the north entrance in 2018 fall and moved to the south entrance in 2019 spring. The location and angle of the camera NDOT01 in 2018 fall are shown in Figure 2-1 and Figure 2-2; its location and angle in 2019 spring are demonstrated in Figure 2-3 and Figure 2-4.

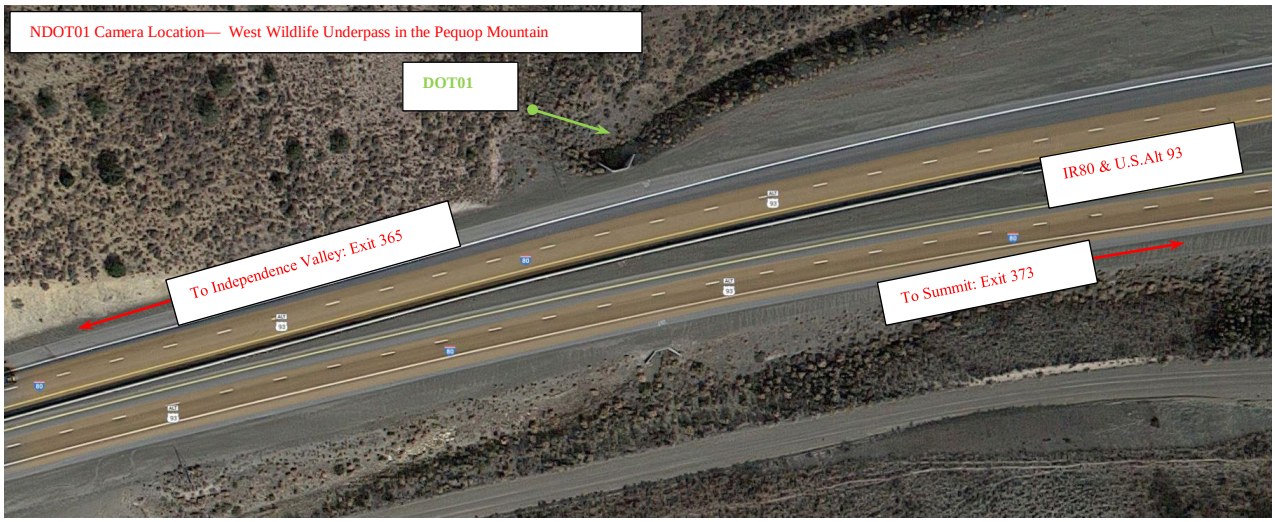

Figure 2-1 Camera layout at the west wildlife underpass in the Pequop Mountain (2018 fall)

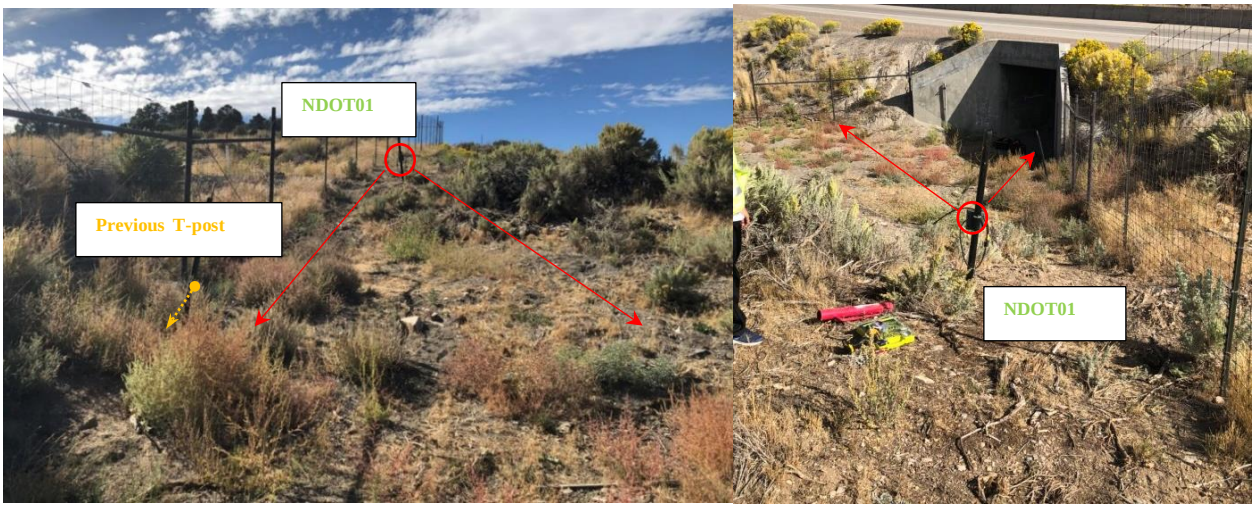

Figure 2-2 Camera location and direction at the north entrance of the west wildlife underpass in the Pequop Mountain (2018 fall)

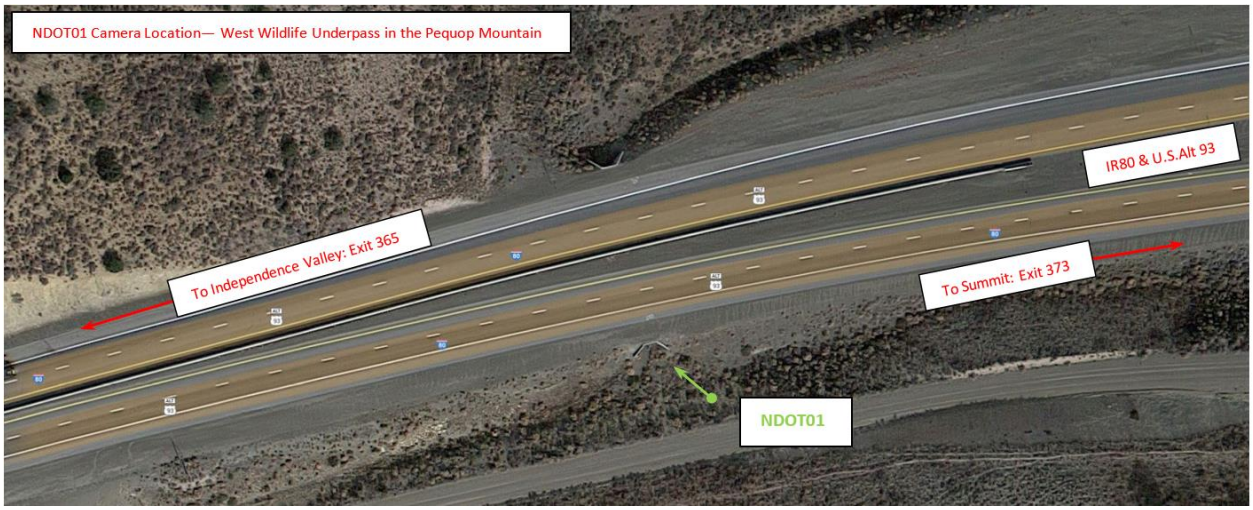

Figure 2-3 Camera layout at the west wildlife underpass in the Pequop Mountain (2019 spring)

Figure 2-4 Camera location and direction at the south entrance of the west wildlife underpass in the Pequop Mountain (2019 spring)

2.2 West vehicle underpass in the Pequop Mountain

The west vehicle underpass in the Pequop Mountains is at the I80 milepost EL 95.25 (latitude: 41.078158^{o}, longitude: -114.570805^{o}), with two highway bridges (NDOT bridge numbers of I1341E and I1341W) for eastbound and westbound I80. Cameras labeled as NDOT02 &NDOT03 were installed at the north entrance in 2018 spring and moved to the south

entrance in 2019 spring. The locations and angles of the cameras NDOT02 and NDOT03 are shown in Figure 2-5 for 2018 fall, and the two cameras' locations and anagles are shown in Figure 2-5 and Figure 2-6 for 2019 spring.; its location and angle in 2019 spring are demonstrated in Figure 2-7 and Figure 2-8.

Figure 2-5 Camera layout at the west vehicle underpass in the Pequop Mountain (2018 fall)

Figure 2-6 Locations and directions of two cameras at the west vehicle underpass in the Pequop Mountain (2019 spring)

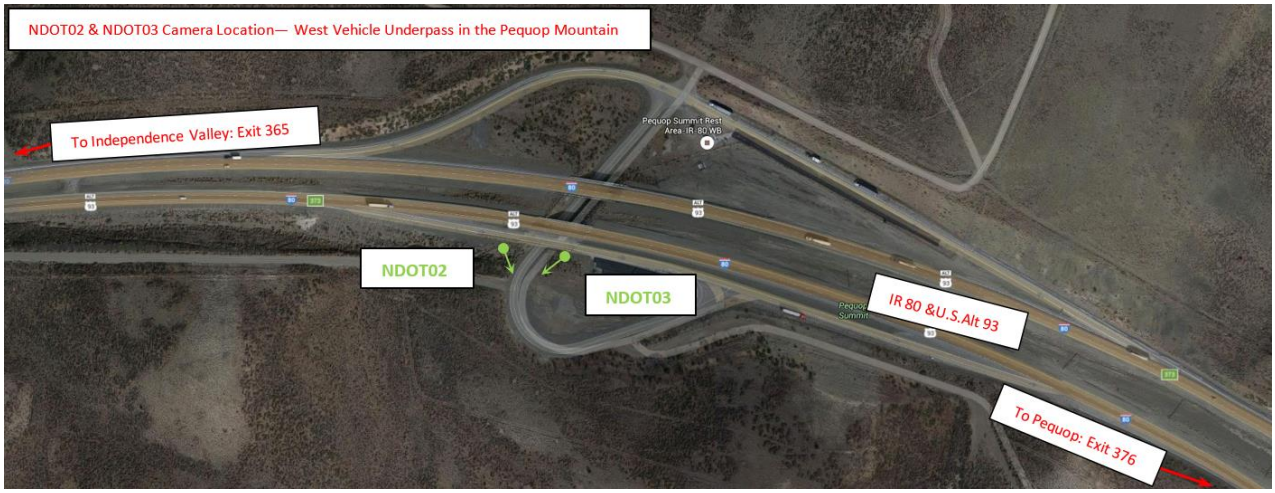

Figure 2-7 Camera layout at the west vehicle underpass in the Pequop Mountain (2019 spring)

Figure 2-8 Locations and directions of two cameras at the west vehicle underpass in the Pequop Mountain (2019 spring)

2.3 East wildlife underpass in the Pequop Mountains

The east wildlife underpass (latitude: 41.069099° and longitude: -114.542419°) in the Pequop Mountain locates to the west of the vehicle underpass at the milepost I80 EL 98.1. A fenced tunnel connects the north entrance and south entrance. The camera NDOT04 was

installed on a fence pole at the north entrance in 2018 fall, Figure 2-9 and Figure 2-10, and moved to the south entrance in 2019 spring, Figure 2-11 and Figure 2-12.

Figure 2-9 Camera layout at the east wildlife underpass in the Pequop Mountains (2018 fall)

Figure 2-10 Locations and angles of the camera at the east wildlife underpass in the Pequop Mountains (2018 fall)

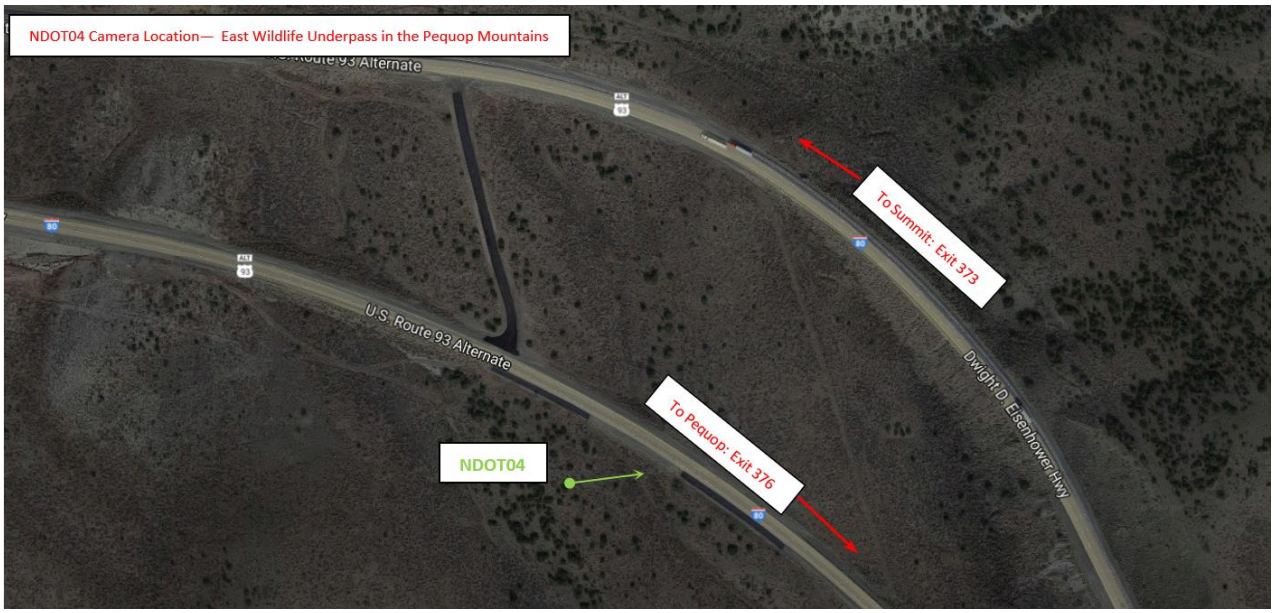

Figure 2-11 Camera layout at the east wildlife underpass in the Pequop Mountains (2019 spring)

Figure 2-12 Locations and angles of the camera at the east wildlife underpass in the Pequop Mountains (2019 spring)

2.4 East wildlife overpass in the Pequop Mountains

Cameras of NDOT06 & NDOT07 & NDOT08 & NDOT09 & NDOT13 were installed at the north entrance of the new overpass in 2018 fall, Figure 2-13, and moved to the south entrance in 2019 spring, Figure 2-14. Due to the wide width of the overpass, five cameras were installed to maximize the coverage. All of them were placed on the fence poles. The camera layout was shown in Figure 2-.

Figure 2-13 Cameras layout at the East Wildlife Overpass in the Pequop Mountains (2018 fall)

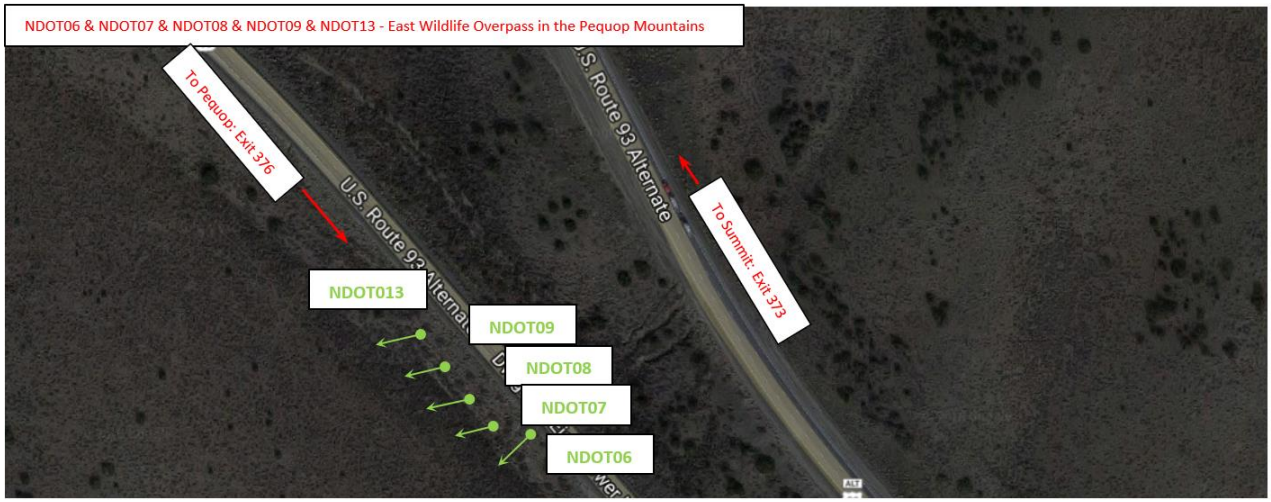

Figure 2-14 Cameras layout at the East Wildlife Overpass in the Pequop Mountains (2019 spring)

2.5 East vehicle underpass in the Pequop Mountains

The east vehicle underpass in the Pequop Mountains is at the milepost EL 98.1 (Latitude: 41.061758°, Longitude: -114.523490°) with two highway bridges for eastbound and westbound I80. Their NDOT bridge numbers are I1159E and I1159W. This underpass can be accessed through the eastbound or westbound I80 Exit 376 (Pequop).

Cameras of NDOT11 &NDOT12 were placed at the north entrance of the underpass in 2018 fall, as shown in Figure 2- and Figure 2-16. The two cameras were moved to the south

entrance in 2019 spring, Figure 2-17. The existing T-posts were used to install the cameras.

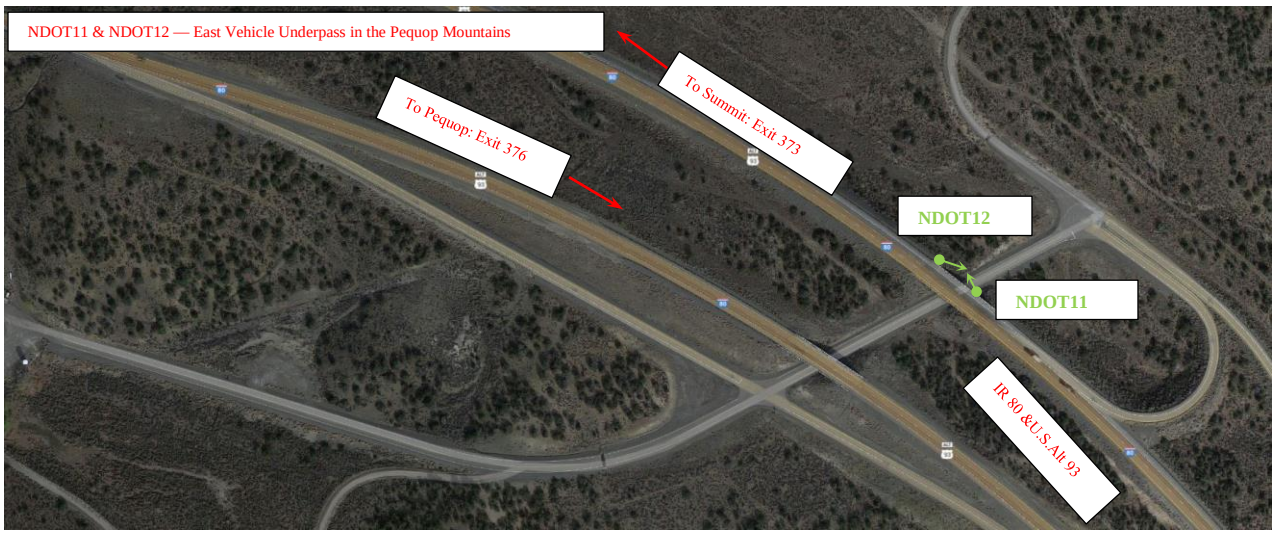

Figure 2-15 Camera layout at the East Vehicle Underpass in the Pequop Mountains (2018 fall)

Figure 2-16 Locations and directions of the cameras at the East Vehicle Underpass in the Pequop Mountains (2018 fall)

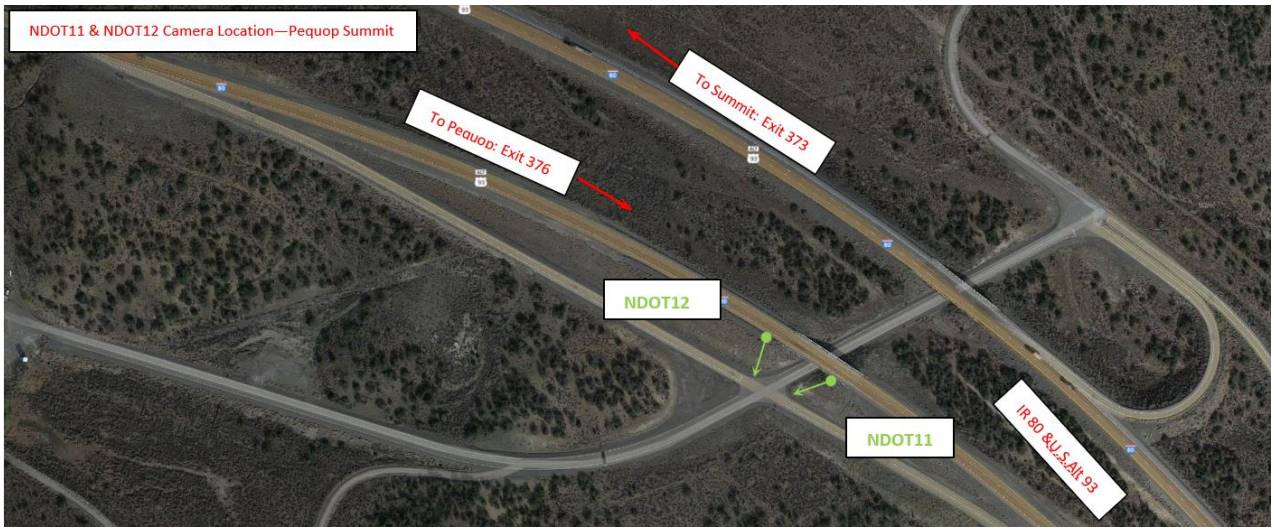

Figure 2-17 Camera layout at the East Vehicle Underpass in the Pequop Mountains (2019 spring)

2.6 West wildlife overpass in the Pequop Mountains

Cameras of NDOT05 & NDOT10& NDOT18& NDOT19& NDOT20& NDOT21 were installed on the new overpass. Due to the wide width of the overpass, we installed five cameras to maximize the coverage. All of them were placed on the fence poles. The camera layout was shown in Figure 2-3 and Figure 2-19 for 2018 fall. Camera installation locations in 2019 spring were shown in Figure 2-4.

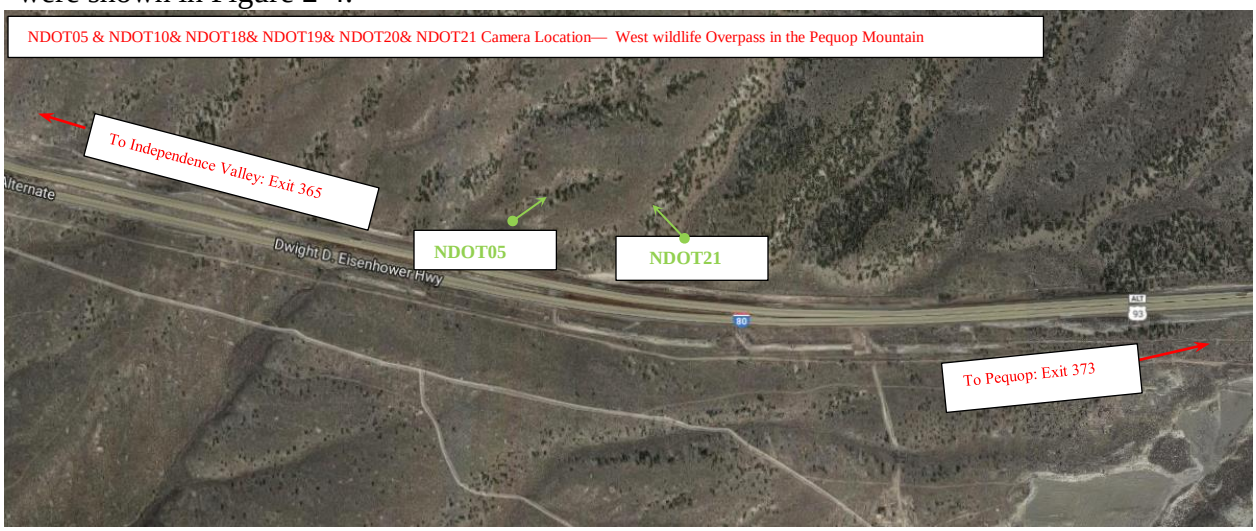

Figure 2-3 Camera layout at the west wildlife overpass in the Pequop Mountain (2018 fall)

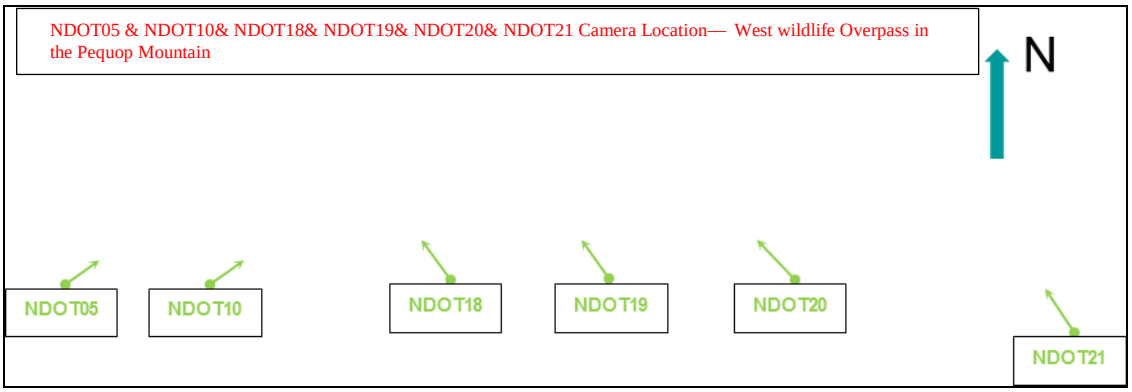

Figure 2-4 Camera installation locations diagram at the west wildlife overpass in the Pequop Mountain (2018 fall)

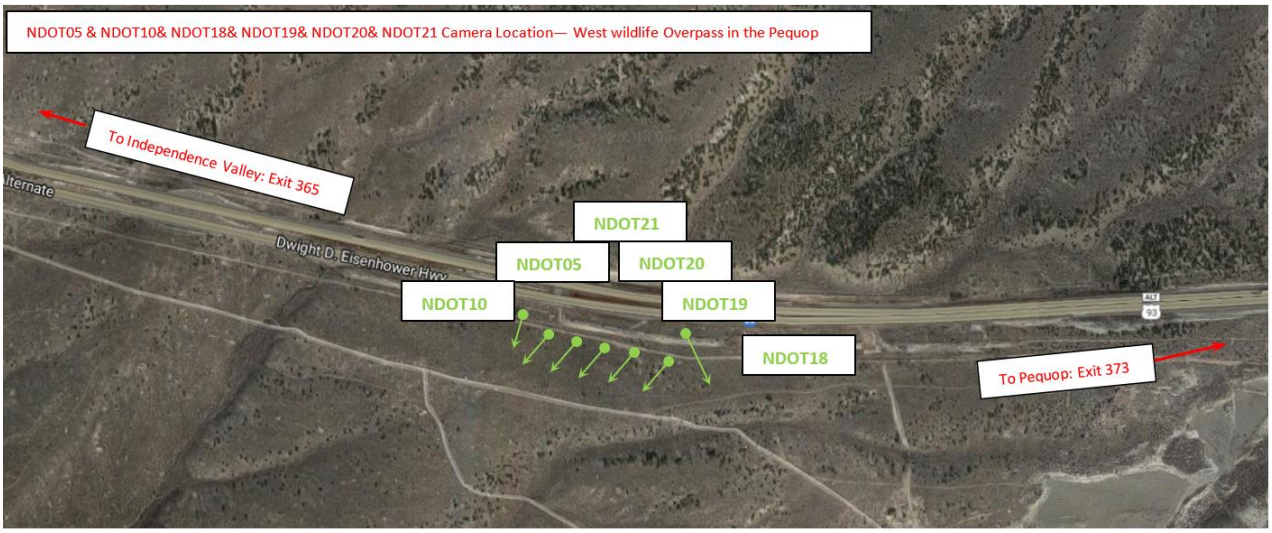

Figure 2-20 Camera layout at the west wildlife overpass in the Pequop Mountain (2019 spring)

2.7 North wildlife underpass of the USA Parkway

The north wildlife underpass of the USA Parkway is at the Milepost 0.08/8.64, Storey County (Latitude: 39.46869542°, Longitude: -119.38878487°). The NDOT gate number is 31. Two cameras were installed at this underpass. The location and direction of the cameras are shown in Figure 2-21.

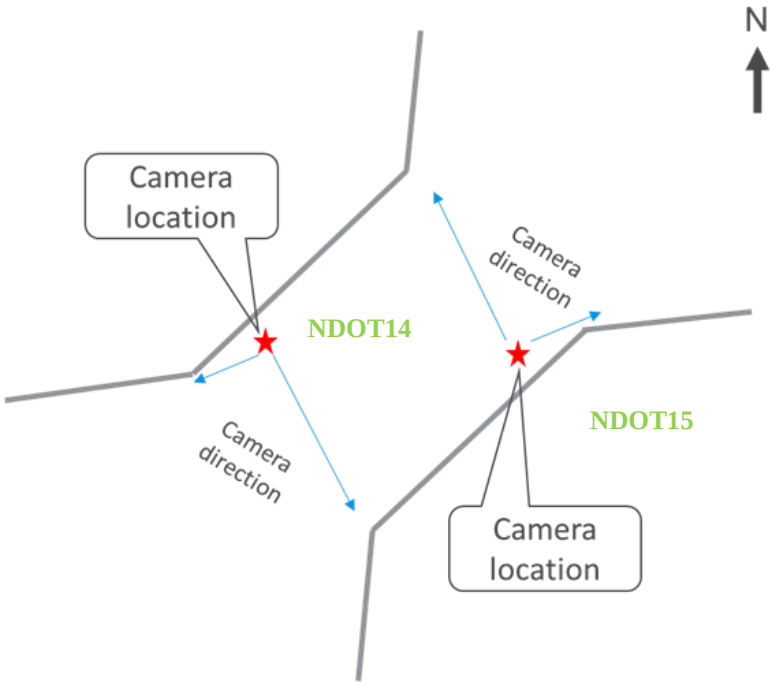

Figure 2-5 location and direction of cameras

Camera brackets were installed by NDOT District II before 10/12/2018. Locations of NDOT14 &NDOT15 were demonstrated in Figure 2-6.

Figure 2-6 Locations and directions of the cameras at the north Wildlife Underpass on USA Parkway

2.8 South wildlife underpass of the USA Parkway

The south wildlife underpass is at the Milepost 1.74/1.74, Lyon Cunty (Latitude: 39.40763476°, Longitude: -119.29304161°). The NDOT gate number is 40. Two cameras were installed at this underpass. Locations and directions of the two cameras were demonstrated in

Figure 2-7.

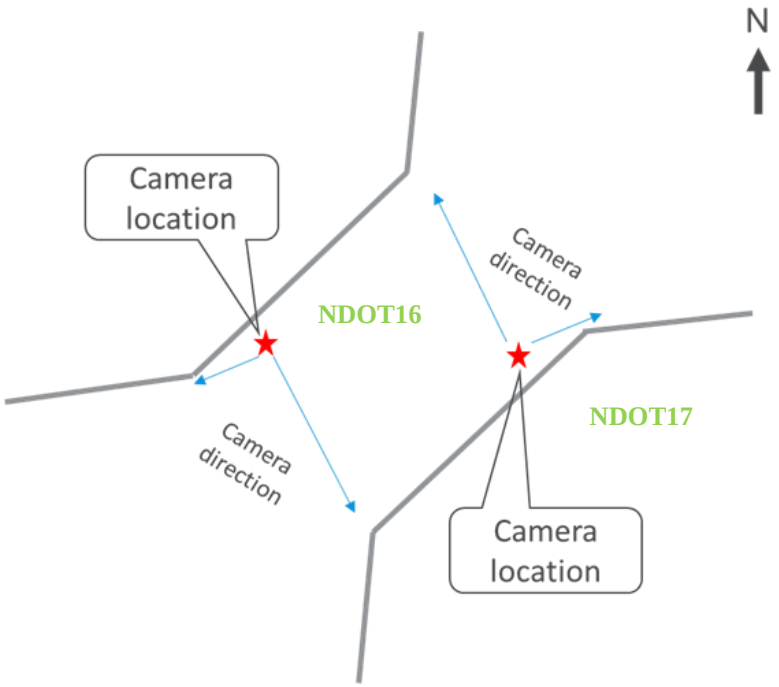

Figure 2-7 location and direction of cameras

Cameras of NDOT16 &NDOT17 were demonstrated in Figure 2-8.

Figure 2-8 Locations and directions of the cameras at the East Wildlife Underpass in the USA Parkway

CHAPTER 3 DATA COLLECTION

3.1 Data collection devices

The CATER team received motion activated wildlife cameras from NDOT and installed the cameras to automatically record wildlife migration activities when using the passing structures. The major features of cameras are listed as the following:

- Flash type: "no glow infrared"
- Trigger speed: "<0.2s"
- Recovery speed: "=1s"
- Detection view angle: "=40 degree"
- Weather proof
- Far range at night
- Continuous picture burst with no delay period
- Picture activation with movement and change in a temperature gradient
- Customizable settings for variation in camera trigger speeds

The camera model is PC900 Hyper Fire Professional High Output Infrared Camera, manufactured by Reconyx™.

3.2 Camera installation

A total of 21 cameras were assigned for this project; eight of them were installed at the structure, and two were kept as a backup. The required accessories for proper camera function included security enclosures, swivel mounts, concrete brackets, lithium batteries, cut resistant padlocks, and two SD cards for each camera. The assigned cameras for each site and the data collection periods were summarized in Table 3-1.

