CAN A NONINVASIVE CAMERA TRAPPING TECHNIQUE BE USED TO MONITOR URBAN BOBCATS (*Lynx rufus*)?

by

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INTRODUCTION

Any change in the status of a wildlife population can have cascading effects on ecosystem function and stability, whether it be gaining or losing a species or a change in population numbers (Gibson and Olden 2014). For example, reintroductions of gray wolves (*Canis lupus*) in Yellowstone National Park caused elk (*Cervus elaphus*) populations to decline, and, this in turn, triggered an increase in aspen (*Populus tremuloides*), as elk avoided such habitat due to heightened predation risk (Ripple and Beschta 2004). Furthermore, changes in ecosystem function can have negative economic and social implications for humans (Pimentel et al. 2005, Boyles et al. 2011). For instance, the European honeybee (*Apis mellifera*) in Australia provides an essential pollination service to the agricultural industry, and it is estimated that the loss of this species would cost the industry over $4 billion (Gordon et al. 2014).

Despite the ecosystem services provided by many species, the primary cause of change to wildlife populations globally is anthropogenic disturbance (Butchart et al. 2010). Humans have been modifying the landscape for decades, and such activities have (1) led to the loss of habitat (McKellar et al. 2014), (2) increased fragmentation (Vaughn and Taylor 1999), (3) displacement of wildlife (Härtel and Steffan-Dewenter 2014; Scott et al. 2014), (4) spread diseases (Daszak et al. 2000), (5) increased the risk of extinction (Myers et al. 2000), and (6) ultimately changed ecosystem function (e.g., introduction of non-native species; Avery et al. 2010). One anthropogenic activity that causes consistent and rapid land-use change is the widespread conversion of native ecosystems to urban development. Urban development creates a large, complex matrix of impervious surfaces, remnant habitat patches, and native and non-native green spaces, which can influence landscape permeability for wildlife (Härtel and Steffan-Dewenter 2014; Levy et al. 2014; Proulx et al. 2014). Essentially, the urban environment reduces connectivity among natural habitat patches and increases population isolation, especially among species that appear intolerant to paved surfaces (e.g., Blanding's turtle; *Emydoidea blandingii*; Proulx et al. 2014). In addition, transportation infrastructure associated with the urban environment can further reduce landscape permeability for wildlife through wildlife-vehicle collisions and impervious surfaces, which, in turn, further isolates habitat (Litvaitis 2001; Riley et al. 2006). In contrast, the influx of anthropogenic food sources (i.e., trash and supplemental feeding) increases the suitability of urban habitat for several generalist and exotic species (i.e., grey squirrel; *Sciurus carolinensis*; Bonnington et al. 2014).

Population monitoring will enable us to determine how wildlife populations may need to be managed to maintain healthy ecosystems and promote essential ecosystem services (Ash and Fazel 2007; CBD 2006). To accurately develop management programs, surveyors and researchers monitor populations to understand species-specific characteristics and determine their responses to a changing environment (Deluca and King 2014). Monitoring the status of wildlife populations is, therefore, important in determining whether a population is stable, declining or increasing in size (Gloor et al. 2001).

Monitoring programs often incorporate active research that enhances the continual success of surveying a target species. For instance, one successful monitoring program that has assisted in informing management implementation includes the efforts to follow the endangered red-cockaded woodpecker (*Picoides borealis*; Costa 2002). This program has aided in decision-making processes for future management directions and in forming local recovery plans for this species (McKellar et al. 2014).

Another successful example includes recent monitoring of wildlife, such as coyotes, in urban habitats (Gehrt et al. 2009; Scott et al. 2014). These studies revealed a general increase in populations, suggesting that wildlife adapted and habituated to the urban matrix as an emerging ecosystem (Bonnington et al. 2014; Riley et al. 2006). However, it is still unclear how varying degrees of urbanization affect wildlife (Ruell et al. 2009). Continued monitoring programs could, therefore, further explain (1) the changing conditions that allow species to inhabit the urban matrix, (2) population dynamics, and (3) whether a species' behavior or characteristics are similar to other regions within their range (McClelland et al. 2012).

To observe and monitor wildlife populations, surveyors utilize a wide range of available scientific techniques, including transects (Balme et al. 2009), point counts (Alldredge et al. 2007), track surveys (Silveira et al. 2003), detection dogs (Harrison 2006), scent stations (Crooks 2002), trail cameras (Karanth 1995), hair snare traps (Bremner-Harrison et al. 2006), and scat surveys (the latter two can also be used to collect DNA samples; Obbard et al. 2010; Ruell et al. 2009). These methods can be used for (1) assessing species presence or absence (Royle and Nichols 2003), (2) monitoring abundances and distributions of populations (Alldredge et al. 2007), and (3) determining trends in population densities and activity patterns across multi-year studies (McClelland et al. 2012). Monitoring programs that evaluate whether a species is present or absent from a specific area use surveying methods such as count data (see Alldrege et al. 2007). These techniques often include visiting specific points or walking along a transect while recording species presence (Royle and Nichols 2003).

To assess changes in population dynamics over time, a common technique used is mark-release-recapture (MRR). In these surveys, a subset of individuals from a population are given a unique mark and then released. The population is resampled at a later date, and the number of marked individuals is compared to non-marked individuals to estimate the population size and evaluate if there has been any change in the population's abundance and density over time (Otis et al. 1978; Ruell et al. 2009). Traditional MRR studies require the physical capture of individuals to add either a temporary or permanent mark for identification, such as a leg band (Silvy et al. 2005; Baker et al. 2004; Henriette and Rocomora 2011). However, these invasive techniques often elevate stress among captured individuals, which may affect their survivorship and behavior, and subsequently bias the survey results (Silvy et al. 2005). For example, other studies have noted that capturing individuals has resulted in physiological changes in (1) body temperatures, (2) respiratory rates, and (3) hormonal levels (Moore et al. 1991; Moore et al. 2000; Carere and van Oers 2004). In addition, fatalities associated with the trapping and/or handling processes have been recorded as another consequence of invasive techniques (Shonfield et al. 2013). Furthermore, invasive techniques can be very expensive and time-consuming (Harrison 2006). Thus, it is preferable to avoid capturing individuals, whenever practical (Silvy et al. 2005).

As an alternative, there are MRR surveys that do not require the physical capture, handling, and marking of individuals (Silvy et al. 2005). These non-invasive techniques involve monitoring individuals with natural markings. A number of species have unique pelt characteristics that allow individuals to be identified (e.g., spot patterns on pelage or the presence of scars; Jackson et al. 2006). Currently, there are protocols in place that standardize the use of non-invasive techniques in monitoring wildlife populations (Harrison 2006; Obbard et al. 2010).

Ultimately, the choice of monitoring techniques depends on the habitat, species, and logistics. For example, some species are cryptic and elusive, particularly carnivores (e.g., coyote; *Canis latrans*; Hennessy 2007), which can make it more challenging to monitor populations using observational techniques, such as point counts (Balme et al. 2009; Dillon and Kelly 2008; Harrison 2006). Even finding signs of presence (as in scat surveys) may be difficult, particularly in cases where a species buries its fecal matter (e.g., felids; Livingston et al. 2005; White 2010). Furthermore, while dog detection and trapping surveys might be very effective at finding cryptic species, these surveys are expensive to conduct, especially in long-term monitoring programs (Harrison 2006).

Given these challenges, digital game cameras have proven to be a cost-effective alternative to monitoring cryptic species, especially when individuals have visually unique natural characteristics (Balme et al. 2009). For example, studies have demonstrated the usefulness of pelt markings among felids in conjunction with camera trap surveys for tigers (*Panthera tigris*; Karanth 1995; Wang and Macdonald 2009), leopards (*Panthera pardus*; Balme et al. 2009; Wang and Macdonald 2009), jaguars (*Panthera onca*; Silver et al. 2004), snow leopards (*Uncia uncia*; Jackson et al. 2006), ocelot (*Leopardus pardalis*; Dillon and Kelly 2007; Dillon and Kelly 2008; Maffei and Noss 2008), Canada lynx (*Lynx canadensis*; Nielsen and McCollough 2009), and bobcats (*Lynx rufus* , Heilbrun et al. 2003; Heilbrun et al. 2006; Larrucea et al. 2007; Symmank et al. 2008).

Nevertheless, such studies have yet to be effectively implemented in an urban setting. In an urban environment, there are obstacles (e.g., buildings and fencing) that may hinder a surveyor's ability to conduct transect-line monitoring techniques. Additionally, urban environments inherently have a higher percentage of impervious surfaces that limit the effectiveness of using track and scat surveys alone (Smallwood and Fitzhugh 1995; Theobald and Shenk 2011). Again, the urban environment can be potentially challenging when trying to monitor a cryptic species.

A good example of a challenging species to survey is bobcats. They are cryptic, solitary, have large home ranges, and debated to have crepuscular tendencies (Riley et al. 2010), making this species difficult to survey with traditional MRR methodology. Furthermore, while bobcats are widely distributed throughout North America and inhabit a diverse array of landscapes (Hansen 2007; Roberts and Crimmins 2010), only in the last 20 years have they appeared in habitats that have undergone considerable anthropogenic disturbances (Harrison 1998). Bobcats have been recorded in agricultural croplands, green spaces in the urban matrix, and areas with lower house densities (Harrison 1998; Riley et al. 2010), including highly urbanized areas such as San Diego and San Fransico (Riley et al. 2010). Thus, there is a need to effectively monitor this species as its population potentially grows within urban environments, particularly as the presence of a predatory species is likely to concern the public. It is, therefore, necessary to identify a method that can effectively monitor bobcats, yet such techniques need to be cost effective and logistically feasible to implement and replicate. For instance, monitoring programs that incorporate camera trapping techniques could be advantageous for observing cryptic, recolonized species, such as coyotes and bobcats in an urban environment (Hennessy 2007; Riley et al. 2010). Use of remote cameras to monitor wildlife species provides an alternative to traditional MRR techniques that once required physical capture, especially among species with distinct characteristics among individuals. Thus, bobcats, with their distinctive pelt characteristics, represent a viable candidate for a MRR program (Heilbrun et al. 2003).

However, to date there are no studies that evaluate efficacy of camera-trap surveys in an urban environment. To address this need and determine whether a cryptic species can be effectively monitored with a camera technique in the urban matrix, we used digital game cameras to monitor the local urban bobcat population in the Dallas-Fort Worth Metroplex, Texas, USA. The objectives of our study were to (1) assess the effectiveness of digital game cameras for surveying urban bobcat populations in a long-term monitoring program and (2) evaluate urban bobcat spatial and temporal activity patterns. This study was conducted in partnership with the Friends of the Fort Worth Nature Center & Refuge, Cross Timbers and North Texas Chapters of the Texas Master Naturalists, and the Texas Parks and Wildlife Department (TPWD).

METHODS

Study Sites

We selected two study sites in which bobcats have frequently been sighted in the Dallas-Fort Worth Metroplex, Texas, USA (TPWD unpublished data; Figure 1). Our first site was the Arlington Trinity corridor (here after referred to as the ‘East site’; total 94.6 km^2; 32°47’22.3368” N, -97°07’36.0984” W) comprised of urban development surrounded by forested habitat patches. The Trinity River bisects the study area, and the site was bordered by four main highways with four or more lanes. Our second site was the Lake Worth corridor (here after referred to as the ‘West site’; total 30.2 km^2; 32°49’28.0380” N, -97°28’38.0136” W), which provided more continuous habitat patches with smaller housing divisions than those present in the East site (Figure 1). A portion (39.3%) of the West site was bordered by Lake Worth. This study area is bisected by a divided state highway and comprised of wetland habitat largely located in the Fort Worth Nature Center and Refuge (FWNC&R).

Focal Species

Bobcats are medium-sized felines with females and males weighing approximately 6.8 kg and 9.6 kg, respectively (Riley et al. 2010). Although there is significant variation among individuals, bobcats in general have brown fur with yellow to red tones on the dorsal surface. The underbelly of individuals tends to be tawny to white in color with visible black spotting and thick bands present on the inner forearms (Larivière and Walton 1997). Additionally, the tail has visible black spots and bands near the tip (Riley et al. 2010). The distribution and clustering of the black spots present all over the body are unique to an individual bobcat (Heilbrun et al. 2003). Urban bobcat home ranges, based on studies conducted in California, average 130-230 ha and 520-640 ha for females and males, respectively, and such ranges tend to be smaller than nonurban populations (Riley et al. 2010). However, bobcats may change their home range size and habitat use based on seasonal requirements (Larivière and Walton 1997). The species predominately consumes lagomorphs and larger-sized rodents (Larivière and Walton 1997; Riley et al. 2010).

