



Monitoring Soundscapes to Investigate Interactions between Human Activities, Sonoran Pronghorn, and other Wildlife in Organ Pipe Cactus National Monument

Natural Resource Report NPS/ORPI/NRR—2019/1927



ON THE COVER

Two adult female Sonoran pronghorn drink at a water site (NPS)

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Natural Resource Report NPS/ORPI/NRR—2019/1927

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Abstract

This Natural Resource funded project was developed to help biologists at Organ Pipe gain insight into how sensitive park wildlife are influenced by human activity. More specifically, we were interested in the impact of cross border activity on the endangered Sonoran pronghorn. To accomplish this, we used a number of acoustical devices and behavioral observations. Organ Pipe biologists teamed with researchers at the University of Arizona and the NPS Natural Sounds and Night Skies Division. A University of Arizona graduate student in the M.S. Wildlife Conservation and Management program was chosen to lead this collaboration. In FY 2016 and 2017 Andrew developed the field methods, conducted field work, and began analysis of field data. During a preliminary trial period, the team deployed nine acoustic units throughout Organ Pipe and a protocol was developed to test for the effects of vehicle noise on pronghorn behavior. We deployed four motion-sensing cameras around a supplemental food and water site for Sonoran pronghorn along with a Larsen-Davis acoustic device and anemometer. We also deployed motion-sensing cameras at 100, 250, and 500 meters from the microphone. With this design we could quantify pronghorn behavior from video captured by the cameras at the site, while sound was recorded simultaneously, in the 30 minute window preceding a vehicles detection at known distances using the road cameras. We measured 26 motorized vehicles disturbances to Sonoran pronghorn from June 2017 through August 2017. We also measured the noise levels of motorized vehicles traveling from a range of distances to understand how motorized vehicle noise propagates across Organ Pipe. Because of logistical and technical difficulties associated with operating a large number of electronic devices in the desert in summer, we successfully captured only five instances of pronghorn-vehicle co-occurrence on both the microphone and cameras. Nevertheless we recorded 2.4 million 1-s (644 hours) measurements of continuous sound equivalents (LAeq) at the site during the study period which included 26 separate incursion by vehicles. We also successfully recorded pronghorn behavior on 15 separate days, scoring 783 individual pronghorn behaviors. This data revealed that pronghorn walked and ran more and stood less when a vehicle was approaching the site. Pronghorn also foraged 50% less at the feed trough and were five times more vigilant when a vehicle approached the site. The Larsen-Davis microphone measured significantly greater sound pressure from an approaching vehicle out to 250 m, but not at 500m. Most the sound measured at the site was associated with wind which followed a predictable 24-hr cycle peaking in mid-afternoon. Consequently, the microphone could only reliably detect vehicle noise a 2-3 minutes before a vehicle arrived and perhaps only seconds before or after a vehicle became visually detectable to pronghorn. Because large pronghorn behavioral responses were detected over the 30-min window preceding a vehicles detection on a traffic-camera on the road approaching the site, pronghorn must be either detecting vehicle noise at much greater distances than the Larsen-Davis unit or using other visual clues (e.g., dust columns) to detect and respond to approaching vehicles.

Introduction

The Sonoran pronghorn (*Antilocapra americana sonorensis*), currently the most endangered mammal on the Endangered Species List and in the U.S., is found only on federal lands in southwest Arizona, primarily the Cabeza Prieta National Wildlife Refuge (CPNWR) and Organ Pipe Cactus National Monument (ORPI). The U.S. pronghorn population is currently less than 400 individuals (Figure 1) and has experienced recent dramatic declines as in 2002 when only 18 individuals were counted during a biennial survey (Bright and Hervert 2005). Climate change, human activity and border-related disturbance are thought to negatively affect pronghorn survival, reproduction, range expansion, and connectivity between the U.S. population and a small Sonoran pronghorn population in Mexico (Bright and Hervert 2005, deVos and Miller 2005, Hervert et al. 2005, Christianson 2017). Consequently, public land managers in the region are tasked to manage visitors, agency activities and other resources to address pronghorn recovery. However, even baseline information on pronghorn number, their use of ORPI and surrounding areas, and their responses to environmental or human-caused stressors is severely lacking (https://www.fws.gov/southwest/es/arizona/Sonoran_Pronghorn.htm).

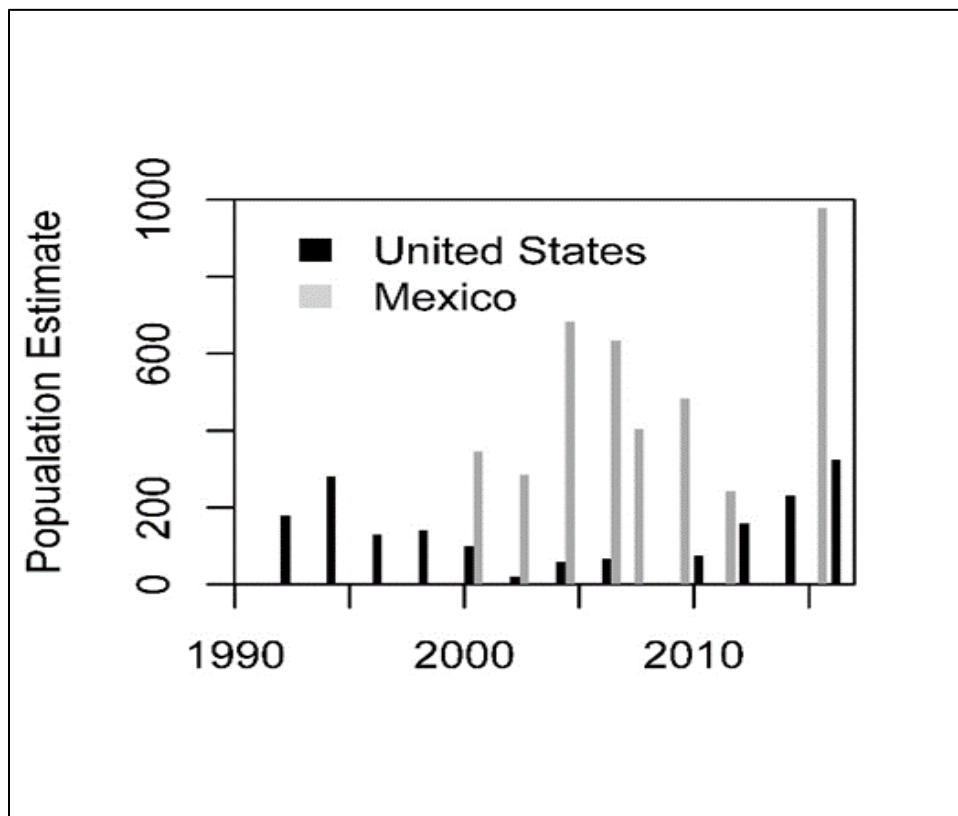


Figure 1. Aerial counts of pronghorn (adjusted for sightability of herd size) in Mexico and southwestern Arizona from 1990 to 2016. Captive breeding and supplemental feeding and watering of free-ranging pronghorn since 2002 have been used to restore U.S. pronghorn.

This project aimed to address key knowledge gaps critical to resource managers by describing how Sonoran pronghorn respond to vehicle noise.