Table 3-1 Camera locations and directions

Camera number	Location	Date	Direction	Date	Direction
NDOT01:	West Wildlife Underpass in the Pequop Mountain	9/15/2018-2/22/2019	Southeast	2/23/2019-5/12/2019	Northwest
NDOT02:	West Vehicle Underpass in the Pequop Mountain	9/15/2018-2/22/2019	Northeast	2/23/2019-5/12/2019	Southwest
NDOT03:			Northwest		Southeast
NDOT04:	East Wildlife Underpass in the Pequop Mountains	9/15/2018-2/22/2019	Southeast	2/23/2019-5/12/2019	Northeast
NDOT06:	East Wildlife Overpass in the Pequop Mountains	9/15/2018-2/22/2019	Northeast	2/23/2019-5/12/2019	South
NDOT07:			Northeast		Southwest
NDOT08:			Northeast		Southwest
NDOT09:			Northeast		Southwest
NDOT13:			Southeast		Southwest
NDOT11:	East Vehicle Underpass in the Pequop Mountains	9/15/2018-2/22/2019	Northeast	2/23/2019-5/12/2019	Southwest
NDOT12:			Northwest		Southeast
NDOT14:	North Wildlife Underpass of the USA Parkway	10/13/2018-5/12/2019	Southeast		
NDOT15:			Northwest		

Camera number	Location	Date	Direction	Date	Direction
NDOT16:	South Wildlife Underpass of the USA Parkway	10/13/2018-5/12/2019	Southeast		
NDOT22:			Northwest		
NDOT05:	West Wildlife Overpass in the Pequop Mountains	11/16/2018-2/22/2019	Northeast	2/23/2019-5/12/2019	Southwest
NDOT10:			Northeast		Southwest
NDOT18:			Northwest		Southeast
NDOT19:			Northwest		Southwest
NDOT20:			Northwest		Southwest
NDOT21:			Northwest		Southwest

3.3 Data collection timelines

Based on NDOT engineers' recommendation, the data collection period was initially planned for nine months, September 2018 through May 2019. The filed data collected once a month or once every two months. From September 2018 to May 2019, the CATER team visited the filed sites five times, and the detailed information is as follows:

Table 3-2 Data collection timeline

ID	Start time	End time	Visited sites	Tasks
1	09/14/2018	09/15/2018	West Wildlife Underpass, West Vehicle Underpass, East Wildlife Underpass, East Wildlife Overpass, East Vehicle Underpass in the Pequop Mountain	Install the cameras.
2	10/12/2018	10/13/2018	West Wildlife Underpass, West Vehicle Underpass, East Wildlife Underpass, East Wildlife Overpass, East Vehicle Underpass in the Pequop Mountain; North and South Wildlife Underpass of the USA Parkway	Collect filed data on west I-80; install the equipment on the underpasses at the USA Parkway.
3	11/18/2018	11/20/2018	All of the crossing structures	Collect filed data; install equipment on the West Wildlife Overpass in the Pequop Mountains
4	01/26/2019	01/27/2019	All of the crossing structures	Collect filed data
5	02/22/2019	02/23/2019	The crossing structures in the Pequop Mountain area	Collect filed data, change the position and direction of the cameras
6	04/05/2019	04/06/2019	All of the crossing structures	Collect filed data
7	05/13/2019	05/14/2019	All of the crossing structures	Collect filed data

3.4 Filed camera maintenance and data collection

During each field visit, the CATER team performed routine maintenance of all the

cameras. The routine maintenance included cleaning camera lens, air dusting, and replacing batteries when necessary. Each camera was assigned two SD cards. An SD card would be swapped out and was replaced with an empty one. The SD cards with the collected pictures were then taken to the CATER lab for picture extraction. The pictures were copied into respective camera folders (NDOT01, NDOT02...) and then uploaded to a CATER internal data server. A field report was composed after each visit to report the photo counts, battery status, any unusual situations found with each camera. A report of the field visit on November 16th, 2018 is presented in Appendix A as an example.

CHAPTER 4 DATA ANALYSIS

CATER analyzed the data extracted from the grouped pictures. This section presents the analysis results of data collected in Pequop Mountain area in 2018 spring (3/21/2018 - 5/1/2018, 41 days), 2018 fall (9/15/2018 - 12/31/2018, 108 days) and 2019 spring (1/01/2019 - 5/12/2019, 133 days), And the data collected in USA Parkway area in 2018 fall (9/15/2018 - 12/31/2018, 108 days) and 2019 spring (1/01/2019 - 5/12/2019, 133 days). The automatic cameras captured 140,009 effective pictures, related to 3,685 wildlife records. Pictures of vehicles, maintenance staff, and non-wildlife/human-related were excluded.

4.1 Crossing activities at the structures

4.1.1 Crossing of different species along I-80

There are total 3,249 groups of pictures recorded at the six crossing structures along I-80. Approaching frequency of different species is shown in the pie chart of Figure 4-1. The 1,553 deer records (groups) counted the major part of all records (groups). Other wildlife species included rabbits, bobcats, coyotes, grey fox, elk, and birds. There were also 904 records related to vehicles and pedestrians at the two vehicle-underpasses in the Pequop Mountain, these records were excluded due to they have nothing to do with wildlife migration. Figure 4-2 shows the number of captured pictures related to each species. Figure 4-3 compares the approaching records in the 2018 spring (3/21/2018 - 5/1/2018, 41 days), 2018 fall (9/15/2018 - 12/31/2018, 108 days), and 2019 spring (1/01/2019 -5/12/2019, 133 days). It shows that more wildlife using these passing structures during 2018 fall than other periods.

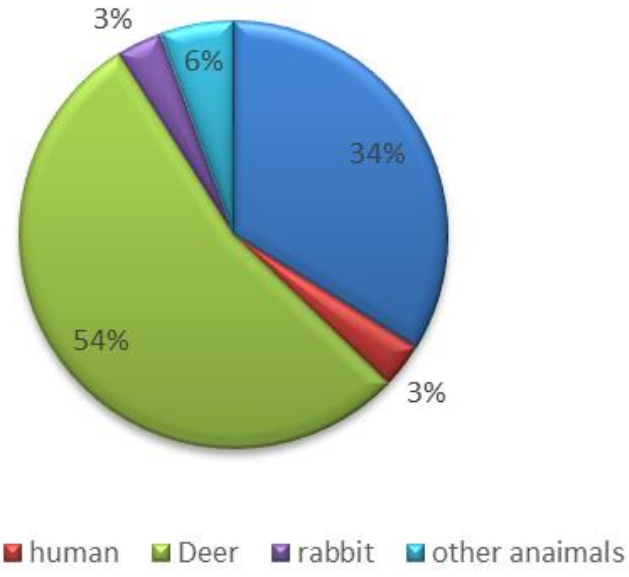

Figure 4-1 Observed frequency percentages of different species at the structures

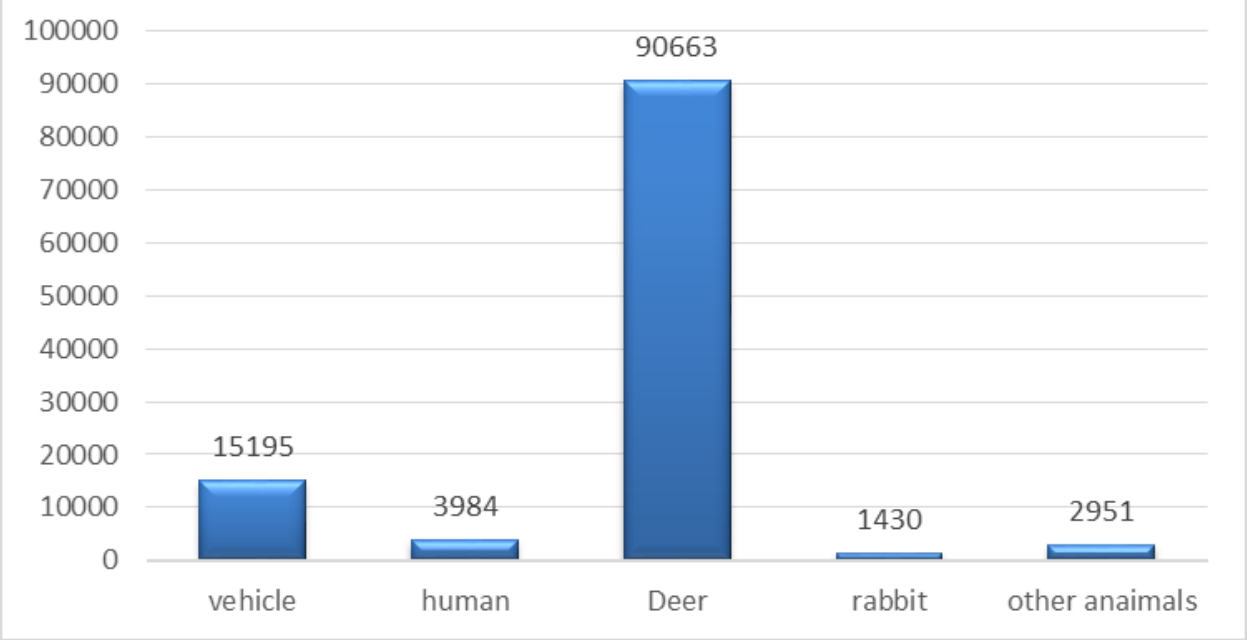

Figure 4-2 Picture numbers of different species at the crossing structures

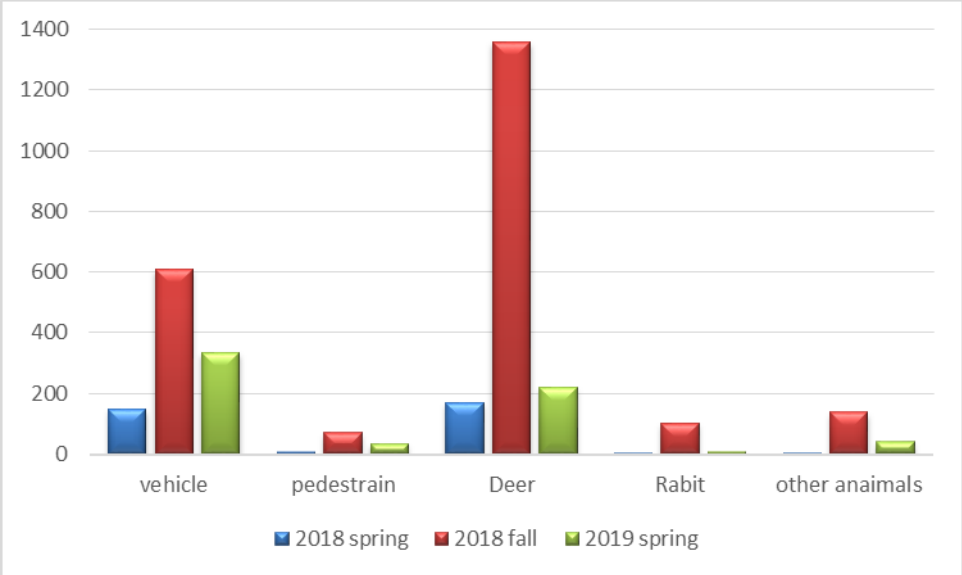

Figure 4-3 Comparison of record (group) numbers in 2018 spring, 2018 fall, and 2019 spring.

4.1.2 Crossing of different species along USA Parkway

There are total 435 groups of pictures recorded at the two crossing structures along USA Parkway, approaching frequencies of different species are shown in the pie chart of Figure 4-4. The 177 horse records (groups) counted the major part of all records. Other species included rabbits, coyotes, cows, and birds. Figure 4-5 shows the number of captured pictures related to each species and compares the approaching records in the 2018 fall (9/15/2018 - 12/31/2018, 108 days), and 2019 spring (1/01/2019 - 5/12/2019, 133 days).

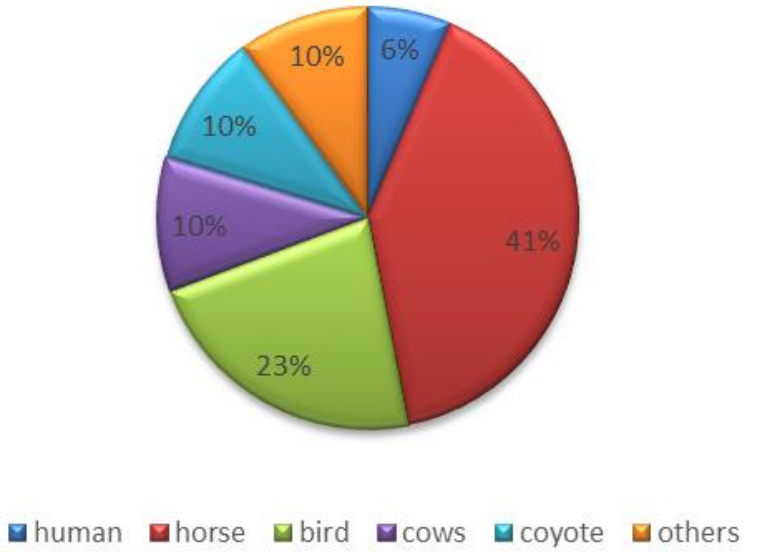

Figure 4-4 Observed frequencies of different species at the structures in USA Parkway

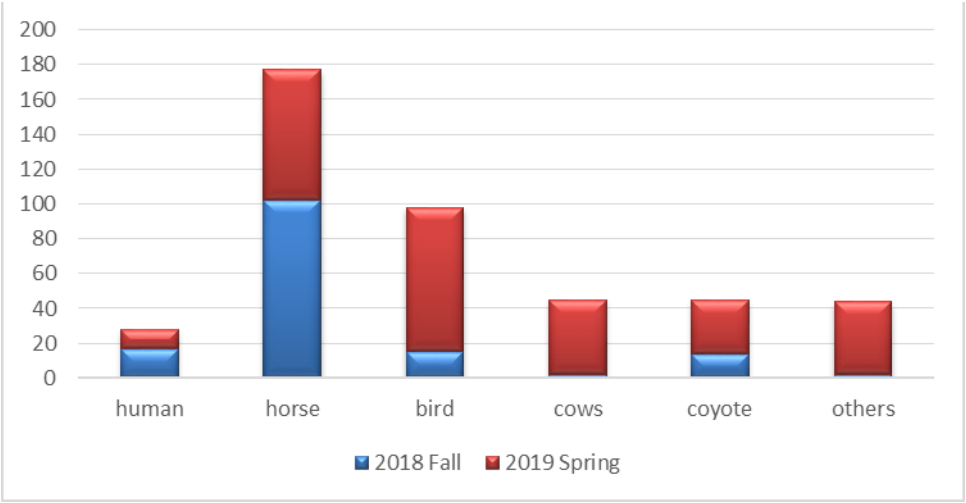

Figure 4-5 Records of different species at the crossing structures in USA Parkway

4.1.3 Deer crossing

Deer are the major large-body wildlife threatening highway traffic in I-80 area. The deer-approaching records are greater in number than records of other wildlife. A total of 816 southbound deer groups with 2,753 deer and a total of 876 northbound deer groups with 2,927 deer were recorded. The number of deer approaching, crossing, and retracting are listed in Table 4-1. Figure 4-6 presents the frequency distribution of deer groups and total deer approaching the structures. The number of deer using these crossing structures daily is shown in Figure 4-7.

Table 4-1 Summary of Deer Activities at the Pequop Mountain Area

	Deer Groups	Deer Approaching	Deer Crossing	Deer Retracting
Southbound	816	2,753	1,901	852
Northbound	876	2,927	1,742	1,185
Unknown	59	171	Unknown	Unknown

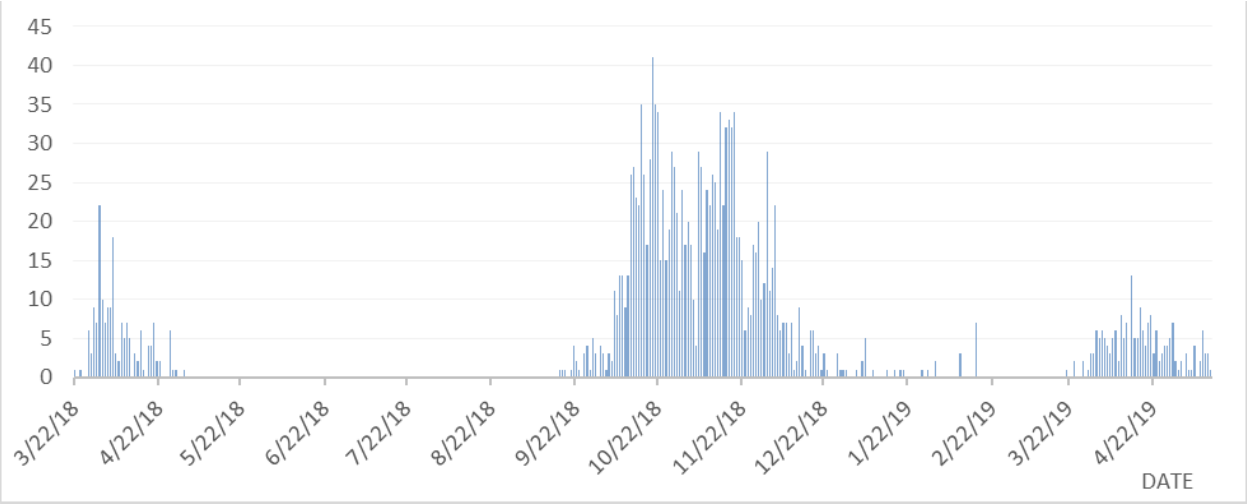

Figure 4-6 Daily frequency of deer groups at six crossing structures along I-80

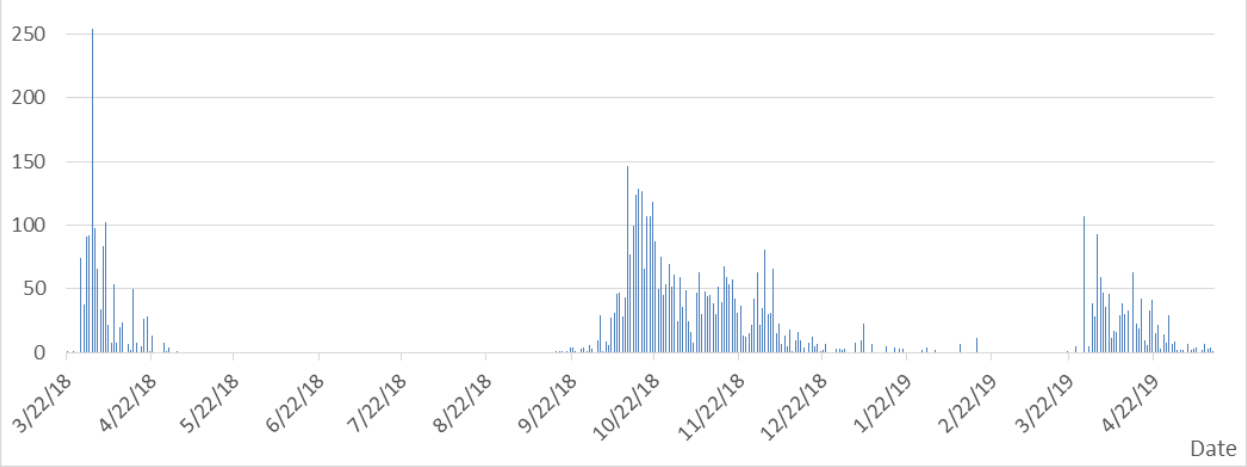

Figure 4-7 Total deer approaching at six crossing structures along I-80

Deer in the two mountain ranges migrate from north of I80 to south in the autumn migratory period and move from south to north during the spring migratory period. Figure 4-8 and Figure 4-9 show the distribution of deer groups and deer approaching in different directions. At the beginning of 2018 fall (9/26 - 10/25), deer groups were observed moving from north/east. The peak of southbound crossings occurred in 2018 October. In the second half of 2018 fall, the northbound and southbound movement was mixed, but the total number of southbound deer was higher than the number of northbound deer. At the end of the 2018 fall period, the number of northbound deer was greater in occurrence than southbound deer. At the beginning of 2019 spring, the number of northbound deer was similar to the number of

southbound deer. However, the major crossing activities were northbound during this migratory period, which is also consistent with the known migratory trend in spring. During the migratory periods, some deer approached the crossing structures but did not cross I80. Comparison of approaching deer and retractions are presented in Figure 4-10. The majority of retractions occurred at begin of 2018 fall migratory period and the beginning of the 2018 spring period.

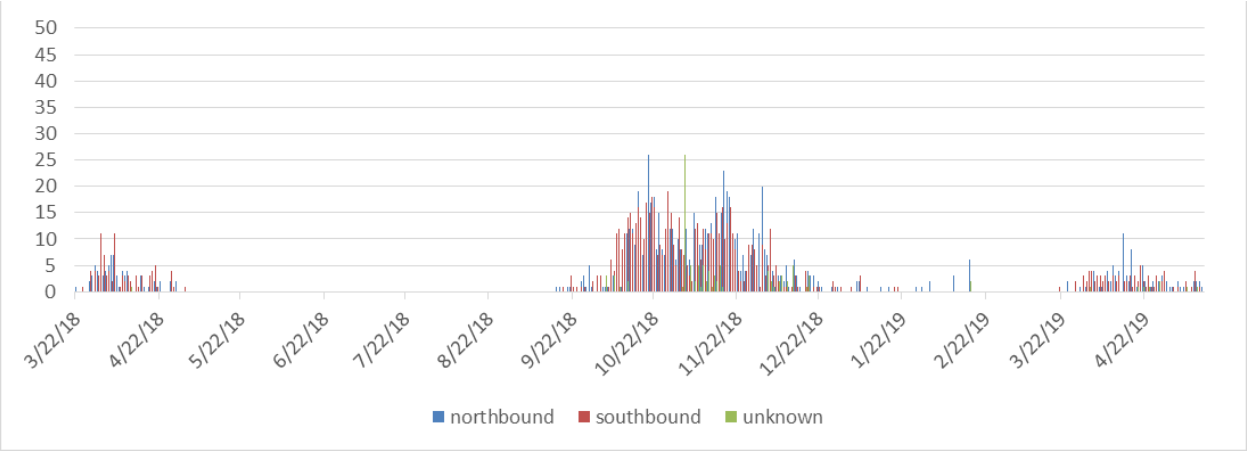

Figure 4-8 Deer groups recorded daily

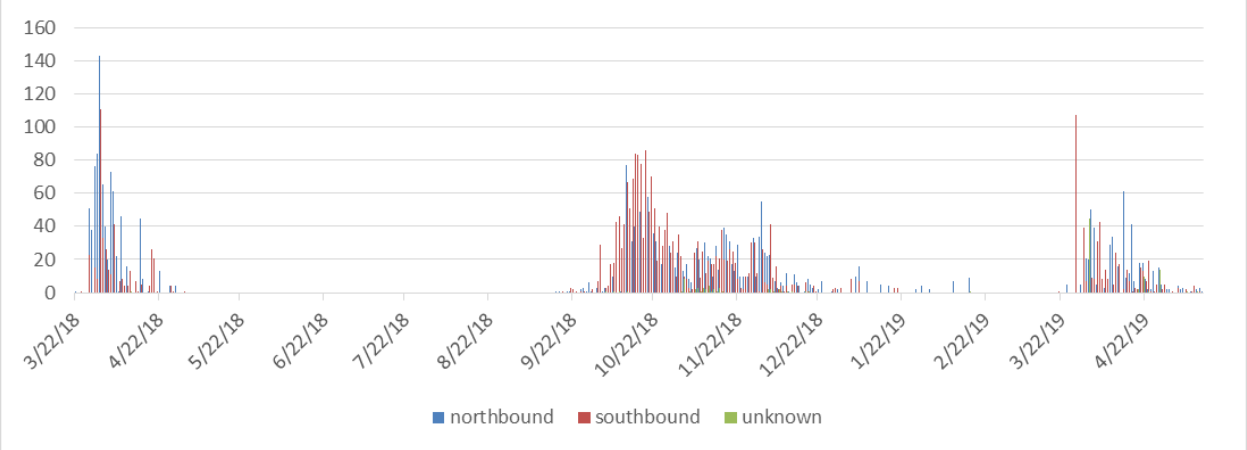

Figure 4-9 Number of deer recorded daily

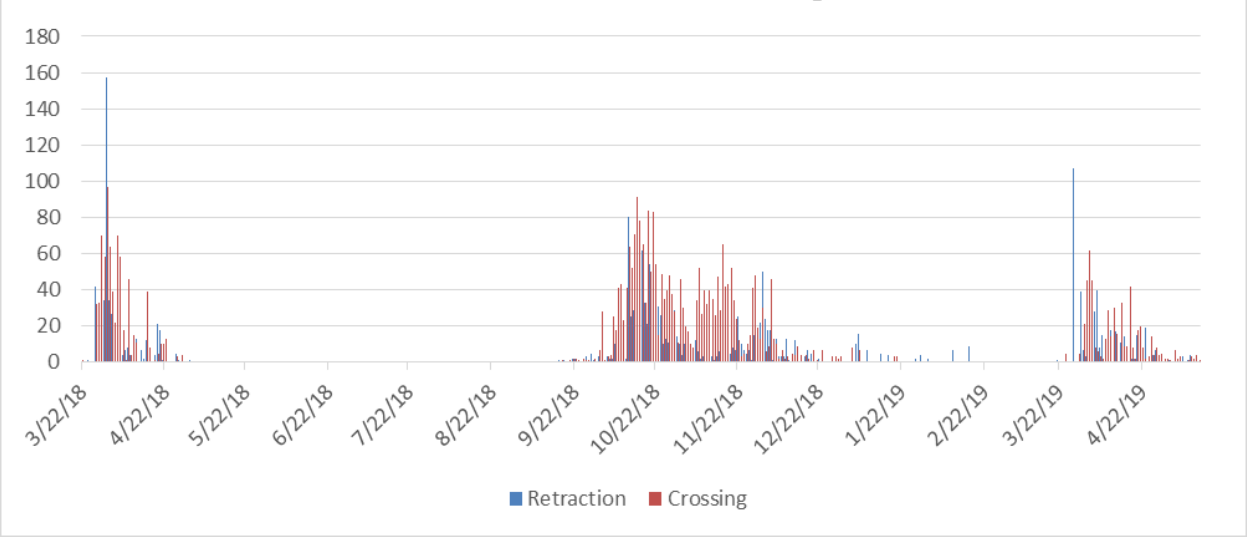

Figure 4-10 Daily frequency of deer crossing and deer retracting

Figure 4-11 presents the monthly frequency distribution of deer approaching the structures. October is the peak month of southbound deer, while April is the peak month of northbound deer. Time of deer crossing was extracted from the pictures. Figure 4-12 summarizes the observed deer in each hour, for both southbound and northbound. The peak time of deer approaching was 6:00 - 8:00 am. Noon had the least deer crossing occurrences.

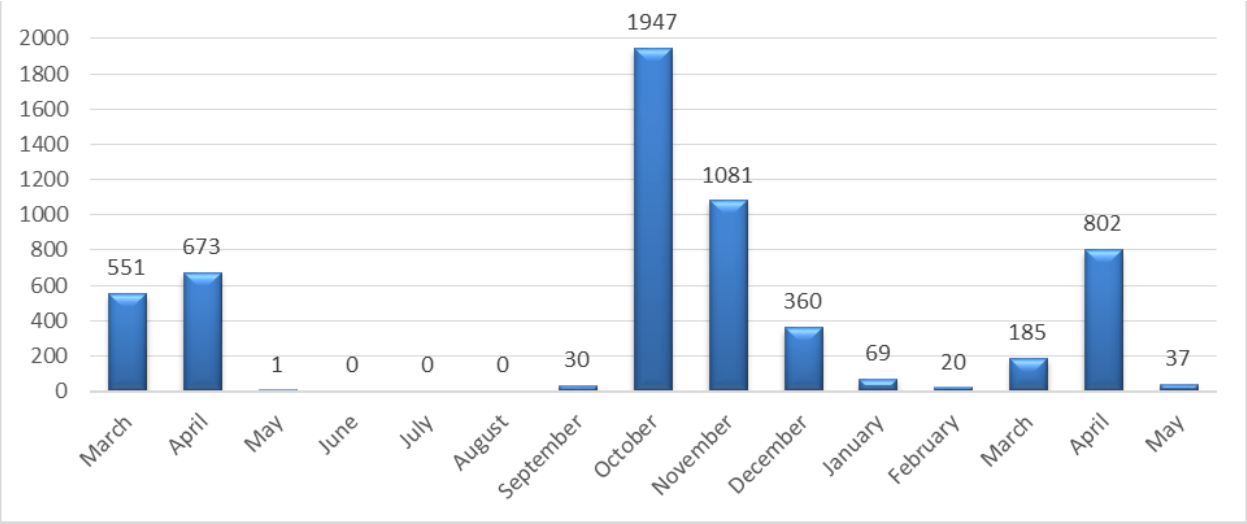

Figure 4-11 Monthly frequency of deer approaching

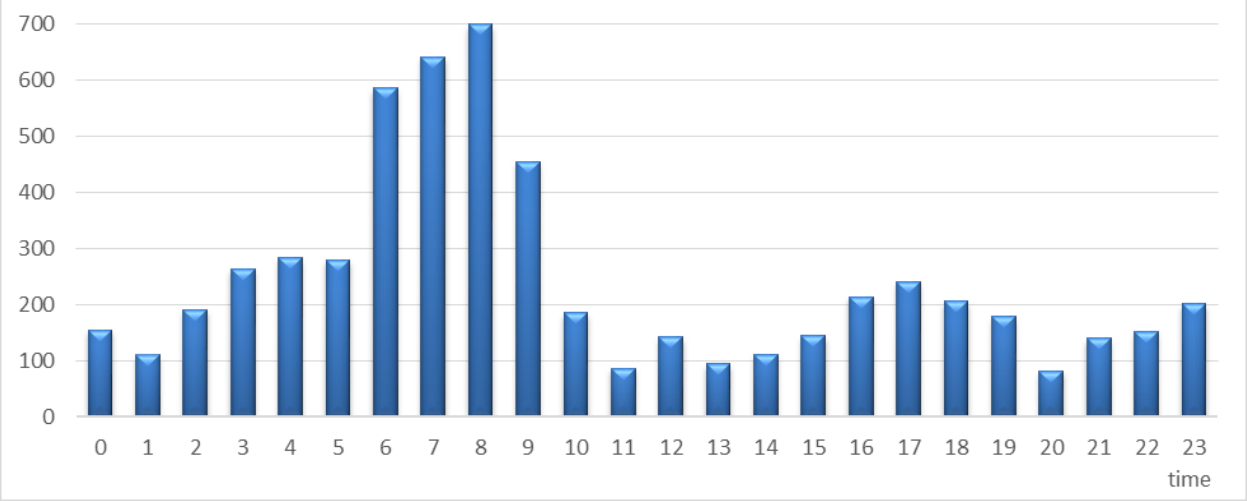

Figure 4-12 Deer approaches by hour

Adult and young deer

Distribution of adult and young deer is in Figure 4-13. There are more adult deer than the young deer using the structures.

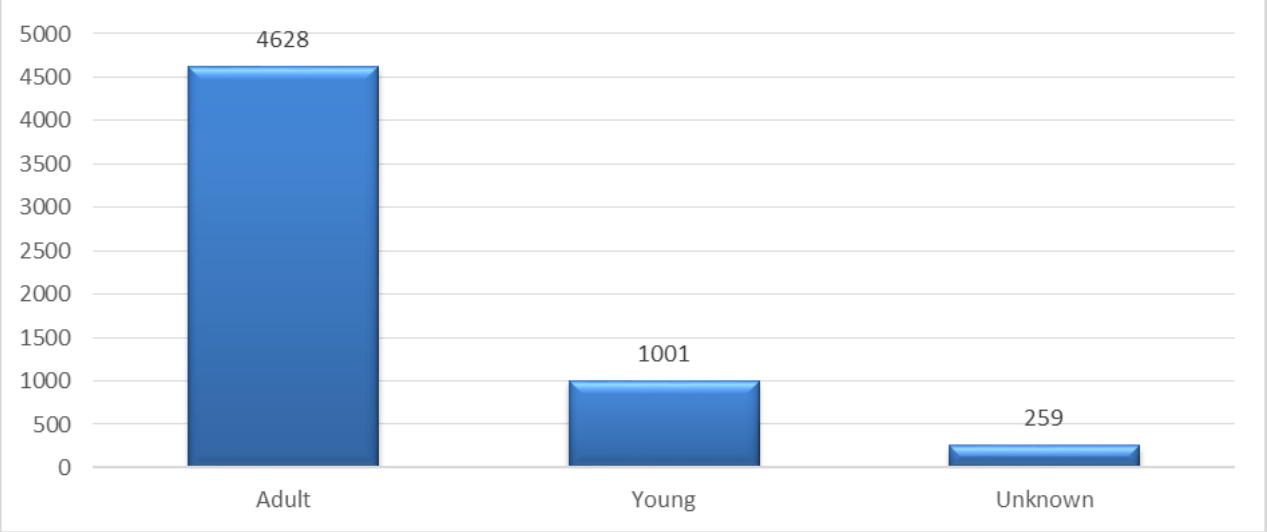

Figure 4-13 Distribution of deer approaching along with age group

Male and female deer

Distribution of male and female deer is in Figure 4-14. There are more female than the male deer using the crossing structures.