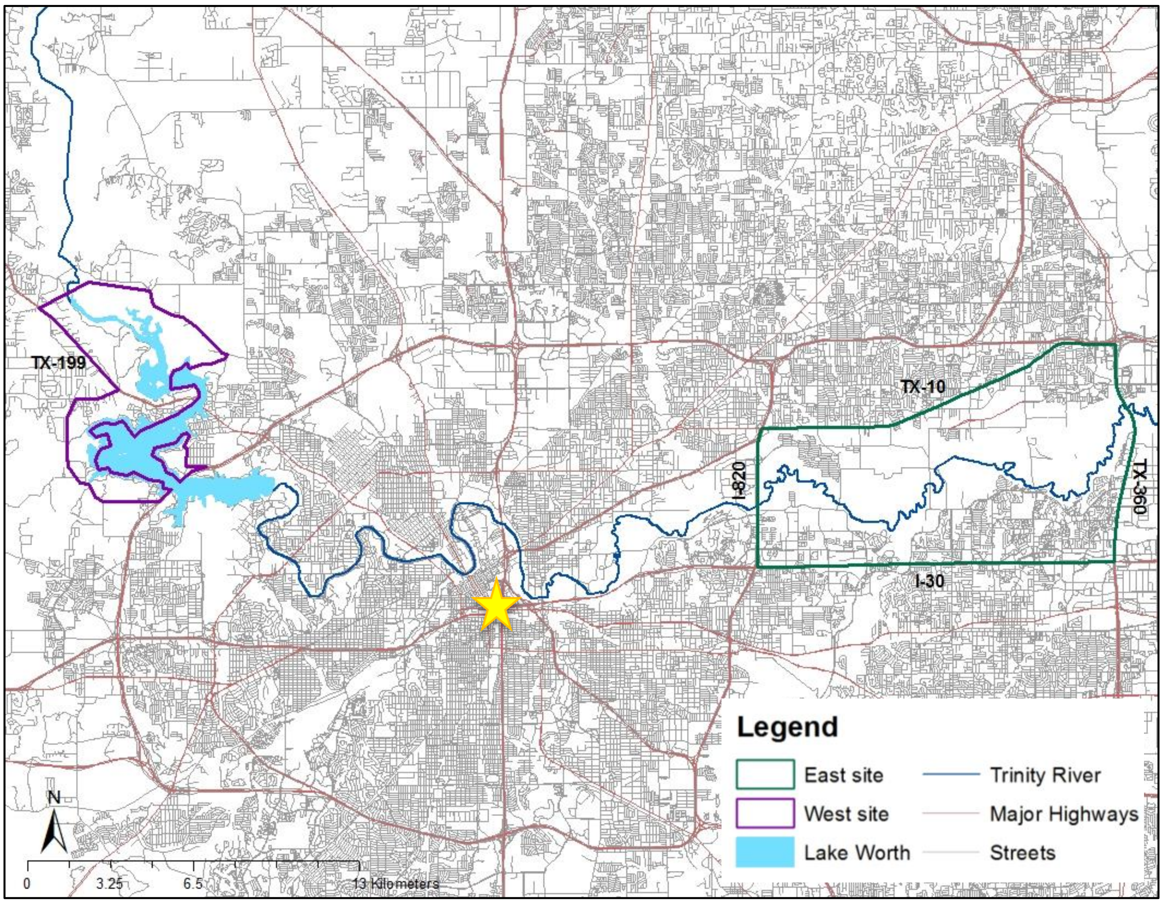

Figure 1. The East and West sites in relation to Fort Worth, TX, USA (the center of the city is represented with a yellow star). The Trinity River in dark blue bisects the East site (green boundary), while Lake Worth in light blue shares boundaries with the West site (purple boundary). The labels running along the outer edge of the East site correspond with the four major highways that define the study area's boundaries. The label next to the West site refers to a state highway that shares the border with the study area, as well as bisecting the site.

Camera Trapping Study Design

We conducted a camera trapping survey from September 2013 through December 2014. The entire study period was divided into four 12-week sessions; session 1 from 9 September

2013 to 8 March 2014, session 2 from 25 January 2014 to 26 June 2014, session 3 from 14 June 2014 to 14 September 2014, and session 4 from 5 September 2014 to 20 December 2014. We rotated 30 camera traps between two locations (hereafter referred to as location A and B) at each site. Thus, 15 camera traps were established in sessions 1 and 3 at location A, and another 15 camera traps were set up in sessions 2 and 4 at location B. Rotating cameras among sessions allowed us to survey each selected grid cell twice throughout the duration of the study.

We established camera stations with a systematic grid overlaid on the East and West sites using ArcMap software (version 10.0; Esri, Redlands, CA, USA). Symmank et al. (2008) suggested that an adequate grid cell size would be approximately 65 ha, as bobcat home range sizes were substantially larger (see the 'Focal Species' section above). For our study sites, we found that 64 ha grid cells, as opposed to 65 ha cells, fit better into our two study sites and reduced the number of cells that bisected the study site boundaries. Thus, the East site included 139 grid cells, while the West site encompassed 49 cells (Figure 2). In ArcMap, we used the 'random point tool' to indiscriminately select 30 grid cells at each site where camera traps could be potentially established. For grid cells in which we could not physically set up a camera station (e.g., they were under water) or we could not acquire landowner permission for the entirety of our survey period, we discarded that grid cell and randomly selected a replacement grid cell. For each session, we surveyed 15 selected grid cells at each study site. Thus, for location A we randomly assigned 15 of the 30 grid cells and for location B we allocated the remaining 15 grid cells (Figure 2).

At each camera trap location, we set up a camera trap assembly, which included, a low glow, infrared Moultrie M-880 digital game camera (Moultrie M-880 Digital Game Cameras; Moultrie Products, LLC, Alabaster, Alabama, USA), a 4GB SDHC memory card, a mounting strap provided by the camera manufacturer, a customized angle-iron security box (based on the

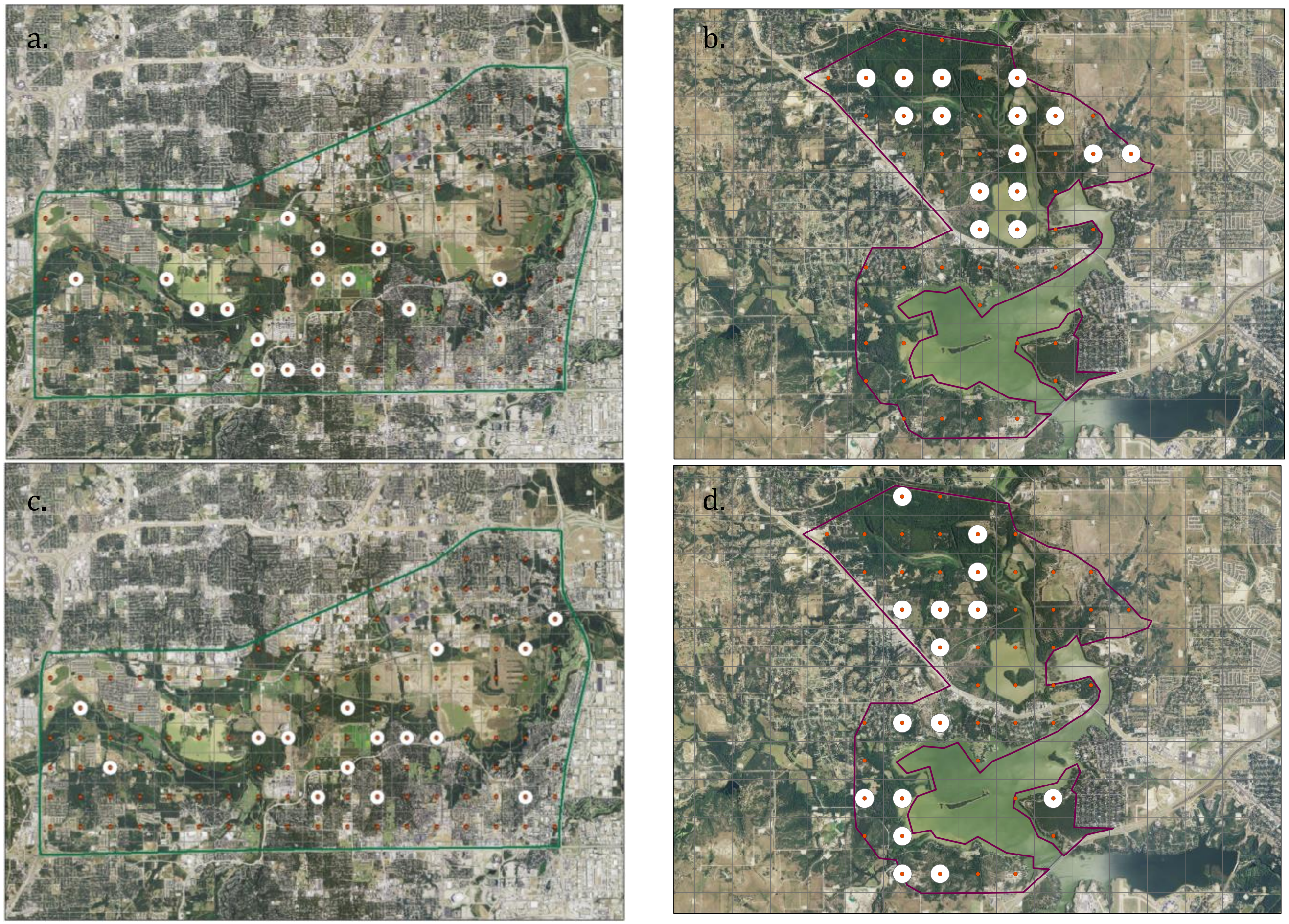

Figure 2. Each map represents the 15-camera trap locations (shown in white circles) visited for each session and are denoted with the grid cell points that are contained within a white circle. The white circles refer to the 200 m buffer zones where camera traps could be established. East site at locations A (a) and B (c), as well as the West site at locations A (b) and B (d).

design used by Zagurski 2013), a galvanized steel cable, eight AA batteries, and a laminated padlock (Figure 3).

Where possible, a camera station was deployed in the centroid of a selected grid cell (Symmank et al. 2008). However, if a camera trap could not be placed in this location (e.g., no suitable mounting features were present), we placed a camera trap within 200 m of the center of the cell. By restricting camera trap stations within a 200 m buffer zone, we were able to ensure that cameras in adjoining grid cells remained independent from each other (O'Brien 2011; Symmank et al. 2008). To identify suitable camera trap locations, we undertook a 30-minute timed randomized walk that meandered outward from the centroid point to the edges of the 200 m buffer zone. Ideal locations comprised of a small-sized tree (< 20 cm dbh) or an equivalent structure (e.g. chain-link fence; Figure 4). Suitable locations were determined in order of priority: (1) presence of public access or game trails, (2) small openings in understory brush, and (3) water within 10 m (Heilbrun et al. 2006).

Figure 3. A representation of the camera trap assembly, which included the camera unit, batteries, an SD card, and customized security equipment (i.e., galvanized steel cable, lock, and security box), used at each camera trap station. In this photograph, the camera was attached to a tree as a mounting feature and at a height where the center of the camera's motion detector was approximately 30 cm from the ground. Specific camera unit angles varied slightly depending on local topography.

Figure 4. A representation of how we set up a digital game camera trap station to face perpendicular to a game trail approximately two meters away from the mounting structure and camera. In this photograph, we added dashed lines to clarify the game trail pathway.

Once an appropriate location was identified, each camera trap assembly was positioned perpendicular to a clear, unobstructed view to increase our chances of capturing a profile view of passing animals. During a preliminary study, we found that the bobcat pelt characteristics were more easily and consistently identified at a profile angle of the face and body (e.g., leg bands in the inner forearms; Mills unpublished data). Furthermore, to ensure photographs were in focus and individuals could be identified, we attached the camera trap assembly to a mounting structure within 2-8 m distance from and perpendicular to a public access or game trail (Heilbrun et al. 2003; Figure 4). In our preliminary trials, we found that this distance optimized photograph clarity. For example, photographs tended to be out of focus at distances < 2 m, and as a result we were unable to identify individuals. In addition, vegetation can obstruct the camera's view and cause accidental triggers ('triggers' were defined as any time the camera went off to capture a photograph), thus we removed small ground vegetation up to 8 m away from the camera assembly to provide an unobstructed view. We positioned cameras so that their motion detection sensor was at a height of 20-45 cm from the ground (Figure 3), as this range corresponded with the height of an adult bobcat (see 'Focal Species' section; Heilbrun et al. 2003). Cameras operated for 24 hours with a rapid three shot burst for each trigger to increase the chance of capturing at least one clear image of an individual (hereafter each series of burst shots will be referred to as a 'burst'). We revisited traps at least once per month to replace SD cards and batteries.

Note that while other studies utilized lures or baits to attract individuals to a camera unit (Harrison 2006; Zagurski 2013), we purposefully did not bait to avoid artificially inflating activity (Gabor et al. 1994; Rowcliffe et al. 2013).

Photograph Processing and Analysis

Once we retrieved SD cards from the field, we immediately transferred all raw data to an external hard drive and filed the data according to trapping session, camera location, and date of collection. We manually cleaned (i.e., removed non-wildlife photographs) and sorted the photographs by either species or groups (e.g., rodents or coyote) into appropriately named folders. In instances where individuals remained in front of a camera and repeatedly set off multiple bursts in succession, we characterized these scenarios as 'trigger events'. Once sorted, we recorded the number of photographs, bursts, and trigger events for each mesocarnivore species (refer to Appendix I). For bobcats specifically, we also recorded the date, time of initial trigger (time first photograph was taken), camera location, duration of time at the camera (using the time stamps from the first and last photographs taken), amount of bursts and photographs per event, age class (if possible), sex (if possible), angle of body and head relative to the camera, and behavior (e.g., investigating the camera, standing, or passing). Age classes were categorized as either adult or juvenile, as we could not determine the differences among first years (i.e., juveniles) and second years (i.e., yearlings) from photographs alone. Juveniles were determined whenever in the presence of a female bobcat and by the diminished size of the individual, as compared to adult bobcat individuals (Johnson et al. 2010). We could only assess sex among adults, as they have fully reached sexual maturity and sexual dimorphism becomes most apparent at this time (Johnson et al. 2010; Larivière and Walton 1997). Beyond sexual dimorphism, a clear posterior angle of an individual provided insight into the sex of the bobcat (Larivière and Walton 1997). As females rear young without the assistance from male bobcats (Larivière and Walton 1997; Riley et al. 2010), we classified any adult bobcat in the presence of young as a female.

Determining Bobcat Activity Patterns

To assess variation in bobcat activity patterns in our first objective, we completed our analysis as a series of steps (Figure 5). In preparation for this analysis, we calculated trap efficiency. This value represented the number of bobcat trigger events across 100 trap nights recorded at each camera trap location for all sessions and at both study sites (Jackson et al. 2006). In step 1, we then compared these trap efficiency values for all the cameras between sessions at the same locations (see Figure 5, Step 1). For this analysis, we used a Mann-Whitney U statistical test in SPSS statistical software (V22.0; IBM Corporation, Armonk, New York, USA; Zar 1999). By comparing sessions at locations A and B separately, we were able to assess whether levels of bobcat activity were driven by season. We used an alpha of 0.05 to assess significance.

If the results of step 1 indicated significant differences in bobcat activity between sessions at the same location, we concluded that seasonality influenced bobcat activity. As this seasonality would influence our analysis, we proceeded to step 2 in which we analyzed trap efficiency data from each session separately. Thus, we conducted a set of Mann-Whitney U tests in which we compared each session at the East site with its equivalent session at the West site (see Figure 5, Step 2i). This test would allow us to confirm distinctions in bobcat activity across the two study sites within the same session.