Ungulates have long been known to respond to the immediate presence of humans in several ways that mimic antipredator responses to natural predators (Phillips and Alldredge 2000, Frid and Dill 2002, Ciuti et al. 2012). While the cues ungulates use to assess risk from humans are not entirely understood, visual, olfactory, and auditory cues from human activity seem to drive a suite of behavioral and physiological responses (Berger et al. 2001, Krausman et al. 2004, Beckmann and Berger 2005, Stankowich 2008). Understanding these responses and the cues that ultimately drive them is important because antipredator response can be costly, affecting survival and reproduction.

A common consequence of anti-human/antipredator responses is that many ungulates reduce their foraging effort, decreasing time spent harvesting or searching for preferred forage (Altendorf et al. 2001, Christianson and Creel 2008). Earlier behavioral observations of Sonoran pronghorn show only a marginal reduction in foraging time in response to disturbance, but a strong decline in traveling time and increase in time spent bedded (Krausman et al. 2004). This suggests that pronghorn may reduce the time they spend traveling between preferred forage patches, but are reluctant to decrease forage intake, and diet quality may suffer. In seasonal arid environments, the 'greenness' of forage plants (i.e., the photosynthetic capacity) strongly determines the nutrient content and digestibility of forages available to herbivores. We predict that one consequence of reduced foraging or travel time may be reduced selection for the most nutritious forage available. Where ungulates are provided supplemental forage that is of high quality, more direct tests of factors limiting access to nutrients can be tested (Brown et al. 1997).

Methods

We conducted an observational study to describe pronghorn behavioral responses to vehicle traffic, including the associated sound produced by vehicles. We positioned a Larson-Davis Model 831 sound-level meter and anemometer next to a pronghorn feed station and water guzzler where free-ranging Sonoran pronghorn were encountered every few days by an approaching vehicle when agency personnel visited the site to supply fresh alfalfa hay. The Charlie Bell feed station and water guzzler was first established in 2003 by the U.S. Fish and Wildlife Service Pronghorn Recovery Team on CPNWR to provide free-ranging Sonoran pronghorn access to forage and water during the hottest part of the year. Several years of monitoring this site by Recovery Team personnel shows it is well used each year by several free-ranging pronghorn. To maintain forage at the site, agency personnel stock feed troughs with alfalfa hay at least once per week. The site also contains an artificial water source that provides water pumped from a nearby well. Although this site lies adjacent to ORPI (Figure 2), we could not locate any similar site within ORPI where pronghorn could be reliably observed for this study. However, the terrain and vegetation at the Charlie Bell site are highly comparable to areas used by pronghorn in ORPI and it is likely the pronghorn we observed in this study use ORPI lands at some point in their lives. Collectively, ORPI and CPNWR form a contiguous region of designated wilderness occupied by the U.S. Sonoran pronghorn population.

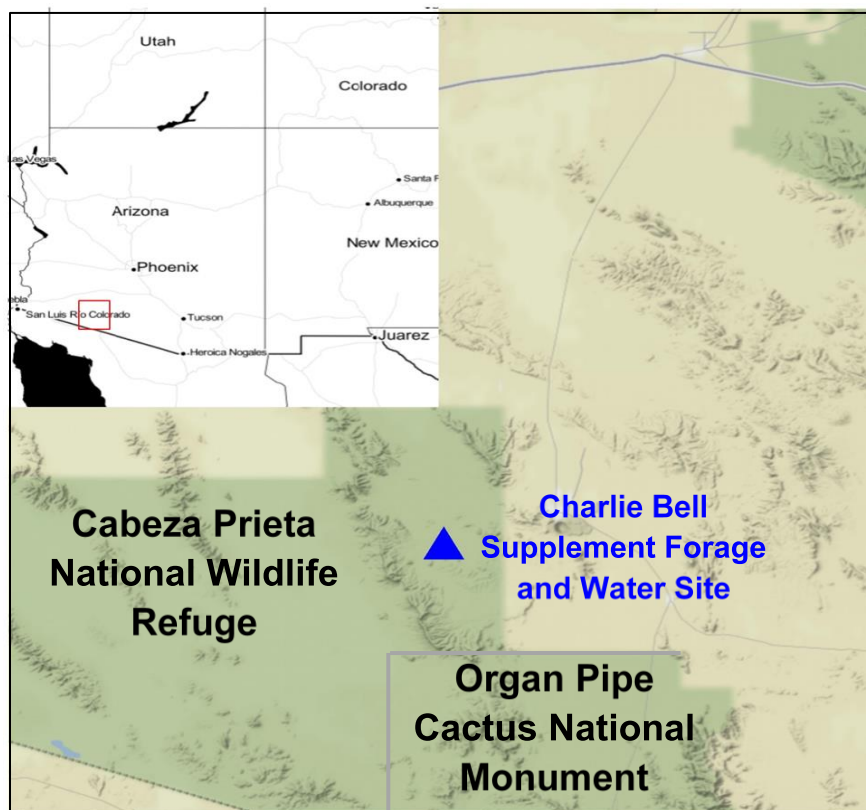


Figure 2. Location of Charlie Bell study site on Cabeza Prieta National Wildlife Refuge in southwestern Arizona.

Quantifying Human Activity

We positioned four motion-sensing cameras (Bushnell TrophyCam Aggressor) around the feed station and three cameras along the roadway leading to the feed station at 100 m, 250 m and 500 m away (Figure 3). Cameras along the roadway were attached to a 2-inch metal strut at a height of 30 cm with the camera facing north to minimize the frequency of over-exposed images and false-triggers caused by the sun. We collected the images from each camera at the end of the study. We noted when each photograph of an approaching vehicle was taken and at which camera. We also noted the type of vehicle and its direction of travel. The 100 m traffic camera was deployed from June 30, 2017 to September 7, 2017. The 250 m and 500 m cameras were deployed on July 10, 2007 through September 7, 2017.