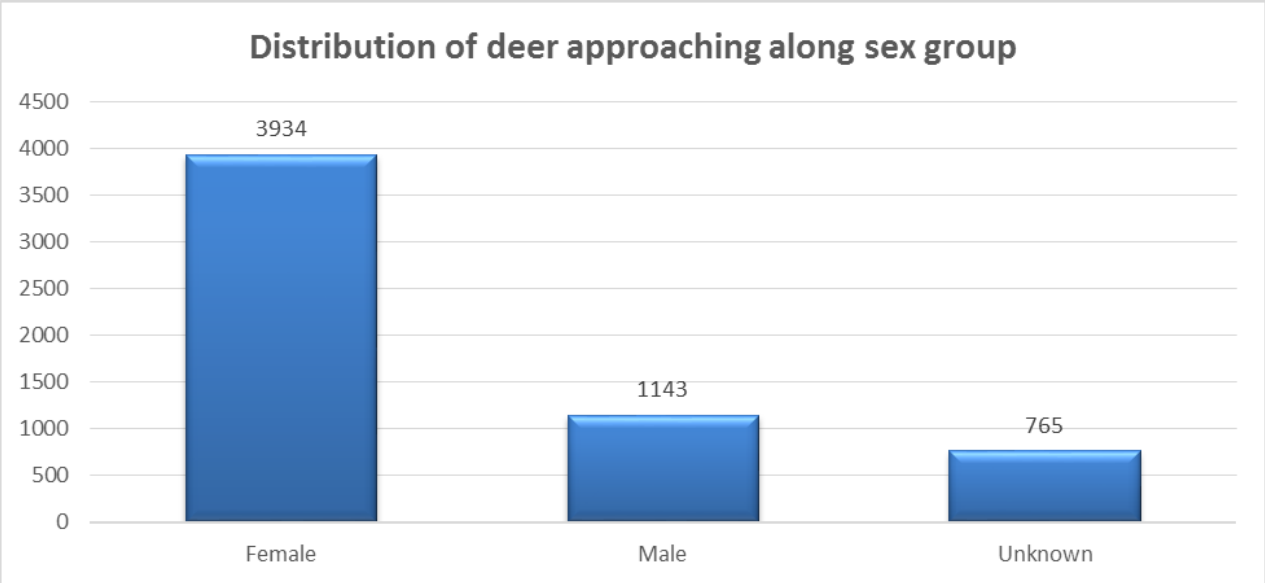

Figure 4-14 Distribution of deer approaching along with sex group

Deer at different temperatures

The environmental temperature was also recorded by the wildlife cameras and was extracted by the picture review. Numbers of deer crossing at different temperatures were plotted in Figure 4-16. Frequency distribution of deer along temperature is shown in Figure 4-15. Most deer crossed the structures in the temperature range of 13°F to 59°F. It does not necessarily mean deer crossings were influenced by temperature. The temperature range may be only determined by the migration seasons.

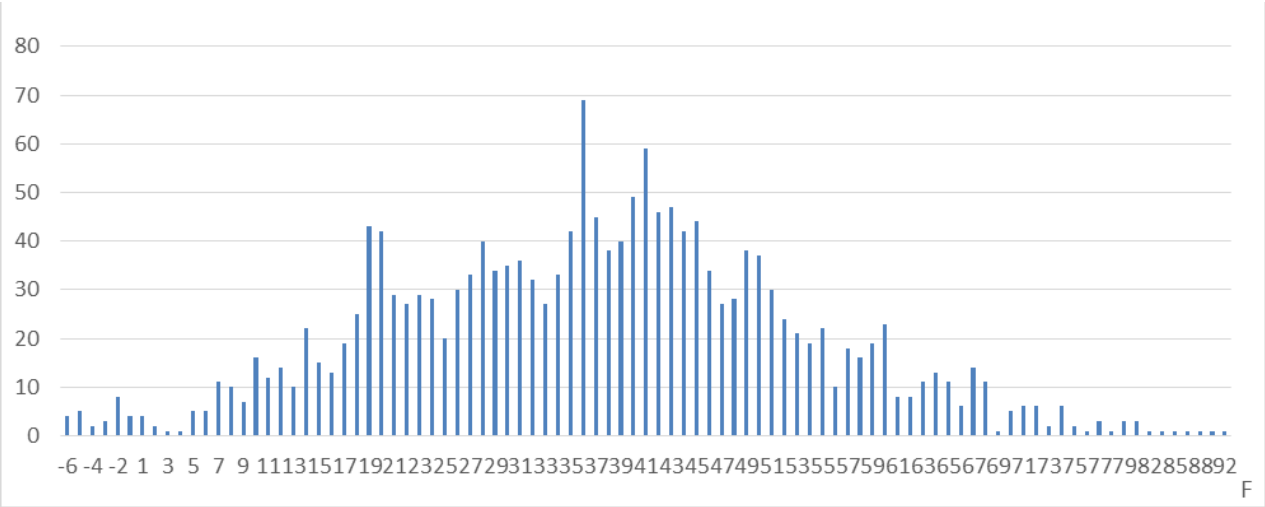

Figure 4-15 Frequency distribution of deer along with temperature

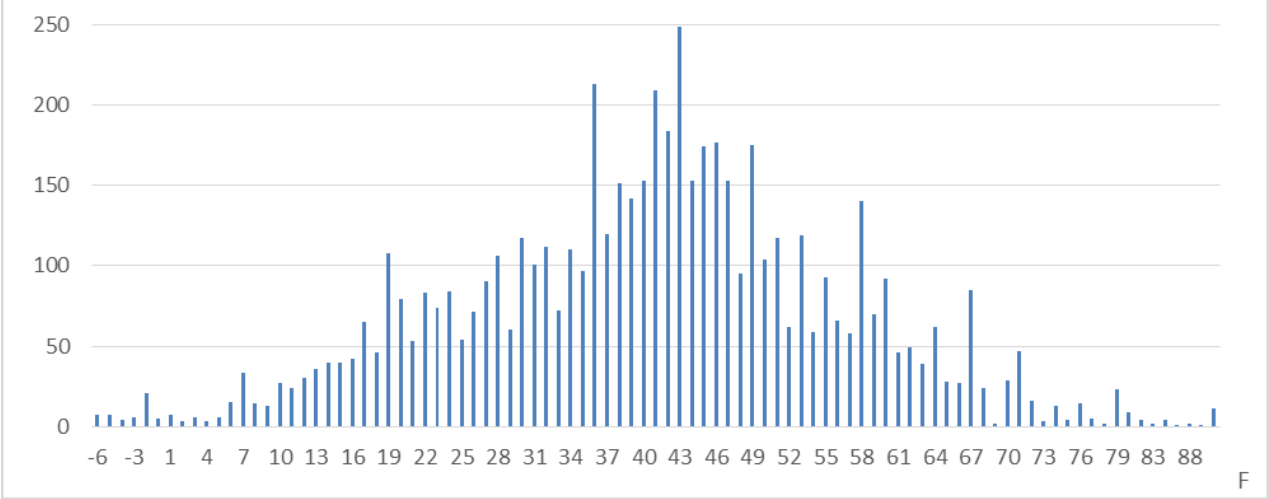

Figure 4-16 Numbers of deer crossing at different temperatures

Deer at the different structures

Frequency distribution of deer and deer groups along the different structures are shown in Figure 4-17. Figure 4-18 compares the total number of deer movement at the different structures. The structures were listed from the most-east wildlife underpass to the most-west underpass. Most deer crossed I80 at the West Wildlife Underpass and East Wildlife Overpass.

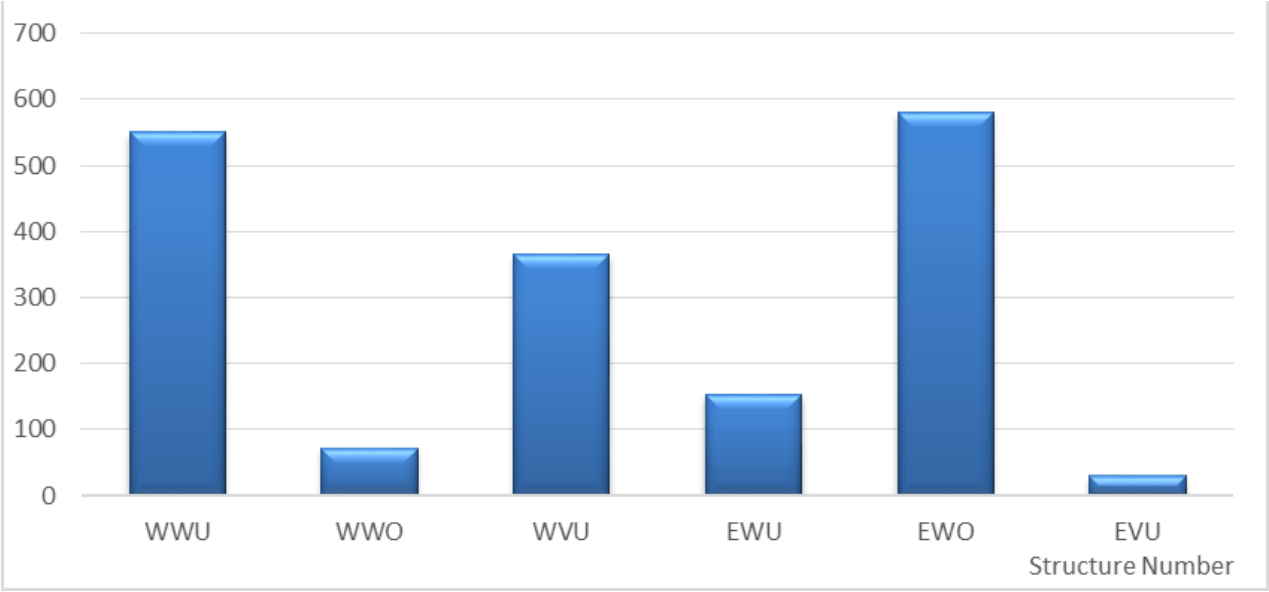

Figure 4-17 Deer groups approaching frequency at different structures

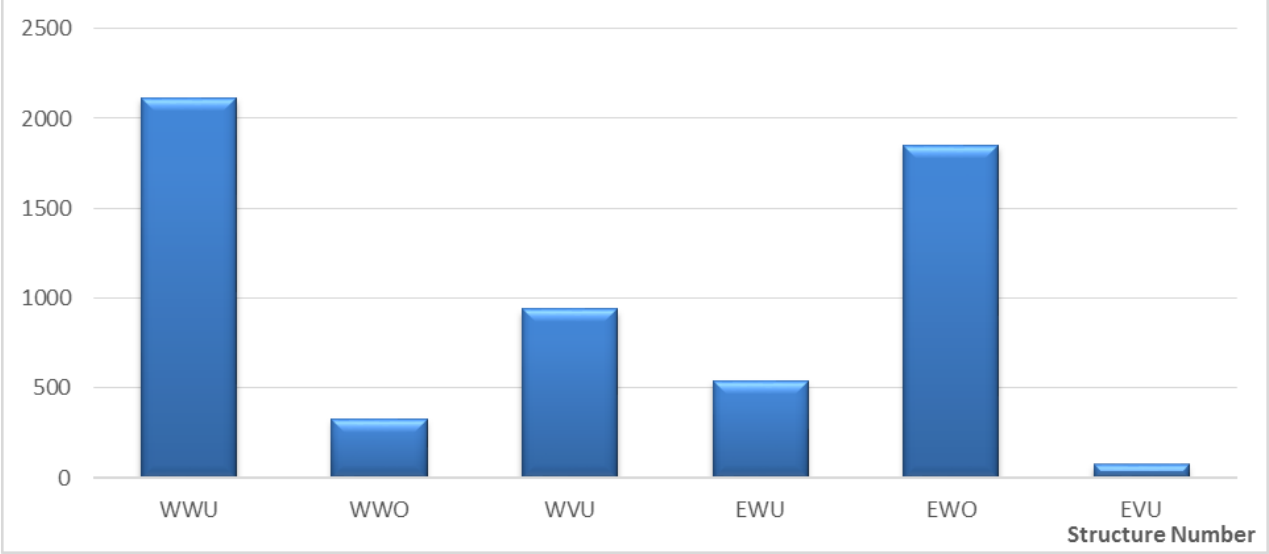

Figure 4-18 Total number of deer approaching the different structures

4.1.4 Wild horses crossing

Wild horses are the major-body wildlife using the crossing structures in the USA Parkway area. The wild horse-approaching records are greater in number than records of other wildlife. A total of 42 southbound wild horses groups with 367 horses and a total of 43 northbound deer groups with 378 horses were recorded. The numbers of horses approaching, crossing, and retracting are listed in Table 4-2. Figure 4-19 presents the frequency distribution of wild horses groups and total wild horses approaching the structures. The number of horses in each record (group) is different, ranging from 1 to 16, as shown in Figure 4-21. Figure 4-22 compared the crossing and retracting horses which indicates that most of the horses crossed the structures rather than retracted.

Table 4-2 Summary of Wild horses Activities at the USA Parkway Area

	Horse Groups	Horse Approaching	Horse Crossing	Horse Retracting
Southbound	73	509	493	16
Northbound	93	566	511	55
Unknown	10	31	Unknown	Unknown

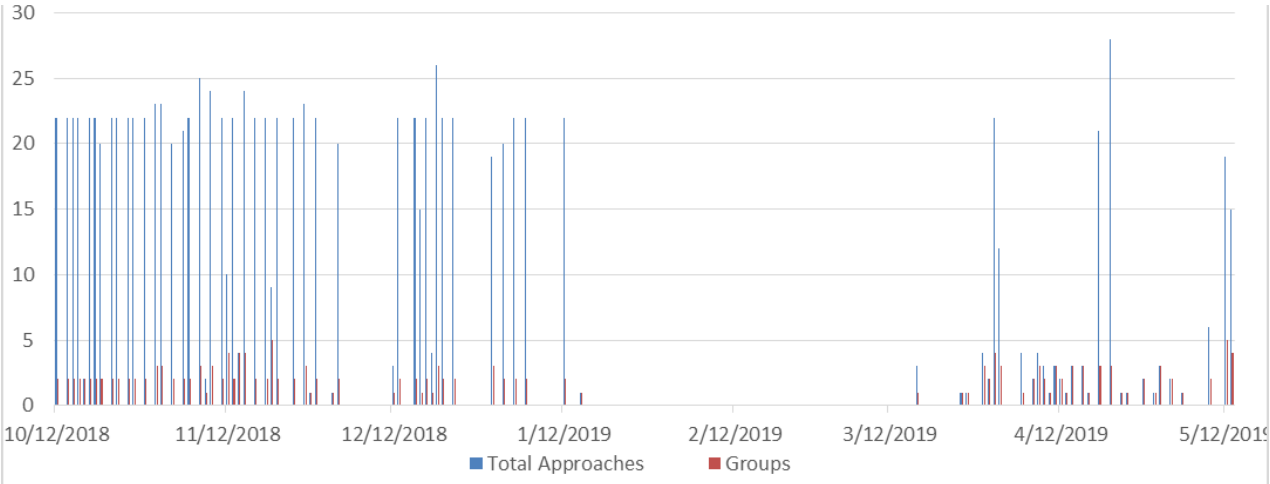

Figure 4-19 Wild horses approaches and daily groups

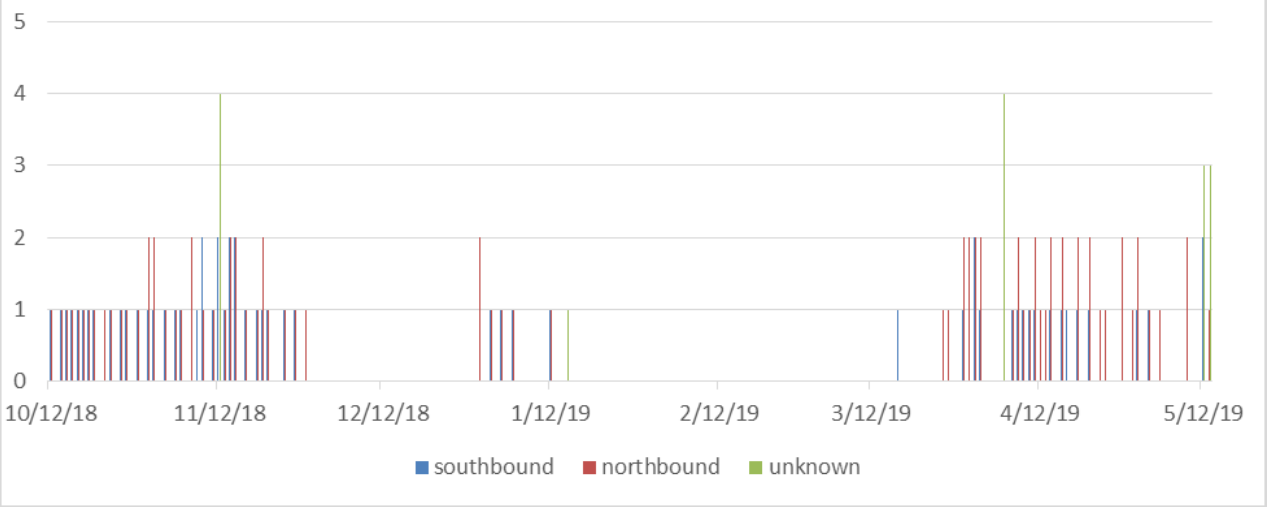

Figure 4-20 Wild horses groups record daily

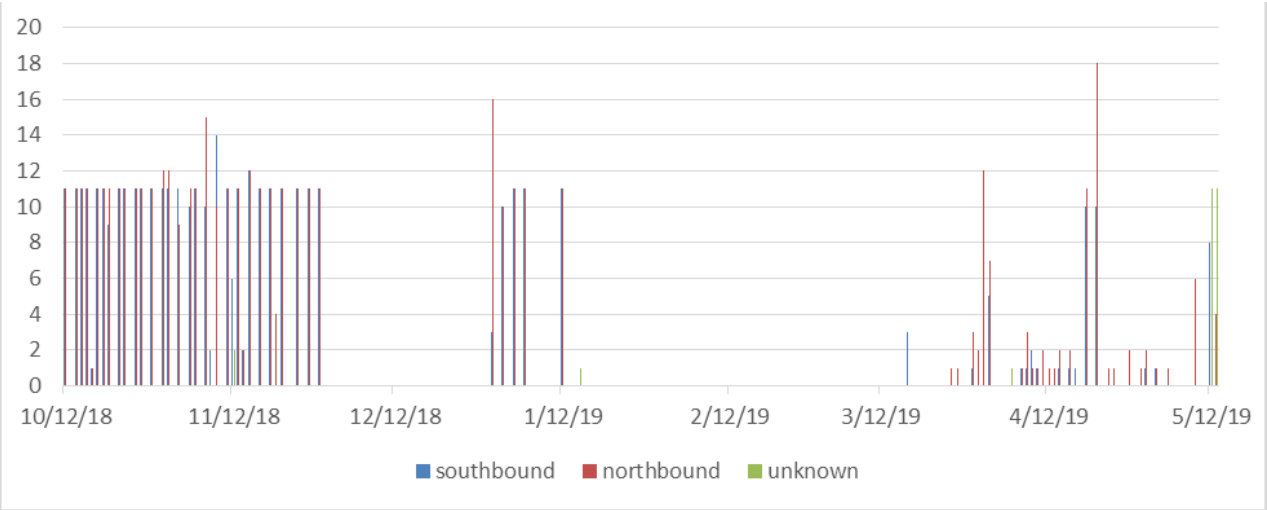

Figure 4-21 Number of wild horses record daily

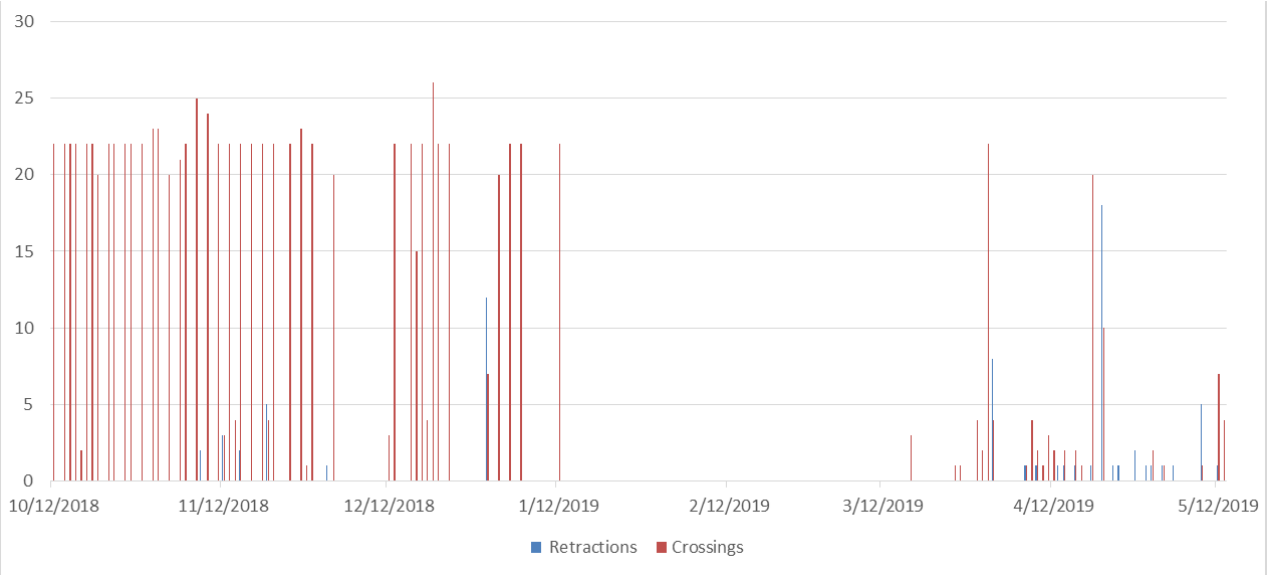

Figure 4-22Wild horses retraction VS crossing

Figure 4-11 presents the monthly frequency distribution of wild horses approaching the structures. November is the peak month of wild horses. Figure 4-24 shows the frequency distribution along hour, in the picture, there were more horses recorded from 9 am to 1 pm.

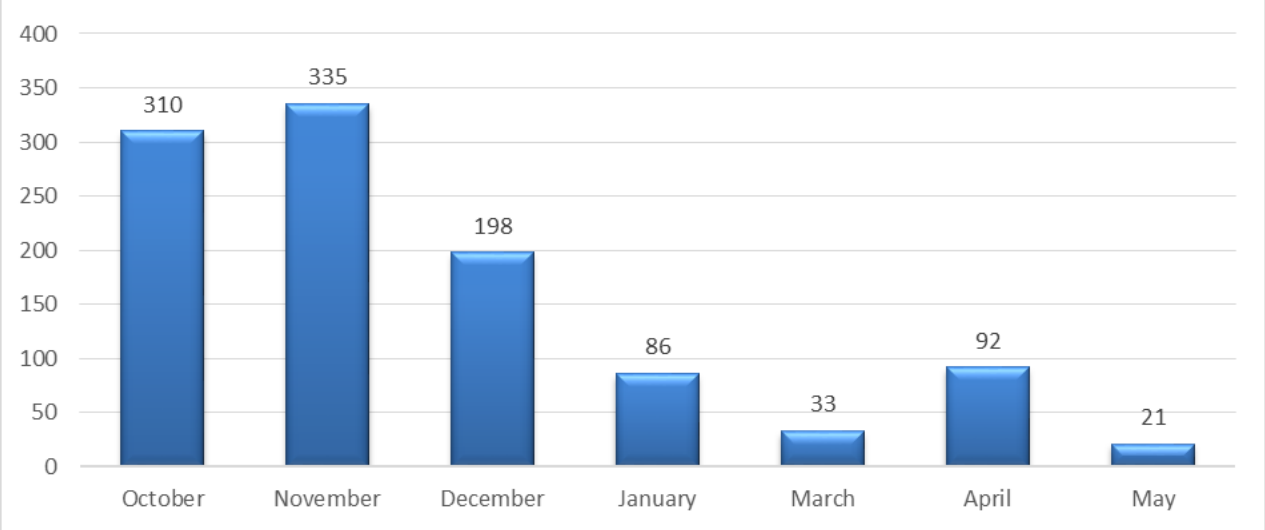

Figure 4-23Monthly frequency of wild horses approaching

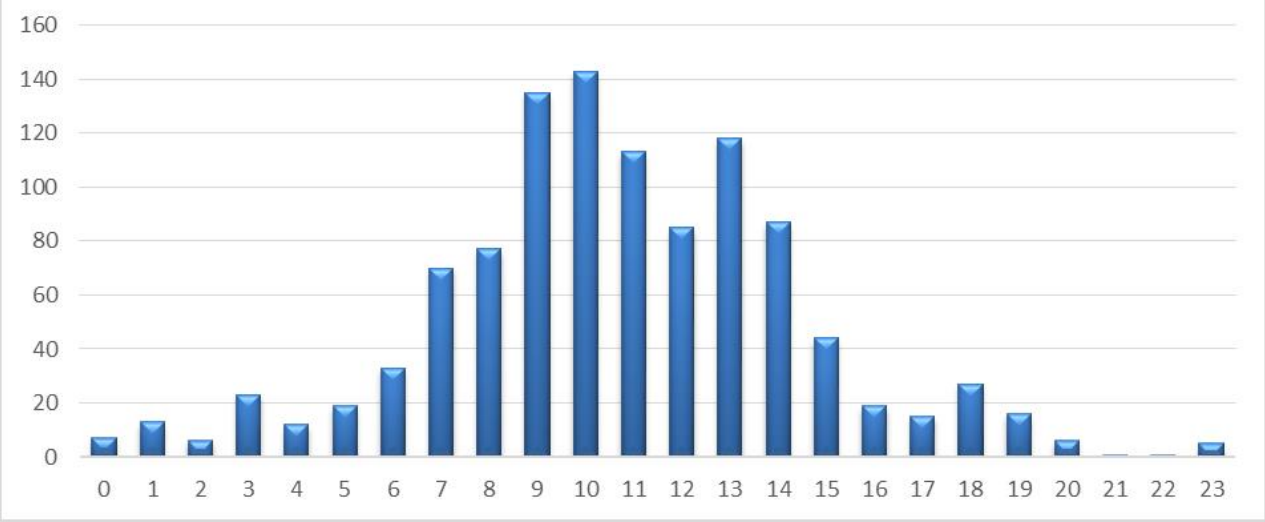

Figure 4-24 Wild horses approaching by hour

Adult and young wild horses

Distribution of adult and young deer is in Figure 4-25. There were more adult wild horses than young horses.

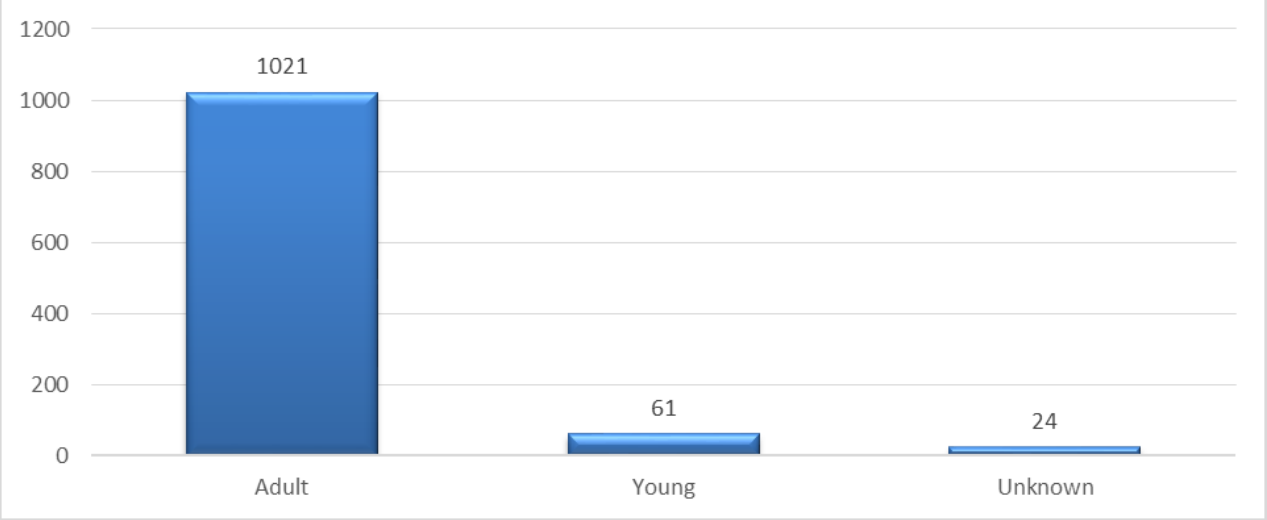

Figure 4-25 Distribution of wild horses approaching along with age group

Male and female wild horse

Distribution of male and female wild horses is in Figure 4-26. Most of their gender could not be identified.

Figure 4-26 Distribution of wild horses approaching along with sex group

Wild horses at different temperatures

The environmental temperature was also recorded by the wildlife cameras was extracted by the picture review. Numbers of wild horses crossing at different temperatures were plotted in Figure 4-28. Frequency distribution of deer along temperature is shown in Figure 4-27. Most wild horses crossed the structures in the temperature range of 35°F to 49°F. It does not necessarily mean wild horses crossings were influenced by temperature. The temperature range may be only determined by the migration seasons.

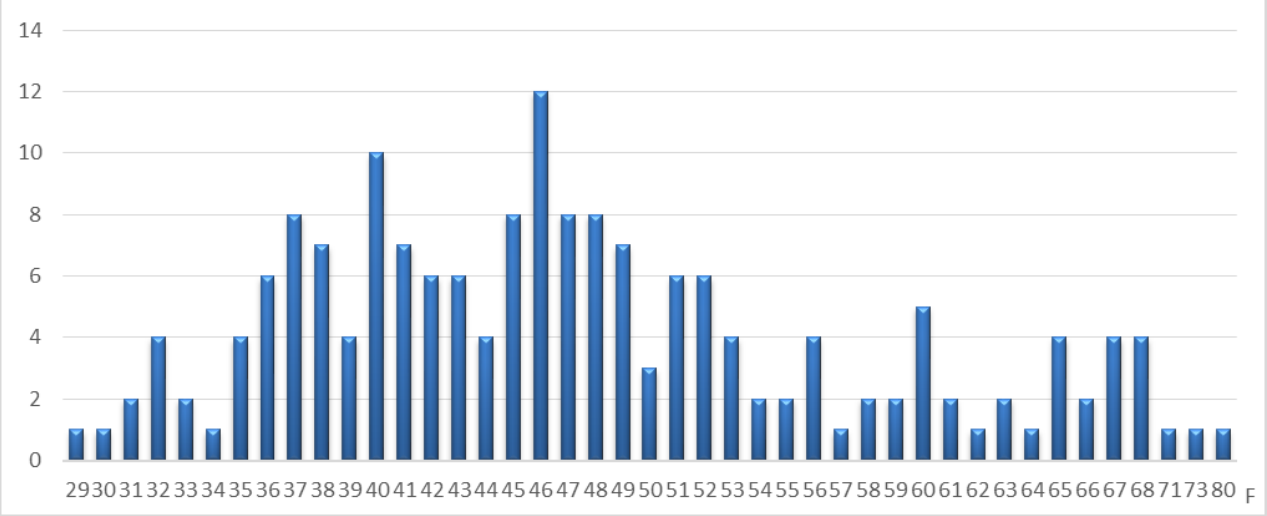

Figure 4-27 Wild horses approach frequency by temperature

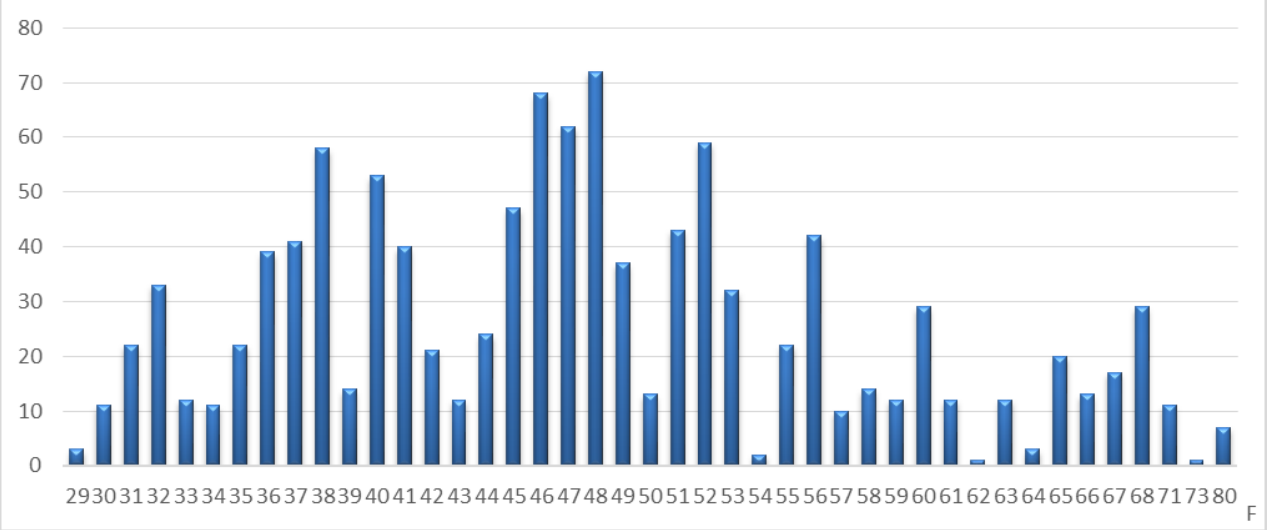

Figure 4-28 Total approach by temperature

Wild horses at the different structures

Frequency distribution of horse and horse groups along the different structures are shown in Figure 4-29 and Figure 4-30. Both the total number of horse and groups of wild horses were higher at the south wildlife underpass.