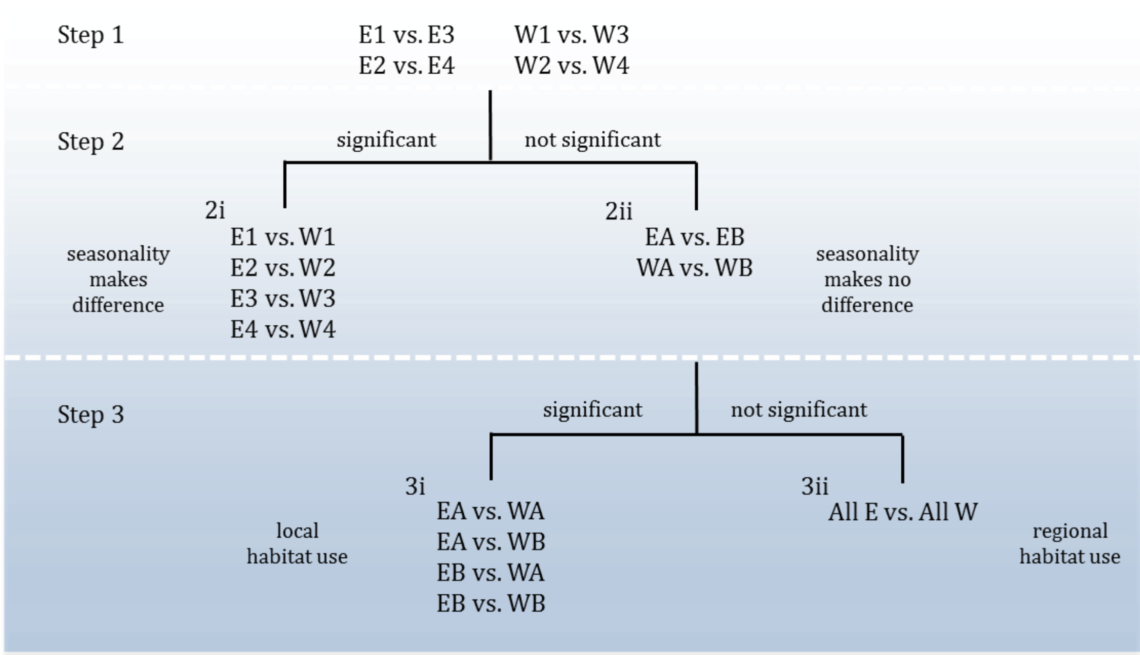

Figure 5. The flow diagram exhibits the sequence of test scenarios followed while running the bobcat trigger events per 100 trap nights through several Mann-Whitney U test scenarios, beginning with the four analyses in step one. Each of the three steps in the analysis sequence has two plausible routes, based on whether the prior test scenario was significant (i) or not significant (ii). E stands for the East site, whereas W denotes the West site. The following letter represents cameras placed at location A or B, as according to each of the study sites.

However, if the results of step 1 showed no significant difference in bobcat activity between sessions at the same location, then we determined that bobcat activity was not influenced by time of year. We then combined data from sessions that occurred at the same locations and proceeded to step 2. For this step, we used a Mann-Whitney U test to assess whether trap efficiency varied among locations A and B within each study site (see Figure 5, Step 2ii). While we recognize this step to be redundant, as the selection of camera trap locations was random, we included step 2 as a precaution to confirm and identify any unexpected biases. We used an alpha of 0.05 to assess significance.

If step 2 showed no significant difference in bobcat activity between locations A and B within the East and West sites, we concluded that bobcat activity patterns did not vary within either site. As a result, we pooled all trap efficiency data from each study site and proceeded to step 3. For this step, we conducted a final Mann-Whitney U test to compare bobcat activity at the East site with the West site (see Figure 5, Step 3ii). Again, we used an alpha of 0.05 to assess significance.

Alternatively, if the results from step 2 indicated that locations A and B were significantly different (see Figure 5, Step 2ii), we determined that local habitat use by bobcats was likely driving the differences in activity observed. Subsequently for step 3, we conducted a Mann-Whitney U test, in which we compared combinations of locations A and B for the East and West sites together (see Figure 5, Step 3i). This comparison allowed us to identify any potential differences in bobcat activity at a specific location(s).

If the results of step 3 illustrated significant difference in bobcat activity between the East and West sites, we determined that bobcat activity could be influenced by site topography. In contrast, if the final analysis in step 3 showed no significant difference between the two study sites, then bobcat activity was considered to be similar across urban habitats at a regional scale.

In addition, we tested daily activity patterns of bobcats that trigged the cameras to determine the times at which individuals were most active. For this, we evaluated the time of the first photograph for each bobcat trigger event (as previously defined in the 'Photograph

Processing and Analysis' section above). For instances with multiple bobcats present in a trigger event (which would most likely include a female bobcat with cubs), we treated this scenario as one trigger event (Zar 1999). Then, based on trigger events for each session at the East and West sites, we used the Rayleigh's Z circular statistical analysis to determine if the data was uniformly distributed on two 12-hour clocks: (1) midnight to noon and (2) noon to midnight (Cristescu et al. 2013; Zar 1999). The use of two 12-hour periods allowed us to accommodate the potentially crepuscular nature of bobcats (Riley et al. 2010). The Rayleigh's Z circular test calculates the average angle on a 360-degree clock face to estimate the mean activity time (Zar 1999). Thus, we used an arctangent transformation to find the mean activity times for bobcat individuals in the eight 12-hour periods for each of the 90-day sessions. We compared the midnight to noon with the noon to midnight clock periods within each study site. For this analysis, we used the Watson's U^2 calculation in Excel software (Office for Mac, Microsoft, Redmond, Washington, USA; Zar 1999), as this statistical test is a standard procedure that can be used with directional data (such as temporal data; Zar 1999). First, we compared the two 12-hour clock periods to determine any non-uniformity within an individual session. If there were no significant differences between the two 12-hour clock periods within each session, we grouped activity for each session into a 24-hour clock period. We then undertook a second set of Watson's U^2 statistical tests to compare daily bobcat activity at the East and West sites per session (i.e., we compared session 1 at the East site with session 1 at the West site, and so on). We compared the sessions across the two study sites in this manner due to the changes in day lengths between the different sessions. These analyses allowed us to determine whether daily activity patterns of our urban bobcats were in fact crepuscular as previous studies suggest (Anderson and Lovallo 2003). If bobcat activity was randomly distributed within a 12-hour period, as determined from the Rayleigh's Z, and not significantly different between the East and West sites with the Watson's

U^2 test, then we determined that bobcats in this study did not demonstrate a specific circadian pattern of activity (i.e., diurnal, nocturnal, and crepuscular). For each statistical test, we used an alpha of 0.05.

Use of Pelt Characteristics to ID Individual Bobcats

We wanted to utilize digital game cameras as a viable option for a noninvasive technique to identify individual bobcats in an urban environment by using pelt characteristics to assess our second objective. Therefore, for each individual trigger event, we applied the standard procedure for spot identification on bobcat pelts, as described by Heilbrun et al. (2003) and Jackson et al. (2006; Figure 6; see the 'Photograph Processing and Analysis' section above). A 'noncapture' resulted from scenarios in which a pelt could not be effectively identified (Heilbrun et al. 2003). Noncaptures occurred when we were able to identify the trigger as a bobcat trigger event, but the bobcat walked either too close or too far from the camera causing the photographs to be out of focus. Under the Jackson et al. (2006) procedure, we classified the most distinguishing feature (e.g., pattern of clustered spots) as the 'primary' identifying factor, as this was considered to be a unique characteristic to that individual (Heilbrun et al. 2003). In additional, we recognized at least two, if not more, 'secondary' factors, which were used to support identification (Figure 6; Jackson et al. 2006).

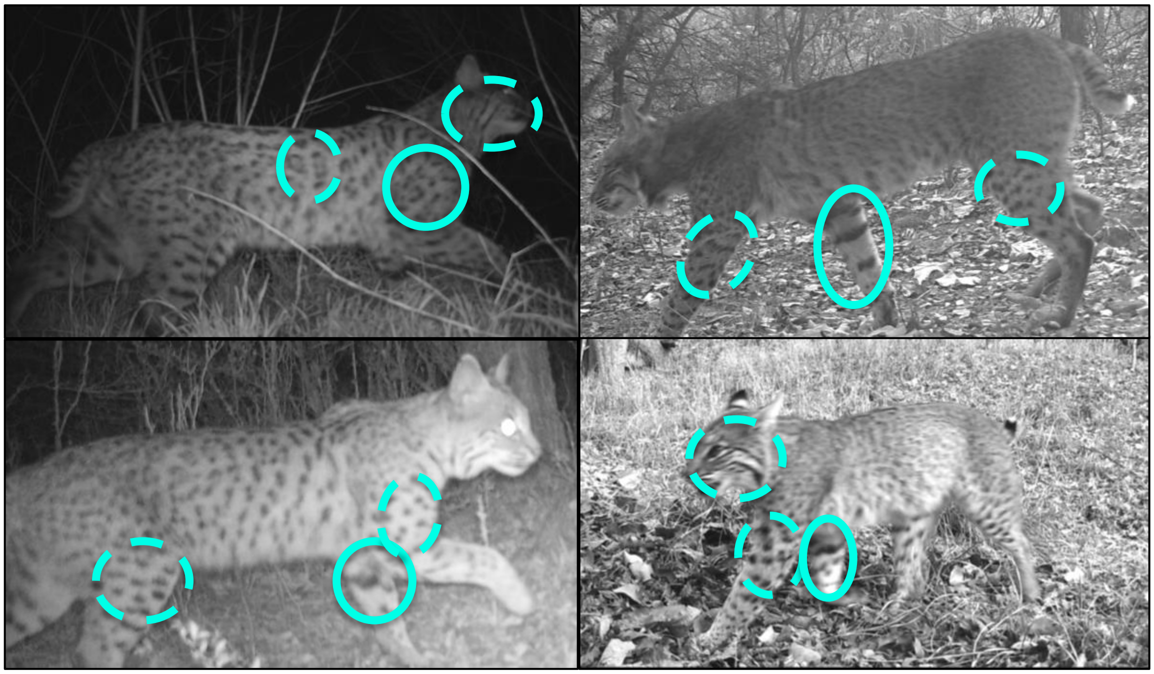

Figure 6. This illustration demonstrates the comparison of four bobcat individuals by identifying pelt characteristics. Solid circles represent the primary identifying factor, while circles with broken lines indicate secondary factors.

Once pelt characteristics were identified for each photographed bobcat, we then created a reference library of bobcat individuals from all photographs taken across the entirety of the study. In this reference library, we compiled one good-quality photograph for each individual in which the primary and secondary spot clusters were clearly visible, and if available, additional photographs of the individual at different angles. Upon verifying a unique individual, we assigned it a sequential identification number (e.g., BOBC001).

In addition, to gain insights into the potential extent of bobcat ranges and range overlap between individual bobcats, we utilized ArcMap software to collate the number of times each bobcat individual visited a specific camera trap location and the number of cameras a single individual was photographed on to create an intensity map. For those individuals that triggered three or more different camera traps, we created polygons in ArcMap to link the multiple camera visits by each bobcat with the 'minimum bounding geometry' tool and selected the convex hull option for geometry. We categorized the polygons of individuals who visited at least three camera traps by sex.

RESULTS

We successfully established a total of 54 camera trap locations (24 camera locations in the East site and 30 camera locations in the West site). As six of the 60 sites selected were compromised during the study (e.g., lost access, cameras were stolen, or site flooded), we were unable to collect complete data sets at these locations, these camera traps were not included in our final analysis (Figure 7). Thus, over the duration of the study period, the remaining cameras recorded 199,752 photographs over a period of 8,630 trap nights. Of these photographs, 106,041 were triggered by the presence of wildlife or domestic animals (Table 1).

Non-mesocarnivore species caught on camera traps included: nine-banded armadillo (*Dasypus novemcinctus*), birds (orders Cuculiformes, Galliformes, Gruiformes, Passeriformes, and Strigiformes), eastern cottontail (*Syvilagus floridanus*), American beaver (*Castor canadensis*), fox squirrel (*Sciurus niger*), mice and woodrats (order Rodentia), wild hog (*Sus scrofa*), white-tailed deer (*Odocoileus virginianus*), cattle (*Bos taurus*), and horses (*Equus ferus caballus*).

Table 1. The number of trap nights, total number of photographs recorded, and bursts (as defined as three photographs per camera trigger) for each of the four sessions at the two study sites. Culled photographs denoted the number of photographs that included non-wildlife individuals, such as humans, within the frame. No subject referred to the number of photographs that lacked either human or wildlife individuals. Subject included wildlife or domestic animals within the frame. Shaded rows represent those sessions pertaining to location A, whereas rows without shading indicate sessions at location B, respective of site.

	Session	Trap Nights	No. Photos	Bursts	Culled	No Subject	Subject
East site	1	883	20,395	6,798	1,476	10,472	8,447
	2	801	21,618	7,206	2,061	10,254	9,303
	3	810	19,655	6,551	1,067	11,929	6,659
	4	896	12,899	4,300	1,417	4,779	6,703
	Total	3,390	74,567	24,855	6,021	37,434	31,112
West site	1	1,626	36,294	12,098	2,997	8,272	25,025
	2	1,390	46,203	15,401	779	24,646	20,778
	3	1,237	16,151	5,383	1,309	4,500	10,342
	4	987	26,537	8,845	511	7,242	18,784
	Total	5,240	125,185	41,727	5,596	44,660	74,929

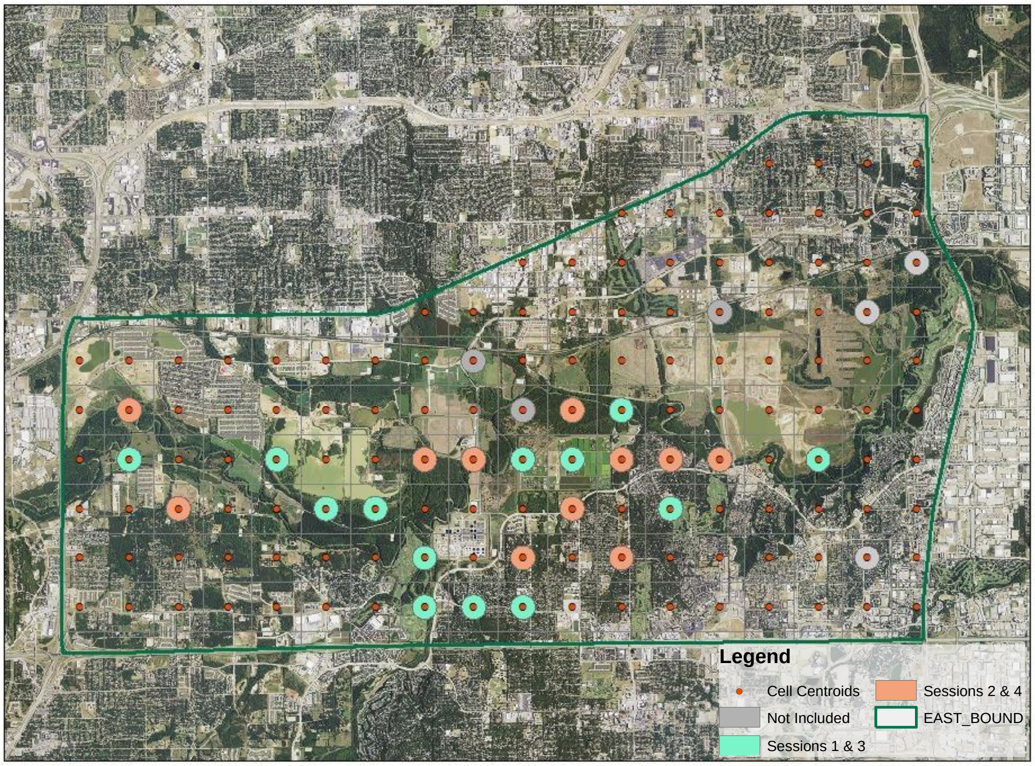

Figure 7. All 30 camera locations selected for the East site, including which were and were not included for the final analysis.