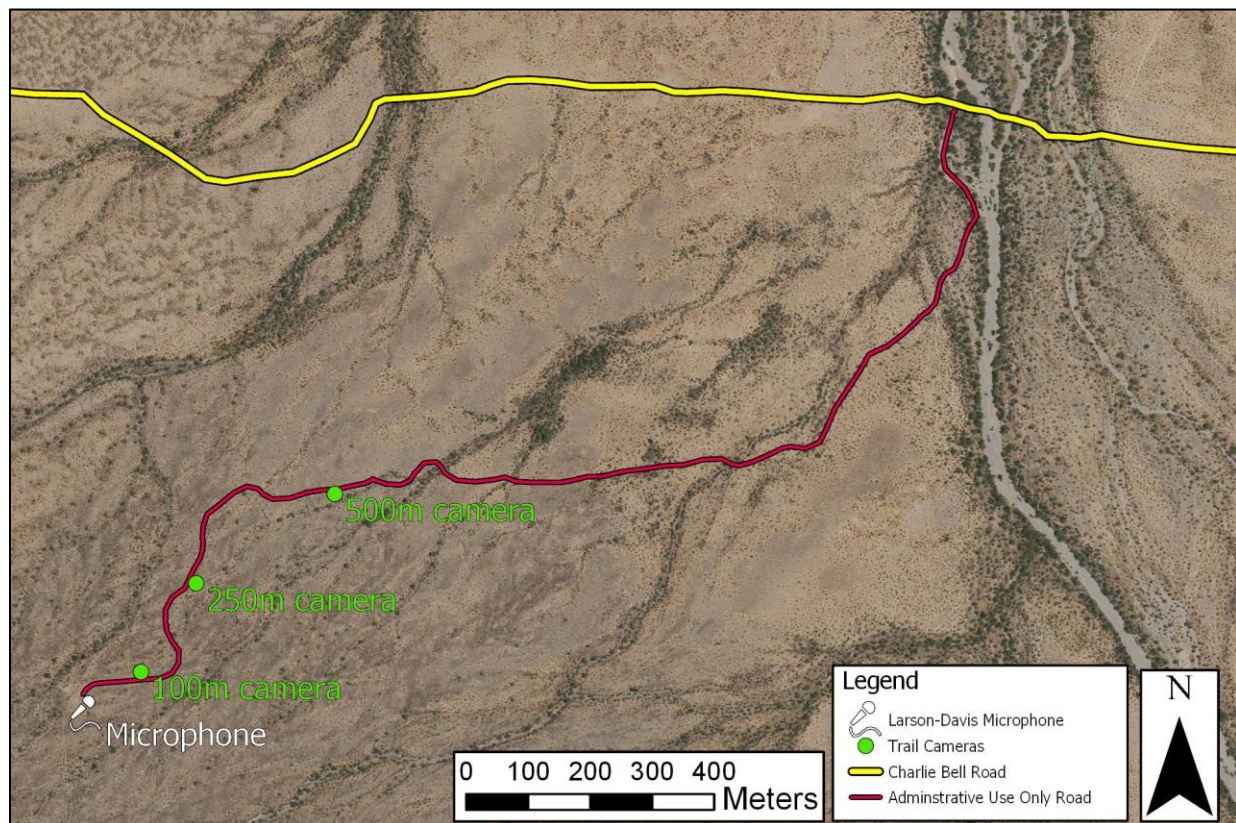


Figure 3. Overview of the pronghorn-vehicle sound study with the location of the microphone at the Charlie Bell feed station in Child's Valley, Cabeza Prieta National Wildlife Refuge and road cameras at 100, 250, and 500 m. The four additional cameras, anemometer, and Larsen-Davis acoustic recording device that were oriented around the pronghorn supplemental feed and water station are not shown.

Quantifying Pronghorn Behavioral Responses

The four motion-sensing cameras (Bushnell TrophyCam Aggressor) located around the Charlie Bell site, in addition to recording the presence of vehicles, also captured pronghorn visiting the artificial water and supplemental forage at the site from 7 June 2017 to 7 September 2017 (Figure 4). Cameras were set to record 60 s of video when triggered so that pronghorn behavior could be observed. Videos were collected and viewed at the end of the study. Whenever pronghorn were observed on a

video, the behavior of each individual pronghorn was scored every 10 s, potentially recording up to seven behaviors for each pronghorn in the video frame. Instantaneous records of pronghorn behavior were recorded by pausing the video at exact 10-s intervals. At each 10-s interval, pronghorn posture was recorded for each individual as standing, walking, running, or bedded. Additional behaviors included vigilant (standing or bedded pronghorn only), grazing, browsing, ruminating, grooming, fighting, at feed, at water, obscured, other, or none. We also noted the age-sex class (young, adult of unknown sex, female, male, unknown), herd position (interior, exterior), markings (radio-collared, ear-tagged, uncollared) and shading (overcast, in shade, in direct sunlight) of each pronghorn.

Using the time of vehicle detections from the three road cameras, we scored all pronghorn behavior captured on the four feed station cameras 30 minutes before the vehicle detection and 30 minutes after the vehicle departed. In addition to recording the behavior around vehicle detections we also recorded behavior of pronghorn at feed stations when no vehicles were detected, scoring behavior on temporally-adjacent days in the clock-hour closest to the most recent vehicle detection.

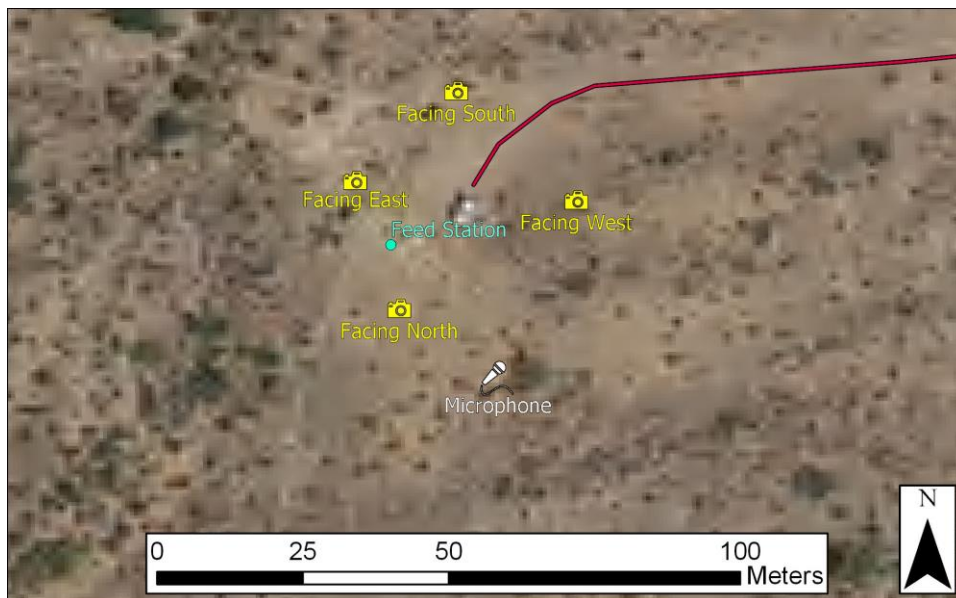


Figure 4. Study design at Charlie Bell feed station in Child's Valley, Cabeza Prieta National Wildlife Refuge. Four Bushnell TrophyCam Aggressor motion-sensor cameras oriented around and facing the feed station to capture 60-s video clips with approximately a 1-minute lag between clips. These four cameras captured the moment vehicles arrived at the site and pronghorn behavior around the feed station. The first road cameras, 100 m from the site is also shown (also Bushnell TrophyCam Aggressor) set to record images (not video) when triggered by a vehicle passing by on the road. The position of the Larsen-Davis microphone and anemometer is indicated by the green arrow.

Acoustic Monitoring

The Larson-Davis microphone and anemometer were deployed adjacent to the feed station from June 7, 2017 to September 8, 2017 following NPS protocols for site placement and set up (Figure 5). The acoustic device and camera units were set to GPS time and checked regularly. Internal clocks of each device drifted by varying degrees. The time was checked on all devices each week and the seconds of

drift were noted (seconds the device was ahead (+) or behind (-) GPS time) before resetting clocks to GPS time (Appendix 1). The Larson-Davis unit (Model 831) recorded sound pressure level from 10 Hz to 20000 Hz every second and also calculated the continuous sound equivalent for the cumulative A-weighted sound level. We used this A-weighted continuous sound equivalent (LAeq) to describe sound at the site.