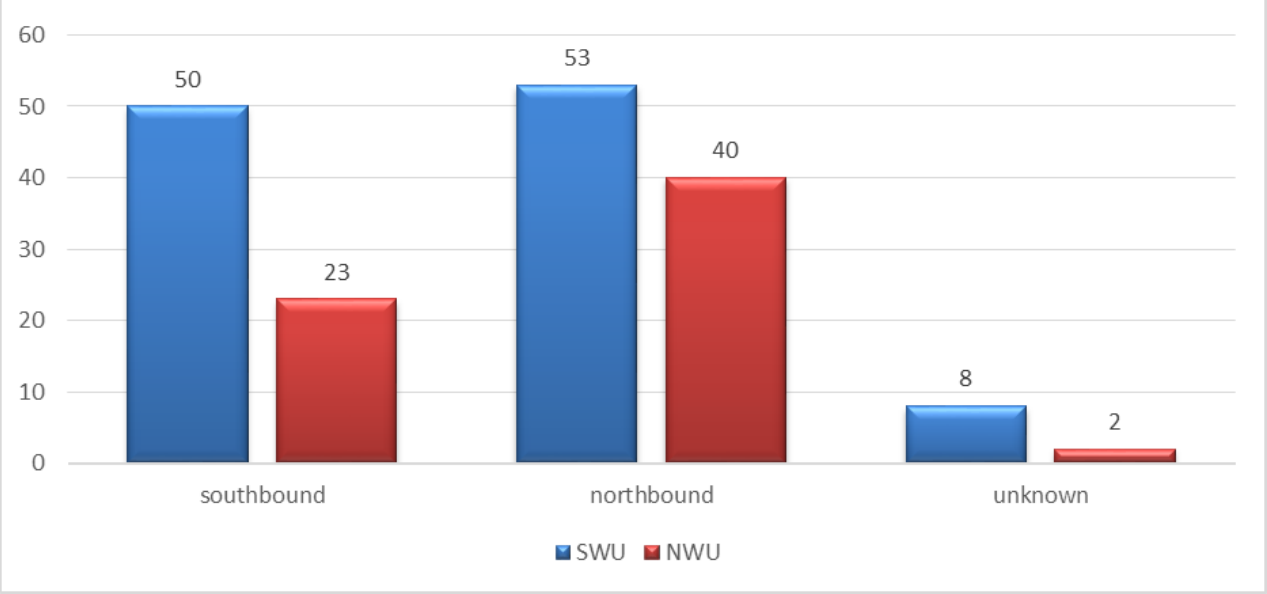

Figure 4-29Wild horses approaching frequency in different directions

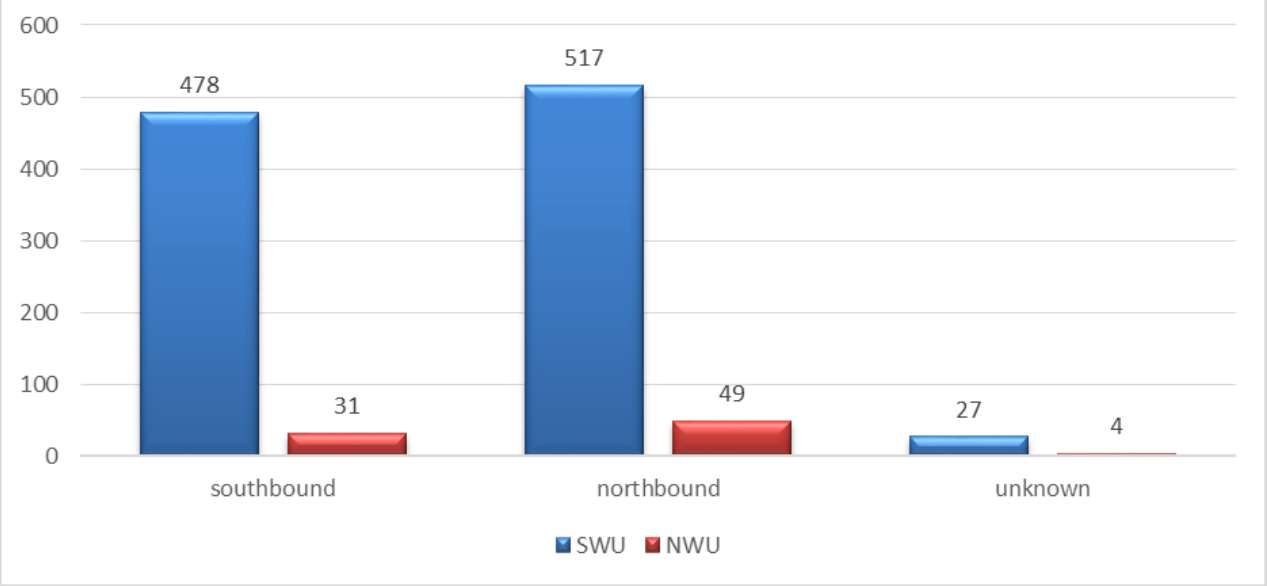

Figure 4-30 Total number of wild horses at different structures

4.2 Wildlife crossing at the West Wildlife Underpass in the Pequop Mountain

A total of 574 group picture collected from 3/24/2018 to 05/12/2019 including **550** deer groups, 15 human groups, 6 coyote group, 1 rabbit group and 1 group with unknown mammals. A total of 173 southbound deer groups with 637 individuals and 349 northbound deer groups with 1413 individuals were observed at the west wildlife underpass in the Pequop Mountains, and there are also 28 groups of deer left without identified direction. The numbers of deer approaching, crossing, and retracting are in Table 4-3. The total number of southbound and northbound deer approaching this wildlife underpass is shown in Figure 4-31. Comparison of deer approaching and retractions is in Figure 4-32. Deer approached this underpass more often in 2018 fall, but most of them retracted rather than crossing through this structure. More deer crossed this structure in 2018 spring. In the late of 2018 fall, there were not many deer

approaching the structure. Deer approached this structure most often from the south in 2018 fall and from the north in 2018 spring and 2019 spring. Frequency distribution of deer approaching this structure by month is shown in Figure 4-33. Frequency distribution of deer approaching by time is in Figure 4-34. Figure 4-35 presents frequency distribution of deer approaching at different temperatures. It shows that the number of deer approached in March and April is basically the same while in 2018 fall, from October, the number of deer approached is gradually decreasing. Deer's favorite approaching time is from 6 am to 8 am and from 4 pm to 6 pm in the afternoon. The most suitable temperature is 30°F to 54 °F. There are more adult deer than young deer and more female deer than male deer approach this underpass.

Table 4-3 Summary of Deer Activities at the west wildlife underpass

	Deer Groups	Deer Approaching	Deer Crossing	Deer Retracting
Southbound	173	637	249	388
Northbound	349	1413	704	709
Unknown	28	77	Unknown	Unknown

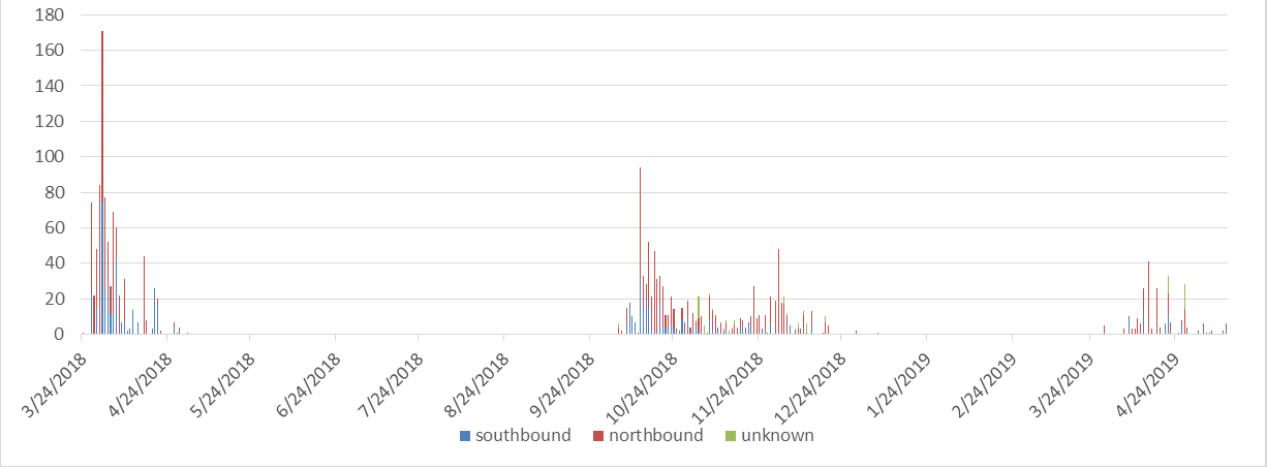

Figure 4-31 Total number of deer approaching at the west wildlife underpass by date

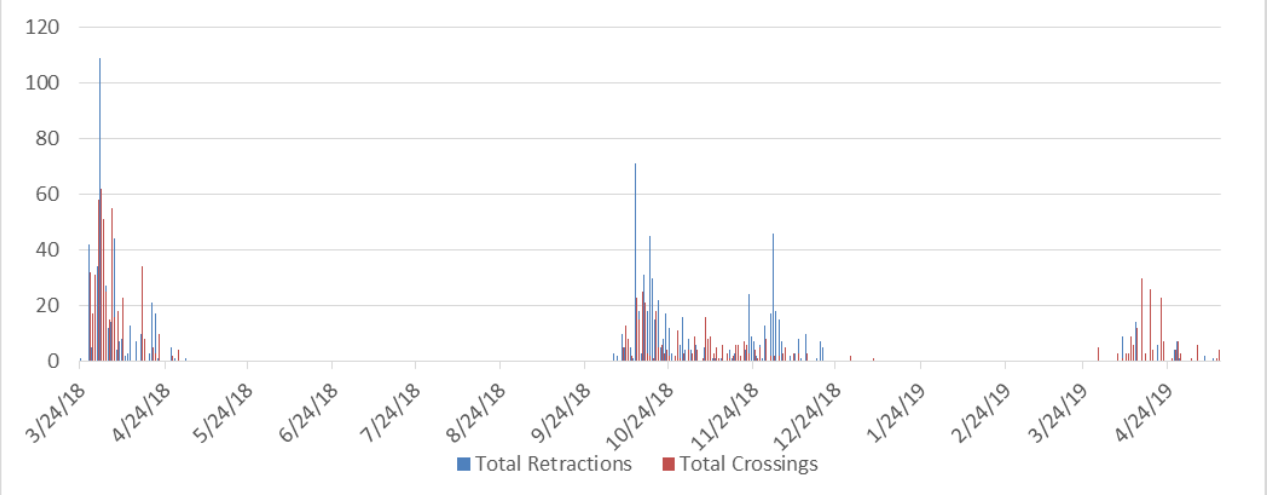

Figure 4-32 Comparison of deer crossing and deer retracting at the west wildlife underpass

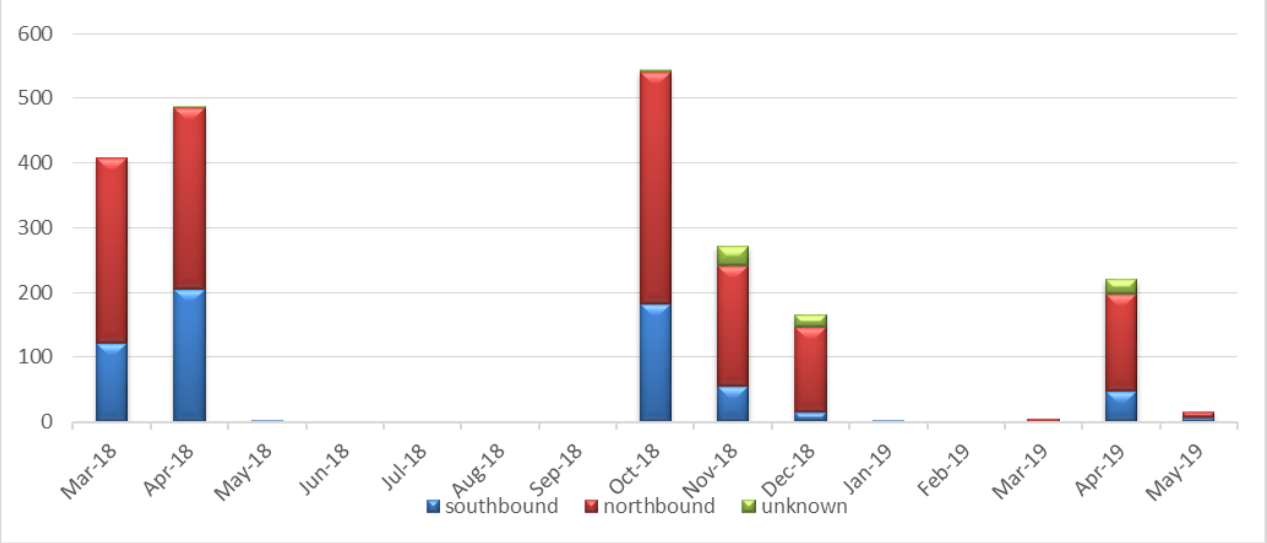

Figure 4-33 Deer approaching by month

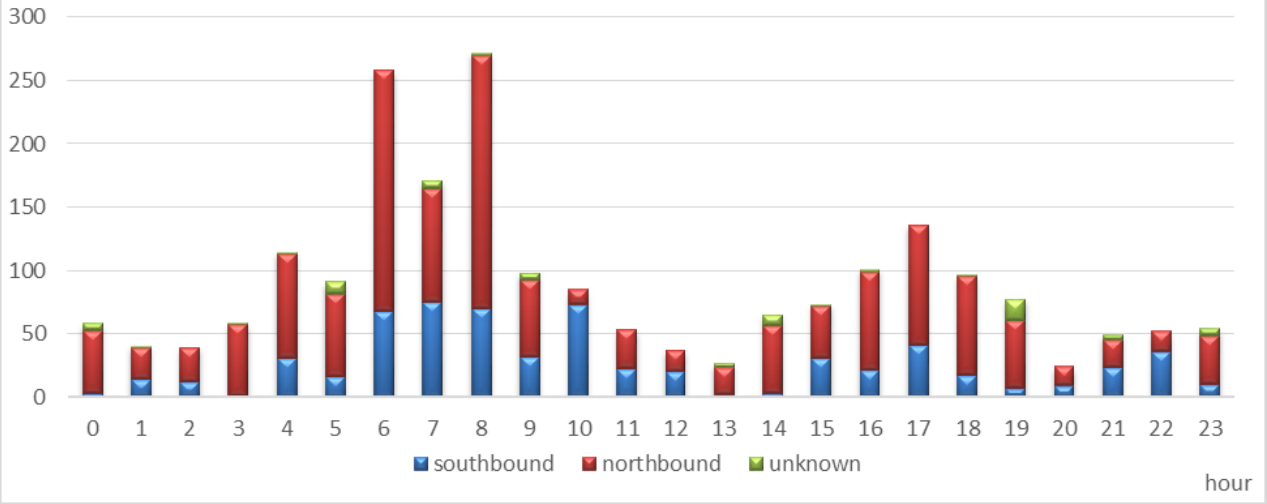

Figure 4-34 Deer approaching by time

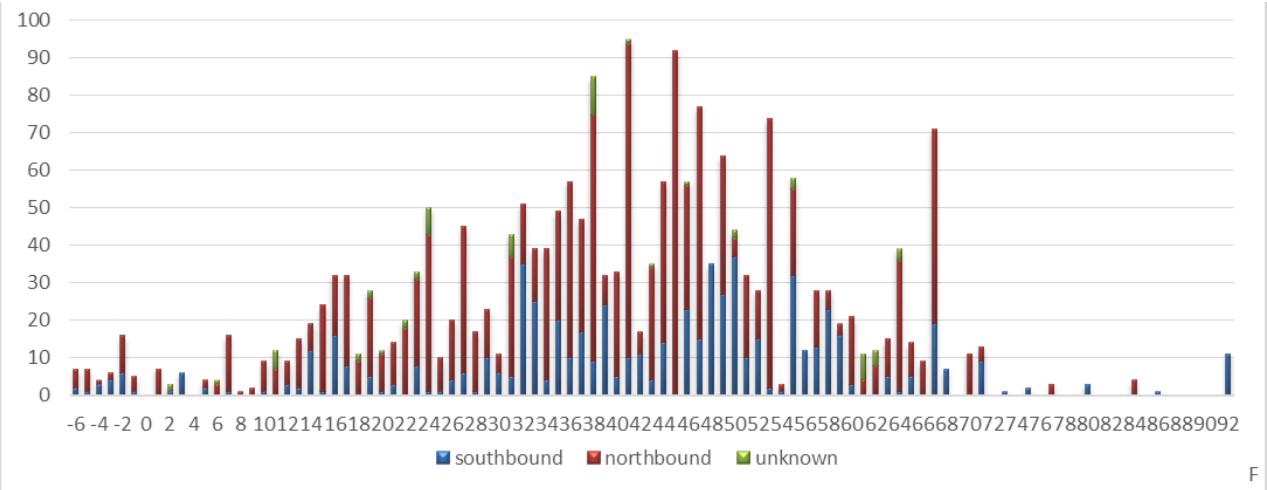

Figure 4-35 Deer approaching by temperature

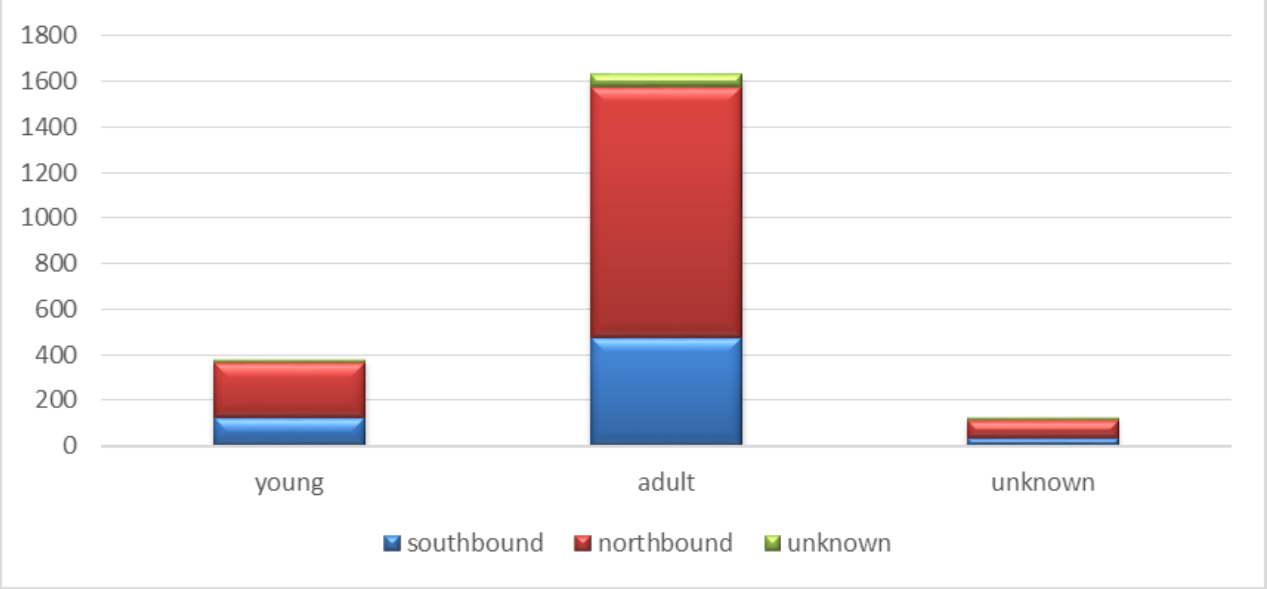

Figure 4-36 Deer approaching by age

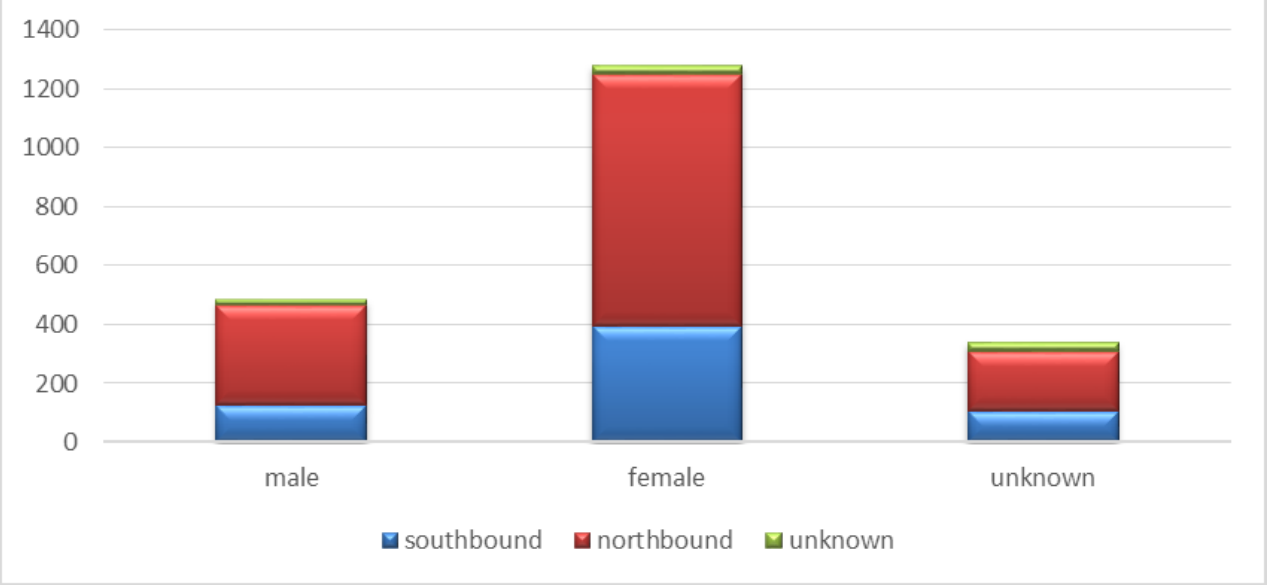

Figure 4-37 Deer approaching by gender

4.3 Wildlife crossing at the West Vehicle Underpass in the Pequop Mountain

A total of 996 group picture collected from 3/24/2018 to 01/25/2019 including **365** deer groups, 610 human and vehicle groups, 11 coyote group, 3 rabbit and squirrel groups and 2 birds groups. A total of 157 southbound deer groups with 361 individuals and 349 northbound deer groups with 557 individuals were observed at the west vehicle underpass in the Pequop Mountains; there are also 6 groups with 7 deer left without identified direction. The numbers of deer approaching, crossing, and retracting are in Table 4-4. The total number of southbound and northbound deer approaching this wildlife underpass is shown in Figure 4-38. Comparison of deer approaching and retractions is in Figure 4-39. More deer approached and crossed this structure in 2018 fall and departure to the south. And in 2018 spring and 2019 spring, most of the deer approached and crossed this structure departure to north. Total number distribution of deer approaching this structure by month is shown in Figure 4-40. Total number distribution of

deer approaching by time is in Figure 4-41. Figure 4-42presents Total number distribution of deer approaching at different temperatures. It shows that during the spring period, more deer approached this structure on April while in 2018 fall, more deer approached this structure in November. Deer's favorite approaching time is from 2 am to 4 am and from 9 pm to 11 pm at night. The most suitable temperature is 20°F to 39 °F. There are more adult deer than young deer and more female deer than male deer approach this underpass based on Figure 4-43 and Figure 4-44.

Table 4-4 Summary of Deer Activities at the West Wildlife Underpass

	Deer Groups	Deer Approaching	Deer Crossing	Deer Retracting
Southbound	157	361	325	31
Northbound	349	557	430	127
Unknown	6	7	Unknown	Unknown

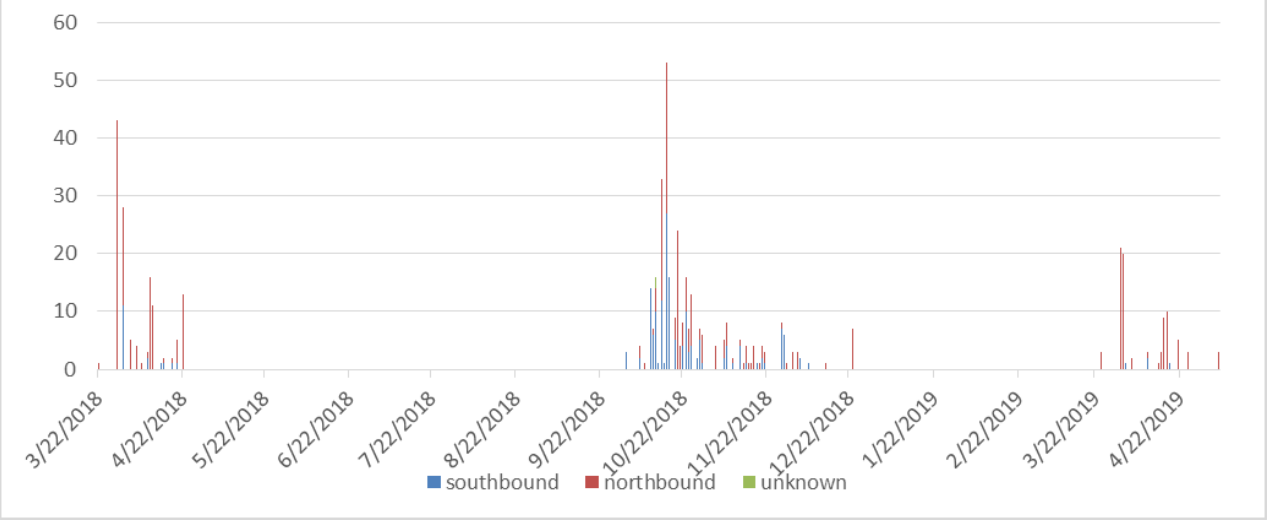

Figure 4-38 Total number of deer approaching at the west vehicle underpass by date

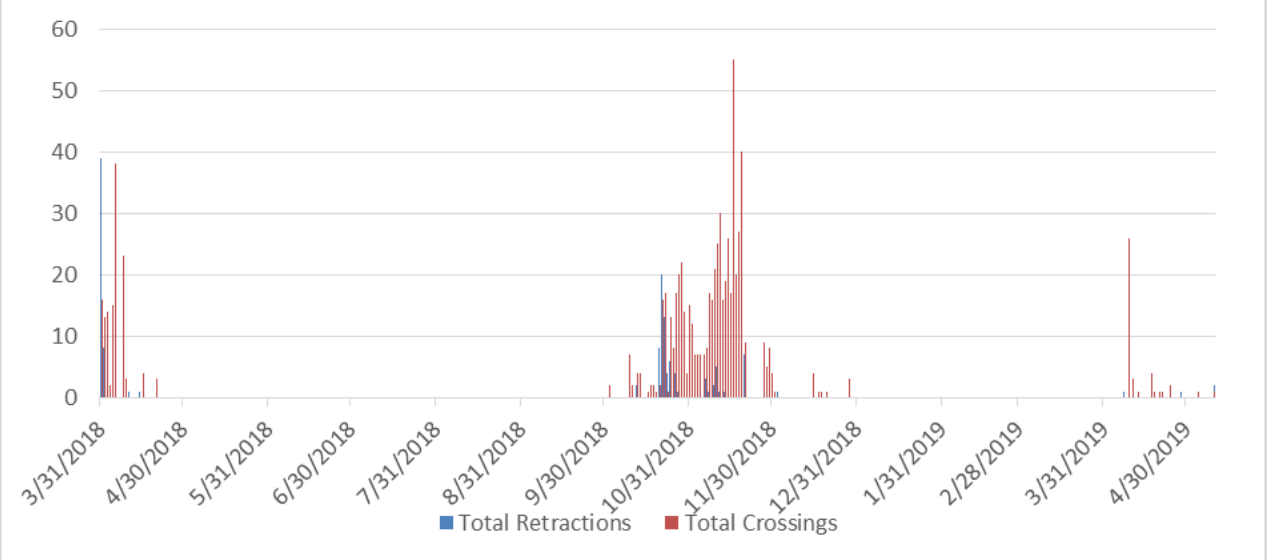

Figure 4-39 Comparison of deer crossing and deer retracting at the west vehicle underpass