We recorded a total of nine mesocarnivore species: bobcat, coyote, Virginia opossum (*Didelphis virginiana*), domestic cat (*Felis catus*), domestic dog (*Canis lupus familiaris*), gray fox (*Urocyon cinereoargenteus*), striped skunk (*Mephitis mephitis*), raccoon (*Procyon lotor*), and an unknown felid. Among these mesocarnivores, raccoons were the most commonly recorded for both the East and West site (Figure 8; refer to Appendix I for further details). Over the study period, we recorded a total of 376 bobcat trigger events (217 and 159 trigger events for the East and West site, respectively), totaling 1,435 photographs (793 and 642 photographs recorded at the East and West sites, respectively). We found bobcats throughout the entirety of each of our study sites, yet the geographic distribution of bobcat trigger events varied across the two study sites (Figure 9). Overall, we found that the entire East site had higher activity at 6.29 bobcat trigger events per 100 trap nights, in comparison to only 3.02 bobcat trigger events per 100 trap nights for the West site (ranging from 4.12 to 10.99 and 1.22 to 5.10 bobcat trigger events per 100 trap nights respectively; Figure 10).

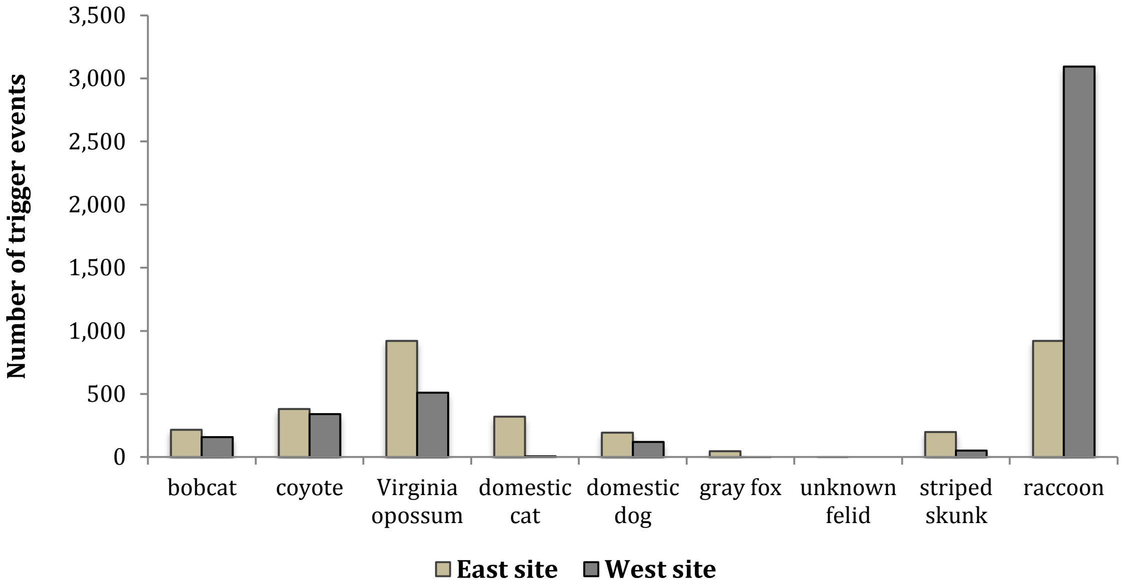

Figure 8. Summary of total trigger events throughout the study period for the nine mesocarnivore species captured with digital game cameras for two study sites in Tarrant County, Texas.

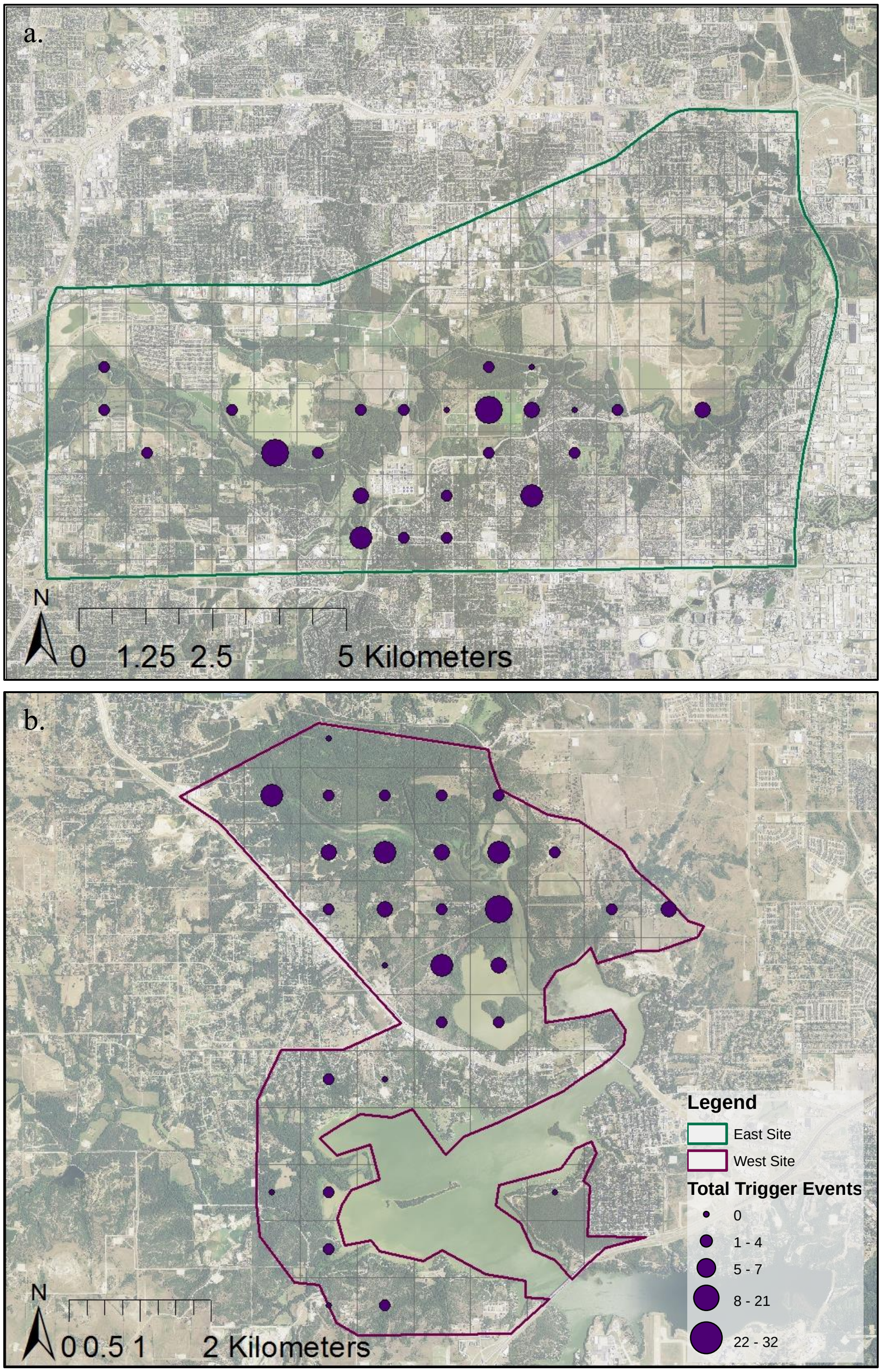

Figure 9. The geographic distribution of total bobcat trigger events recorded at the various camera trap locations throughout both the East site (a) and the West site (b).

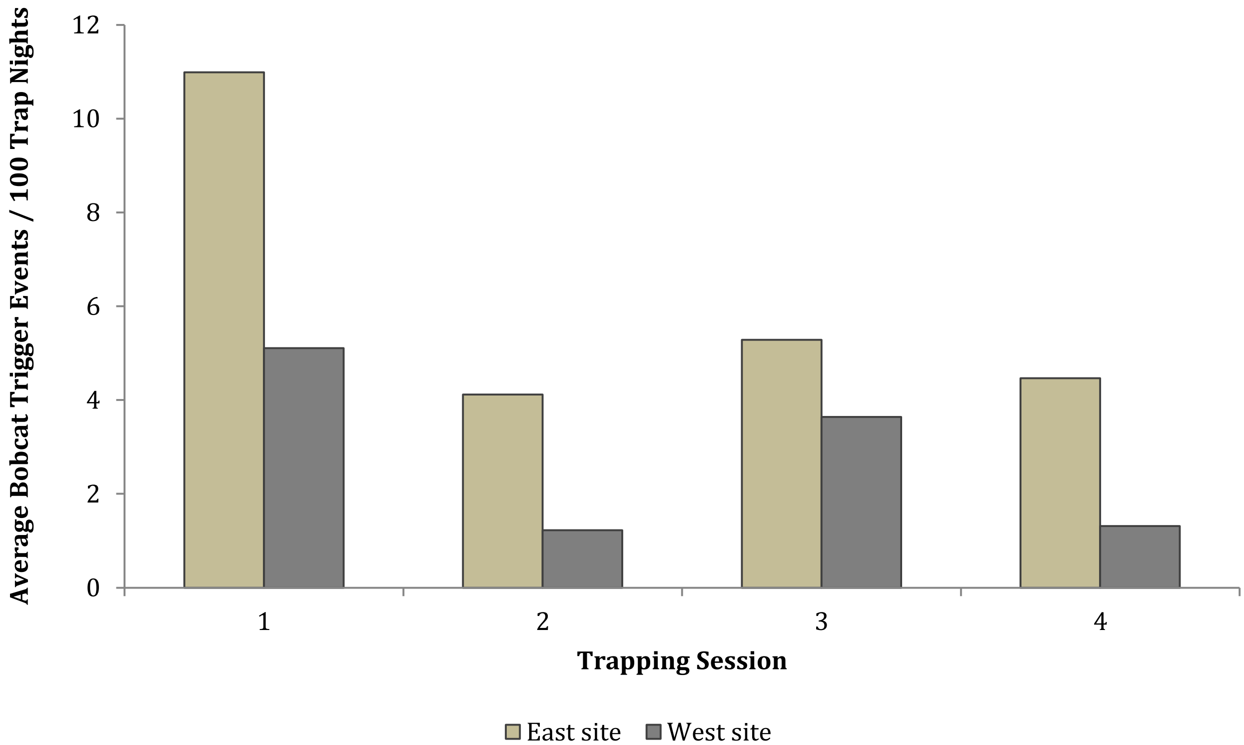

Figure 10. Averaged bobcat trigger events per 100 trap nights recorded at camera traps for the four trapping sessions at the two study sites in Tarrant County, Texas.

Determining Bobcat Activity Patterns

In our analysis to compare trap efficiency, the Mann-Whitney U tests in step 1 revealed no significant differences in bobcat activity within location A or location B at either the East or West sites (Figure 11). These results indicated that seasonality does not influence bobcat activity at either study site. Thus, we proceeded to step 2ii in which we combined all of the data from locations A and B at both the East and West sites. In this second step, we did not find any significant difference in bobcat activity rates between locations A and B at the East site ($U_{23, 24}$ = 246.50; P = 0.882; Figure 12); however, despite camera positions being randomly selected, the West site demonstrated significant differences in bobcat activity between locations A and B ($U_{30, 26}$ = 258; P = 0.028; Figure 12). This result indicated that local topography may be driving bobcat activity within the West site. Due to these differences in locations A and B, we advanced to step 3i in the series of Mann-Whitney U analyses to test the combinations of locations A and B between the East and West sites. Cameras placed at location A of the West site did not demonstrate any significant difference in bobcat activity when compared to location A or location B of the East site ($U_{30, 23}$ = 293.50; P = 0.353 for location A and $U_{30, 22}$ = 331.50; P = 0.334 for location B). However, bobcat activity at location B in the West site was significantly different from both locations A and B at the East site ($U_{26, 23}$ = 174.50, P = 0.011 and $U_{26, 22}$ = 139, P = 0.002, respectively; Figure 12). Thus, overall only location B at the West site demonstrated significant differences in bobcat activity (Figure 13).