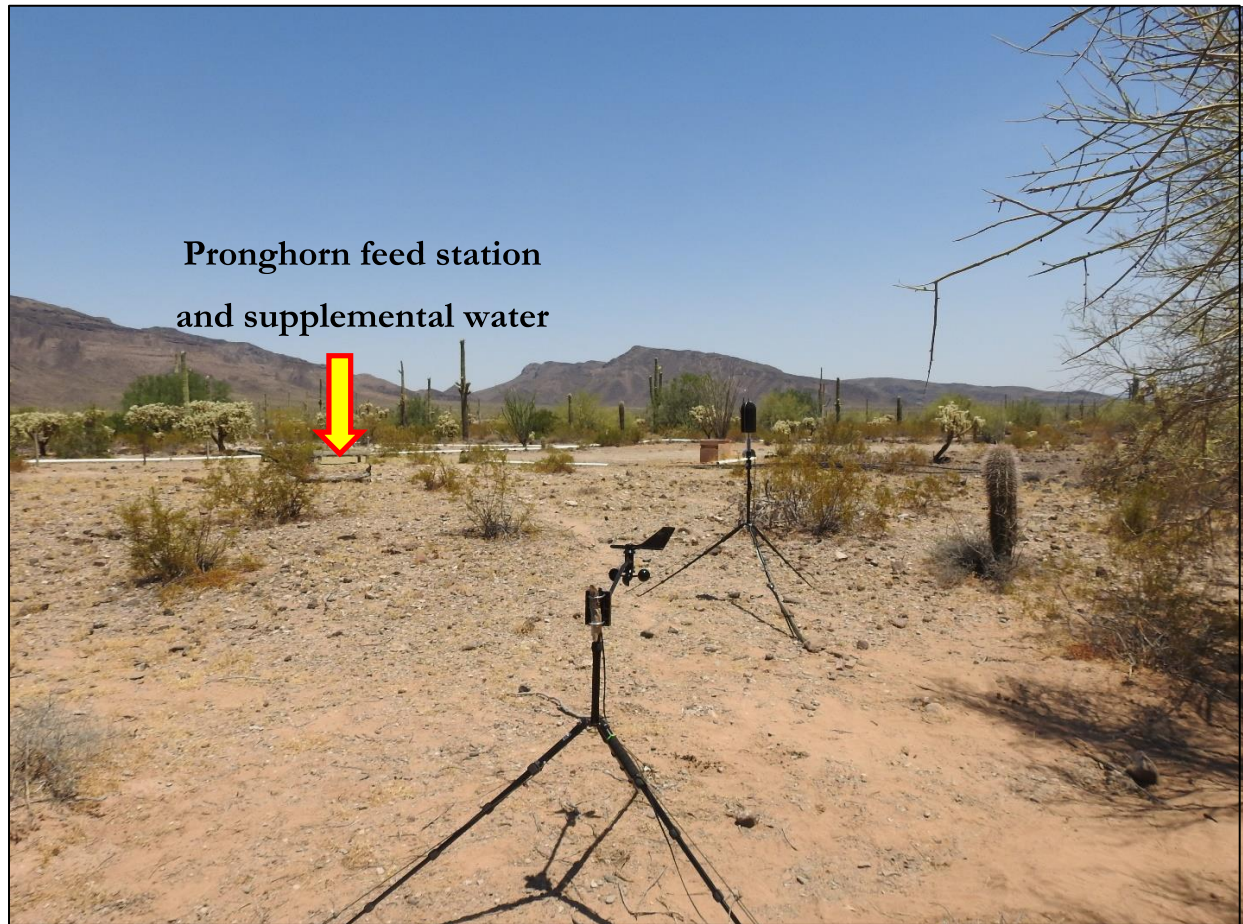


Figure 5. Larsen-Davis Model 831 sound-level meter and anemometer in relation to the Charlie Bell pronghorn feed station and supplemental water.

Data Analysis

The Larson-Davis unit organized all data in daily subsets of sound recordings with the LAeq for each second of the day (86,400 records per day). We organized these records into a single dataset in R (R Core Team 2018) for analysis alongside pronghorn behavioral scoring and vehicle traffic records from motion-sensing camera data.

We fit linear models of sound data ($\log LA_{eq}$), modelling the effects of wind speed. We also considered cyclical patterns fitting cosinor terms ($\sin 2\pi \cdot \text{decimal day}$ and $\cos 2\pi \cdot \text{decimal day}$) to test for 24 hr cycling in LAeq levels. Because the level of sound data was large (over 2.4 million observations), we subsampled sound data for several analyses, taking every 1000th observation.

Results

We encountered significant logistical and technological challenges at all stages of this project. A primary challenge involved locating a tractable site that (1) could be repeatedly visited by vehicles during the study (Figure 6), (2) was frequently used by pronghorn and (3) allowed for multiple site installations of cameras and microphones at minimal risk of vandalism or tampering. Only one site, the Charlie Bell feed station and guzzler, proved tractable. Further, we found significant challenges in maintaining operational status in the Larsen Davis acoustic devices while simultaneously maintaining the network of motion sensing cameras at the site. Finally, time drift in cameras resulted in temporal misalignment of behavioral videos and sound recordings. The result of these challenges was small sample sizes due to a shorter-than-expected data collection period and lost or poor quality data. We successfully described pronghorn behavior in the 30 minutes prior to the arrival of a vehicle at the site in only 5 instances (Figure 7). Subsequently, we failed to collect sufficient data to strongly test for effects of vehicle noise on Sonoran pronghorn. Nevertheless, we did collect substantial data for a nominal exploration of this relationship.



Figure 6. A vehicle 250 m away from the Charlie Bell site as detected by the 250 m road camera.

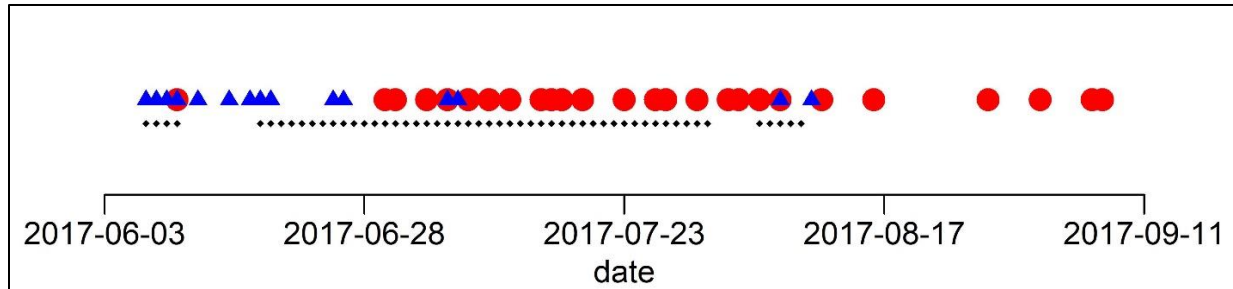


Figure 7. Timeline of vehicle detections (red circles) and pronghorn behavioral observations (blue triangles) scored at the Charlie Bell site during this study. Pronghorn and vehicles overlapped within 30 minutes of each other in only 5 instances. Days when the Larson-Davis acoustic device was successfully operating are also shown (black points).

We observed large numbers of pronghorn using the Charlie Bell site during the study. However, most of this pronghorn use occurred at night while vehicles always approached the site during the day (Figure 8). We recorded pronghorn behavior from video captured at the site on 15 separate days during the study; five of these behavioral observations occurred within 30 minutes of a vehicle approaching the site. The other 10 days of observation provide a control to test for differences in pronghorn behavior associated with vehicle approaches (Figure 8). We recorded a total of 783 pronghorn behaviors, mostly walking and standing (98.5% of observations) (Table 1). The proportion of pronghorn walking versus standing was significantly higher when a vehicle was approaching than when a vehicle never approached (0.288 vs 0.245, Fisher's exact test odds ratio = 0.606, $P = 0.008$). Running was a posture rarely observed; nevertheless, running pronghorn were detected more frequently when a vehicle was approaching than when no vehicle approached (odds ratio = 6.65, $P = 0.020$).