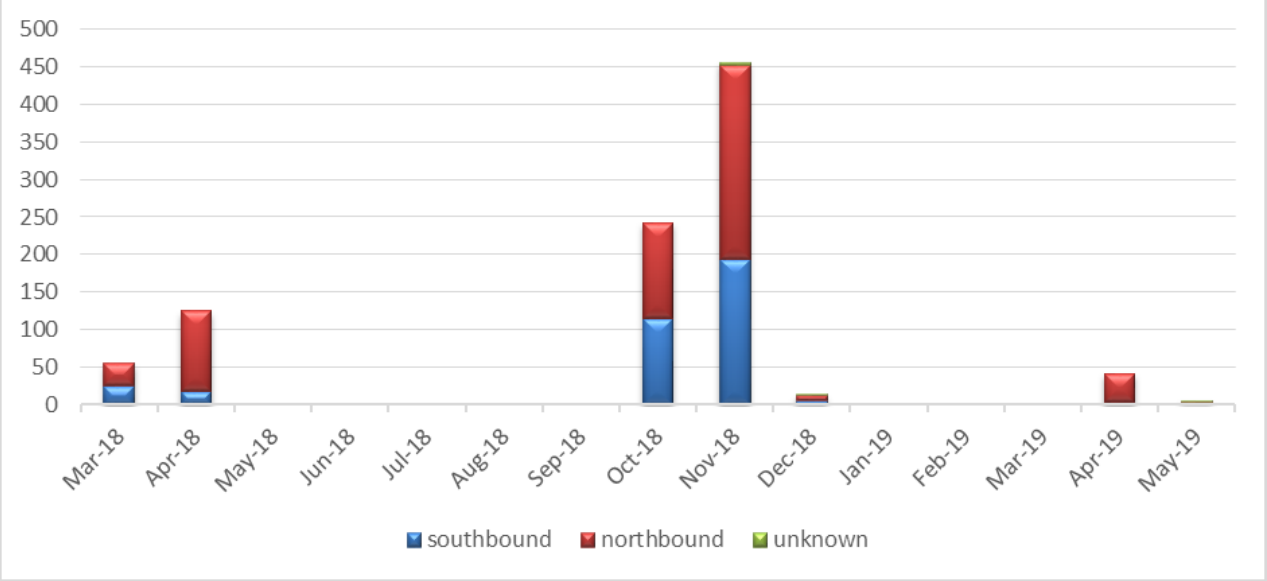

Figure 4-40 Deer approaching by month

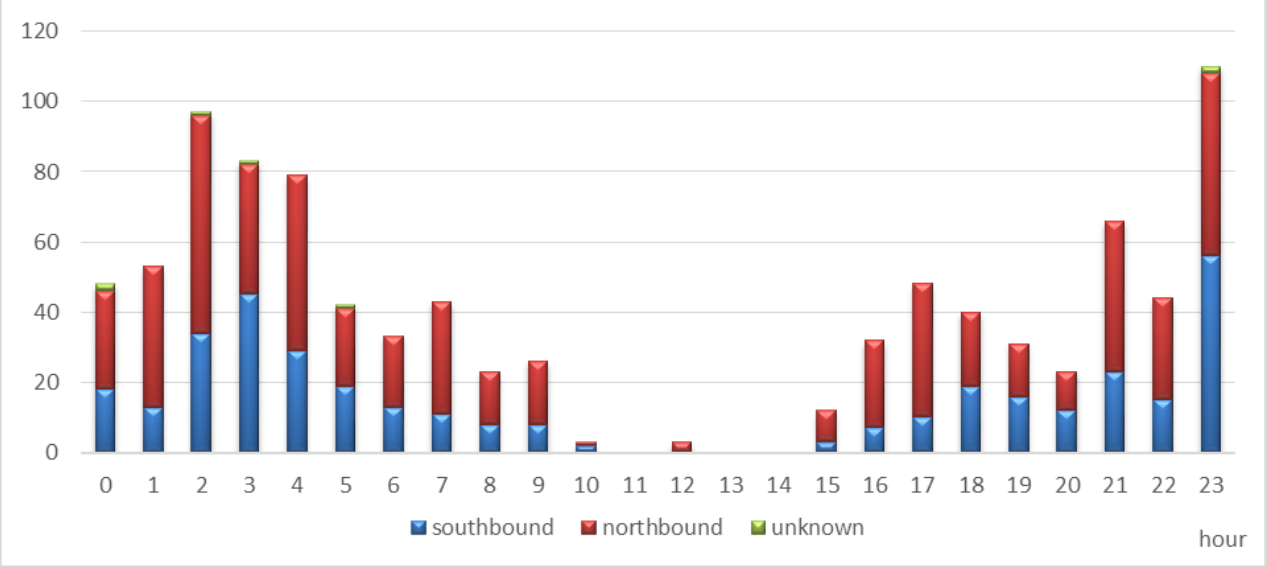

Figure 4-41 Deer approaching by time

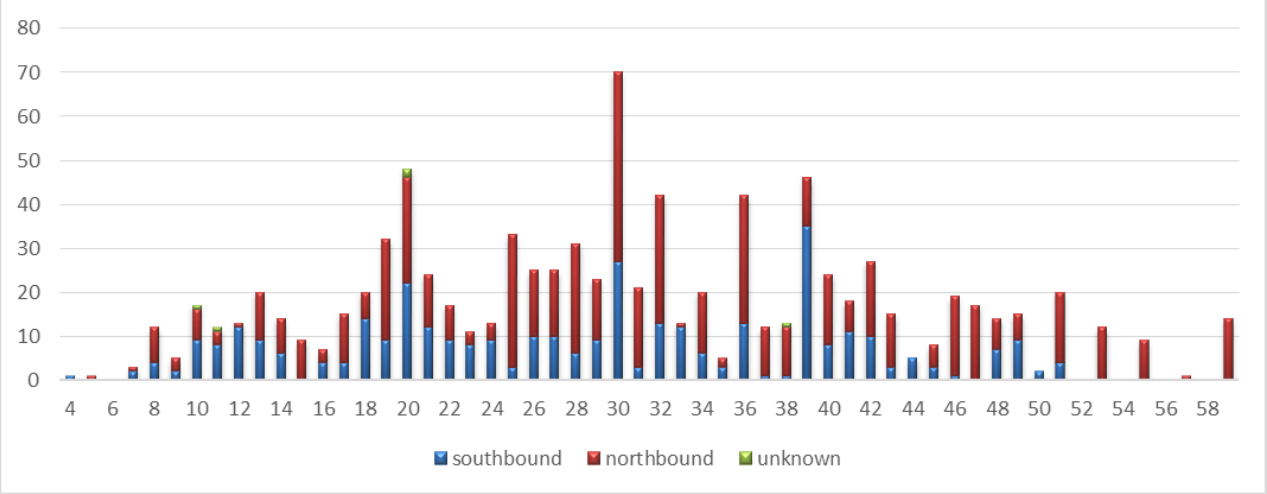

Figure 4-42 Deer approaching by temperature

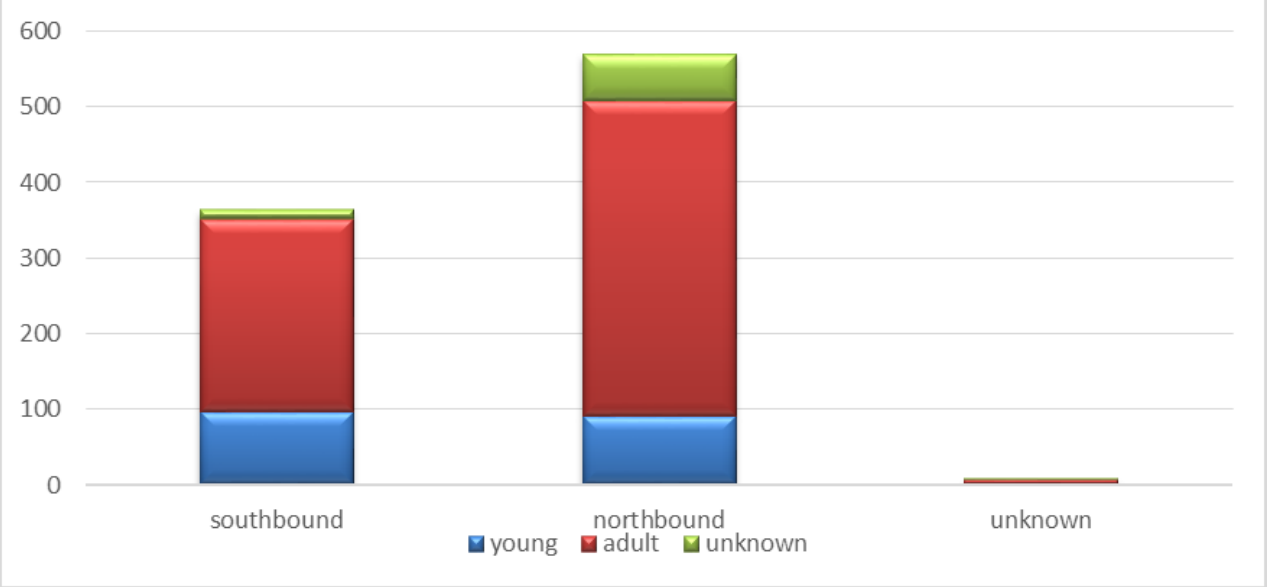

Figure 4-43 Deer approaching by age

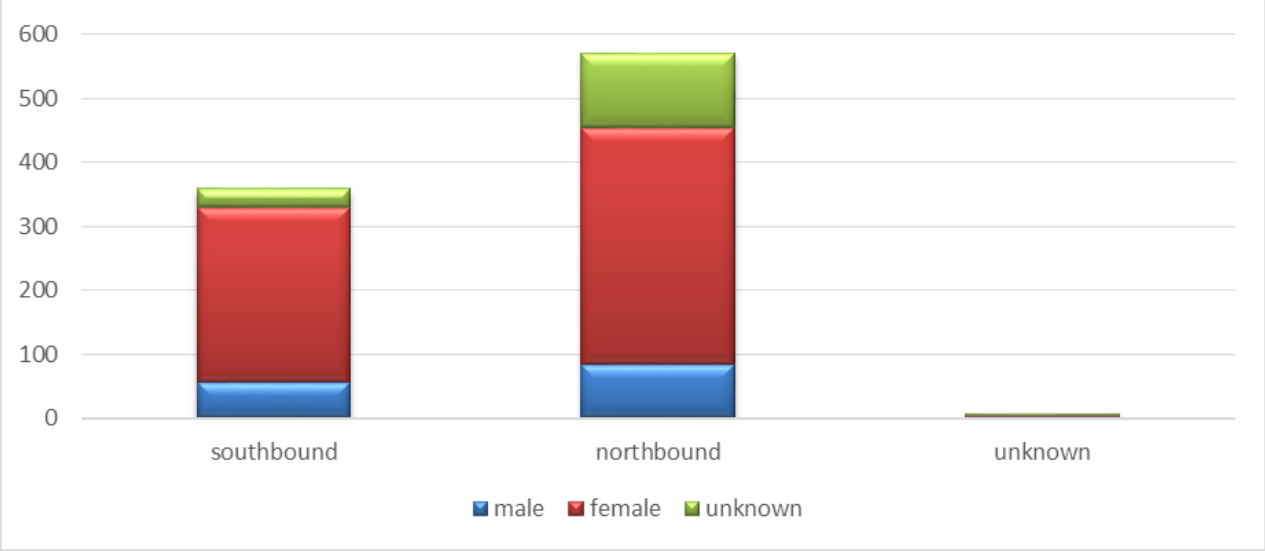

Figure 4-44 Deer approaching by gender

4.4 Wildlife crossing at the East Wildlife Underpass in the Pequop Mountains

A total of 171 group picture collected from 3/24/2018 to 05/12/2019 including **154** deer groups, 11 human groups, 5 coyote group, and 1 raven group. A total of 59 southbound deer groups with 179 individuals and 94 northbound deer groups with 352 individuals were observed at the east wildlife underpass in the Pequop Mountains, and there is also 1 group of deer left without identified direction. The numbers of deer approaching, crossing, and retracting are in Table 4-5. The total number of southbound and northbound deer approaching this wildlife underpass is shown in Figure 4-45. Comparison of deer approaching and retractions is in Figure 4-46. More deer approached and crossed this structure in 2018 fall, then most of them departure to south. Less number of deer approached this structure during spring period, and usually they would cross this structure and departure to north. Total number distribution of deer approaching this structure by month is shown in Figure 4-47. Total number distribution of deer approaching by time is in Figure 4-48. Figure 4-49 presents total number distribution of deer approaching at different temperatures. It shows that the number of deer approached in March and April is basically the same while in 2018 fall, from October, the number of deer approached is gradually decreasing and there were most deer approached this structure on October. Deer's favorite approaching time is from 6 am to 9 am in the morning. The most suitable temperature is 35°F to 54 °F. There are more adult deer than young deer and more female deer than male deer approach this underpass based on Figure 4-50 and Figure 4-51.

Table 4-5 Summary of Deer Activities at the East Wildlife Underpass

	Deer Groups	**Deer Approaching**	**Deer Crossing**	**Deer Retracting**
Southbound	59	179	116	63
Northbound	94	352	256	96
Unknown	1	2	Unknown	Unknown

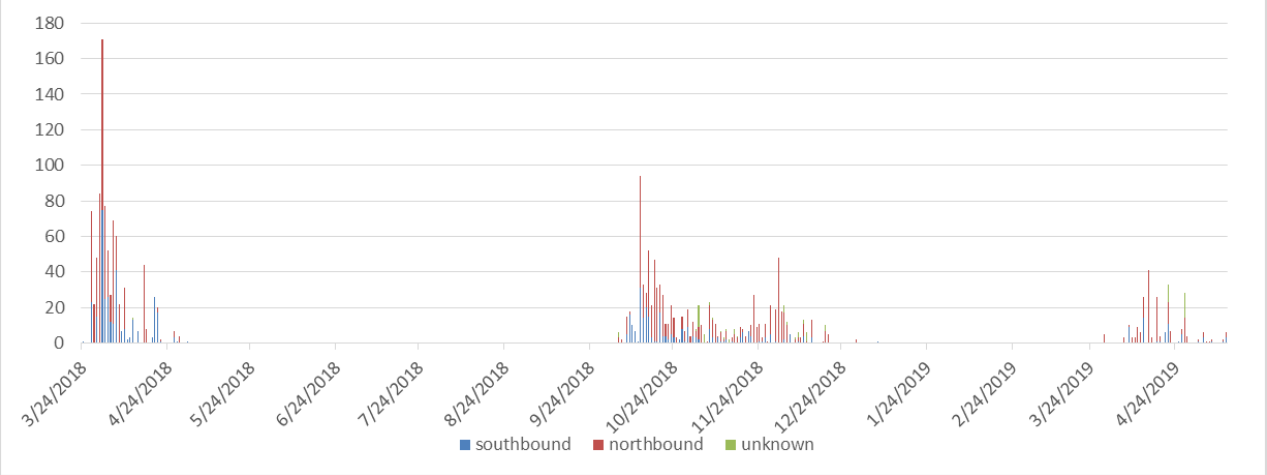

Figure 4-45 Total number of deer approaching at the East Wildlife Underpass by date

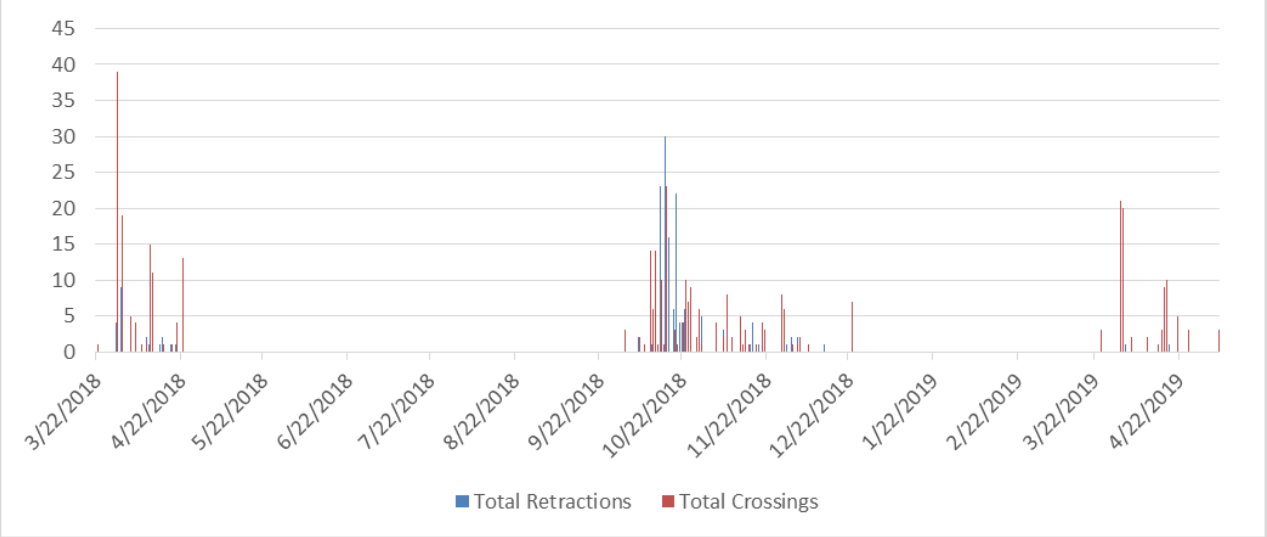

Figure 4-46 Comparison of deer crossing and deer retracting at the East Wildlife Underpass

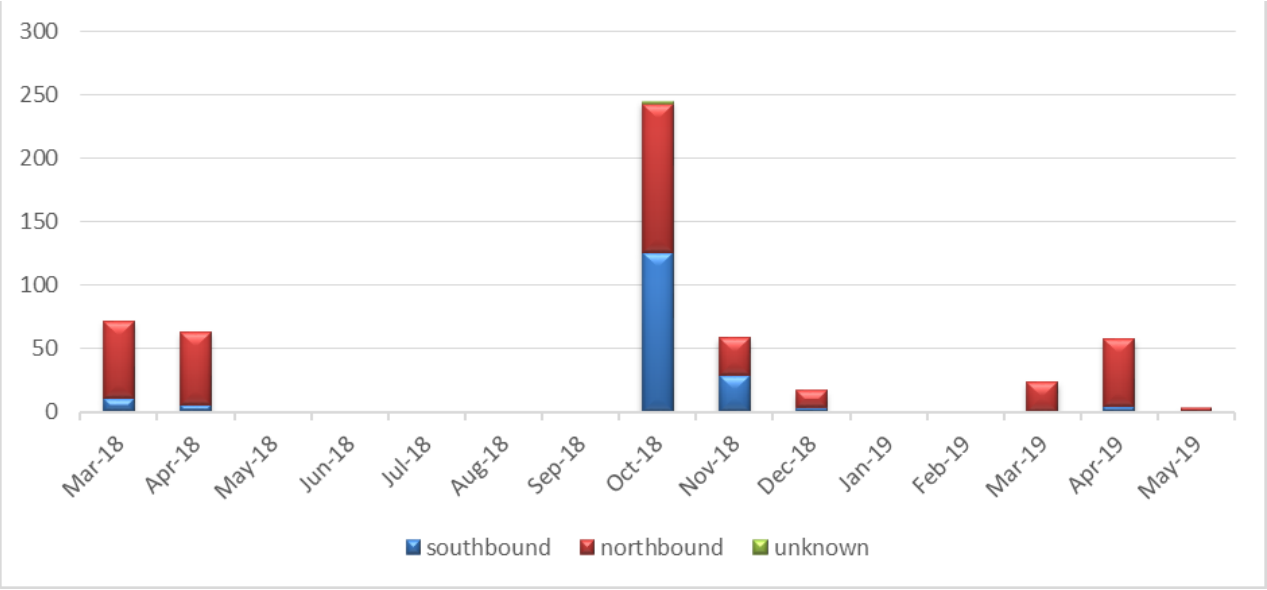

Figure 4-47 Deer approaching by month

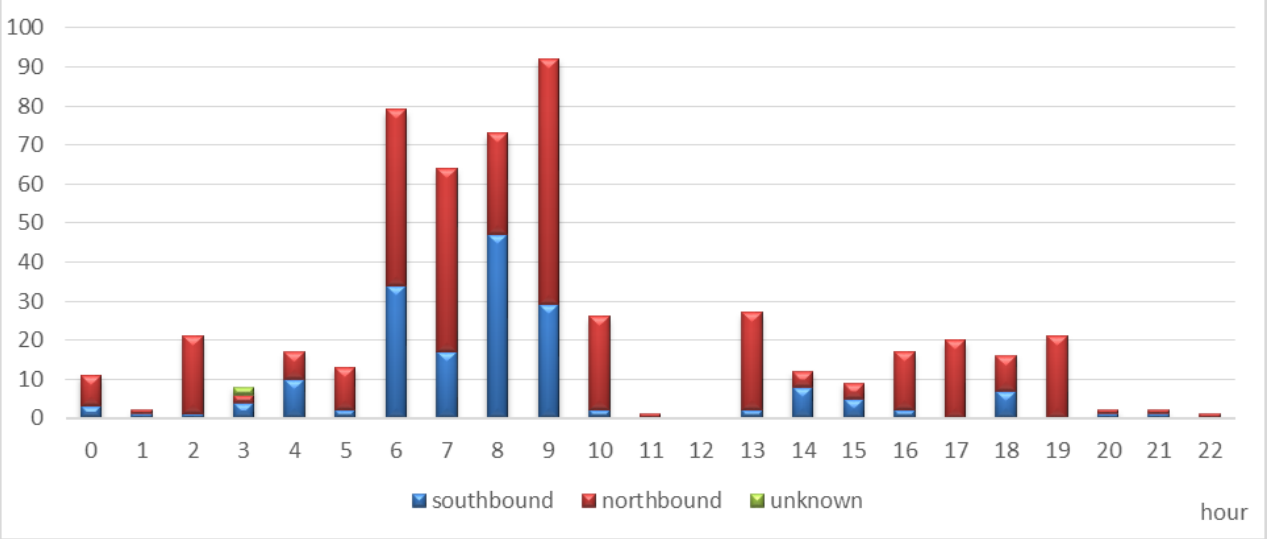

Figure 4-48 Deer approaching by time

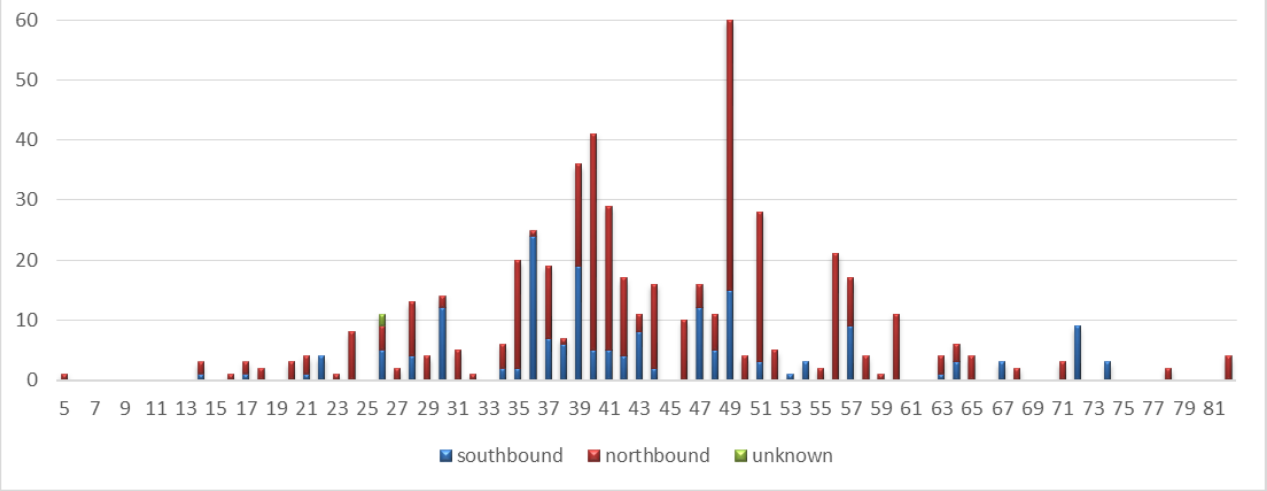

Figure 4-49 Deer approaching by temperature

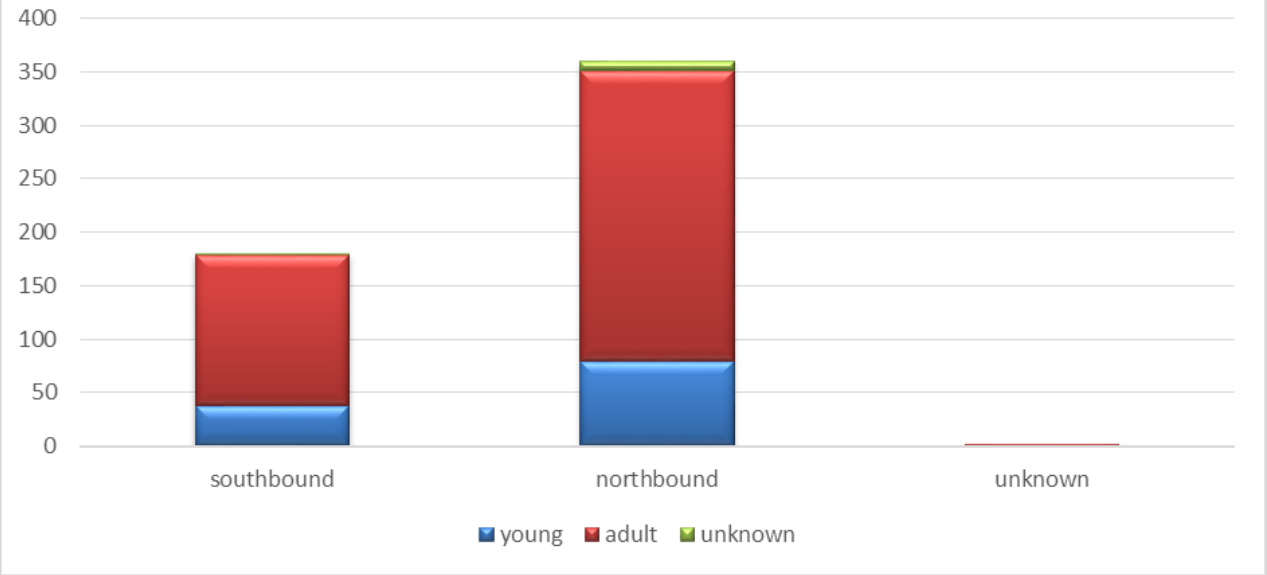

Figure 4-50 Deer approaching by age

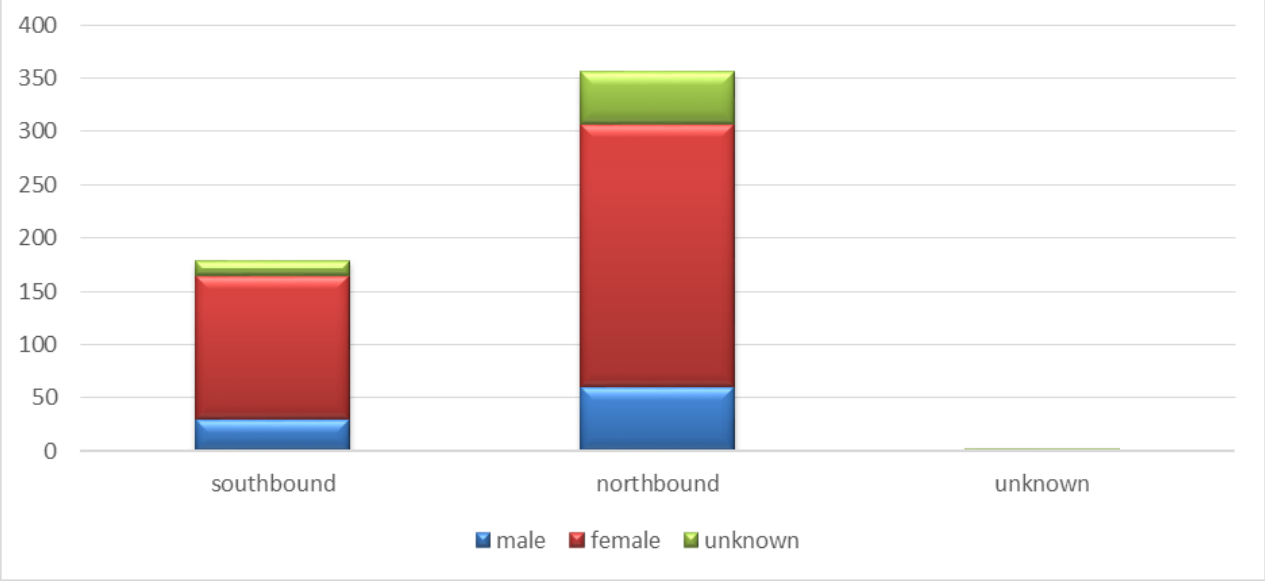

Figure 4-51 Deer approaching by gender

4.5 Wildlife crossing at the East Wildlife Overpass in the Pequop Mountains

A total of 790 group picture collected from 09/16/2018 to 05/12/2019 including **580** deer groups, 27 human groups, 67 coyote group, 93 rabbit group and 9 groups with bird, the other14 groups including fox, bobcat and unknown mammal. A total of 392 southbound deer groups with 1458 individuals and 167 northbound deer groups with 300 individuals were observed at the west wildlife underpass in the Pequop Mountains, and there are also 21 groups of deer left without identified direction which means there were more deer approached this structure and departure to south than to north. The numbers of deer approaching, crossing, and retracting are in Table 4-6. The total number of southbound and northbound deer approaching this wildlife underpass is shown in Figure 4-52. Comparison of deer approaching and retractions is in Figure 4-53. Deer approached this underpass more often in 2018 fall, and most of them crossed through this structure then departure to south. During the spring period, the total number of deer was less than the fall period, and the southbound was still greater than northbound. The total number distribution of deer approaching this structure by month is shown in Figure 4-54. The total number distribution of deer approaching by time is in Figure 4-55. Figure 4-56 presents the total number distribution of deer approaching at different temperatures. It shows that in 2018 fall, from October, the number of deer approached is gradually decreasing. And in 2019 spring, the number of deer approached is gradually increasing. Deer's favorite approaching time is from 6 am to 9 am. The most suitable temperature is 30°F to 50 °F. There are more adult deer than young deer and more female deer than male deer approach this underpass Figure 4-57 and Figure 4-58.

Table 4-6 Summary of Deer Activities at the West Wildlife Underpass

	Deer Groups	**Deer Approaching**	**Deer Crossing**	**Deer Retracting**
Southbound	392	1458	1169	289
Northbound	167	300	172	127
Unknown	21	81	Unknown	Unknown

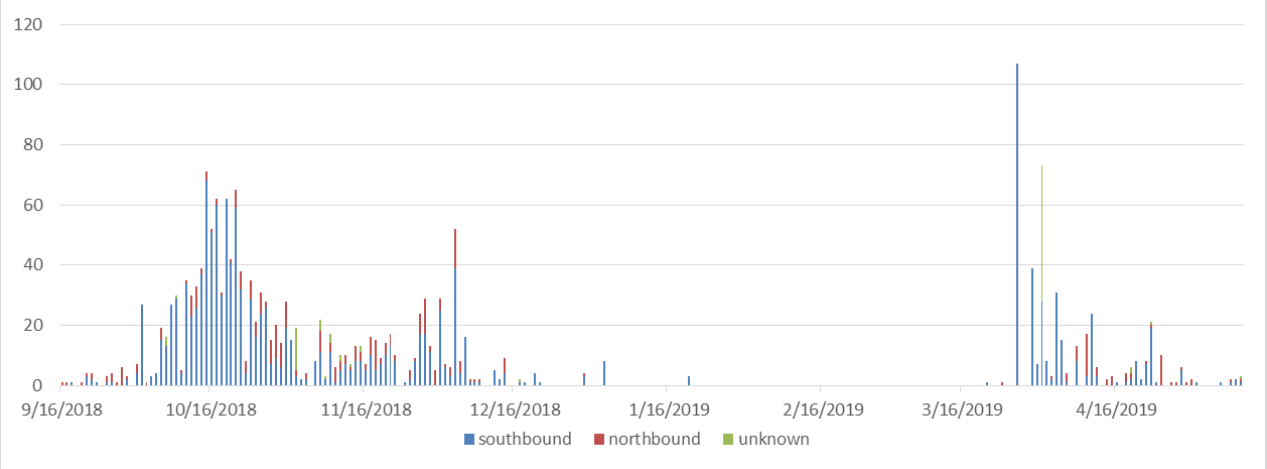

Figure 4-52 Total number of deer approaching at the west wildlife underpass by date

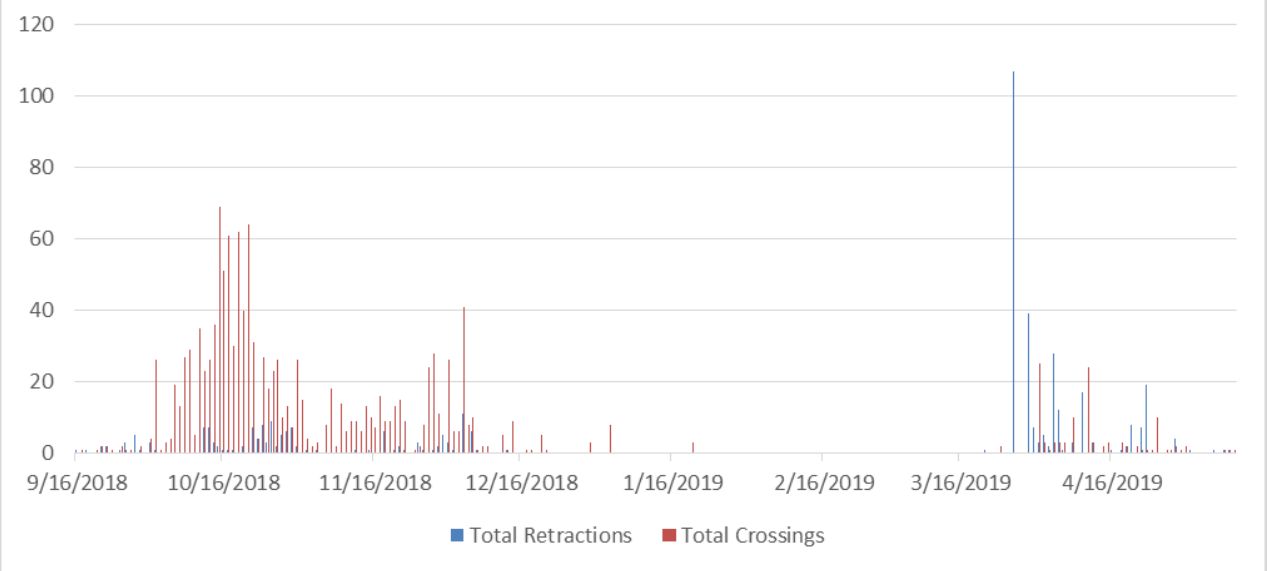

Figure 4-53 Comparison of deer crossing and deer retracting at the west wildlife underpass