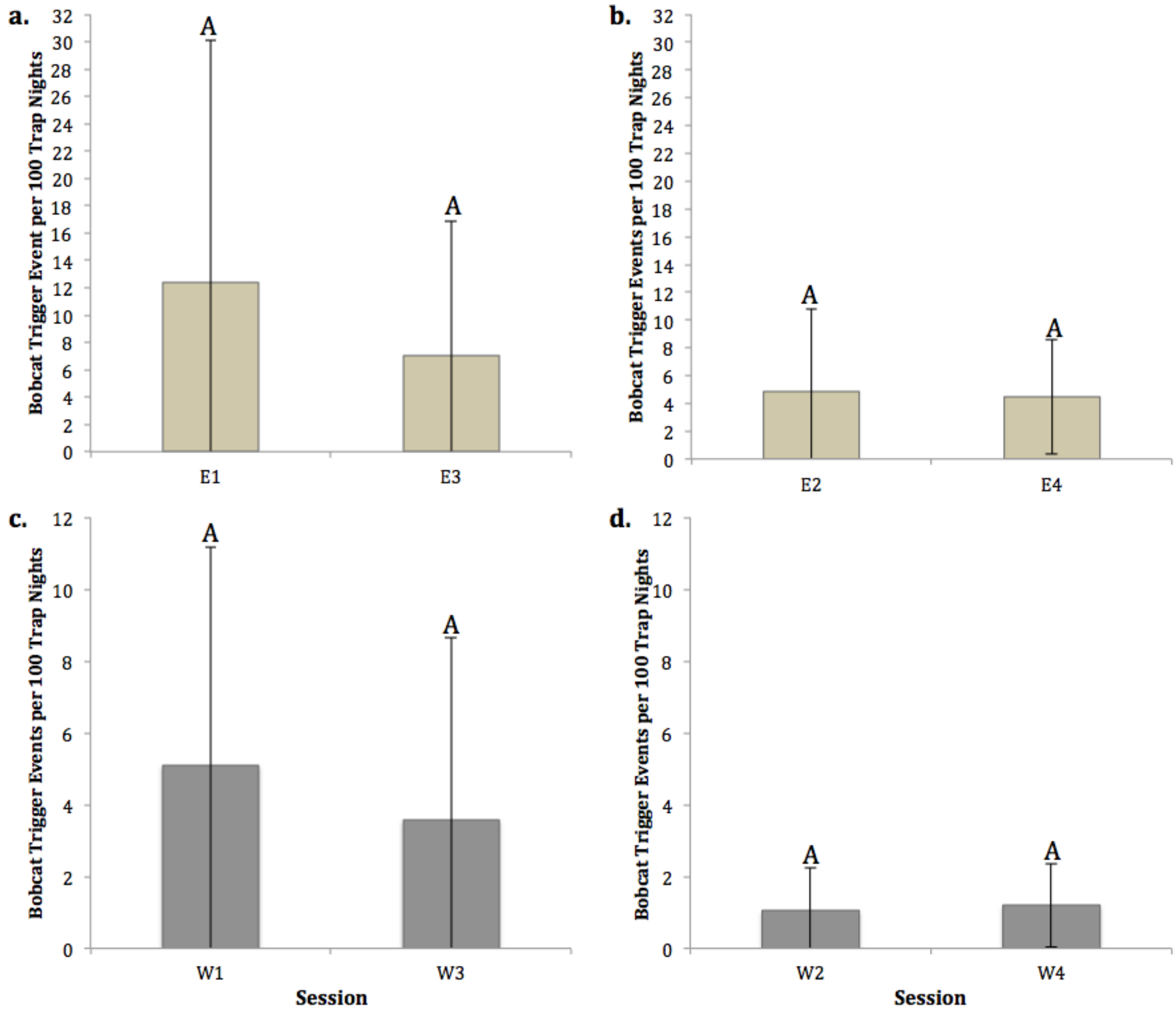

Figure 11. Results from step 1 in the Mann-Whitney U analysis in testing each of the study sites within either locations A or B. Illustrated are the average frequencies of bobcat trigger events per 100 trap nights recorded at camera trap locations for each of the four sessions and the standard deviation bars are presented for values above zero. The 'A' or 'B' present above each bar demonstrates similarities or differences, as determined from each of the four test scenarios.

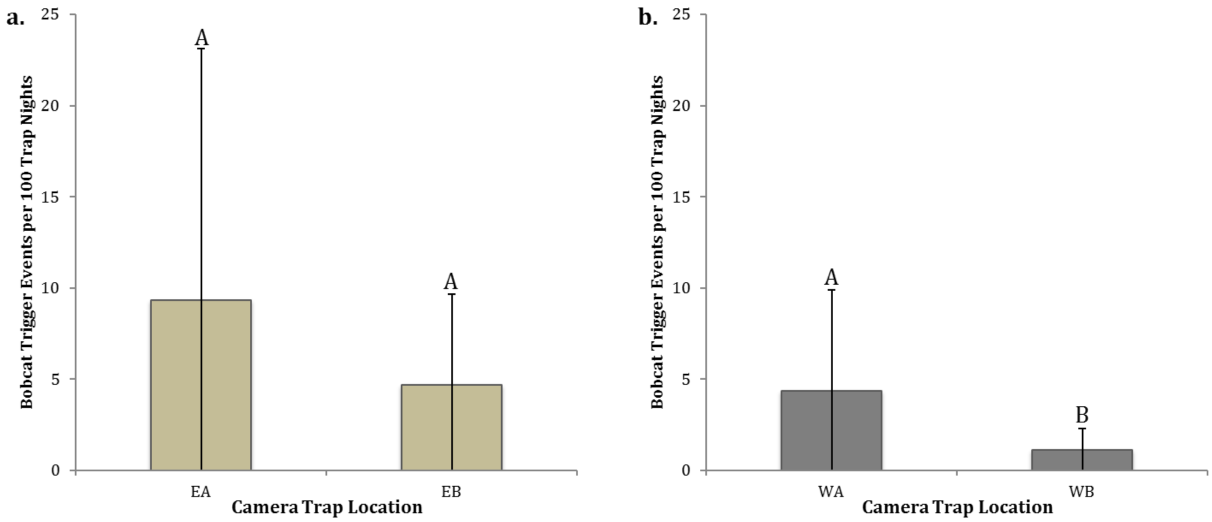

Figure 12. Results from step 2 in the Mann-Whitney U analysis for testing camera trap locations A and B at the East (a) and West sites (b). Illustrated are the average frequencies of bobcat trigger events per 100 trap nights recorded at all of the camera trap locations for the two location sets, and the standard deviation bars are presented for values above zero. The 'A' or 'B' present above each bar demonstrates similarities or differences, as determined from each of the test scenarios.

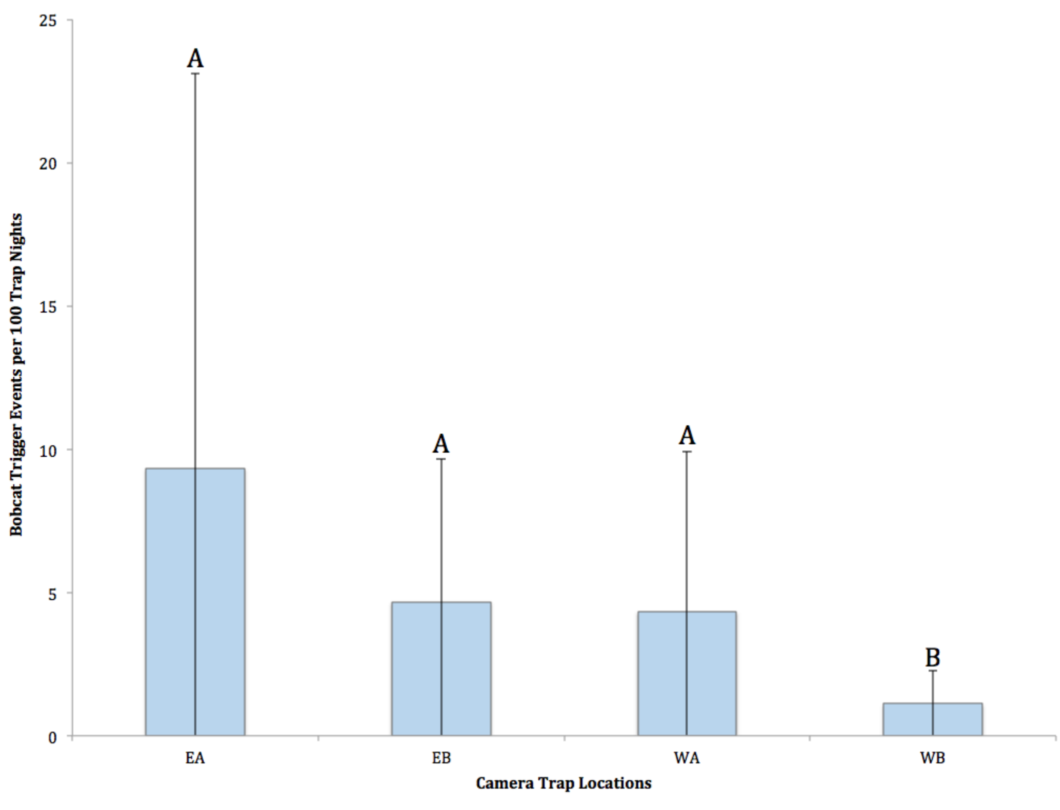

Figure 13. Results from step 3 in the Mann-Whitney U analysis for comparing camera trap locations A and B at the East and West sites. Illustrated are the average frequencies of bobcat trigger events per 100 trap nights recorded at all of the camera trap locations for the two location sets, and the standard deviation bars are presented for values above zero. The 'A' or 'B' present above each bar demonstrates similarities or differences, as determined from each of the test scenarios.

For our analysis to assess bobcat daily activity patterns, we completed a Rayleigh's Z circular statistical analysis for both time periods (i.e., (1) midnight to noon and (2) noon to midnight) and all four sessions at the East and West sites. The Rayleigh's Z test showed that bobcat activity in the first and second clock periods for each session was randomly distributed, except for the second 12-hour period in session 3 at both the East and the West sites (Table 2). In these sessions, peak bobcat activity was observed at 16:00 at the East site (Figure 14) and between 20:00 and 22:00 at the West site (Figure 15).

When we compared the two 12-hour clock periods, each of the four trapping sessions at the East and West sites, using the Watson's U^2, we found that bobcat activity patterns were not significantly different from each other (Table 3). Thus, we proceeded to group bobcat activity in the two 12-hour clock periods within each session, respective of site, into a single 24-hour clock period. Then we compared bobcat activity patterns over this 24-hour clock period for each session between our study sites. In this second Watson's U^2 analysis, we found that bobcat activity on a 24-hour clock at the East and West sites significantly differed in sessions 2 and 4 (Table 3). Thus, bobcat activity patterns differed at location B in the West site, in comparison to location B at the East site. Note we captured fewer samples at location B in the West site than the other locations within any given hour (Figure 15).

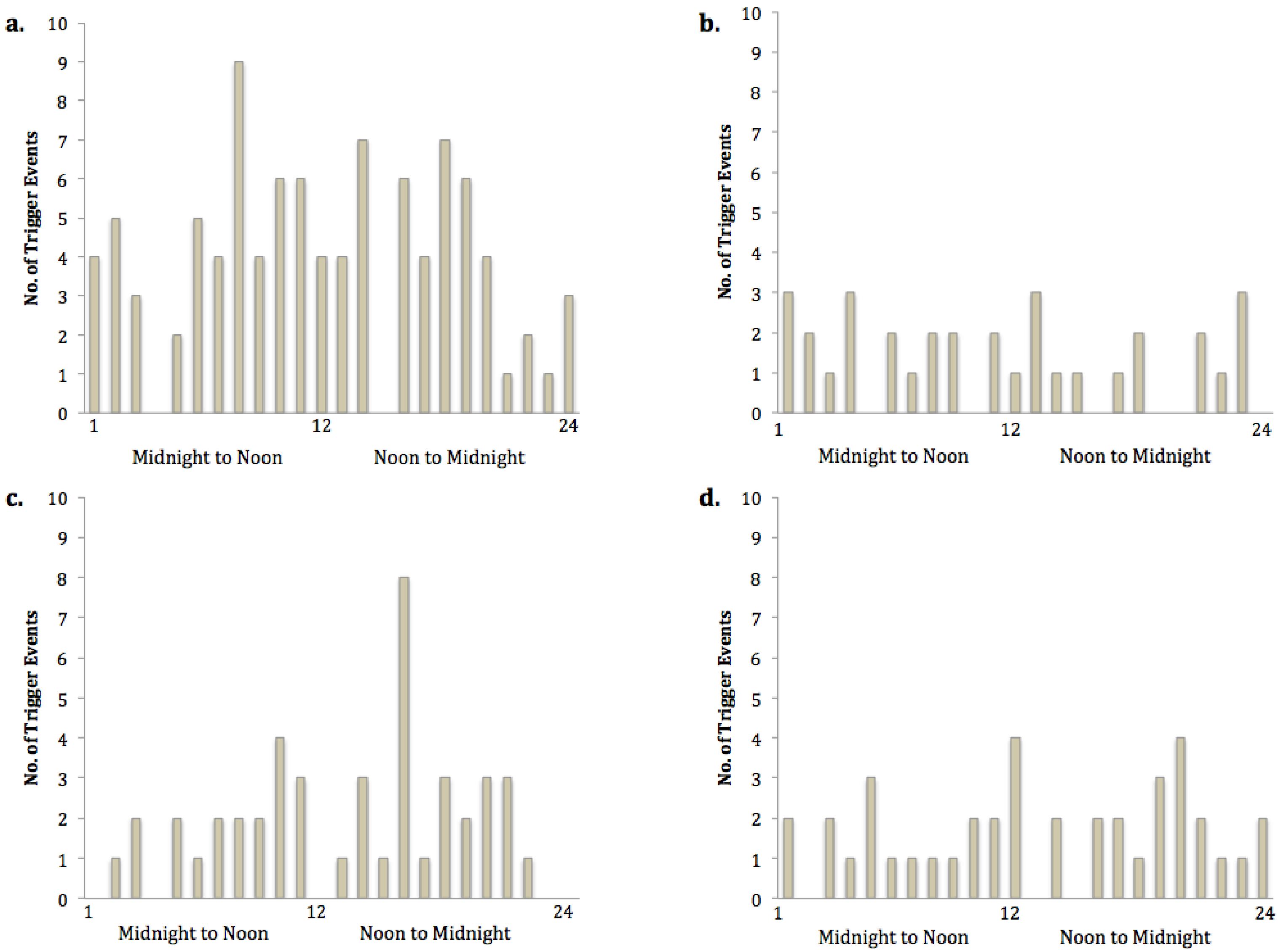

Figure 14. The number of bobcat trigger events for the East site that took place during each hour in a 24 hour period for each of the trapping sessions: (a) session 1, (b) session 2, (c) session 3, and (d) session 4. The hour categories represent the time that took place within a given hour on a 24-hour clock (i.e., 1 equates to time that passed between 0:01 to 1:00).