Pronghorn activity also differed depending on whether a vehicle's arrival was imminent or not (Table 2). Not surprisingly, pronghorn were five times more vigilant when a vehicle was arriving at the site than when not (0.362 vs 0.071, odds ratio 7.358, $P < 0.001$). Consequently, the proportion of pronghorn feeding at the supplemental forage trough was less when vehicles approached than when not (0.500 vs 0.740, odds ratio = 0.352, $P < 0.001$). Pronghorn grazed little on native vegetation around the site. However, the proportion of pronghorn grazing on native vegetation was three times higher when vehicles were approaching the site than when not (0.095 vs 0.032, odds ratio = 3.14, $P = 0.009$).

Wind was the dominant sound recorded at the guzzler. Initial modeling to detect daily cycles in sound levels suggested an annual pattern. However, including wind speed in our model of LAeq largely removed this rhythm. Wind speed explained fully half of the variation in sound level measured at the site (r^2 from linear model = 0.554). Wind showed a predictable daily pattern described by the cosinor model, being low in the mornings and picking up in late afternoons (Figure 9). While sound from wind dominated the site, sound from approaching vehicles could be reliably measured from up to 250 m away (Figure 10). Sound pressure levels (LAeq) when vehicles were detected at the site, at the 100 m traffic camera, or the 250 m traffic camera, were noticeability higher

than sound levels measured at the site 1 hour before or after a vehicle arrived or at mean vehicle arrival times on days when no vehicles approached (Figure 8).

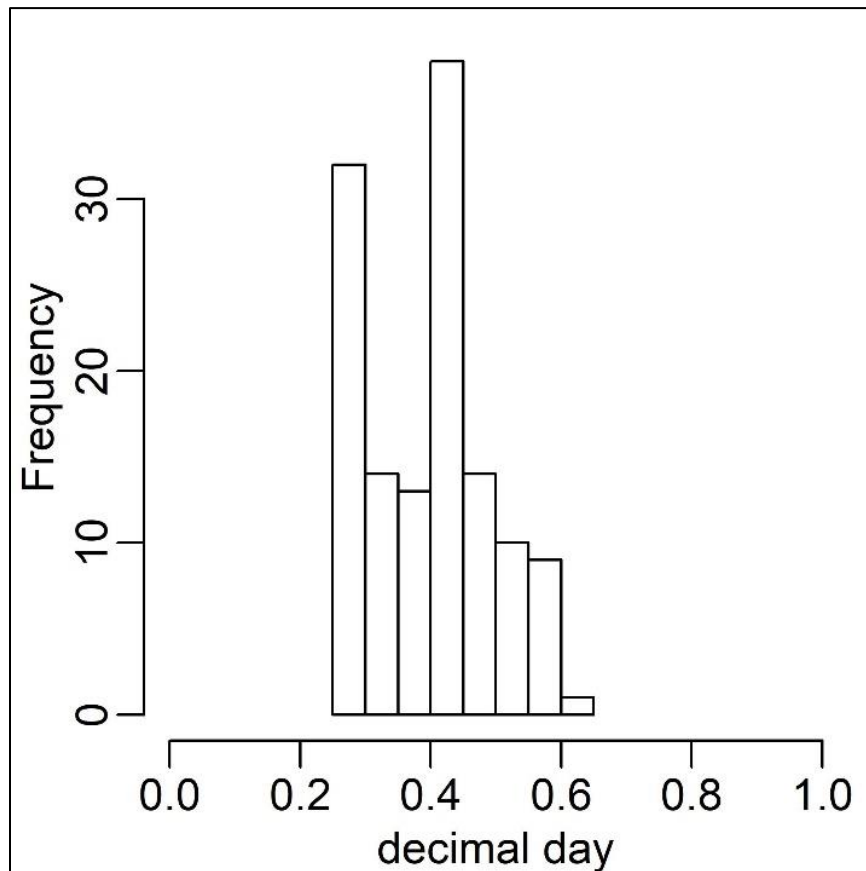


Figure 8. Vehicle detections at the three motion sensing cameras placed on the road approaching the Charlie Bell Site located 100 m, 250 m, and 500 m from the site. All vehicle detections occurred during daylight hours. Peaks at 0800 and 1200 occurred due to scheduled visits by agency personnel and study personnel to maintain the site.

Table 1. Sonoran pronghorn postures observed on video from motion-sensing cameras at the Charlie Bell site in the 30 minutes preceding a vehicle's arrival at the site versus comparable 30 minute intervals with no vehicle arrival.

Posture	Vehicle approaching	Vehicle absent
Bedded	0	5
Running	5	2
Standing	148	452
Walking	60	111

Table 2. Sonoran pronghorn behaviors observed on video from motion-sensing cameras at the Charlie Bell site in the 30 minutes preceding a vehicle's arrival at the site versus comparable 30 minute intervals with no vehicle arrival.

Behavior	Vehicle Approaching	Vehicle Absent
Feeding at trough	58	322
Grazing	11	14
Obscured	0	53
Vigilant	42	31
All other behaviors	5	15