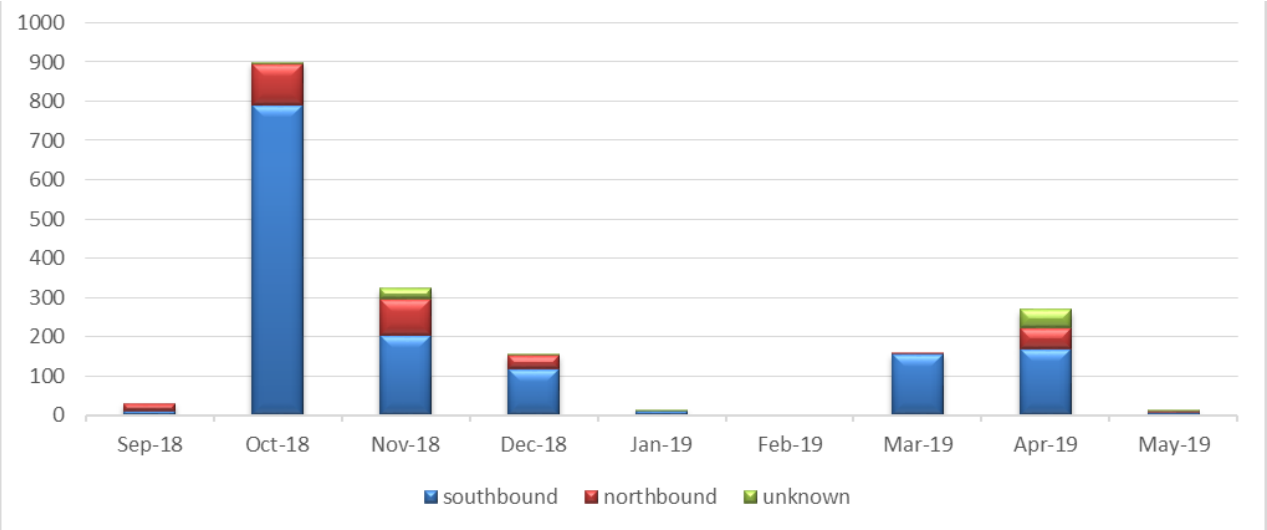

Figure 4-54 Deer approaching by month

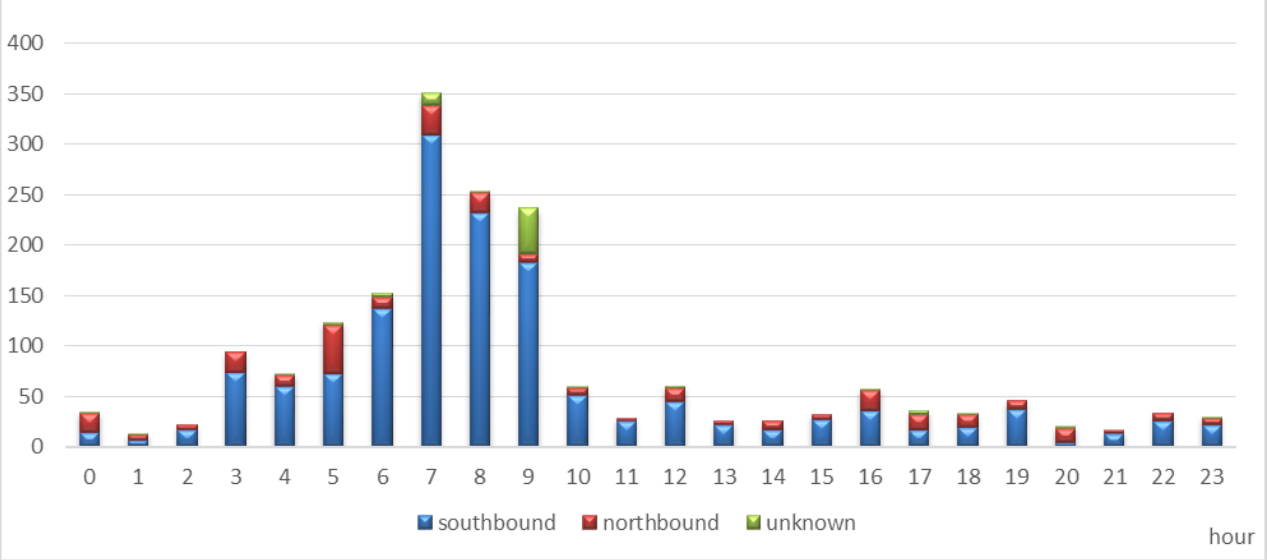

Figure 4-55 Deer approaching by time

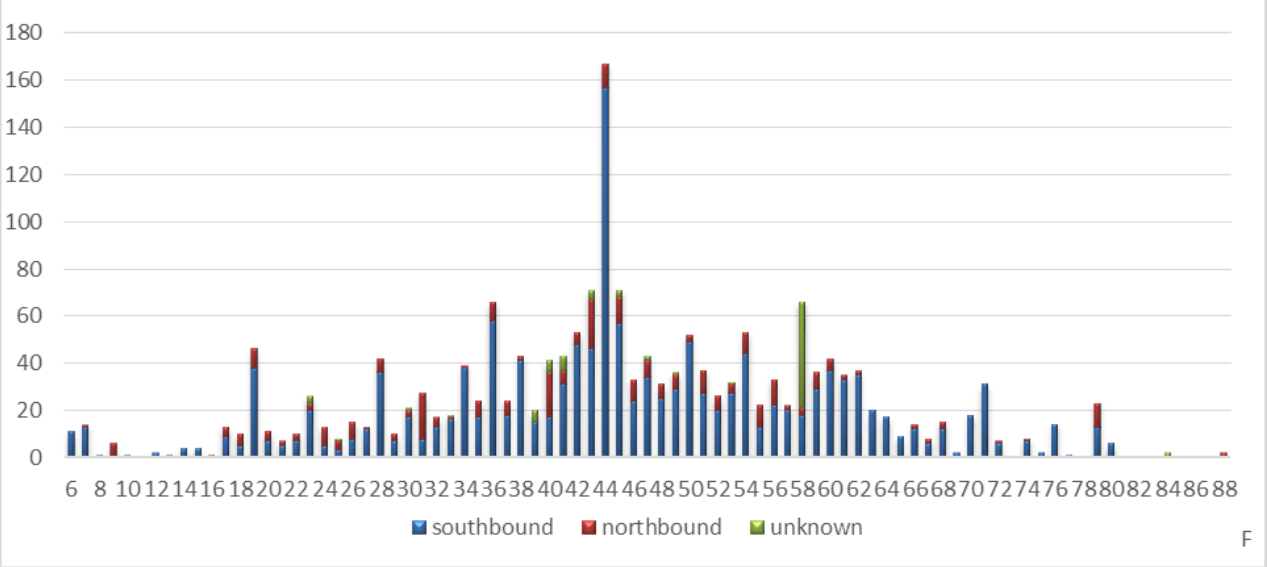

Figure 4-56 Deer approaching by temperature

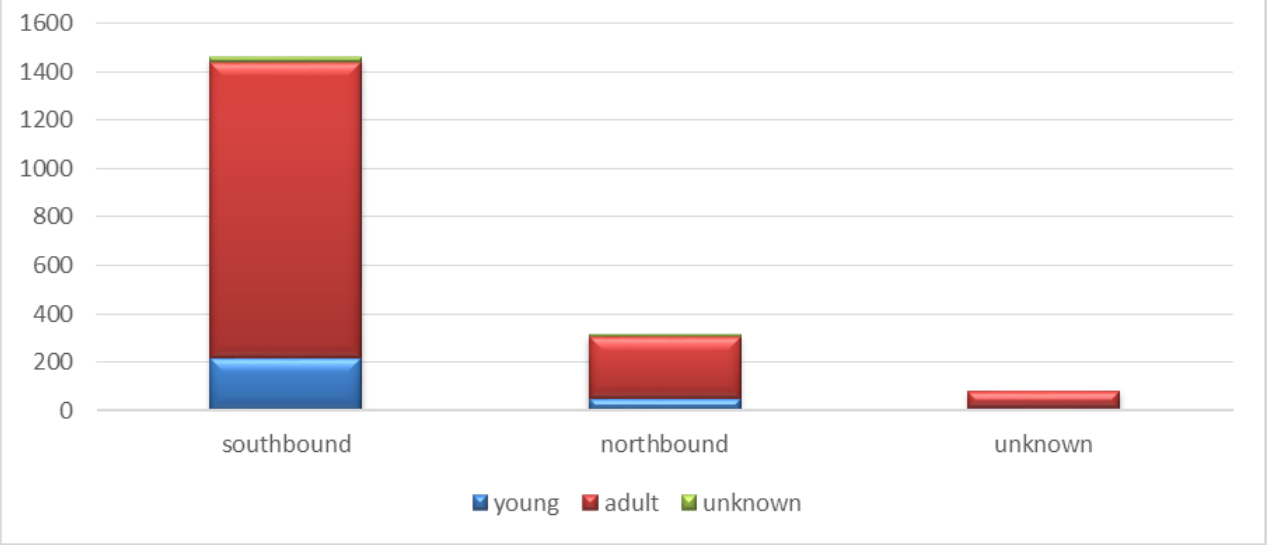

Figure 4-57 Deer approaching by age

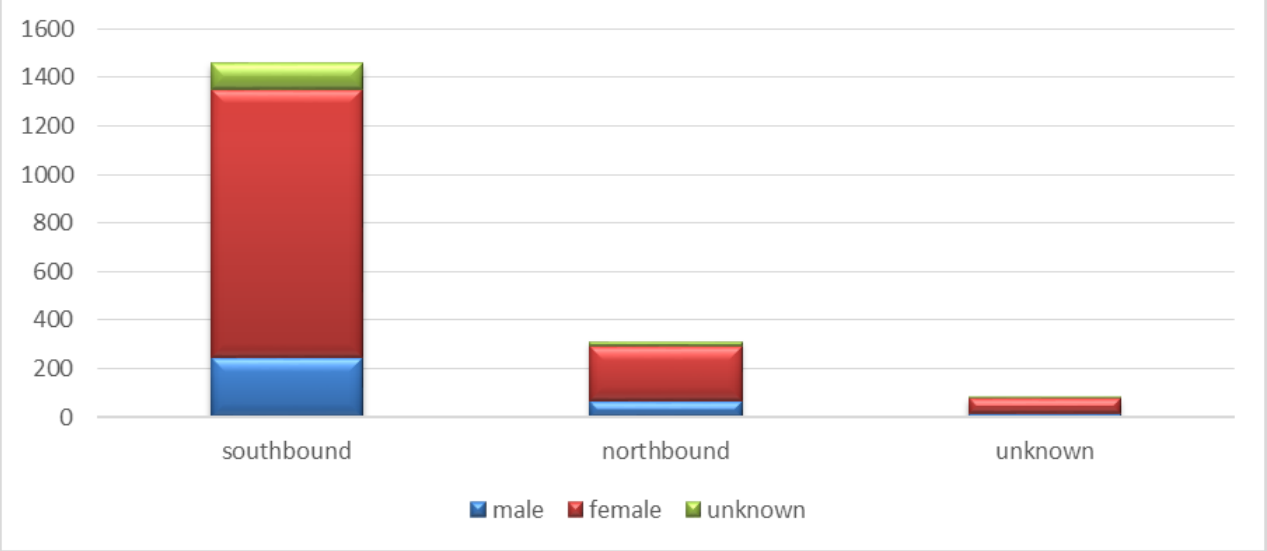

Figure 4-58 Deer approaching by gender

4.6 Wildlife crossing at the East Vehicle Underpass in the Pequop Mountains

A total of 572 group picture collected from 3/24/2018 to 01/25/2019, including **30** deer groups, 537 human and vehicle groups, 3 coyote group, 1 bird group, and 1 mountain lion group. A total of 12 southbound deer groups with 28 individuals and 16 northbound deer groups with 30 individuals were observed at the east vehicle underpass in the Pequop Mountains, and there are also 2 groups of deer left without identified direction. The numbers of deer approaching, crossing, and retracting are in Table 4-7. The total number of southbound and northbound deer approaching this wildlife underpass is shown in Figure 4-59. Comparison of deer approaching and retractions is in Figure 4-60. Less deer used this underpass because of the high volume of the traffic. There were more deer captured during 2018 fall period, and more of them approached this structure in October and then departure to the south while during 2018 spring period, most of deer departure to the north. The total number distribution of deer approaching this structure by month is shown in Figure 4-61. The total number distribution of deer approaching by time is in Figure 4-62. Figure 4-63 presents the total number distribution

of deer approaching at different temperatures. It shows that the number of deer approached in March is much higher than in April while in 2018 fall and 2019 spring, from October, the number of deer approached is gradually decreasing. Deer's favorite approaching time is from 6 pm to 10 pm in the afternoon. The most suitable temperature is 22°F to 44 °F. There are more adult deer than young deer and more female deer than male deer approach this underpass based on Figure 4-64 and Figure 4-65.

Table 4-7 Summary of Deer Activities at the east vehicle underpass

	Deer Groups	Deer Approaching	Deer Crossing	Deer Retracting
Southbound	12	28	28	0
Northbound	16	30	11	19
Unknown	2	2	Unknown	Unknown

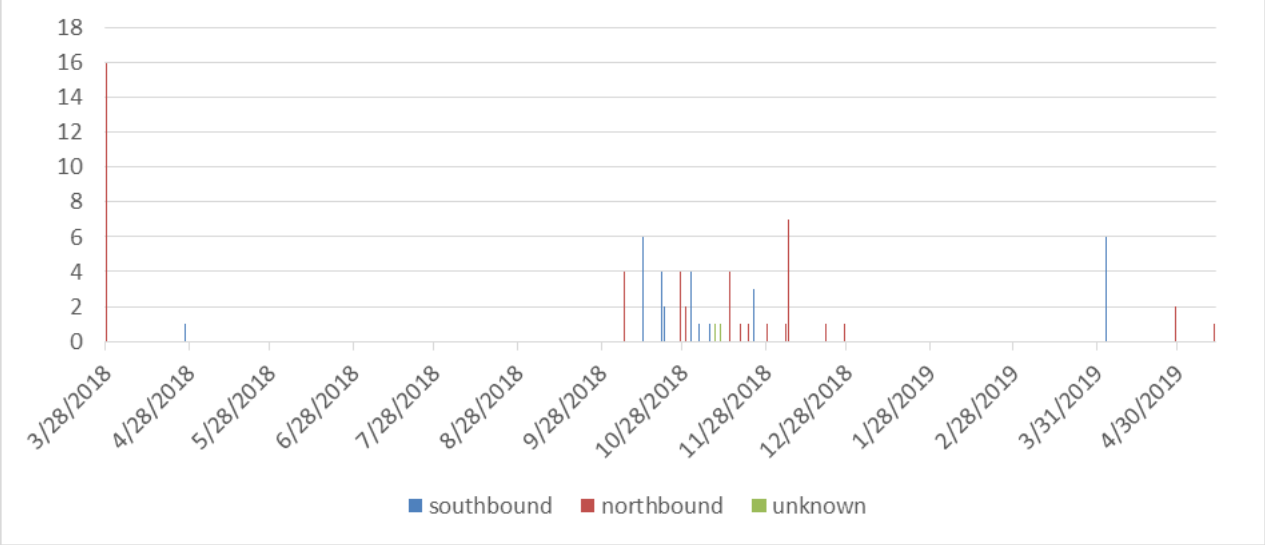

Figure 4-59 Total number of deer approaching at the east vehicle underpass by date

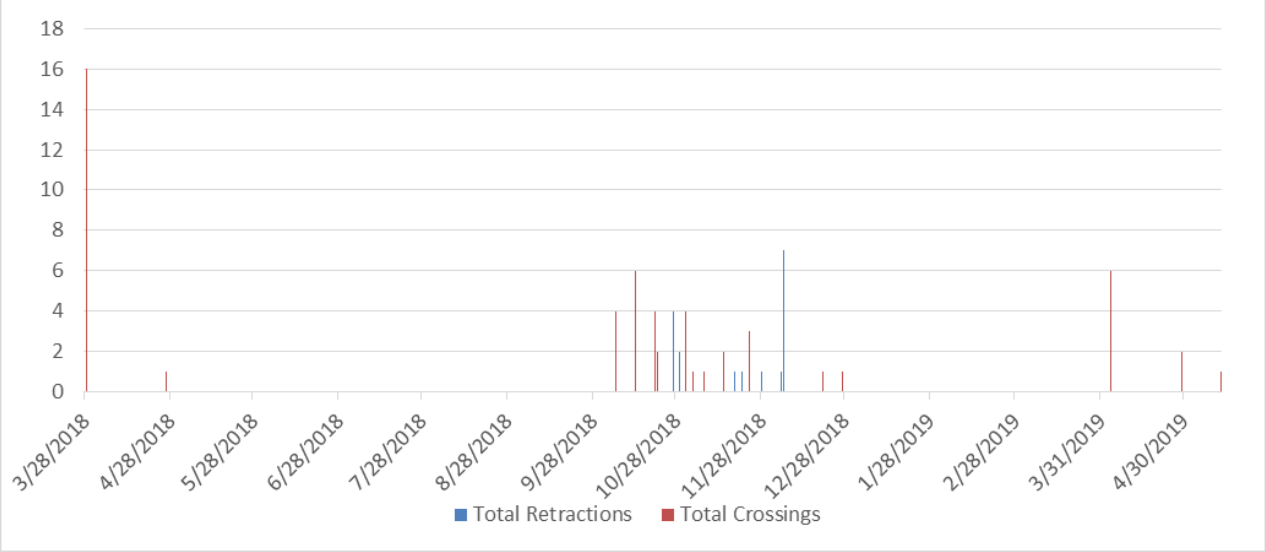

Figure 4-60 Comparison of deer crossing and deer retracting at the east vehicle underpass

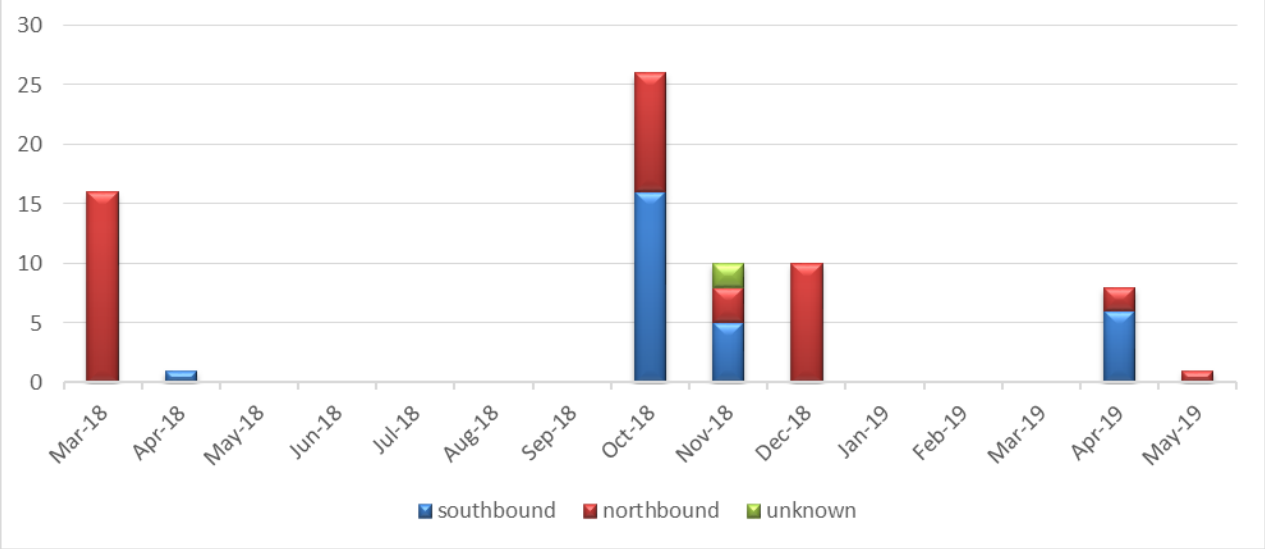

Figure 4-61 Deer approaching by month

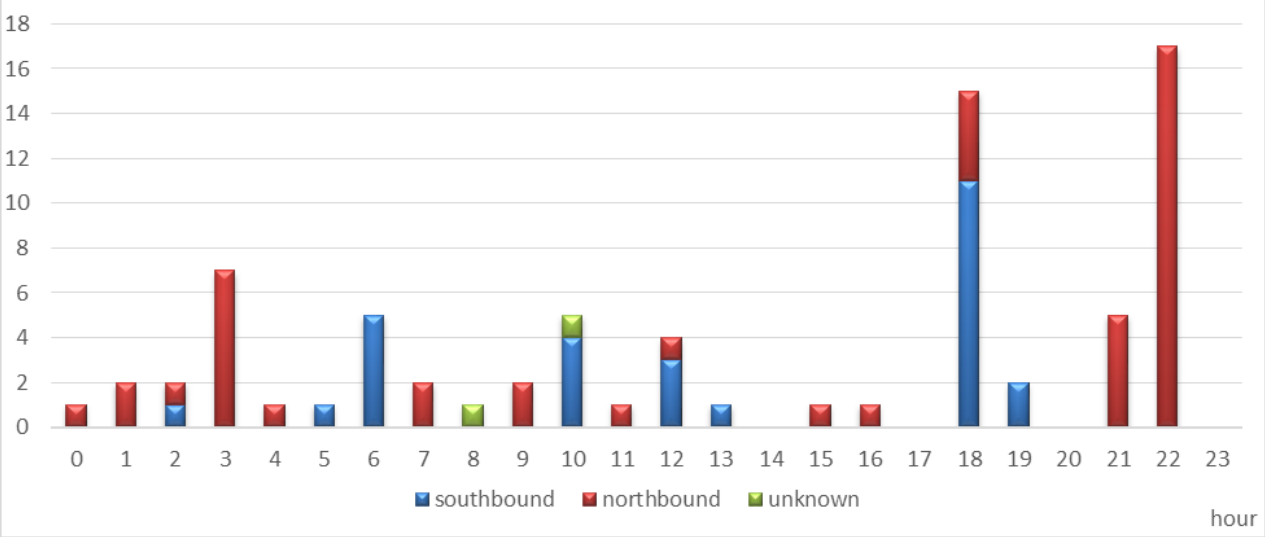

Figure 4-62 Deer approaching by time

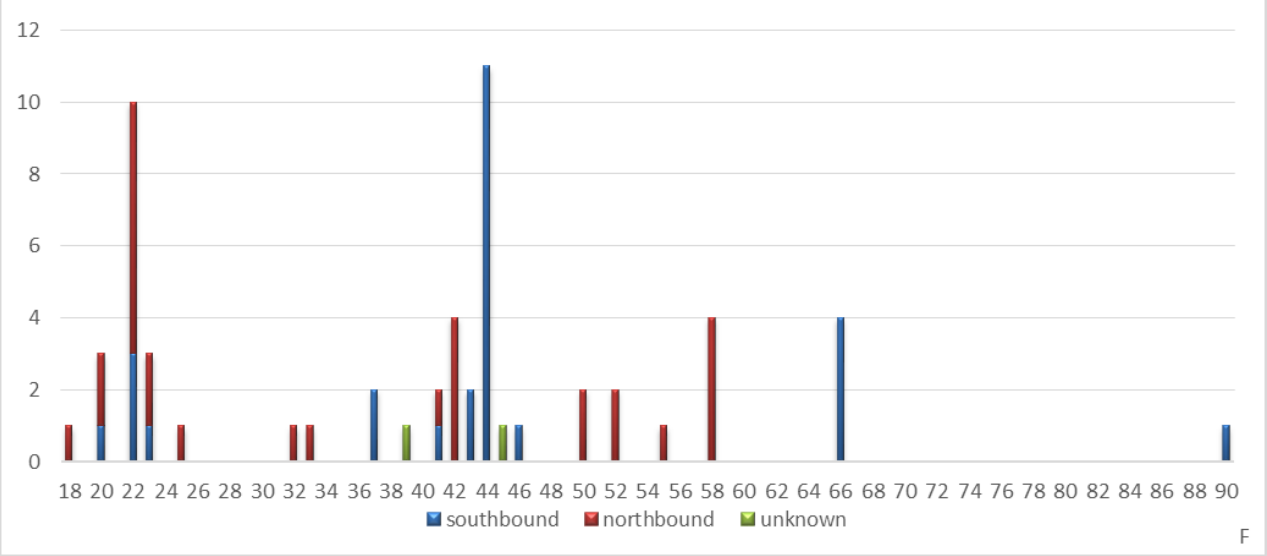

Figure 4-63 Deer approaching by temperature

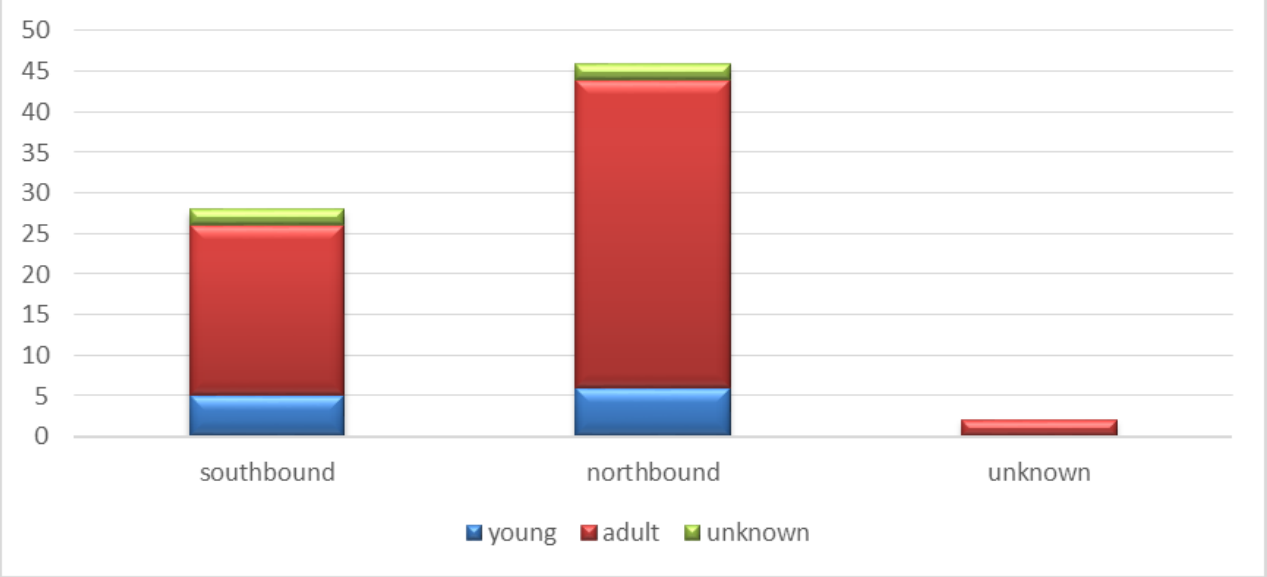

Figure 4-64 Deer approaching by age

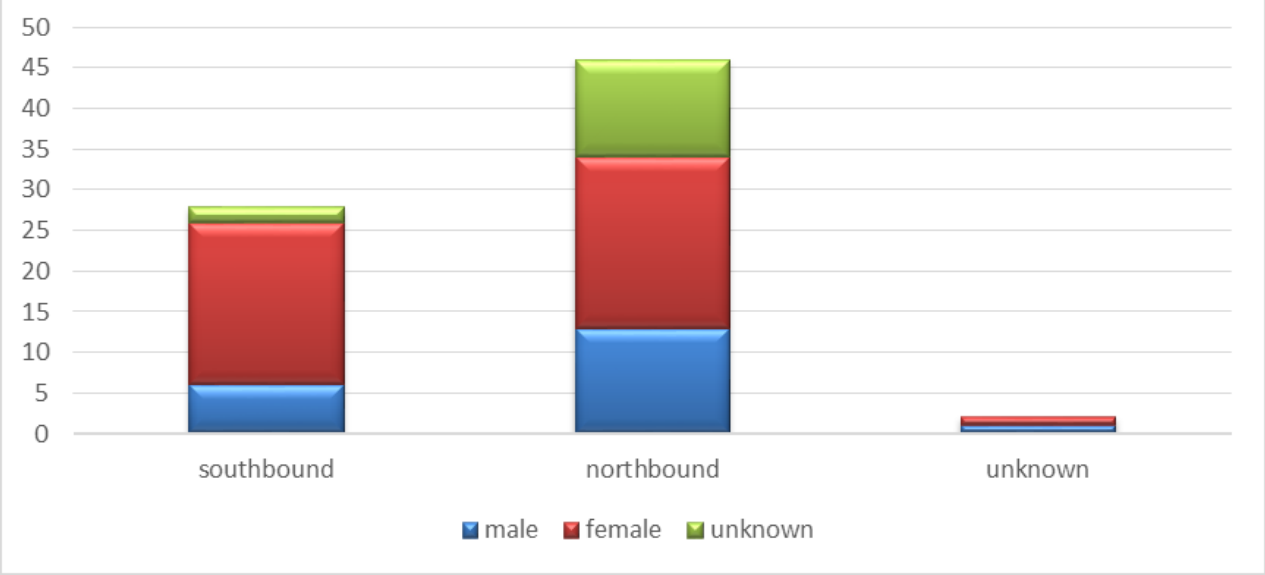

Figure 4-65 Deer approaching by gender

4.7 Wildlife crossing at the West Wildlife Overpass in the Pequop Mountains

A total of 146 group picture collected from 11/19/2018 to 05/12/2019 including **77** deer groups, 10 human groups, 33 coyote and fox groups, 4 cat groups, 1 badger group, and 4 bird groups. A total of 28 southbound deer groups with 108 individuals and 48 northbound deer groups with 232 individuals were observed at the west wildlife overpass in the Pequop Mountains, and there was also 1 group of deer left without identified direction. The numbers of deer approaching, crossing, and retracting are in Table 4-8. The total number of southbound and northbound deer approaching this wildlife underpass is shown in Figure 4-66. Comparison of deer approaching and retractions is in Figure 4-67. The total number distribution of deer approaching this structure by month is shown in Figure 4-68. The total number distribution of deer approaching by time is in Figure 4-69. Figure 4-70 presents the total number distribution of deer approaching at different temperatures. It shows that there are more deer approached this structure then departure to north rather than to south, and many deer retracting rather than crossing. More deer approached this structure in April 2019 while the other month the number of deer is limited. Deer's favorite approaching time is from 6 am to 9 am in the morning. The most suitable temperature is 36°F to 46 °F. There are more adult deer than young deer and more female deer than male deer approach this underpass based on Figure 4-71 and Figure 4-72.

Table 4-8 Summary of Deer Activities at the west wildlife overpass

	Deer Groups	Deer Approaching	Deer Crossing	Deer Retracting
Southbound	28	108	27	81
Northbound	48	232	152	80
Unknown	1	2	Unknown	Unknown

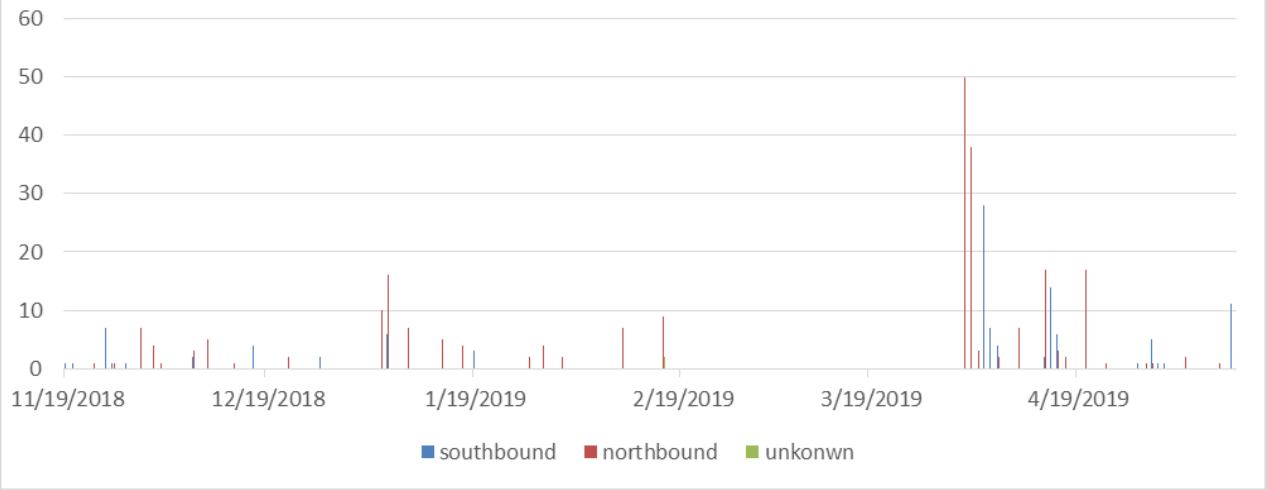

Figure 4-66 Total number of deer approaching at the west wildlife overpass by date

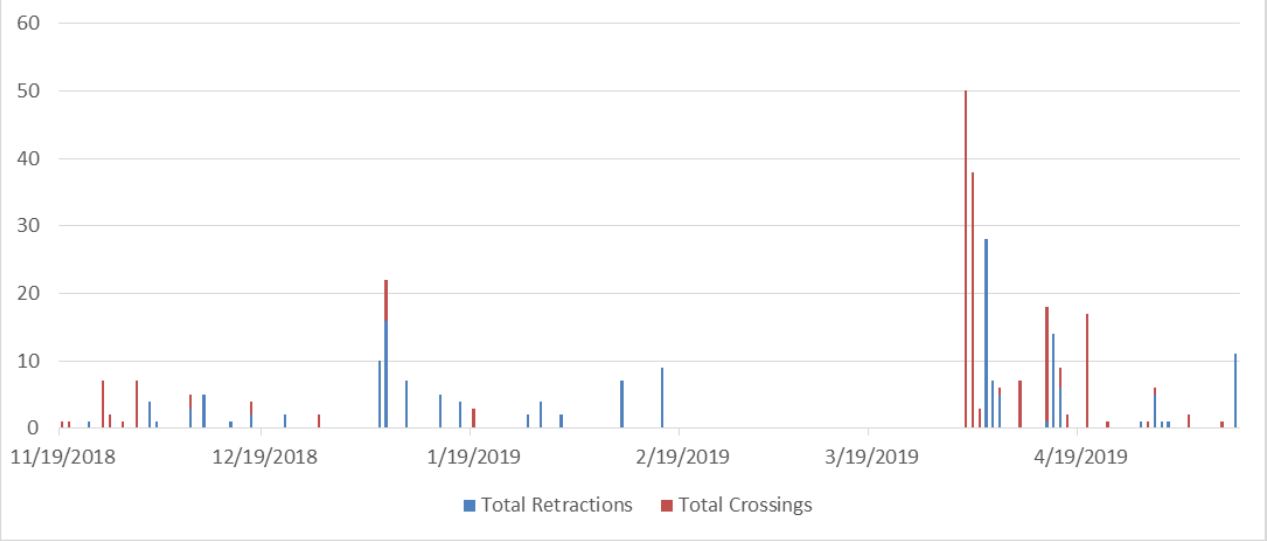

Figure 4-67 Comparison of deer crossing and deer retracting at the west wildlife overpass