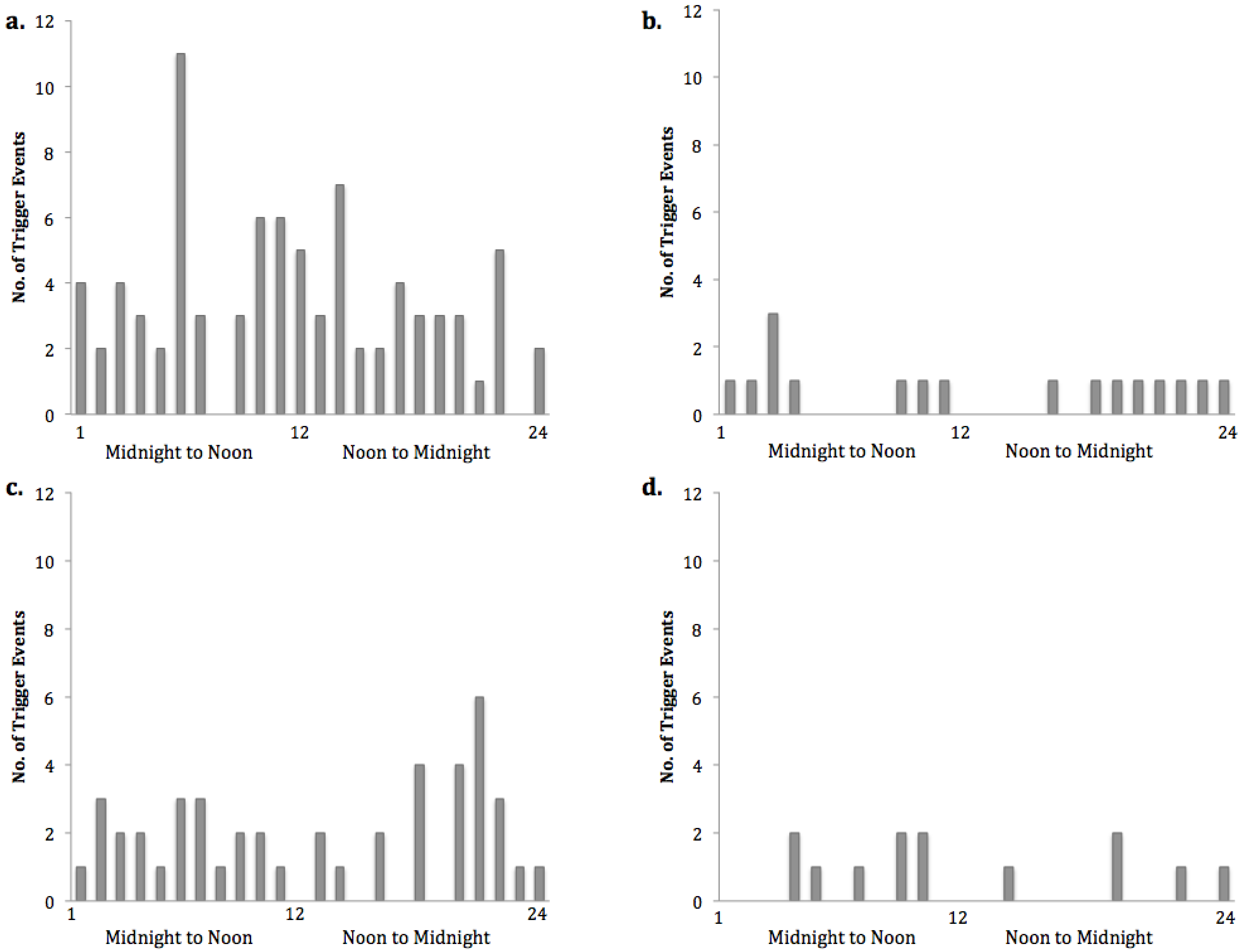

Figure 15. The number of bobcat trigger events for the West site that took place during each hour in a 24 hour period for each of the trapping sessions: (a) session 1, (b) session 2, (c) session 3, and (d) session 4. The hour categories represent the time that took place within a given hour on a 24-hour clock (i.e., 1 equates to time that passed between 0:01 to 1:00).

Table 2. Results of the Rayleigh's Z statistical analysis for each session at the two study sites for the two 12-hour clock periods: (1) midnight to noon, and (2) noon to midnight. The letter E or W denotes either the East or West sites, respectively. The number following the study site refers to the trapping session. The sample number for each test is denoted as n. The mean angle is represented as a time interval under the μ_a column. The *z* value represents the Rayleigh's Z. Critical values (CV) were determined at an α of 0.05.

	Midnight to Noon				Noon to Midnight			
Site	n	μ_a	*z*	CV	n	μ_a	*z*	CV
E1	52	5:52	2.845	2.981	45	17:58	2.031	2.972
E2	19	0:47	2.845	2.956	14	23:58	0.740	2.937
E3	19	6:07	0.935	2.956	26	17:58	3.282	2.966
E4	20	0:18	0.525	2.956	20	18:01	1.815	2.956
W1	49	5:59	0.066	2.981	35	11:02	0.386	2.975
W2	9	0:01	1.593	2.899	8	18:09	1.287	2.885
W3	21	5:58	0.519	2.958	24	18:04	3.591	2.963
W4	8	5:49	1.045	2.885	5	23:54	0.058	2.800

Table 3. Results from the Watson's U^2 statistical analyses for the daily activity of bobcat individuals that triggered camera stations. The letter E or W denotes either the East or West sites, respectively. The number following the study site refers to the trapping session. For the AM vs. PM scenarios, AM is the midnight to noon clock and PM is the noon to midnight clock. N_1 denotes the number of samples for the midnight to noon clocks in the first scenarios and the East site samples in the second set of scenarios. N_2 denotes the number of samples for the noon to midnight clocks in the first set of scenarios and the West site samples in the second set of scenarios. Critical values (CV) were determined at an α of 0.05.

Scenario	N_1	N_2	U^2	CV	Significant
AM vs. PM					
E1	48	45	0.041	0.186	*No*
E2	19	14	0.062	0.184	*No*
E3	19	25	0.086	0.184	*No*
E4	20	20	0.000	0.184	*No*
W1	45	35	0.152	0.186	*No*
W2	9	8	0.006	0.1832	*No*
W3	20	24	0.016	0.184	*No*
W4	8	5	0.051	0.1823	*No*
Study Sites					
E1 vs. W1	93	80	0.081	0.187	*No*
E2 vs. W2	33	17	0.294	0.185	*Yes*
E3 vs. W3	44	44	0.006	0.186	*No*
E4 vs. W4	40	13	0.490	0.186	*Yes*

Use of Pelt Characteristics to ID Individual Bobcats

Bobcat trigger events fluctuated throughout the survey period for both study sites (Figure 16). Of these 376 bobcat trigger events, 287 (76.3%) were successfully identified to an individual (166 and 121 trigger events recorded in the East and West sites, respectively). We added a total of 79 bobcat individuals (50 individuals in the East site and 29 individuals from the West site) to the reference library (refer to 'Appendix II: Bobcat Reference Library'). Among those identified, none were recorded at both study sites. A total of 17 individuals were identified using both the left and right lateral angles of the body. Among the remaining, we identified individuals from only one lateral angle (31 identified from the left side and 31 identified from the right side; Table 4). Twenty-three individuals were captured at two or more trapping sessions from their respective study site, yet only two individuals from both study sites respectively were identified in all four sessions (Table 4). Refer to Appendix II: Bobcat Reference Library for more details on specific camera locations each individual triggered.

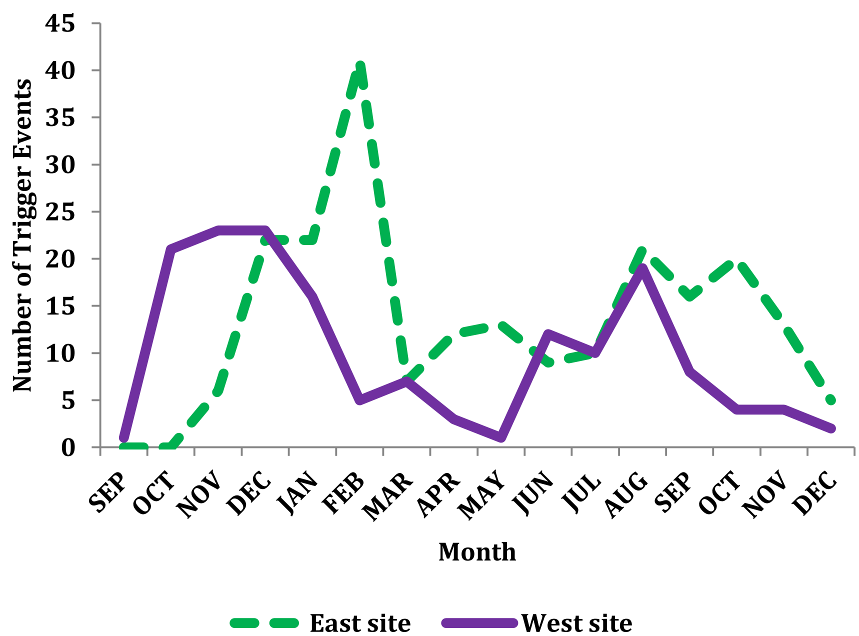

Figure 16. The fluctuations in bobcat trigger events recorded throughout the study period for both the East and West sites.

Table 4. We documented the study site and each session(s) an individual was captured at, as well as the number of camera traps an individual triggered, total trigger events, sex (if applicable), age class (if applicable), the visible lateral side(s) present in the photographs used for identification of that individual, and whether that particular bobcat triggered the cameras during daytime or nighttime hours.

ID Number	Study Site	Sessions	Cameras Visited	Trigger Events	Sex	Age Class	Side(s) Visible	Day/Night
BOBC001	West	1, 2, 4	3	5	Male	Adult	Left	Both
BOBC002	West	1, 3	3	29	Male	Adult	Both	Night
BOBC003	West	1	1	2	Male	Adult	Right	Day
BOBC004	West	1, 3	5	9	Male	Adult	Left	Both
BOBC005	West	1, 4	2	2	N/A	Juvenile	Left	Day
BOBC006	West	1	1	1	N/A	Juvenile	Left	Day
BOBC007	West	1	1	5	Female	Adult	Both	Day
BOBC008	West	1	1	1	Male	Adult	Left	Day
BOBC009	West	1	1	1	Female	Adult	Both	Night
BOBC010	West	1, 3	4	6	Female	Adult	Right	Both
BOBC011	West	1, 2, 3, 4	5	10	Female	Adult	Left	Both
BOBC012	West	1, 2, 3, 4	5	7	Male	Adult	Both	Both
BOBC013	West	1, 4	2	3	N/A	Adult	Both	Both
BOBC014	East	1, 2, 3, 4	3	10	Female	Adult	Right	Day
BOBC015	East	1, 2	2	4	N/A	Adult	Right	Both
BOBC016	East	1	1	1	Male	Adult	Right	Day
BOBC017	East	1	1	3	N/A	Adult	Right	Both
BOBC018	East	1	1	1	Female	Adult	Left	Day
BOBC019	East	1	1	1	Female	Adult	Left	Day
BOBC020	East	1, 2, 4	2	7	N/A	Adult	Both	Both
BOBC021	East	1, 2, 4	2	4	N/A	Adult	Left	Both
BOBC022	East	1, 2, 3, 4	3	6	Female	Adult	Left	Both
BOBC023	East	1	1	1	N/A	Adult	Right	Night
BOBC024	East	1, 2, 3	2	10	Female	Adult	Right	Both
BOBC025	East	1	1	2	N/A	Adult	Left	Both
BOBC026	East	1	1	7	N/A	Adult	Right	Both
BOBC027	East	1	1	2	Female	Adult	Both	Day

ID Number	Study Site	Sessions	Cameras Visited	Trigger Events	Sex	Age Class	Side(s) Visible	Day/Night
BOBC028	East	1	1	1	N/A	N/A	Right	Both
BOBC029	East	1, 3, 4	4	11	Male	Adult	Both	Both
BOBC030	West	3, 4	4	9	Male	Adult	Right	Both
BOBC031	East	1, 2, 4	4	7	Male	Adult	Both	Both
BOBC032	West	1, 2	2	2	Male	Adult	Right	Day
BOBC033	West	1	1	1	N/A	Adult	Right	Day
BOBC034	West	1	2	2	Female	Adult	Right	Both
BOBC035	East	1, 3	2	5	Female	Adult	Right	Day
BOBC036	East	1, 3, 4	3	6	Female	Adult	Left	Both
BOBC037	West	2	1	1	Female	Adult	Left	Night
BOBC038	East	2, 3	4	7	Female	Adult	Both	Both
BOBC039	East	1, 2	2	2	Female	Adult	Left	Day
BOBC040	East	1	1	2	N/A	Juvenile	Right	Day
BOBC041	East	2, 4	2	1	N/A	Juvenile	Left	Both
BOBC042	West	4	1	1	N/A	Adult	Right	Day
BOBC043	West	4	1	1	N/A	Adult	Right	Day
BOBC044	West	4	1	1	N/A	Adult	Right	Night
BOBC045	West	4	1	1	N/A	Adult	Left	Day
BOBC046	West	1, 2, 3	3	6	Female	Adult	Both	Both
BOBC047	West	2	1	1	Female	Adult	Left	Day
BOBC048	West	2	1	1	N/A	Adult	Left	Day
BOBC049	West	2	1	1	N/A	Adult	Right	Night
BOBC050	West	2	2	2	Female	Adult	Left	Both
BOBC051	East	2	1	1	Female	Adult	Left	Day
BOBC052	East	1, 2	2	1	N/A	Adult	Left	Day
BOBC053	East	2, 4	2	5	Male	Adult	Left	Night
BOBC054	East	2	1	2	Female	Adult	Left	Night
BOBC055	East	1, 2	2	1	N/A	Adult	Right	Day
BOBC056	East	2, 3, 4	2	5	Male	Adult	Both	Both
BOBC057	East	3	1	2	Female	Adult	Right	Both

ID Number	Study Site	Sessions	Cameras Visited	Trigger Events	Sex	Age Class	Sides Visible	Day/Night
BOBC058	East	3	1	2	N/A	N/A	Left	Day
BOBC059	East	3	1	6	Female	Adult	Left	Day
BOBC060	East	3	1	1	N/A	Adult	Right	Day
BOBC061	East	3	1	1	N/A	Adult	Right	Day
BOBC062	East	4	1	1	N/A	Juvenile	Left	Day
BOBC063	East	4	1	1	N/A	Juvenile	Right	Day
BOBC064	East	4	1	1	N/A	Adult	Right	Day
BOBC065	East	4	1	1	N/A	Adult	Right	Day
BOBC066	East	2, 4	2	2	Female	Adult	Left	Both
BOBC067	East	4	1	1	N/A	Juvenile	Right	Night
BOBC068	East	4	1	1	N/A	Adult	Left	Day
BOBC069	East	4	1	1	N/A	Adult	Left	Night
BOBC070	East	4	1	1	Male	Adult	Right	Night
BOBC071	East	2, 4	1	2	Male	Adult	Right	Both
BOBC072	East	4	1	4	Male	Adult	Right	Both
BOBC073	East	3	3	3	Male	Adult	Left	Both
BOBC074	East	3	1	8	Female	Adult	Both	Both
BOBC075	East	3	1	2	Female	Adult	Both	Day
BOBC076	East	1, 3	1	2	N/A	Juvenile	Left	Both
BOBC077	East	3	1	1	Female	Adult	Right	Night
BOBC078	West	1, 3	2	8	Male	Adult	Both	Both
BOBC079	West	3	1	3	Male	Adult	Both	Both

While bobcats were found across the entirety of both study sites, individuals were most often recaptured on a single camera multiple times (Table 4). We found that bobcats tended to be captured on multiple occasions at one specific camera trap, specific to the individual. In addition, we identified 16 individuals using both the left and right side angles (Table 4). Two camera traps near larger bodies of water in the East site had the highest recorded number of bobcats (up to 9 individuals; Figure 17a). At the West site, the highest number of individuals identified at one camera trap was eight (Figure 17b). Of the 79 identified bobcats, 32 were captured at two or more camera trap locations (19 and 13 in the East and West sites, respectively). Only 15 individuals triggered three or more cameras (7 and 8 in the East and West sites, respectively; Figure 18). We found that individuals in West site demonstrated extensive range overlap (Figure 18b). Three individuals in the West site visited five different camera traps (Figure 19). The highest number of camera traps visited by an individual in the East site was four (Figure 19).