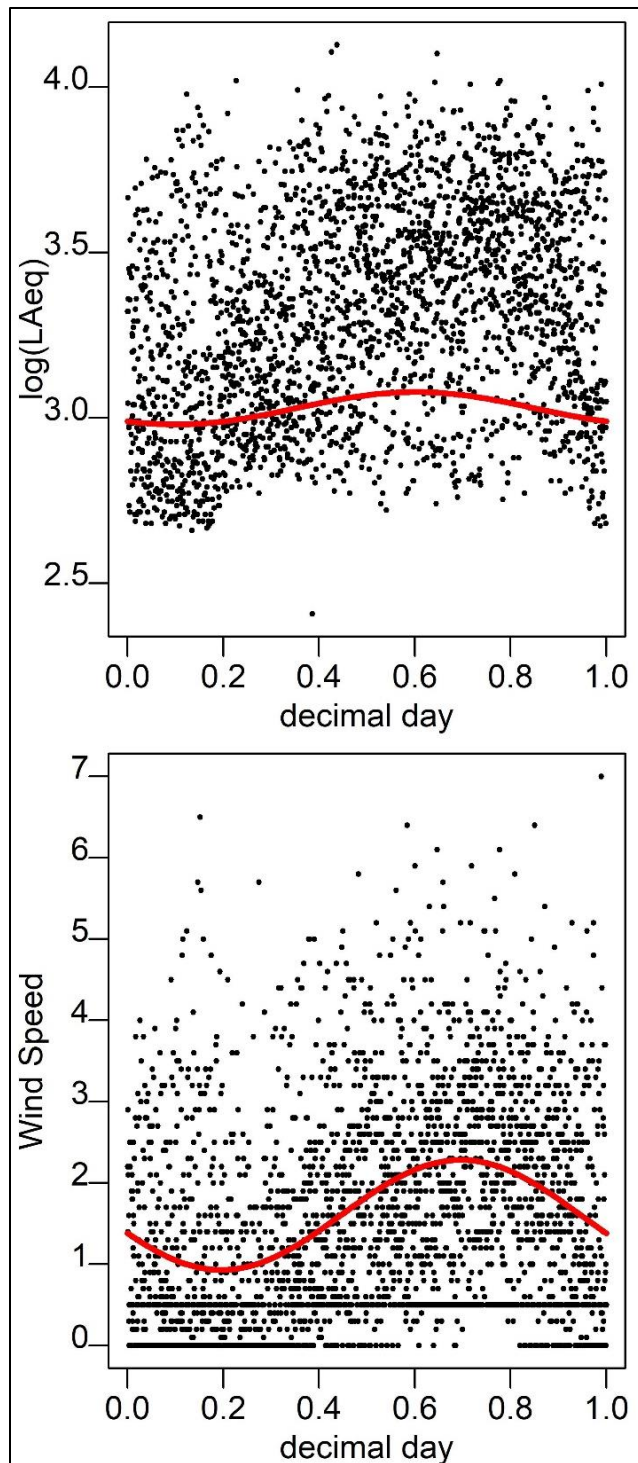


Figure 9. Sound level (top panel) at the Charlie Bell site from June 30 to August 8, 2017 showed no clear daily rhythm once wind speed was included in a linear model of LAeq (A-weighted equivalent continuous sound measured over 1-s intervals from 10 to 10000 Hz at 1/3 steps) with cosinor terms to test for a daily cycle. Wind speed (lower panel) showed a clear 24-hour cycle that accounts for much of the variation in sound recorded during the study. For graphical clarity and computational speed, only every 1000th observation was used.

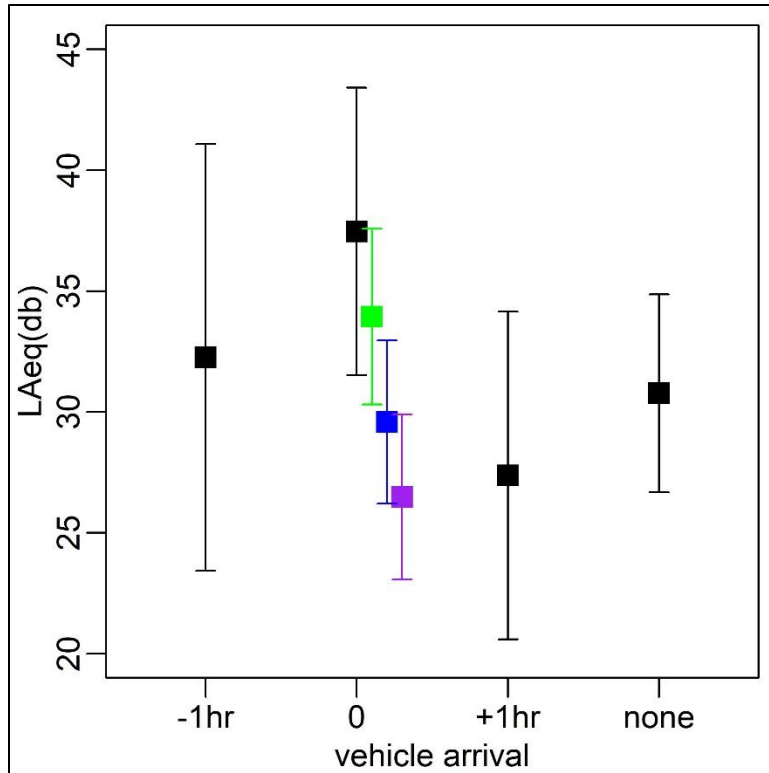


Figure 10. Mean continuous equivalent sound pressure level ($\pm 95\%$ CI) at the Charlie Bell site 1 hr before, during, and 1 hr after a vehicle arrived. Sound pressure level measured at the mean time of vehicle detections (08:42) but on days with no vehicle detections is also shown (none). Sound levels measured when vehicles were detected at the 100 m (green), 250 m (blue), and 500 m (purple) traffic cameras is shown at the 0 mark. Sound was measured at 1-s intervals and mean sound over the nine 1-s intervals surrounding a vehicle detection was used to estimate sound pressure level at each detection.

Discussion

Sonoran pronghorn, like many ungulates, respond to human activity in ways that appear to mimic responses to natural predators (Byers 1997). Here, we found differences in posture and activity between pronghorn approached by a vehicle and those not approached that included increased vigilance and decreased feeding. The finding of decreased feeding is significant as it implies Sonoran pronghorn, although not hunted for at least the past 50 years, still view humans as a significant risk. Others have shown some species will mount antipredator responses that carry very large costs that can reduce survival, lower reproduction, and negatively impact population growth rates (Peckarsky et al. 1993, Ruxton and Lima 1997, Zanette et al. 2011, Christianson and Creel 2014). It seems likely that pronghorn may experience significant costs from vehicle interactions throughout their range.

We experienced challenges in temporally aligning our sampling such that pronghorn behavior and sound could both be measured with and without vehicles approaching at similar times of day. The changes in pronghorn behavior we quantified in 30-minute windows preceding a vehicle's arrival in five instances suggest sound may play an important role. First, differences in sound pressure were detected when a vehicle was 100 m and 250m from the microphone but not 500 m. This represents a timespan of approximately 1 and 3 minutes, respectively, before an approaching vehicle would arrive at the site (i.e. the endpoint of a 30-min behavioral observation). Because pronghorn showed significant behavioral differences over the 30-minute window, it is likely they responded to vehicles at distances (several km) beyond the range of detection by the Larson-Davis unit. It is likely pronghorn were responding to sound produced by vehicles over these long distances. However, approaching vehicles often raise large dust clouds, and the reflected sunlight of vehicle metal and glass can travel long distances through the sparse vegetation in this landscape. Vision in addition to sound may remain an important tool for detecting and responding to human activity in pronghorn.

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Appendix A. Time checks on Bushnell TrophyCam Aggressors and the Larson-Davis microphone used in this study.

Table A-1. Time drift in cameras and Larson-Davis unit that needed to be accounted for to ensure synchrony when aligning vehicle distance, sound level, and pronghorn behavior.

Last Check	New Check	Device	Type	Time drift
7 June 2017	10 June 2017	AG013 facing west	feed station camera	4 s faster
7 June 2017	10 June 2017	AG015 facing south	feed station camera	1 s faster
7 June 2017	10 June 2017	AG008 facing east	feed station camera	1 s slower
7 June 2017	10 June 2017	AG016 facing north	feed station camera	13 s faster
7 June 2017	18 June 2017	Larson-Davis unit	microphone	3 s faster
10 June 2017	18 June 2017	AG013 facing west	feed station camera	18 s faster
10 June 2017	18 June 2017	AG015 facing south	feed station camera	10 s faster
10 June 2017	18 June 2017	AG008 facing east	feed station camera	5 s faster
10 June 2017	18 June 2017	AG016 facing north	feed station camera	9 s faster
18 June 2017	30 June 2017	Larson-Davis unit	microphone	1 s faster
18 June 2017	30 June 2017	AG013 facing west	feed station camera	15 s faster
18 June 2017	30 June 2017	AG015 facing south	feed station camera	10 s faster
18 June 2017	30 June 2017	AG008 facing east	feed station camera	1 min 16 s slower
18 June 2017	30 June 2017	AG016 facing north	feed station camera	12 s faster
30 June 2017	10 July 2017	Larson-Davis unit	microphone	3 s faster
30 June 2017	10 July 2017	AG013 facing west	feed station camera	49 s slower
30 June 2017	10 July 2017	AG015 facing south	feed station camera	8 s faster
30 June 2017	10 July 2017	AG008 facing east	feed station camera	2 s slower
30 June 2017	10 July 2017	AG016 facing north	feed station camera	11 s faster
10 July 2017	27 July 2017	Larson-Davis unit	microphone	1 s faster
10 July 2017	27 July 2017	AG013 facing west	feed station camera	21 s faster
10 July 2017	27 July 2017	AG015 facing south	feed station camera	17 s slower
10 July 2017	27 July 2017	AG008 facing east	feed station camera	8 s faster
10 July 2017	27 July 2017	AG016 facing north	feed station camera	12 s faster
27 July 2017	5 August 2017	AG013 facing west	feed station camera	10 s faster
27 July 2017	5 August 2017	AG015 facing south	feed station camera	6 s faster