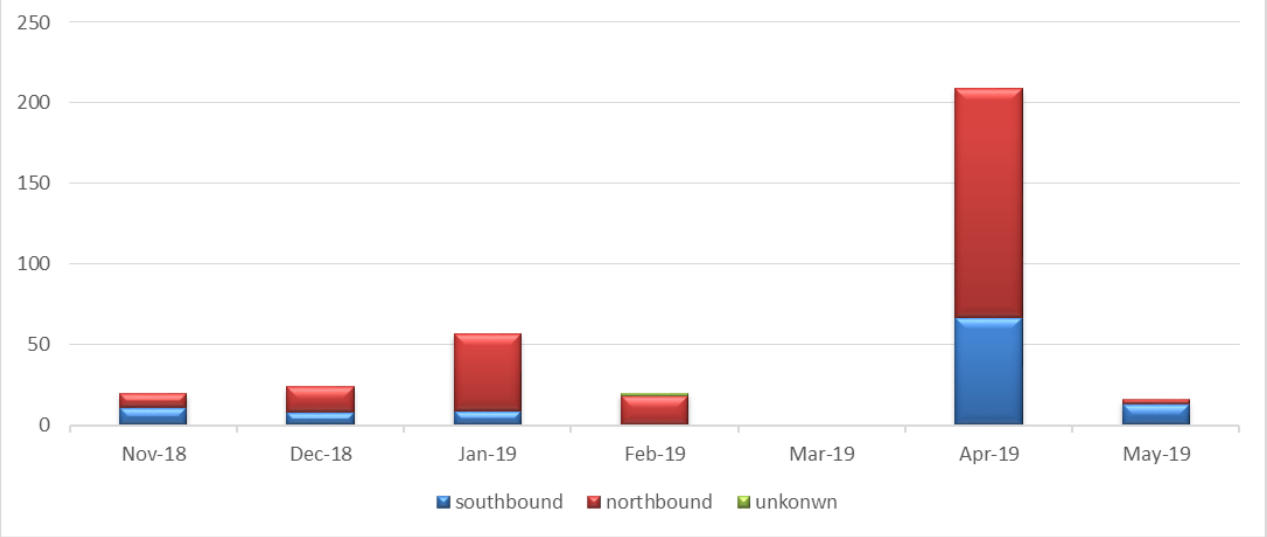

Figure 4-68 Deer approaching by month

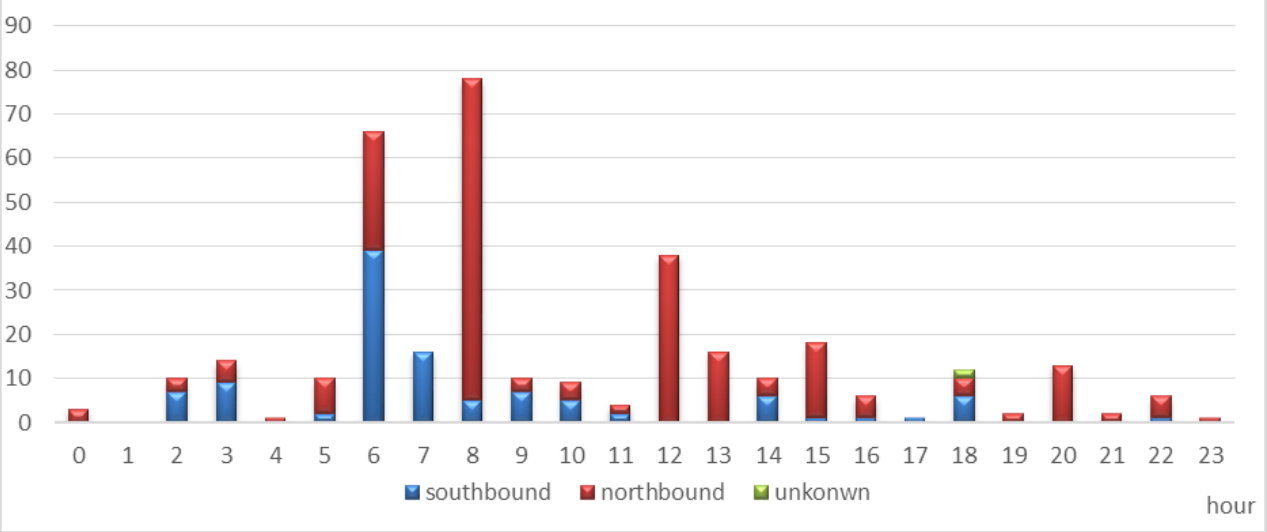

Figure 4-69 Deer approaching by time

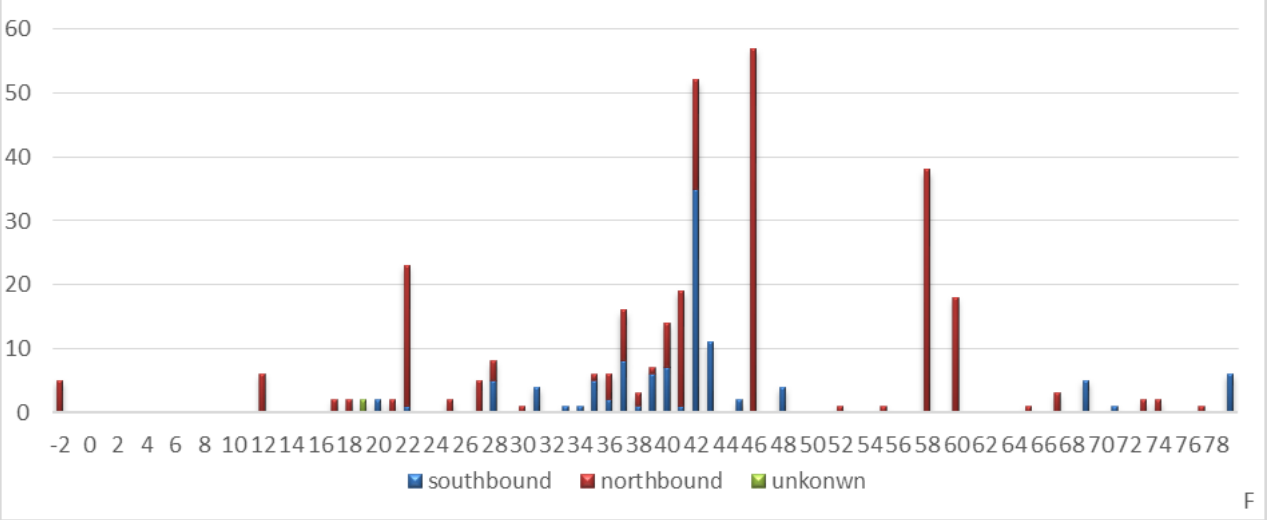

Figure 4-70 Deer approaching by temperature

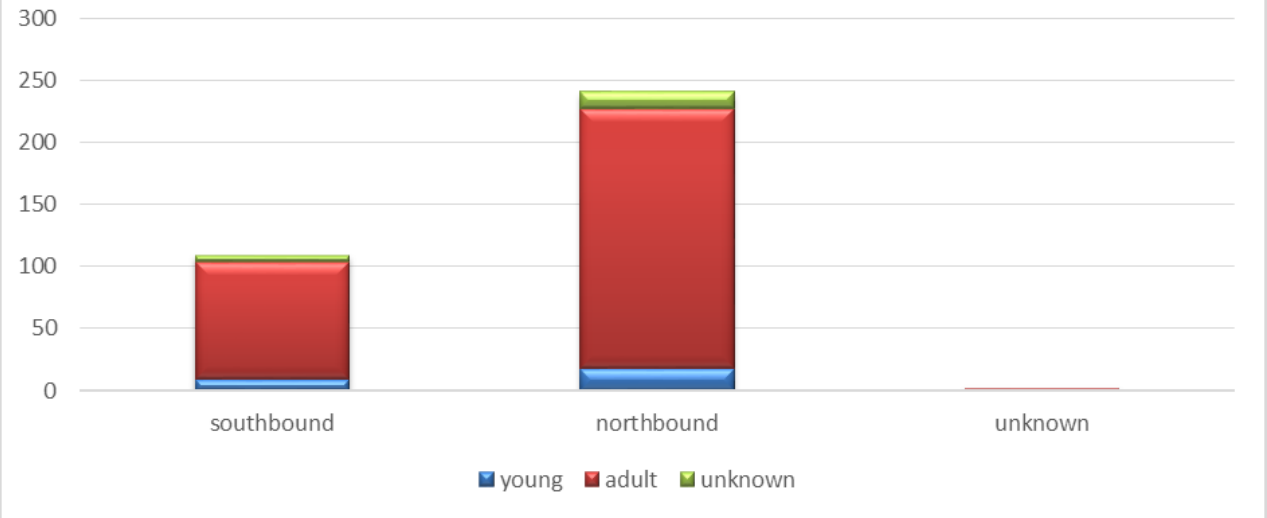

Figure 4-71 Deer approaching by age

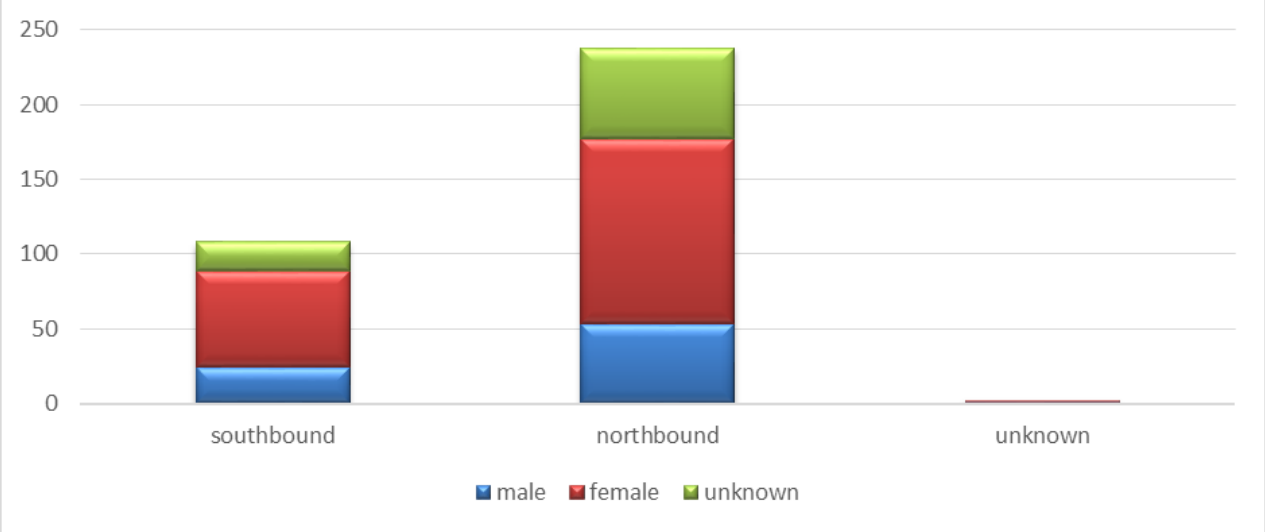

Figure 4-72 Deer approaching by gender

4.8 Wildlife crossing at the North Wildlife Underpass of the USA Parkway

A total of 204 group picture collected from 10/17/2018 to 05/12/2019 including **65** wild horses groups, 15 human groups, 22 cow groups, 75 bird groups and 3 groups with wild horses. A total of 21 southbound wild horses groups with 31 individuals and 40 northbound wild horses groups with 49 individuals were observed at the west wildlife underpass in the Pequop Mountains, and there are also 4 groups of wild horses left without identified direction. The numbers of wild horses approaching, crossing, and retracting are in Table 4-9. The total number of southbound and northbound wild horses approaching this wildlife underpass is shown in Figure 4-73. Comparison of wild horses approaching and retractions is in Figure 4-74. The total number distribution of deer approaching this structure by month is shown in Figure 4-75. Frequency distribution of wild horses approaching by time is in Figure 4-76. Figure 4-77presents the total number distribution of deer approaching at different temperatures. The total number of wild horses is less than the south wildlife underpass along USA Parkway. Besides that, usually, the number of horse crossed this structure and departure to south generally equals to the number of horse departure to north. There are some groups of wild horses approached this structure then retracted rather than crossing it. Wild horse's favorite approaching time is from 9 am to 2 pm. The most suitable temperature is 40°F to 50 °F. There were more adult wild horses than young horse approach this underpass based on Figure 4-78. What's more, this structure locked from 11/23/2018 for a month and the gender of the horse is difficult to identify.

Table 4-9 Summary of Deer Activities at the North Wildlife Underpass

	Horse Groups	**Horse Approaching**	**Horse Crossing**	**Horse Retracting**
Southbound	21	31	19	12
Northbound	40	49	30	19
Unknown	4	Unknown	Unknown	Unknown

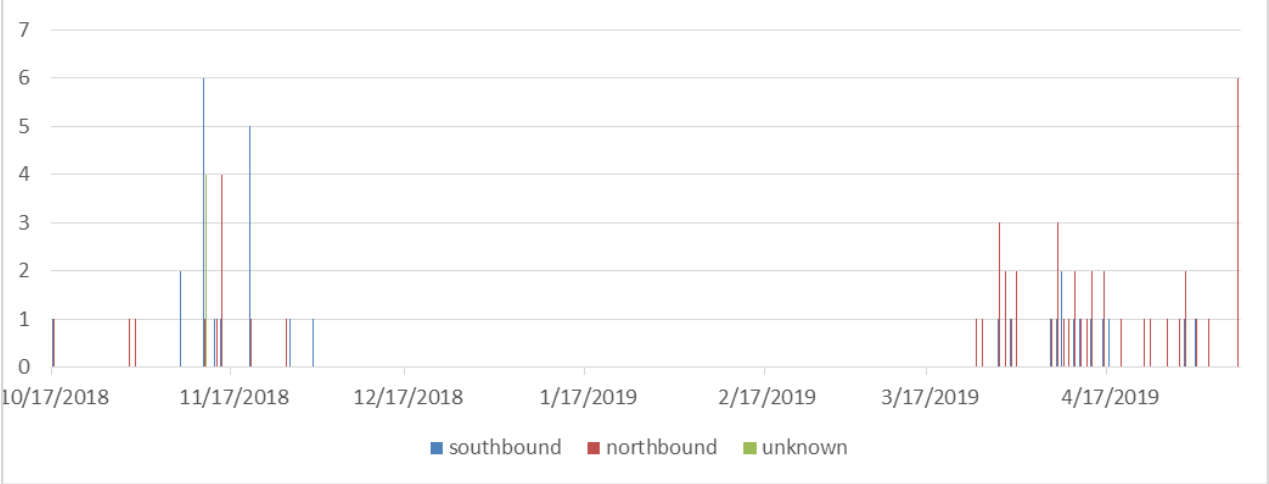

Figure 4-73 Total number of deer approaching at the North Wildlife Underpass by date

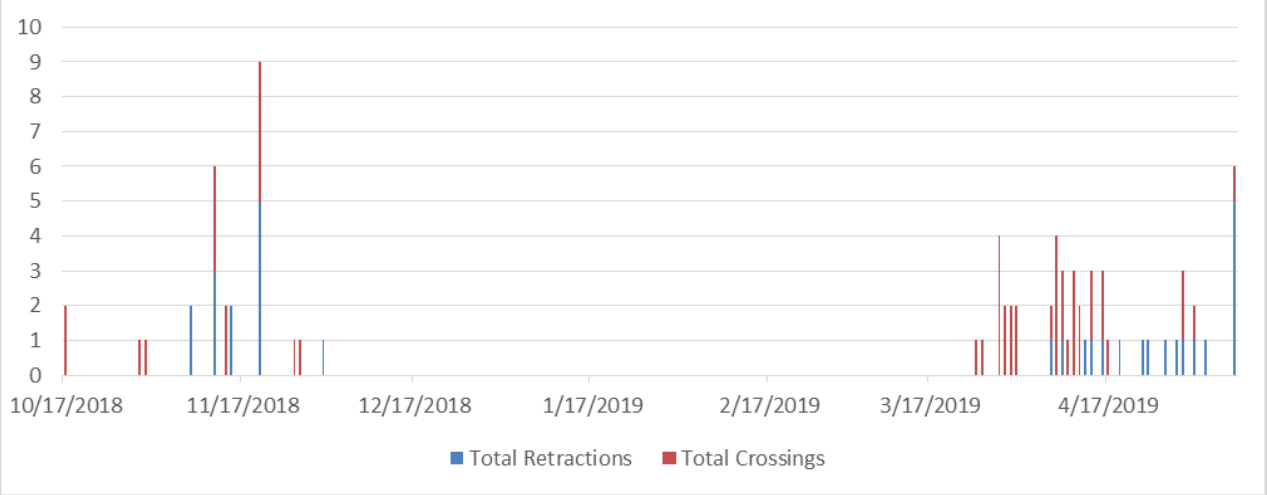

Figure 4-74 Comparison of horse crossing and horse retracting at the North Wildlife Underpass

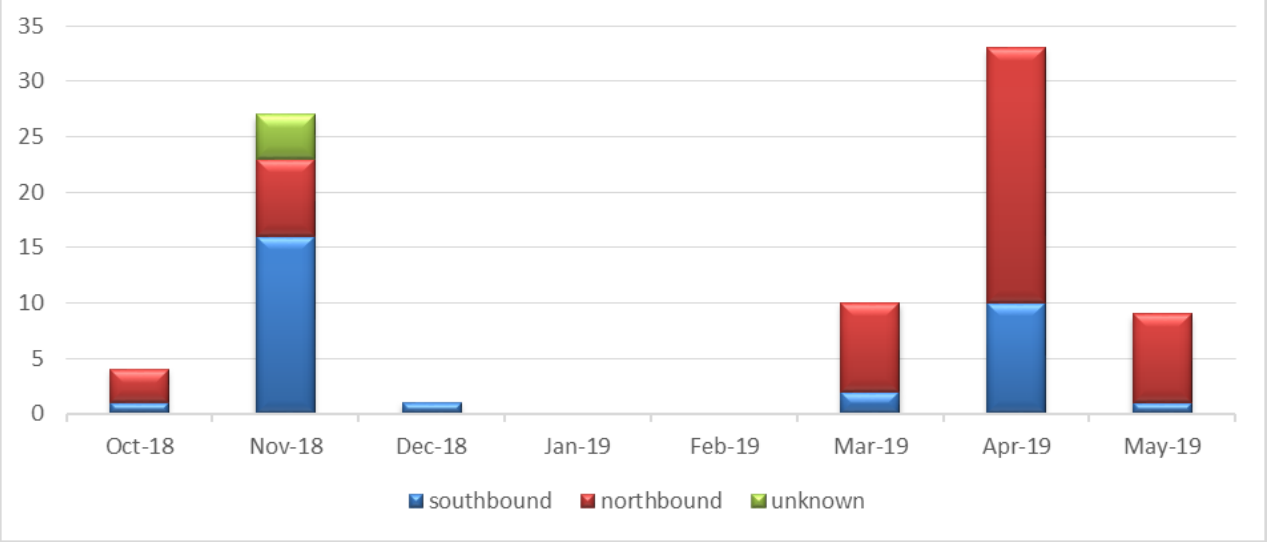

Figure 4-75 Wild horses approaching by month

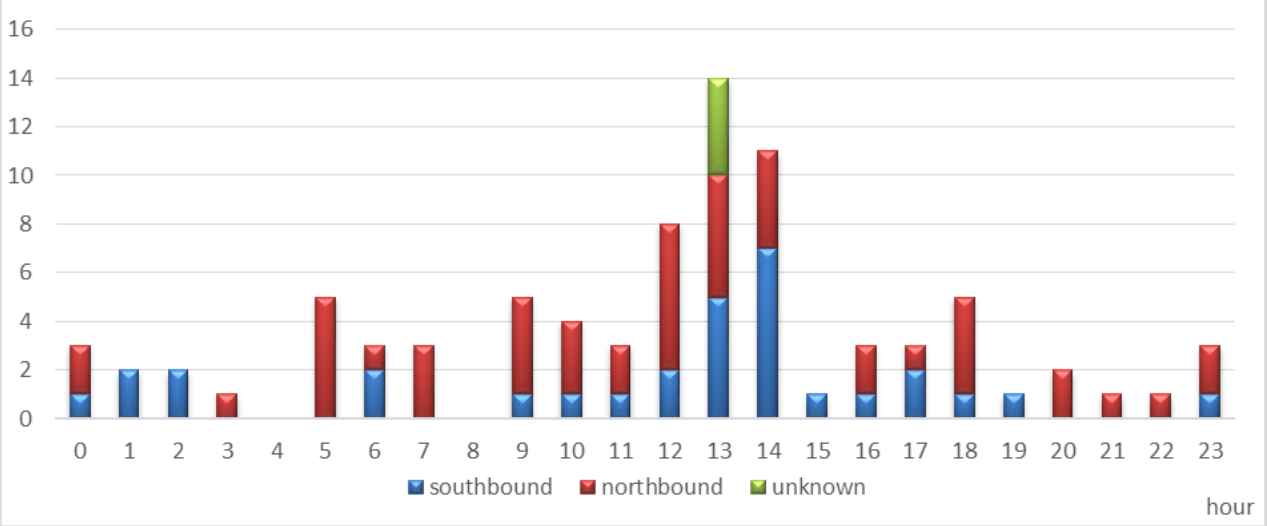

Figure 4-76 Wild horses approaching by time

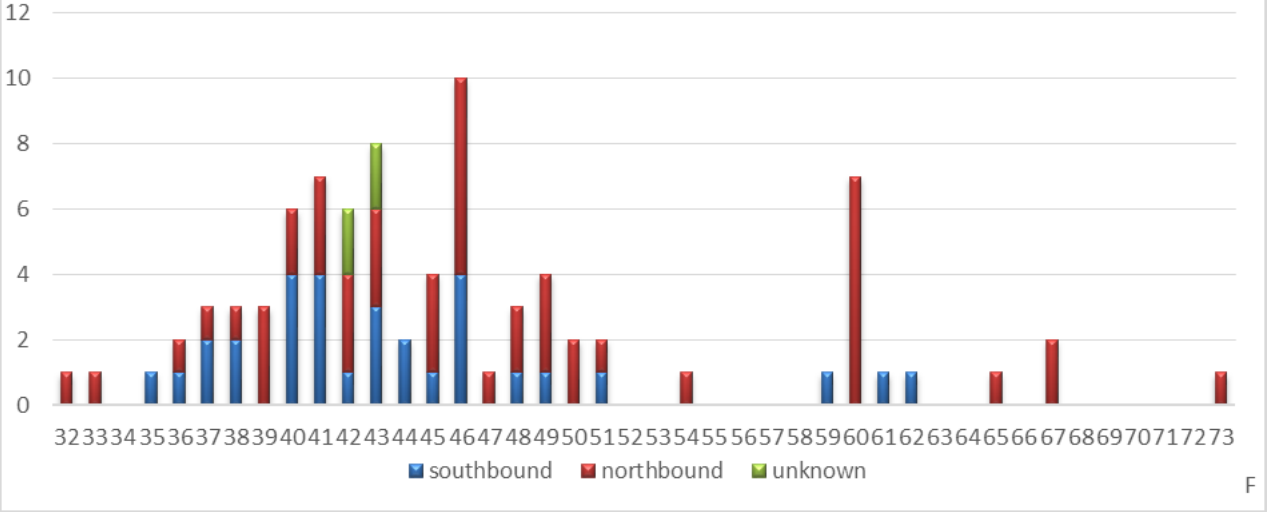

Figure 4-77 Wild horses approaching by temperature

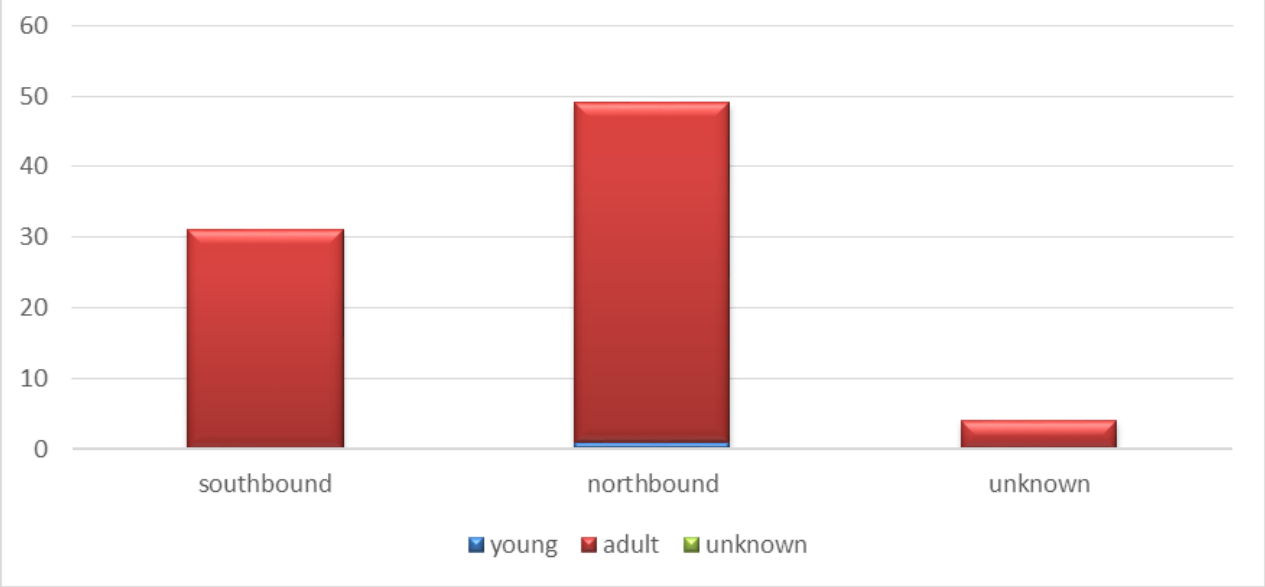

Figure 4-78 Wild horses approaching by age

4.9 Wildlife crossing at the South Wildlife Underpass of the USA Parkway

A total of 231 group picture collected from 10/12/2018 to 05/12/2019 including **113** horse groups, 22 cow groups, 24 bird groups, 47 coyote groups and 17 groups with human and vehicle. A total of 50 southbound wild horses groups with 478 individuals and 54 northbound wild horses groups with 524 individuals were observed at the South Wildlife Underpass in the Pequop Mountains, and there are also 9 groups of wild horses left without identified direction. The numbers of wild horses approaching, crossing, and retracting are in Table 4-10. The total number of southbound and northbound wild horses approaching this wildlife underpass is shown in Figure 4-79. Comparison of deer approaching and retractions is in Figure 4-80. Wild horses approached this underpass more often in 2018 fall, and most of them crossed his structure. The total number of wild horses approached every day is steady. And the number of southbound and northbound are usually same one which means the same groups wild horses use this structure twice every day. The total number distribution of wild horses approaching this structure by month is shown in Figure 4-81. The total number distribution of wild horses approaching by time is in Figure 4-82. Figure 4-83 presents the total number distribution of wild horses approaching at different temperatures. It shows that the number of wild horses approached in October and November is basically the same while after that, the number of wild horses approached is gradually decreasing. Wild horse's favorite approaching time is from 7 am to 2 pm in the afternoon. The most suitable temperature is 35°F to 56 °F. There were more adult wild horses than young deer based on Figure 4-84, and the gender of the horse is difficult to identify.

Table 4-10 Summary of Deer Activities at the South Wildlife Underpass

	Deer Groups	**Deer Approaching**	**Deer Crossing**	**Deer Retracting**
Southbound	50	478	474	4
Northbound	54	524	482	42
Unknown	9	27	Unknown	Unknown

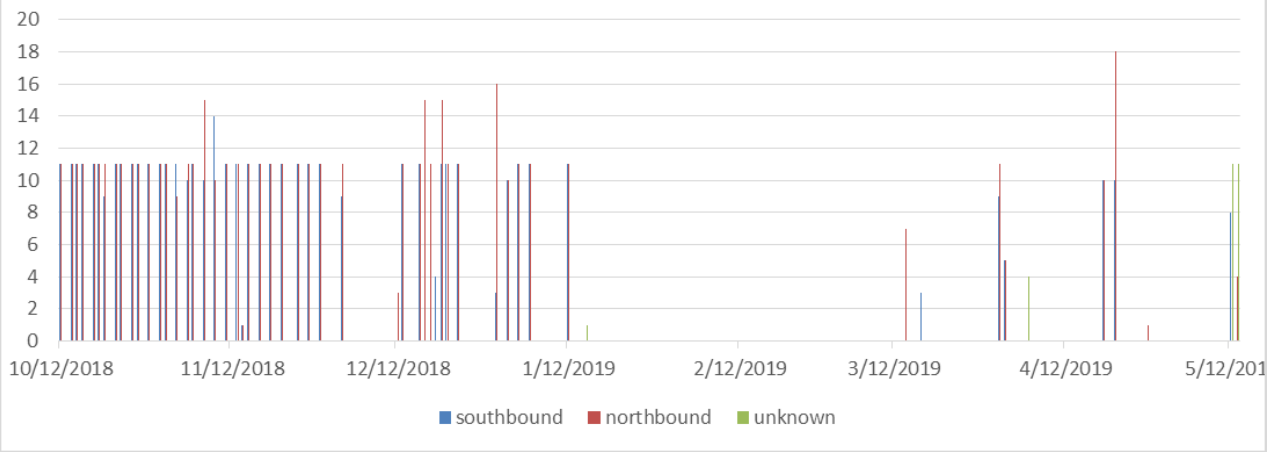

Figure 4-79 Total number of deer approaching at the South Wildlife Underpass by date

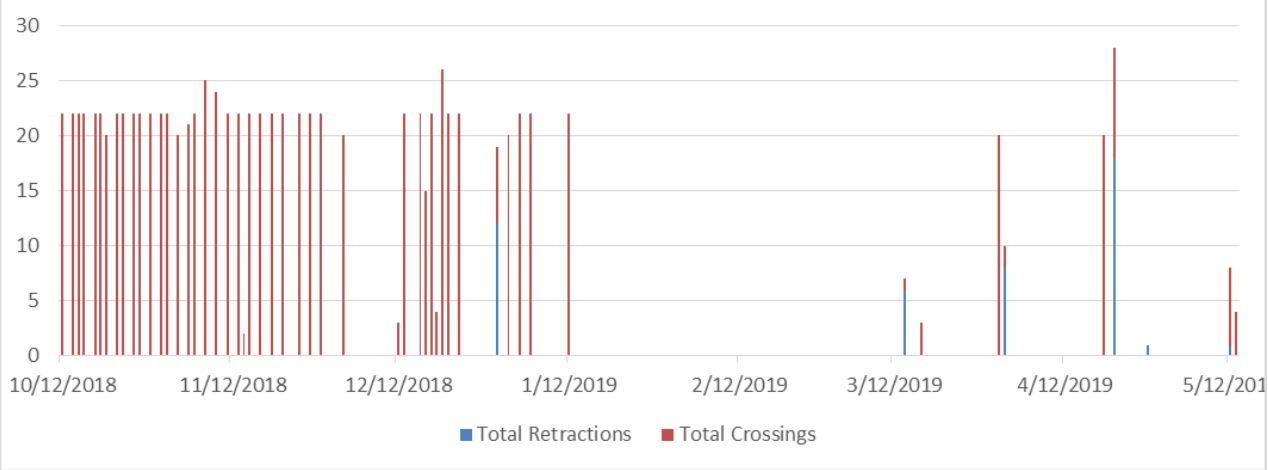

Figure 4-80 Comparison of deer crossing and deer retracting at the South Wildlife Underpass

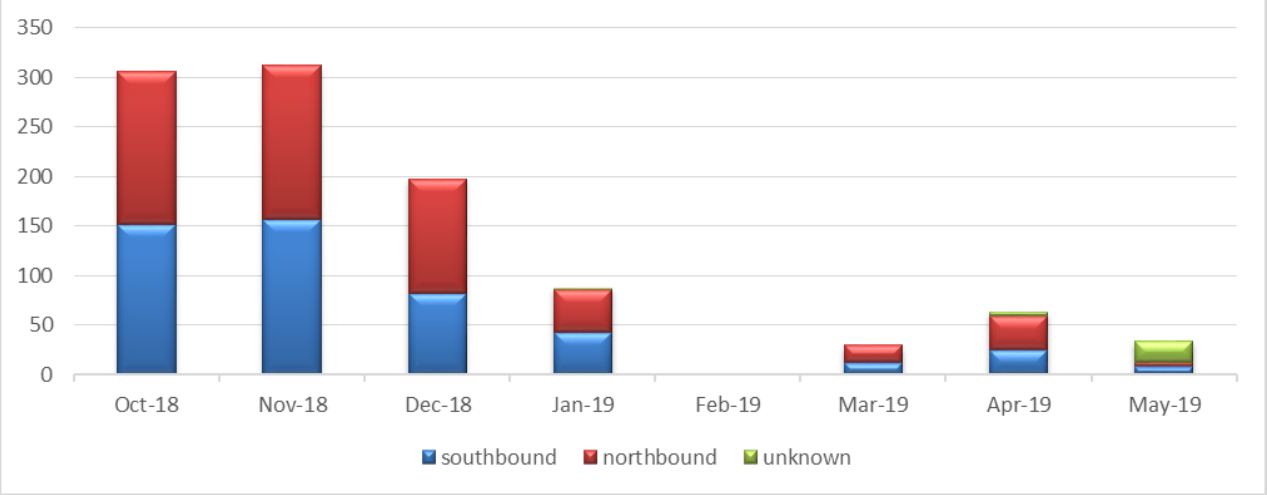

Figure 4-81 Wild horses approaching by month

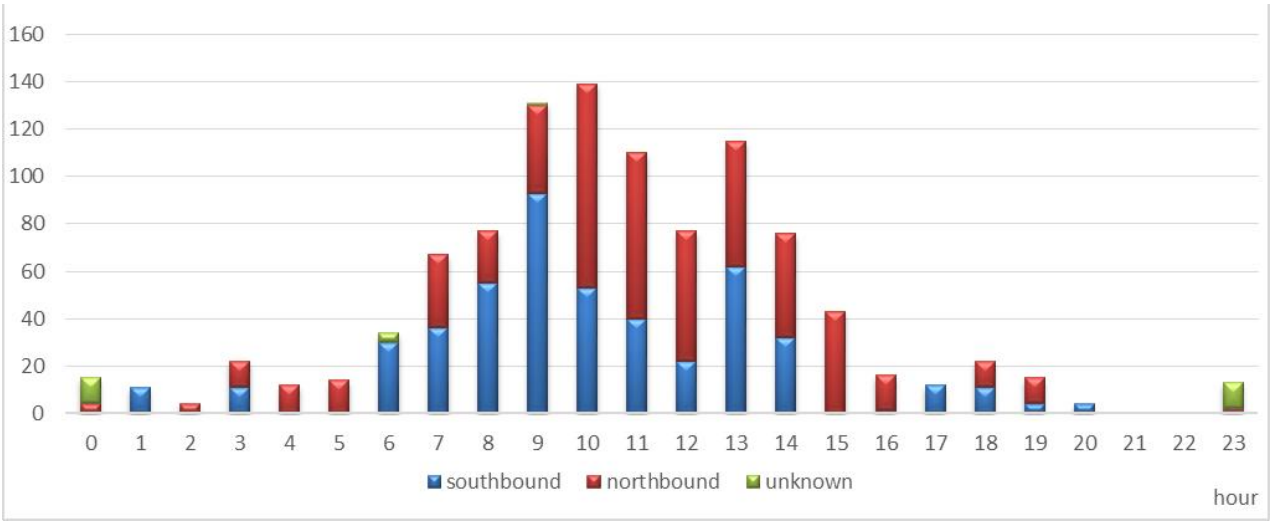

Figure 4-82 Wild horses approaching by time

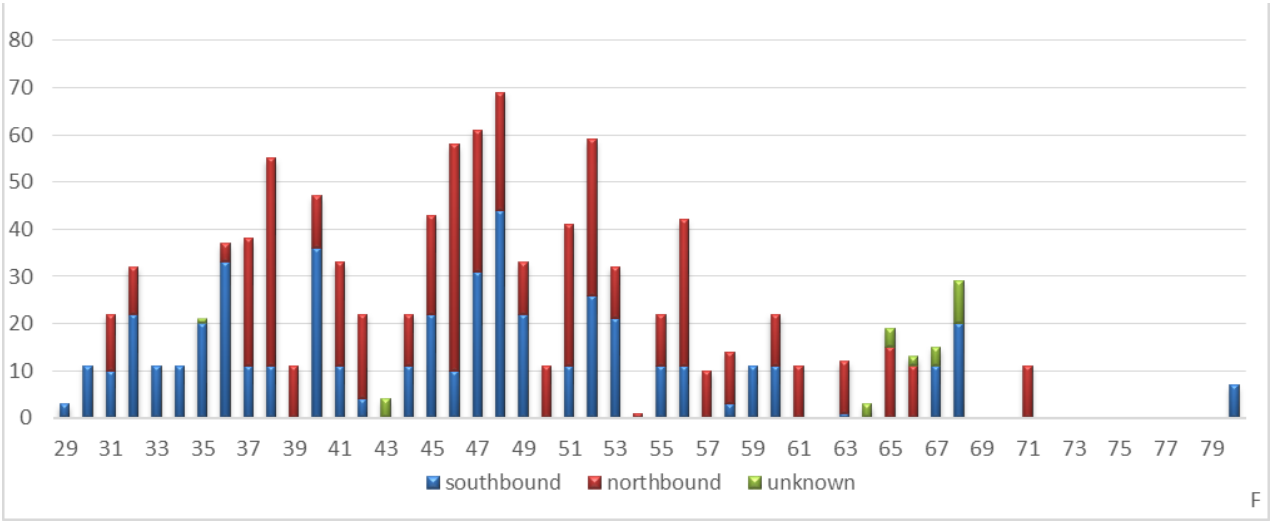

Figure 4-83 Wild horses approaching by temperature

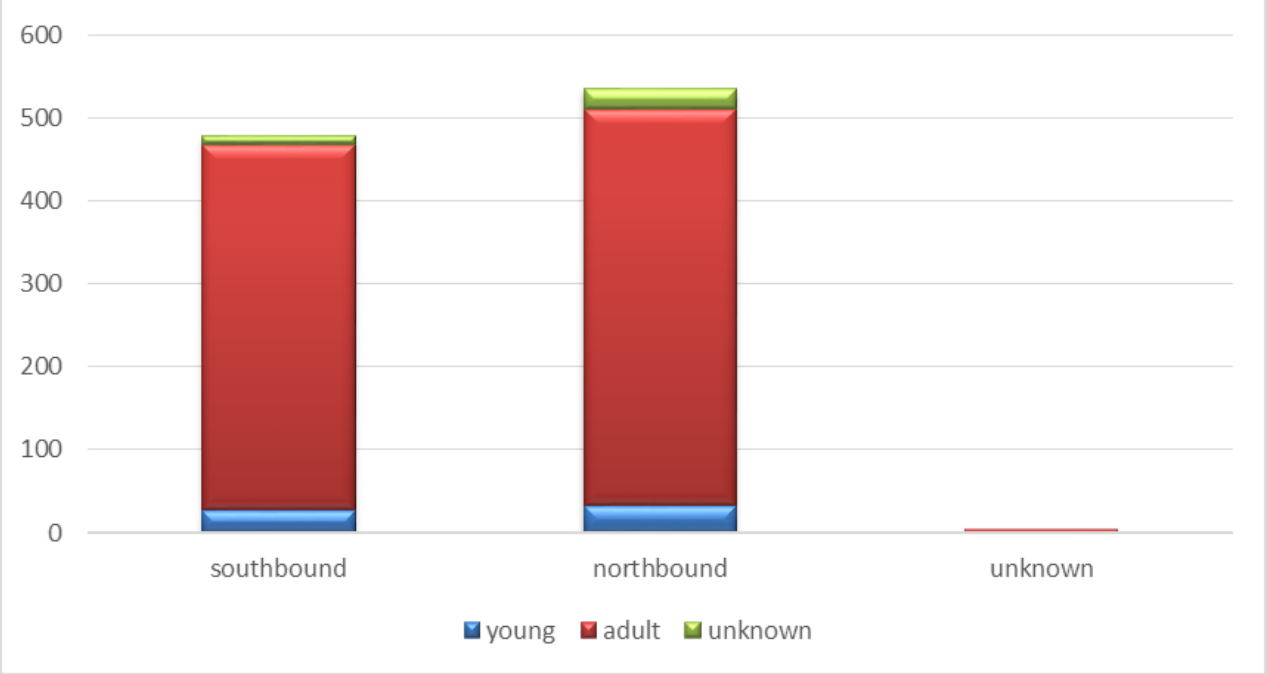

Figure 4-84 Wild horses approaching by age

CHAPTER 5 CONCLUSIONS AND RECOMMENDATIONS

The CATER team completed the following tasks in this project:

1. To use motion activated wildlife cameras to monitor humans and horses' usage of the crossing structures along I80 in the Pequop Moutain and along the USA Parkway.