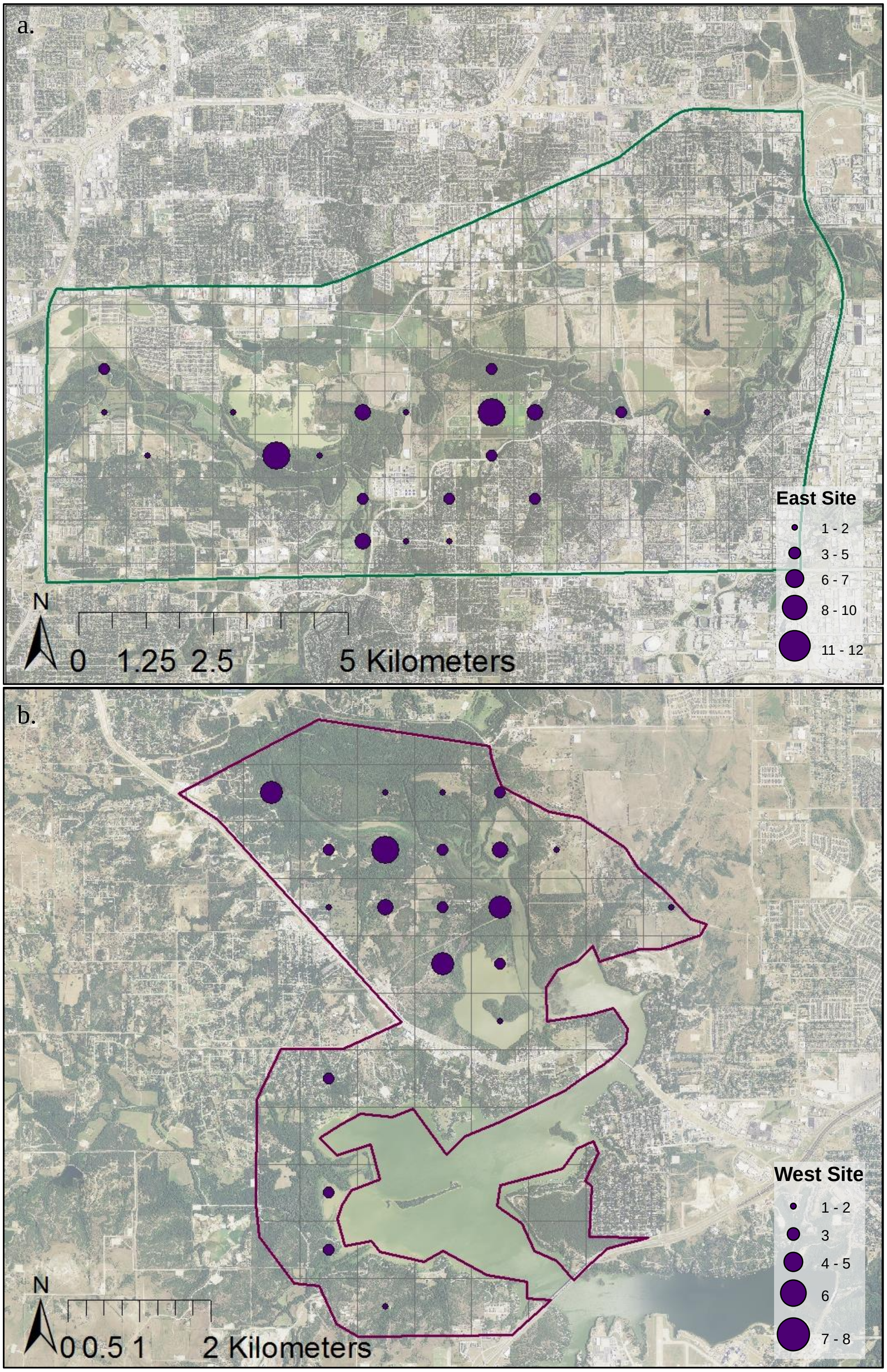

Figure 17. Intensity maps of the number of identified adult bobcat individuals for the East (a) and West sites (b).

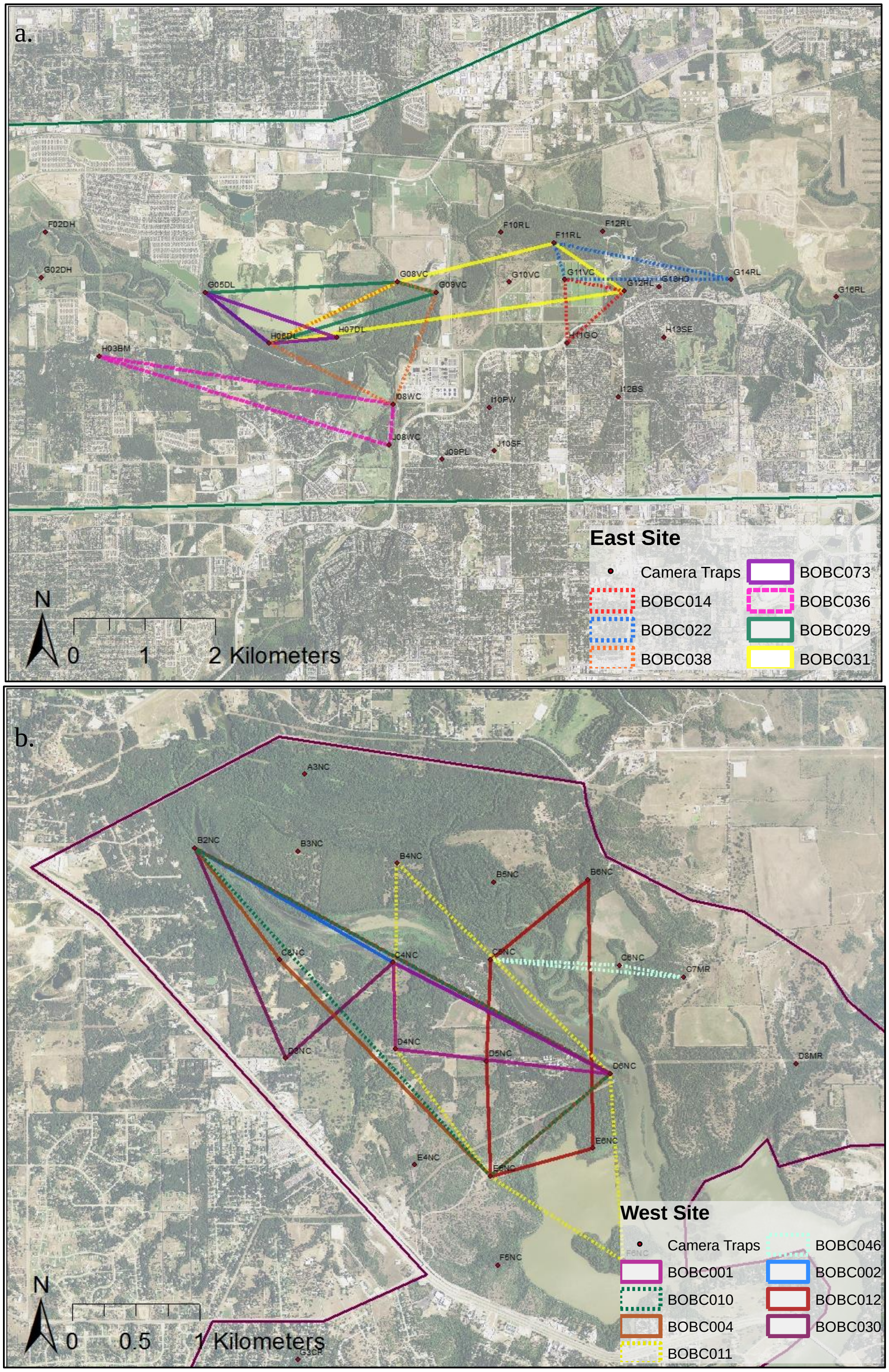

Figure 18. Geometric polygons that link the area of cameras triggered by identified bobcats that triggered three or more independent camera stations at either the East (a) or West sites (b). Males are represented with solid lines, whereas females have dashed lines.

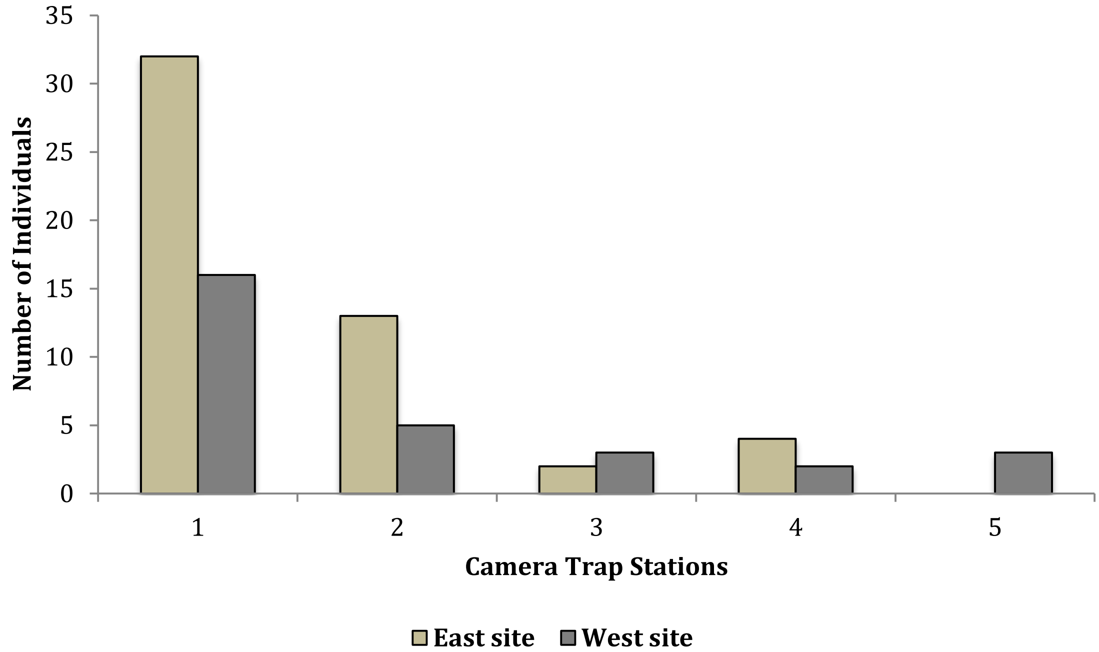

Figure 19. The number of identified bobcat individuals for the amount of different camera trap locations captured at, respective to the two study sites.

DISCUSSION

Our study at two urban sites in Tarrant County, Texas, effectively demonstrated that digital game cameras can be used to monitor where and when bobcats were most active and identify individual bobcats by distinguishing pelt characteristics. With the use of digital game cameras, we found that bobcats were not seasonal, even though the total number of bobcat trigger events fluctuated throughout the year at the two study sites. Even with our study setup of 15 cameras at two locations revisited across two sessions, which was a relatively small number of cameras, we were able to reveal that the local topography of the urban matrix influences bobcat activity. These findings are supported by other urban studies conducted on bobcat populations in California (Riley et al. 2003; Tigas et al. 2002).

In this study, we were able to record and document bobcat activity with geographic placement of cameras in the urban matrix. We found that bobcats were present over the majority of both study sites. Tucker et al. (2008) assessed that bobcat populations in fragmented environments in southern Iowa primarily remained in natural, forested habitat patches. Additionally, Riley et al. (2010) suggested that bobcats avoid developed areas within the urban matrix, particularly adult females. In our study, we recorded both male and female bobcats present in neighborhoods, as well as the green spaces within the urban matrix of our study sites. However, we noted that the highest number of bobcat trigger events took place where cameras were closest to water. This potential relationship with presence of water is consistent with other studies on urban populations (Riley et al. 2010).