Last Check	New Check	Device	Type	Time drift
27 July 2017	5 August 2017	AG008 facing east	feed station camera	0
27 July 2017	5 August 2017	AG016 facing north	feed station camera	5 s faster
5 August 2017	7 Sept 2017	AG013 facing west	feed station camera	No check
5 August 2017	7 Sept 2017	AG015 facing south	feed station camera	40 s faster
5 August 2017	7 Sept 2017	AG008 facing east	feed station camera	6 s faster
5 August 2017	7 Sept 2017	AG016 facing north	feed station camera	11 s slower
30 June 2017	10 July 2017	AG001 100 m	road camera	3s slower
10 July 2017	7 Sept 2017	AG001 100m	road camera	4 m 30 s slower
10 July 2017	7 Sept 2017	AG009 250 m	road camera	1 m 6 s faster
10 July 2017	7 Sept 2017	AG010 500 m	road camera	58 s faster

Appendix B. Vehicle detections from motion-sensing cameras placed along the road approaching the Charlie Bell Site at 500 m, 250 m, and 100 m.

Table B-1. Vehicle detections by three road traffic cameras at 100 m, 250 m, and 500 m, from a pronghorn feed station and Larson-Davis unit.

camera_id	cam_dist_m	image_id	date	time	vehicle	notes
ag001	100	06300047.jpg	30_june_2017	13:54:42	ua_silver	–
ag001	100	07010077.jpg	1_july_2017	11:50:27	az_gf_gray	–
ag001	100	07010081.jpg	1_july_2017	12:05:53	az_gf_gray	–
ag001	100	07040187.jpg	4_july_2017	10:22:29	az_gf_gray	–
ag001	100	07040188.jpg	4_july_2017	10:37:33	az_gf_gray	–
ag001	100	07060237.jpg	6_july_2017	9:26:47	az_gf_gray	–
ag001	100	07060238.jpg	6_july_2017	10:15:44	az_gf_gray	–
ag001	100	07080376.jpg	8_july_2017	9:04:28	az_gf_gray	–
ag001	100	07080377.jpg	8_july_2017	9:09:36	az_gf_gray	–
ag001	100	07100408.jpg	10_july_2017	6:46:49	ua_silver	–
ag001	100	07100409.jpg	10_july_2017	10:00:04	ua_silver	–
ag009	250	07100007.jpg	10_july_2017	11:37:00	ua_silver	–
ag010	500	07120020.jpg	12_july_2017	11:30:06	ua_silver	–
ag009	250	07120018.jpg	12_july_2017	11:31:25	ua_silver	–
ag001	100	07120039.jpg	12_july_2017	11:32:04	ua_silver	–
ag001	100	07120053.jpg	12_july_2017	13:13:06	ua_silver	–
ag009	250	07120019.jpg	12_july_2017	13:14:45	ua_silver	–
ag010	500	07120022.jpg	12_july_2017	13:16:18	ua_silver	–
ag010	500	07150041.jpg	15_july_2017	11:04:20	az_gf_gray	–
ag009	250	07150036.jpg	15_july_2017	11:06:01	az_gf_gray	–
ag001	100	07150104.jpg	15_july_2017	11:06:27	az_gf_gray	–
ag001	100	07150106.jpg	15_july_2017	11:37:07	az_gf_gray	–
ag009	250	07150037.jpg	15_july_2017	11:38:54	az_gf_gray	–
ag010	500	07150042.jpg	15_july_2017	11:40:21	az_gf_gray	–
ag010	500	07160045.jpg	16_july_2017	8:25:13	az_gf_gray	–
ag009	250	07160038.jpg	16_july_2017	8:26:52	az_gf_gray	–

camera_id	cam_dist_m	image_id	date	time	vehicle	notes
ag001	100	07160111.jpg	16_july_2017	8:27:06	az_gf_gray	—
ag001	100	07160112.jpg	16_july_2017	8:33:19	az_gf_gray	—
ag009	250	07160039.jpg	16_july_2017	8:35:37	az_gf_gray	—
ag010	500	07160046.jpg	16_july_2017	8:37:06	az_gf_gray	—
ag010	500	07170049.jpg	17_july_2017	6:12:28	az_gf_gray	—
ag009	250	07170041.jpg	17_july_2017	6:13:50	az_gf_gray	—
ag001	100	07170120.jpg	17_july_2017	6:13:42	az_gf_gray	—
ag001	100	07170121.jpg	17_july_2017	6:15:52	az_gf_gray	—
ag009	250	07170042.jpg	17_july_2017	6:17:44	az_gf_gray	—
ag010	500	07170050.jpg	17_july_2017	6:18:53	az_gf_gray	—
ag010	500	07190055.jpg	19_july_2017	9:46:23	az_gf_gray	2_trucks
ag009	250	07190046.jpg	19_july_2017	9:47:54	az_gf_gray	1st_truck
ag001	100	07190139.jpg	19_july_2017	9:47:40	az_gf_gray	2_trucks
ag009	250	07190047.jpg	19_july_2017	9:48:11	az_gf_gray	2nd_truck
ag001	100	07190140.jpg	19_july_2017	10:21:53	az_gf_gray	—
ag001	100	07190141.jpg	19_july_2017	10:22:53	az_gf_gray	—
ag009	250	07190048.jpg	19_july_2017	10:24:12	az_gf_gray	—
ag009	250	07190049.jpg	19_july_2017	10:24:56	az_gf_gray	—
ag010	500	07190056.jpg	19_july_2017	10:25:36	az_gf_gray	—
ag010	500	07190057.jpg	19_july_2017	10:26:12	az_gf_gray	—
ag010	500	07230069.jpg	23_july_2017	9:14:41	az_gf_gray	—
ag009	250	07230057.jpg	23_july_2017	9:16:10	az_gf_gray	—
ag001	100	07230191.jpg	23_july_2017	9:15:27	az_gf_gray	—
ag001	100	07230192.jpg	23_july_2017	9:44:14	az_gf_gray	—
ag009	250	07230058.jpg	23_july_2017	9:46:54	az_gf_gray	—
ag010	500	07230070.jpg	23_july_2017	9:55:19	az_gf_gray	—
ag010	500	07260083.jpg	26_july_2017	10:12:18	az_gf_gray	—
ag009	250	07260065.jpg	26_july_2017	10:13:56	az_gf_gray	—
ag001	100	07260290.jpg	26_july_2017	10:12:19	az_gf_gray	—
ag001	100	07260291.jpg	26_july_2017	10:14:42	az_gf_gray	—
ag009	250	07260066.jpg	26_july_2017	10:18:19	az_gf_gray	—