2. To rename and group all pictures by using the picture metadata.

3. To document the captured motion activities into Microsoft Excel spreadsheets and Microsoft Access database.

4. To analyze usage of the underpass by wild and feral horses and humans.

UNR CATER performed the study to monitor how wildlife animals and humans use these overpasses and underpasses. This study used 21 motion-activated-wildlife cameras to automatically capture pictures of human and wildlife activities. This report documents major findings in the three migratory periods of 2018 spring, 2018 fall, and 2019 spring. Pictures were recorded by the automatic cameras at the eight crossing structures, including two 10' x 10' wildlife underpasses, two vehicle underpasses and two wildlife overpass in the Pequop Mountains, two wildlife underpasses in the USA Parkway area. A total of 140,009 effective pictures related to 3,686 wildlife and human records were captured in 2018 spring (3/21/2018 – 5/1/2018), 2018 fall (9/14/2018 – 12/31/2018), and 2019 spring (1/01/2019 – 5/13/19). Pictures were processed for renaming and grouping. Wildlife approaching/crossing records were extracted by picture review and stored in the Excel/Access database. The data analysis results are presented in this report, which can be summarized as the following:

Wildlife movements within the Pequop Mountains in Spring 2018, Fall 2018 and Spring 2019

Deer are the major wildlife species crossing the structures in the Pequop Mountains. There were many deer approaching the west wildlife underpass and the west wildlife overpass.

Wildlife movements along USA Parkway in Fall 2018 and Spring 2019

Wild horses are the major wildlife species crossing the structures in the USA Parkway area. There are more wilde horses approached the south wildlife underpass than the north wildlife underpass. Generally, the same groups crossed the structures twice every day, and there are more horses captured during 2018 fall period than 2019 spring period.

REFERENCES

Huijser, M.P., J. Fuller, M.E. Wagner, A. Hardy and A.P. Clevenger. Animal-vehicle collision data collection: a synthesis of highway practice. National Cooperative Highway Research Program Synthesis 370. Transportation Research Board, Washington, DC, 2007.

Forman, R. T. T. Estimate of the Area Affected Ecologically by the Road System in the United States. Conservation Biology 14: 31–35. doi:10.1046/j.1523-1739.2000.99299.x. 2000.

Clevenger, A. P. and M. P. Huijser. Wildlife Crossing Structure Handbook, Design and Evaluation in North America. - Publication No. FHWA-CFL/TD-11-003. Department of Transportation, Federal Highway Administration. Washington D.C., USA. 2011.

Appendix A- Data collection report example

NDOT01	West Wildlife Underpass in the Pequop Mountain
Dates of Data Collection:	10/12/18 - 11/16/18
Battery Life:	60%
Battery Change:	Yes
Picture Taken:	11456
Relevant Pictures:	11338

An example of a summary of collection data table is shown below:

Table 0-1 Summary of collected data sample

Card NO.	Location	Number of pictures	Relevant Pictures	Number of pictures in one motion	Remarks
NDOT 1	West Wildlife Underpass in the Pequop Mountain	11456	11338	10	
NDOT 2	West Vehicle Underpass in the Pequop Mountain	9020	6160	10	Grass movement affected the shooting effect
NDOT 3		1910	860	10	

Here is a camera layout example:

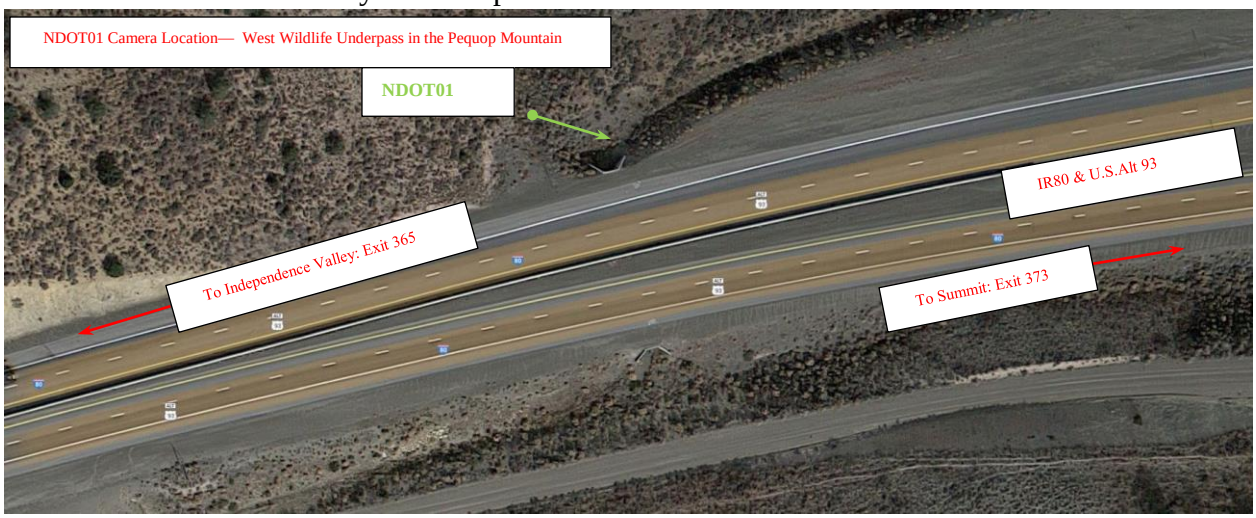

Figure 0-1 Camera layout at Underpass in the Pequop Mountain

Field Observations

Overall, no damages were observed on any of the cameras, each one is still in good condition. No flaws as of yet. No batteries were exchanged since the life still greater than 50%. All SD cards were switched out and replaced with new SD cards, and are labeled accordingly.

Camera NDOT01 has a sensitive detection issue. There were over 11,000 pictures

taken. There were a lot of animals that were taken from this camera, all of them are deer. Animals use this underpass almost every day, especially from 10/13 to 10/19, there are more deer cross the underpass than other days.

The battery reading for this cameras is very low. When the camera was opened, the readings showed 61% respectively, but when we proceeded to shut it off, switched SD cards and turned the camera back on, the battery reading then shows 99%. It could be the cooler temperatures that could be affecting the reading.

Suggest acquiring some cleaning supplies for the next visit. It may rain on the site this week and the dirt/dust collected on the camera lens may stain and clog it up and we would not get any good pictures.

Appendix B- Wildlife –Pic-Organizer user manual

The Wildlife-Pic-Organizer software main interface is as Figure 1. The left column works as a file explorer for a user to locate the folder with the pictures for processing. The right column window shows the selected folder contents. The guidance of using the software is as follows.

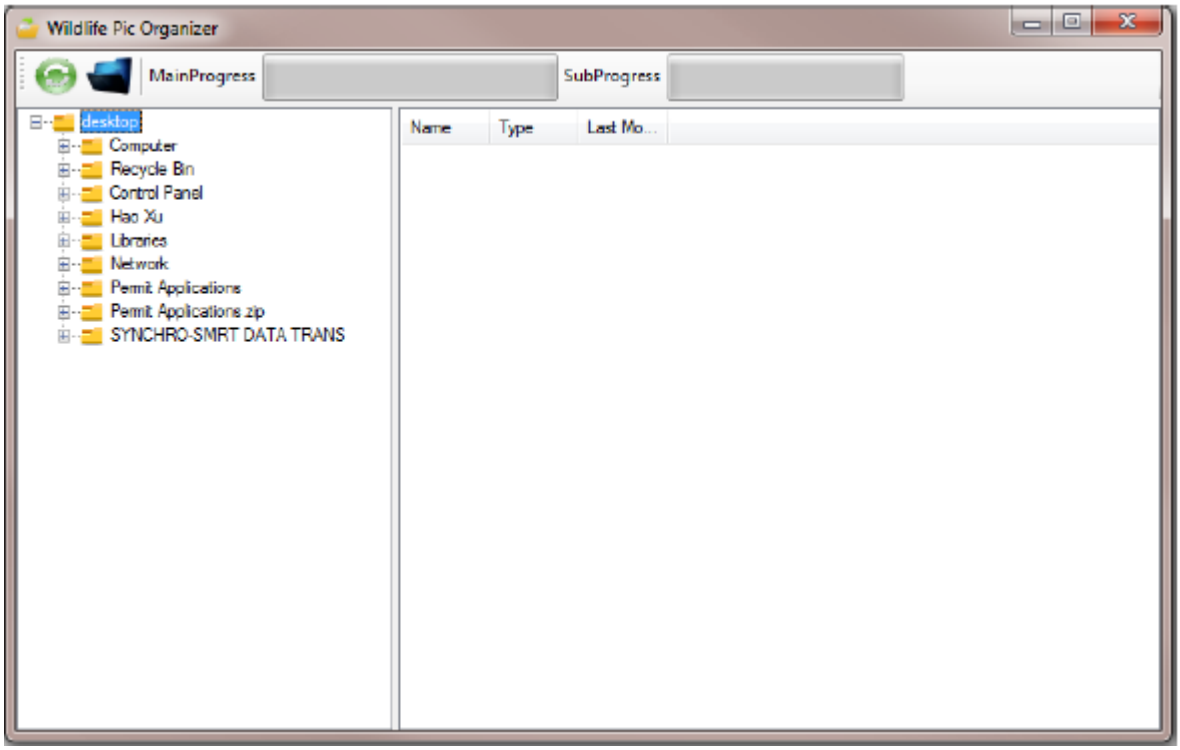

Figure 0-1 Main software window

Step 1

After collecting pictures from cameras in the field, the user needs to create a folder for each camera. Folders should be named with camera IDs (NDOT 01, NDOT 02 …). Pictures are then copied to corresponding folders, as shown in Figure 2 and Figure 3.

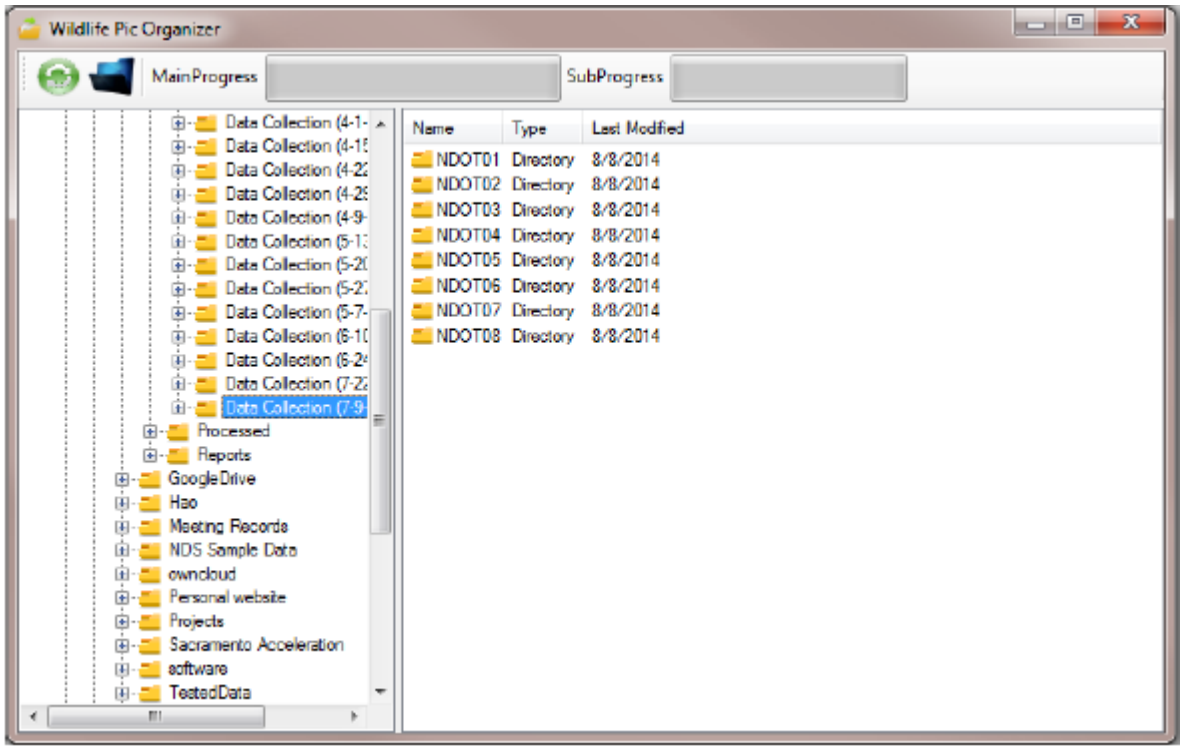

Figure 0-2 Camera folders named with camera IDs

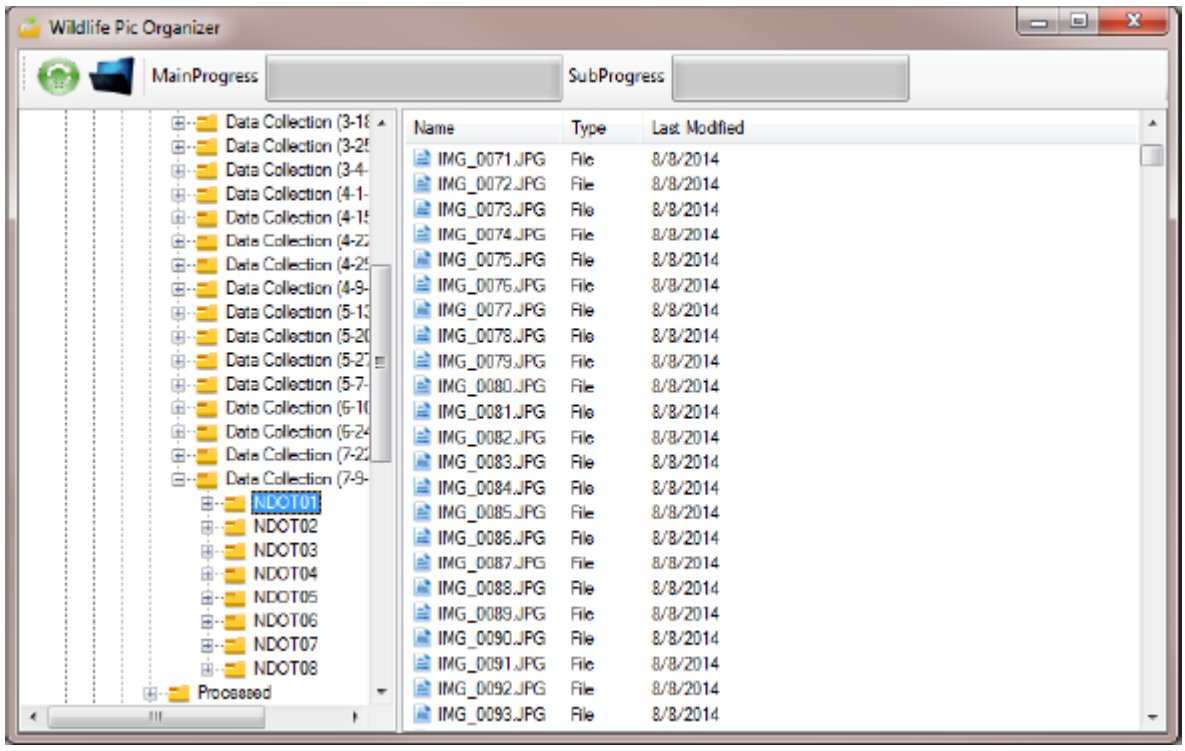

Figure 0-3 Pictures in a camera folder

Step 2

The user then selects the parent folder containing the camera folders in the left window of the software. When clicking the upper-left button as marked with the red circle in Figure 4, the software renames all pictures in each camera folder under the selected parent folder. The

picture name format is "Camera ID_Date_Time (sequenced picture ID of that series)". And during this procedure, the software shows the progress by the progress bars, as shown in Figure 5. The left progress bar shows the major process for all pictures and the right bar shows the sub process in each folder. The program uses the camera folder name, which is also the camera ID, as part of the picture name under it, so the user needs to make sure the folder name is correct. The renaming results are demonstrated in Figure 6.

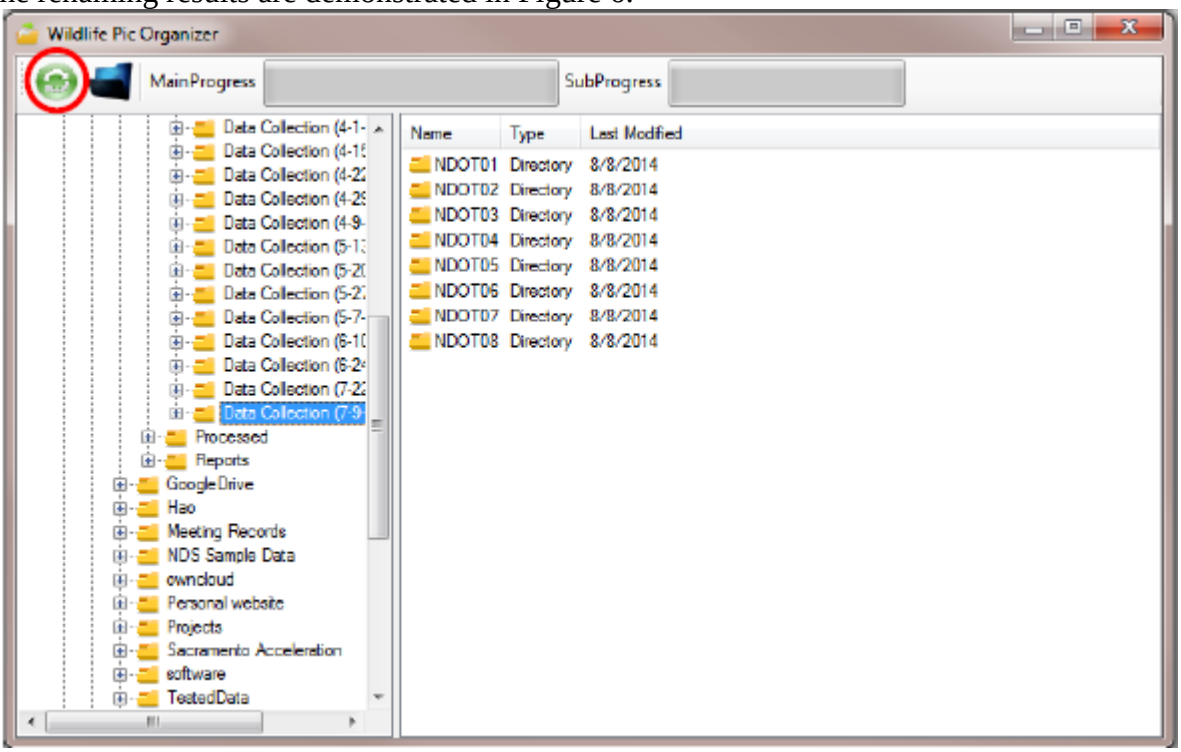

Figure 0-4 Selecting the parent folder of the camera folders and clicking the upper-left button for picture renaming

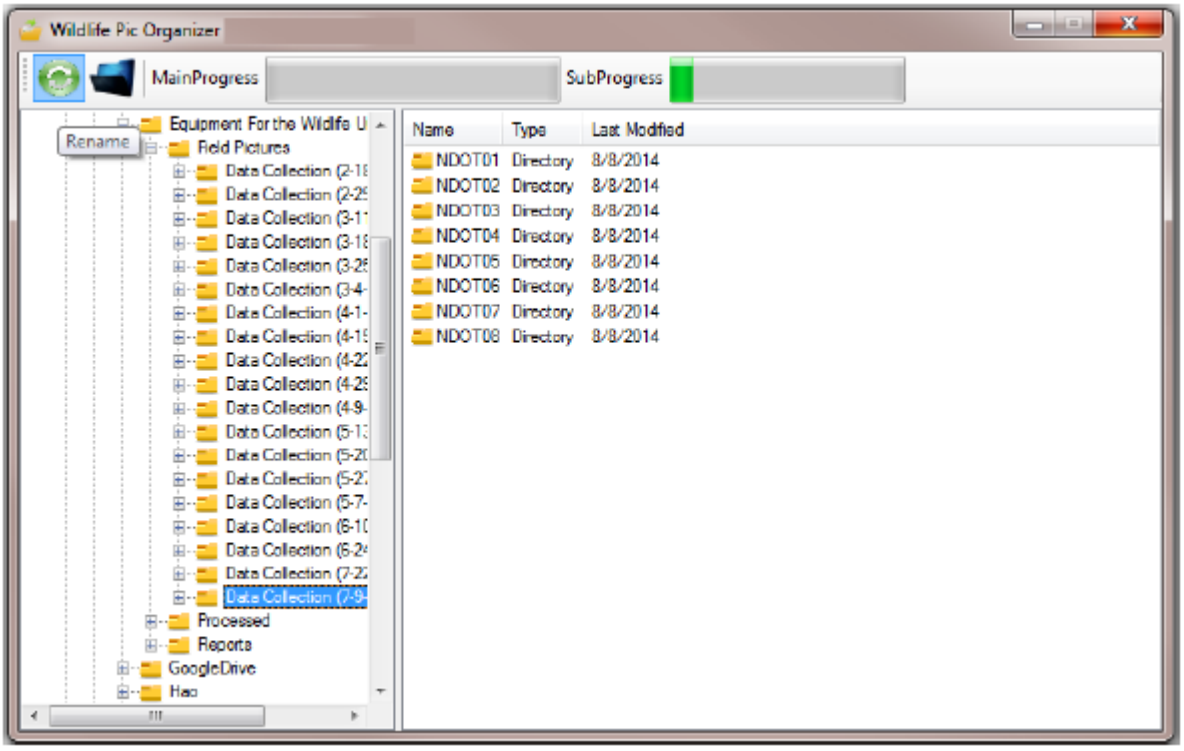

Figure 0-5 Renaming process

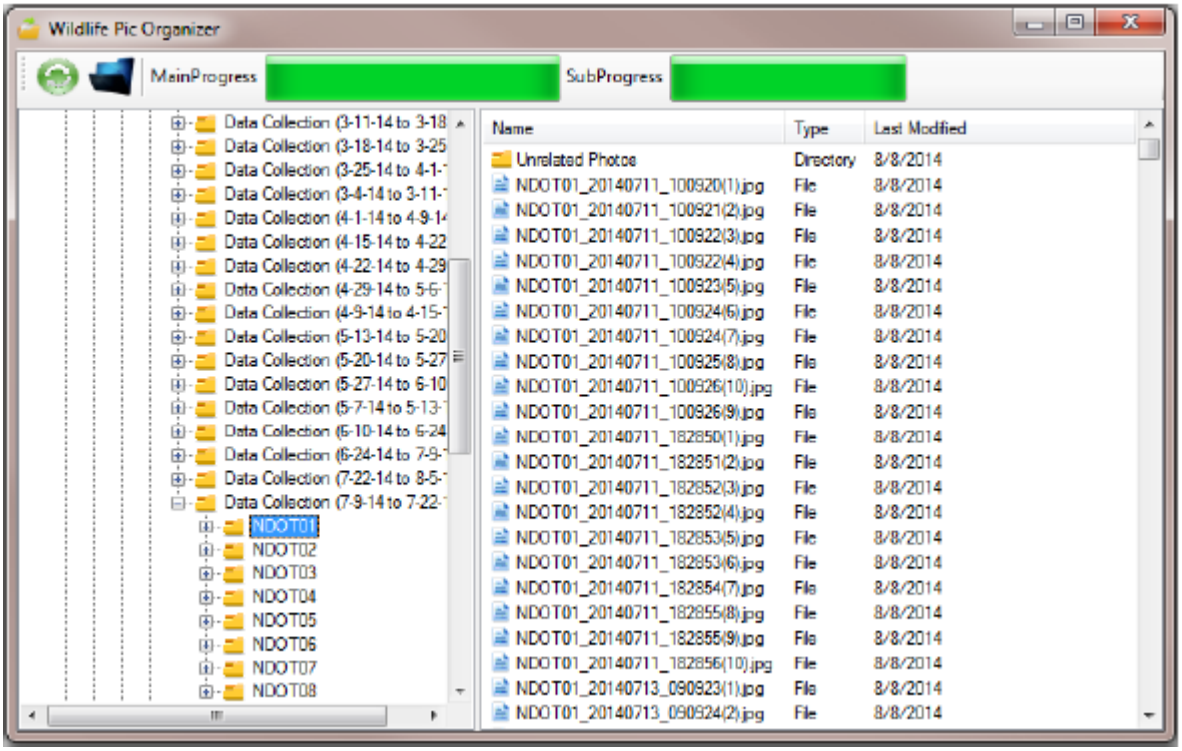

Figure 0-6 Renaming results

Step 3

After the renaming process, the user can click the "organizing function" button as marked with a red circle in Figure 7. The program creates a folder named "Grouped" and sub-folders for picture groups, as shown in Figure 8. A sub-folder is named by connecting the first

picture's capture-time (YearMonthDay_HourMinuteSecond) and the last picture's capture-time (YearMonthDay_HourMinuteSecond) with hyphens. For example, if the first picture of a sub-folder was captured at 18:01:04 on 07/08/2014 and the last picture was captured at 18:01:15 on the same day, the sub-folder's name is "20140708_180104-20140708_180115". All pictures are then copied into the corresponding folders based on the time metadata.

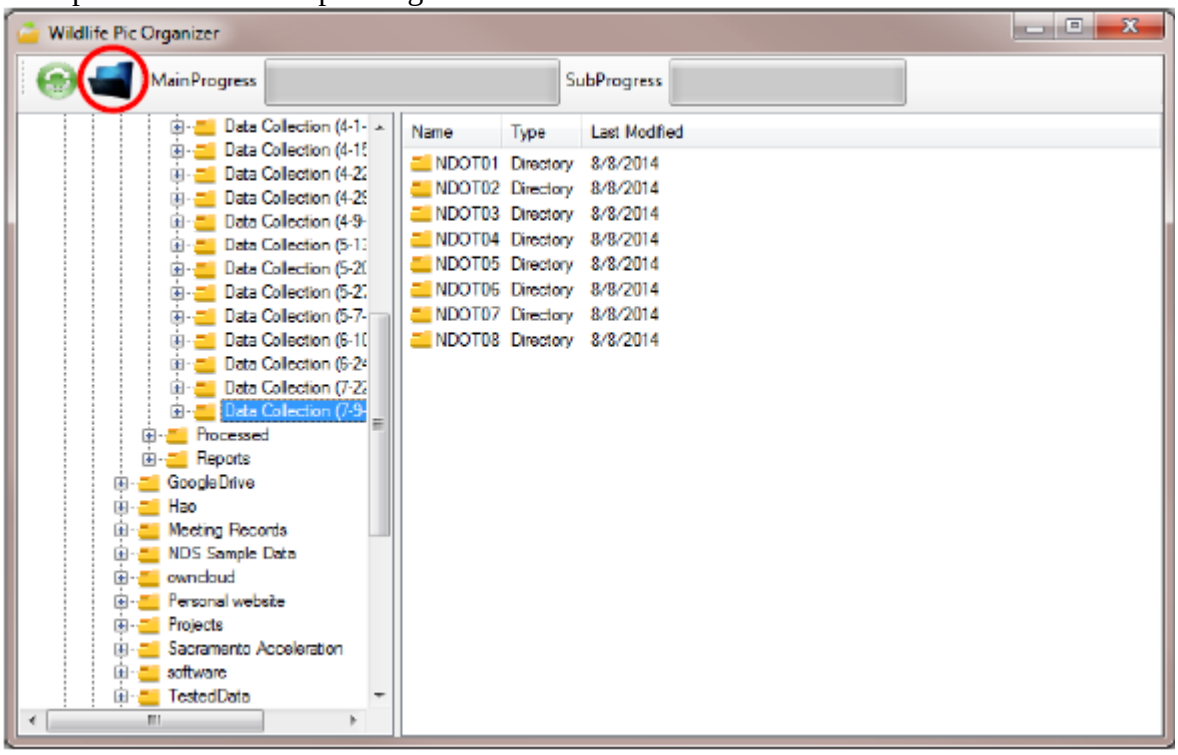

Figure 0-7 Selecting the parent folder of the camera folders and clicking the upper-left button for picture grouping

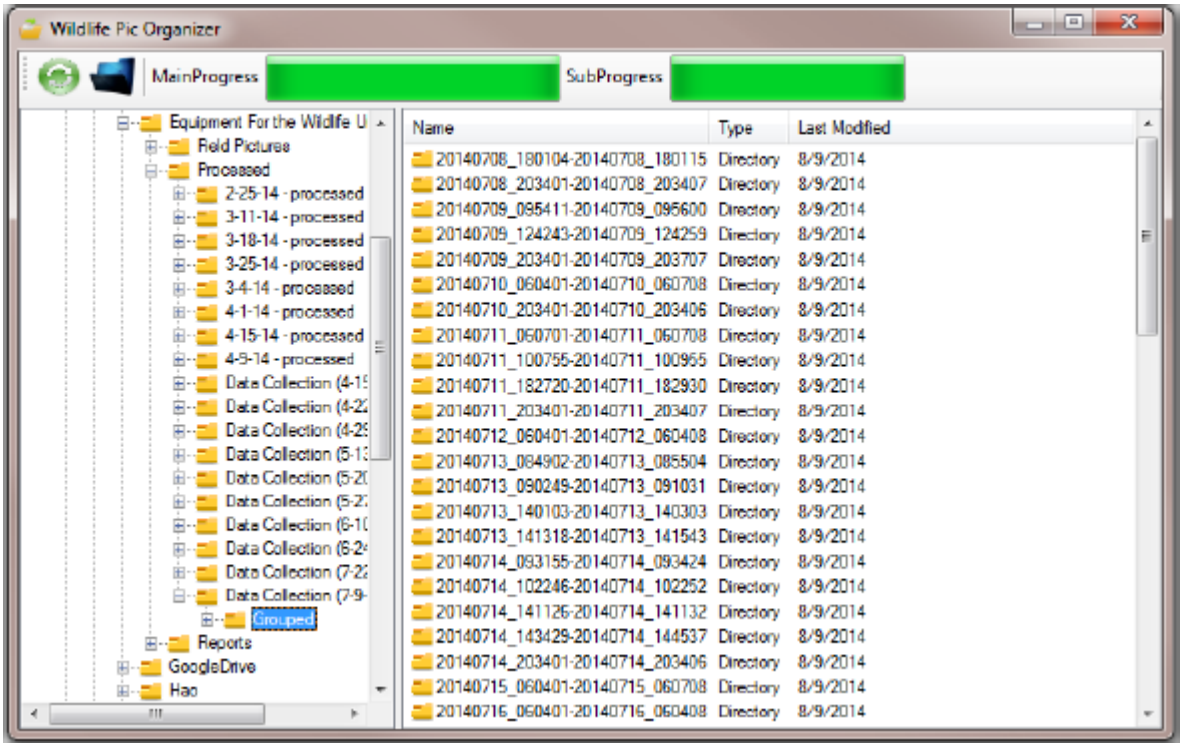

Figure 0-8 Grouping results

Nevada Department of Transportation
Kristina L. Swallow, P.E. Director
Ken Chambers, Research Division Chief
(775) 888-7220
kchambers@dot.nv.gov
1263 South Stewart Street
Carson City, Nevada 89712