camera_id	cam_dist_m	image_id	date	time	vehicle	notes
ag010	500	07260084.jpg	26_july_2017	10:19:43	az_gf_gray	—
ag010	500	07270086.jpg	27_july_2017	8:10:12	ua_silver	—
ag009	250	07270069.jpg	27_july_2017	8:12:04	ua_silver	—
ag001	100	07270300.jpg	27_july_2017	8:10:32	ua_silver	—
ag001	100	07270311.jpg	27_july_2017	13:42:46	ua_silver	—
ag009	250	07270070.jpg	27_july_2017	13:46:29	ua_silver	—
ag010	500	07270087.jpg	27_july_2017	13:47:57	ua_silver	—
ag010	500	07300090.jpg	30_july_2017	7:19:39	az_gf_gray	—
ag009	250	07300079.jpg	30_july_2017	7:21:09	az_gf_gray	—
ag001	100	07300331.jpg	30_july_2017	7:19:04	az_gf_gray	—
ag001	100	07300332.jpg	30_july_2017	7:41:37	az_gf_gray	—
ag009	250	07300080.jpg	30_july_2017	7:45:31	az_gf_gray	—
ag010	500	07300091.jpg	30_july_2017	7:46:53	az_gf_gray	—
ag010	500	08020099.jpg	2_aug_2017	10:44:30	az_gf_gray	—
ag009	250	08020084.jpg	2_aug_2017	10:45:56	az_gf_gray	—
ag001	100	08020351.jpg	2_aug_2017	10:43:41	az_gf_gray	—
ag001	100	08020352.jpg	2_aug_2017	10:49:21	az_gf_gray	—
ag009	250	08020085.jpg	2_aug_2017	10:53:42	az_gf_gray	—
ag010	500	08020100.jpg	2_aug_2017	10:55:25	az_gf_gray	—
ag010	500	08030101.jpg	3_aug_2017	10:16:04	az_gf_gray	—
ag009	250	08030089.jpg	3_aug_2017	10:17:45	az_gf_gray	—
ag001	100	08030353.jpg	3_aug_2017	10:15:24	az_gf_gray	—
ag001	100	08030354.jpg	3_aug_2017	10:36:10	az_gf_gray	—
ag009	250	08030090.jpg	3_aug_2017	10:40:24	az_gf_gray	—
ag010	500	08030102.jpg	3_aug_2017	10:41:45	az_gf_gray	—
ag010	500	08050106.jpg	5_aug_2017	10:17:37	ua_silver	—
ag009	250	08050098.jpg	5_aug_2017	10:19:16	ua_silver	—
ag001	100	08050358.jpg	5_aug_2017	10:16:57	ua_silver	—
ag001	100	08050359.jpg	5_aug_2017	12:28:43	ua_silver	—
ag009	250	08050099.jpg	5_aug_2017	12:32:56	ua_silver	—
ag010	500	08050107.jpg	5_aug_2017	12:34:10	ua_silver	—

camera_id	cam_dist_m	image_id	date	time	vehicle	notes
ag010	500	08070111.jpg	7_aug_2017	6:21:08	az_gf_gray	—
ag009	250	08070105.jpg	7_aug_2017	6:22:19	az_gf_gray	—
ag001	100	08070364.jpg	7_aug_2017	6:19:50	az_gf_gray	—
ag001	100	08070365.jpg	7_aug_2017	6:51:11	az_gf_gray	—
ag009	250	08070106.jpg	7_aug_2017	6:55:57	az_gf_gray	—
ag010	500	08070112.jpg	7_aug_2017	6:57:17	az_gf_gray	—
ag010	500	08110121.jpg	11_aug_2017	7:06:18	az_gf_gray	—
ag009	250	08110112.jpg	11_aug_2017	7:07:28	az_gf_gray	—
ag001	100	08110374.jpg	11_aug_2017	7:04:34	az_gf_gray	—
ag001	100	08110375.jpg	11_aug_2017	7:11:30	az_gf_gray	—
ag009	250	08110114.jpg	11_aug_2017	7:22:49	az_gf_gray	—
ag010	500	08110122.jpg	11_aug_2017	7:24:12	az_gf_gray	—
ag010	500	08160147.jpg	16_aug_2017	12:24:12	az_gf_gray	—
ag009	250	08160127.jpg	16_aug_2017	12:25:37	az_gf_gray	—
ag001	100	08160409.jpg	16_aug_2017	12:22:33	az_gf_gray	—
ag001	100	08160410.jpg	16_aug_2017	12:37:43	az_gf_gray	—
ag009	250	08160128.jpg	16_aug_2017	12:37:43	az_gf_gray	—
ag010	500	08160148.jpg	16_aug_2017	12:44:17	az_gf_gray	—
ag010	500	08270193.jpg	27_aug_2017	6:12:47	az_gf_gray	—
ag009	250	08270156.jpg	27_aug_2017	6:14:10	az_gf_gray	—
ag001	100	08270491.jpg	27_aug_2017	6:10:14	az_gf_gray	—
ag001	100	08270492.jpg	27_aug_2017	6:38:51	az_gf_gray	—
ag009	250	08270157.jpg	27_aug_2017	6:44:27	az_gf_gray	—
ag010	500	08270193.jpg	27_aug_2017	6:45:43	az_gf_gray	—
ag010	500	09010211.jpg	1_sept_2017	6:16:11	az_gf_gray	—
ag009	250	09010170.jpg	1_sept_2017	6:17:57	az_gf_gray	—
ag001	100	09010524.jpg	1_sept_2017	6:13:56	az_gf_gray	—
ag001	100	09010525.jpg	1_sept_2017	6:29:07	az_gf_gray	—
ag009	250	09010171.jpg	1_sept_2017	6:35:15	az_gf_gray	—
ag010	500	09010212.jpg	1_sept_2017	6:36:39	az_gf_gray	—
ag010	500	09060222.jpg	6_sept_2017	6:51:14	az_gf_gray	—

camera_id	cam_dist_m	image_id	date	time	vehicle	notes
ag009	250	09060183.jpg	6_sept_2017	6:53:22	az_gf_gray	–
ag001	100	09060548.jpg	6_sept_2017	6:48:51	az_gf_gray	–
ag001	100	09060549.jpg	6_sept_2017	7:12:29	az_gf_gray	–
ag009	250	09060184.jpg	6_sept_2017	7:18:50	az_gf_gray	–
ag010	500	09060223.jpg	6_sept_2017	7:20:06	az_gf_gray	–
ag010	500	09070226.jpg	7_sept_2017	9:44:49	ua_silver	–
ag009	250	09070186.jpg	7_sept_2017	9:46:42	ua_silver	–
ag001	100	09070552.jpg	7_sept_2017	9:42:18	ua_silver	–
ag001	100	09070553.jpg	7_sept_2017	13:34:12	ua_silver	–
ag009	250	09070187.jpg	7_sept_2017	14:11:32	ua_silver	–
ag010	500	09070227.jpg	7_sept_2017	14:35:29	ua_silver	–

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