We identified that bobcat activity differed more in the southern portion of the West site than either the northern region of that site or the East site. Even though bobcat activity was reduced across the entire study area during the second and fourth sessions in the West site, there were fewer numbers of individual bobcats and very little activity in the southern portion of the study site. The overall decrease in activity across the study site could have occurred if these camera locations were situated in habitat not preferred by bobcats, such as areas with an open understory (Riley et al. 2010). We hypothesized that the differences in the two regions of the West site, even when comparing camera locations within the same sessions, was due to the presence of a state highway (TX-199) that bisected the site. Even though we documented bobcat presence in the southern region of the West site, the majority of bobcats were found north of this highway system, particularly in the nature refuge. Only one of the identified bobcat individuals in our study was documented in both regions of the study site, and the camera that individual triggered in the southern portion was within a mile of the highway and the nature refuge. In comparison, we did not note any potential points of resistance in bobcat movements in the East site, as several individuals traversed throughout this site during the study. Thus, the placement of TX-199 potentially acts as a boundary and effectively separates the two regions of the West site. Other studies on bobcat populations in fragmented habitats have also shown that bobcat populations were sensitive to the geographic placement of roads, as they reduced connectivity and dispersal between populations (Crooks 2002; Riley et al. 2003; Ruell et al. 2009). Therefore, the state highway may be acting as a point of resistance for bobcat dispersal between the two halves of the West site. As for the reduced bobcat presence in the southern portion of the West site, we theorize this could have resulted in differences in habitat availability preferred by the species (Larrucea et al. 2007; Riley et al. 2010)

We were also able to use our camera trapping survey technique to explore bobcat activity patterns effectively. We did not find any circadian pattern of activity in our urban bobcat populations. Bobcats were active throughout the day and night over the entirety of both study sites. Comparable to the findings by Riley et al. (2003) and Tigas et al. (2002), bobcats did often trigger camera stations at night in heavily developed neighborhoods. Further, our study did not find that bobcats reduced overall activity during the middle of the day, as found in other urban studies (Riley et al. 2010). In contrast, Luniak (2004) theorized that urban predators should shift their daily activity patterns to times in which human populations are less active, thus becoming increasingly more crepuscular than populations found in more rural environments. Anderson and Lovallo (2003) supported this theory, as they documented that their urban bobcat population was increasingly shifting activity towards both earlier and later in the day. In addition, Tigas et al. (2002) documented a bimodal circadian activity pattern from bobcat individuals in their study.

Using digital game cameras, we were able to successfully assess unique pelt characteristics on bobcats that triggered the digital game cameras to identify to the individual level. The importance of demonstrating the ability to identify individuals through a noninvasive monitoring technique illustrates the potential of utilizing our methods in future long-term MRR monitoring programs (Heilbrun et al. 2003; Harrison 2006; Jackson et al. 2006). Similar to Heilbrun et al. (2003), we found that the inner forearms were most beneficial for identifying bobcat individuals. Unlike Heilbrun et al. (2003), few bobcat individuals stared directly at the camera as they walked past. In their study, they suggested that this might have resulted from the cameras making a small, audible clicking sound upon trigger (Heilbrun et al. 2003). As bobcats did not generally seem to notice the camera traps or demonstrate investigative behavior, the camera setup we used potentially does not alter bobcat behavior. Thus, as the majority of bobcats did not stare directly at the camera, we relied on using the banding patterns present on the cheeks and tuffs of individuals to assist in effectively identifying many of the secondary pelt characteristics.

The digital game camera design in our study allowed us to observe range overlap among individuals. As Riley et al. (2010) predicted for urban bobcats, we identified that bobcat individuals were overlapping ranges they frequented, regardless of sex, at both study sites. In fact, Riley (2006) reported that urban bobcats were more likely to overlap extensive portions of their home ranges among and within sexes in an urban population compared to those found in rural environments. At stations with highest water availability present, we identified as many as nine bobcat individuals at one camera location. Larrucea et al. (2007) only found a maximum of two individuals per camera station during their digital game camera study in northern California.

CONCLUSION

A successful digital game camera design used to identify unique characteristics among a wildlife population has the potential to assess population dynamics, such as population estimates, occurrence, or density (Heilbrun et al. 2003; Larrucea et al. 2007). For the objectives of our study, we were able to collect data with only a single camera unit per location. However, a two-camera set up would provide a more accurate population dynamic assessment and prevent the chance of overestimating the population size, as cameras would capture both sides of the individual simultaneously (Heilbrun et al. 2003; Ryan 2011). The one-camera set up that we used in this study is more beneficial for conducting wildlife monitoring programs, as the use of only one camera unit per station would allow surveyors to establish twice as many camera trap locations. For the amount of data collected, we found that digital game cameras were cost-effective, a noninvasive monitoring technique, not labor intensive, and were relatively simple to operate. Harrison (2006) came to similar conclusions after assessing that digital game camera studies were more cost-effective and able to run for longer periods of time with minimal upkeep once established in comparison to other MRR techniques (i.e., radio-collaring; Riley 2006; Ruell et al. 2009; Tigas et al. 2002). Further, long-term monitoring programs that utilize digital game cameras require less initial training as compared to programs that involve hiring a dog for tracking or a professional to identify wildlife tracks and/or scat (Harrison 2006).

Based on our study, we determined that digital game cameras provide a viable alternative to traditional MRR techniques in terms of the amount of data possible to collect (e.g., predator activity, presence, range overlap, and additional activity and/or behavior). Digital game camera units provide an excellent opportunity for researchers and managers to develop long-term monitoring programs for bobcats, as well as other mesocarnivore species that are solitary, cryptic, and costly to observe through other MRR techniques in an urban matrix. The methods of identification that we used would be most beneficial for monitoring wildlife species that exhibit unique pelt characteristics, but could also be applied to feral animals like dogs and cats. In depth digital game camera studies could determine the microhabitat use patterns for urban predator population both in the Dallas/Fort Worth Metroplex and other urban areas across the country.

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APPENDIX I: MESOCARNIVORE SUMMARY TABLES

Bobcat (*Lynx rufus*)

	East Site				West Site			
	Location	Photos	Bursts	Events	Location	Photos	Bursts	Events
Session 1	G05DL	9	3	3	B2NC	3	1	1
	G10VC	0	0	0	B3NC	2	1	1
	G11VC	99	34	29	B4NC	3	1	1
	H06DL	100	35	35	B6NC	6	2	2
	H07DO	81	27	7	C3NC	7	3	3
	H13SE	3	1	1	C4NC	27	9	9
	I08WC	9	3	3	C6NC	33	12	10
	J08WC	86	30	18	C7MR	3	1	1
	J09PL	3	1	1	D6NC	78	26	26
	J10SE	0	0	0	D8MR	3	1	1
					D9MR	140	47	7
					E5NC	35	13	12
					E6NC	51	17	7
					F5NC	9	3	1
					F6NC	6	2	2
Total		390	134	97		406	139	84
Session 2	F02DH	9	3	2	A3NC	0	0	0
	F11RL	0	0	0	B5NC	3	1	1
	G08VC	33	11	5	C5NC	9	3	3
	G09VC	3	1	1	D3NC	0	0	0
	G12RL	15	5	5	D4NC	15	5	5
	G13HD	0	0	0	D5NC	3	1	1
	G14RL	15	5	4	G3CR	6	2	2
	H03BM	3	1	1	G4TF	0	0	0
	H11GO	3	1	1	I2WW	0	0	0
	I10PW	15	5	5	I3WW	9	3	3
	I12BS	30	10	9	I7MA	0	0	0
					J3LH	3	1	1
					K3SC	0	0	0
					K4WW	3	1	1
Total		126	42	33		51	17	17

Bobcat (*Lynx rufus*)

	East Site				West Site			
	Location	Photos	Bursts	Events	Location	Photos	Bursts	Events
Session 3	F12RL	0	0	0	B2NC	43	15	15
	G02DH	6	2	2	B3NC	0	0	0
	G05DL	3	1	1	B4NC	3	1	1
	G10VC	0	0	0	B6NC	3	1	1
	G11VC	29	11	11	C3NC	9	3	3
	G16RL	40	16	11	C4NC	11	4	4
	H06DL	21	7	7	C6NC	15	5	5
	H07DL	3	1	1	C7MR	0	0	0
	H13SE	0	0	0	D6NC	20	7	6
	I08WC	48	16	10	D8MR	0	0	0
	J08WC	6	2	2	D9MR	0	0	0
	J09PL	1	1	1	E5NC	39	13	9
	J10SF	3	1	1	E6NC	0	0	0
					F5NC	0	0	0
					F6NC	3	1	1
Total		160	58	47		146	50	45
Session 4	F02DH	6	2	2	A2NC	0	0	0
	F11RL	18	6	5	B5NC	4	2	2
	G08VC	14	5	3	C5NC	5	3	3
	G09VC	3	1	1	D3NC	6	2	1
	G12RL	13	7	7	D4NC	3	2	2
	G13HD	0	0	0	D5NC	4	2	2
	G14RL	3	1	1	E4NC	0	0	0
	H03BM	3	1	1	G3CR	0	0	0
	H11GO	13	7	6	I2WW	0	0	0
	I10PW	5	3	3	I3WW	15	5	1
	I12BS	39	13	11	I7MA	0	0	0
					J3LH	2	2	2
Total		117	46	40		39	18	13
Site Totals		793	280	217		642	224	159

Coyote (*Canis latrans*)

	East Side				West Site			
	Location	Photos	Bursts	Events	Location	Photos	Bursts	Events
Session 1	G05DL	38	14	13	B2NC	63	21	8
	G10VC	0	0	0	B3NC	24	9	7
	G11VC	15	6	6	B4NC	6	2	2
	H06DL	154	56	46	B6NC	247	85	19
	H07DO	3	1	1	C3NC	11	4	1
	H13SE	12	4	4	C4NC	31	12	11
	I08WC	38	14	13	C6NC	291	105	63
	J08WC	38	13	13	C7MR	57	19	13
	J09PL	13	5	3	D6NC	8	3	3
	J10SE	0	0	0	D8MR	56	20	11
					D9MR	7	3	3
					E5NC	12	6	5
					E6NC	34	12	9
					F5NC	8	6	6
					F6NC	55	20	15
Total		311	113	99		910	327	176
Session 2	F02DH	50	17	13	A3NC	9	3	2
	F11RL	6	2	2	B5NC	39	13	8
	G08VC	11	4	3	C5NC	13	5	4
	G09VC	6	2	2	D3NC	6	2	2
	G12RL	81	29	27	D4NC	3	1	1
	G13HD	0	0	0	D5NC	63	21	4
	G14RL	64	22	19	G3CR	24	8	8
	H03BM	15	6	5	G4TF	21	7	6
	H11GO	18	6	4	I2WW	45	16	12
	I10PW	40	15	13	I3WW	12	5	5
	I12BS	36	12	11	I7MA	6	2	2
					J3LH	6	2	1
					K3SC	22	8	5
					K4WW	0	0	0
Total		327	115	99		269	93	60

Coyote (*Canis latrans*)

	East Site				West Site			
	Location	Photos	Bursts	Events	Location	Photos	Bursts	Events
Session 3	F12RL	6	2	2	B2NC	3	1	1
	G02DH	5	2	2	B3NC	3	1	1
	G05DL	0	0	0	B4NC	39	13	5
	G10VC	207	72	21	B6NC	0	0	0
	G11VC	0	0	0	C3NC	8	3	3
	G16RL	11	6	5	C4NC	7	4	4
	H06DL	121	43	31	C6NC	107	39	30
	H07DL	6	2	2	C7MR	11	4	4
	H13SE	0	0	0	D6NC	3	1	1
	I08WC	45	15	10	D8MR	63	21	8
	J08WC	60	20	10	D9MR	6	2	1
	J09PL	0	0	0	E5NC	3	2	2
	J10SF	0	0	0	E6NC	3	1	1
					F5NC	6	2	1
					F6NC	0	0	0
Total		461	162	83		262	94	62
Session 4	F02DH	96	31	22	A2NC	14	6	4
	F11RL	15	5	5	B5NC	15	6	5
	G08VC	25	9	5	C5NC	5	3	3
	G09VC	18	6	5	D3NC	0	0	0
	G12RL	22	10	10	D4NC	0	0	0
	G13HD	0	0	0	D5NC	1	1	1
	G14RL	18	6	4	E4NC	12	4	4
	H03BM	12	4	4	G3CR	0	0	0
	H11GO	8	4	4	I2WW	2	2	2
	I10PW	42	25	22	I3WW	18	10	10
	I12BS	57	19	18	I7MA	15	6	5
					J3LH	11	8	8
Total		313	119	99		93	46	42
Site Totals		1,412	509	380		1,534	560	340

Virginia Opossum (*Didelphis virginiana*)

	East Site				West Site			
	Location	Photos	Bursts	Events	Location	Photos	Bursts	Events
Session 1	G05DL	0	0	0	B2NC	24	8	7
	G10VC	0	0	0	B3NC	45	15	9
	G11VC	36	13	13	B4NC	19	7	5
	H06DL	0	0	0	B6NC	3	1	1
	H07DO	92	31	27	C3NC	3	1	1
	H13SE	0	0	0	C4NC	27	9	9
	I08WC	146	49	36	C6NC	6	2	2
	J08WC	551	189	132	C7MR	0	0	0
	J09PL	21	7	4	D6NC	104	36	31
	J10SE	9	3	2	D8MR	79	28	20
					D9MR	6	2	2
					E5NC	6	2	2
					E6NC	24	8	7
					F5NC	42	23	16
					F6NC	45	15	15
Total		855	292	214		433	157	127
Session 2	F02DH	36	12	10	A3NC	9	3	3
	F11RL	27	9	7	B5NC	0	0	0
	G08VC	51	17	9	C5NC	0	0	0
	G09VC	313	109	61	D3NC	0	0	0
	G12RL	172	57	43	D4NC	0	0	0
	G13HD	98	33	32	D5NC	0	0	0
	G14RL	144	49	35	G3CR	128	43	39
	H03BM	0	0	0	G4TF	0	0	0
	H11GO	180	61	39	I2WW	32	11	9
	I10PW	75	25	21	I3WW	9	3	3
	I12BS	9	3	3	I7MA	21	7	5
					J3LH	49	17	15
					K3SC	0	0	0
					K4WW	9	3	3
Total		1,105	375	260		257	87	77

Virginia Opossum (*Didelphis virginiana*)

	East Site				West Site			
	Location	Photos	Bursts	Events	Location	Photos	Bursts	Events
Session 3	F12RL	21	7	4	B2NC	49	17	15
	G02DH	102	34	13	B3NC	0	0	0
	G05DL	12	4	4	B4NC	6	2	2
	G10VC	3	1	1	B6NC	49	17	11
	G11VC	118	40	20	C3NC	0	0	0
	G16RL	35	13	9	C4NC	57	19	18
	H06DL	0	0	0	C6NC	165	55	54
	H07DL	93	31	30	C7MR	6	2	2
	H13SE	15	5	5	D6NC	24	8	8
	I08WC	48	16	15	D8MR	9	3	3
	J08WC	652	221	128	D9MR	0	0	0
	J09PL	0	0	0	E5NC	8	3	3
	J10SF	0	0	0	E6NC	3	1	1
					F5NC	84	29	28
					F6NC	0	0	0
Total		1,099	372	229		460	156	145
Session 4	F02DH	12	3	3	A2NC	69	23	17
	F11RL	42	14	13	B5NC	6	4	4
	G08VC	171	58	47	C5NC	5	3	3
	G09VC	96	33	22	D3NC	0	0	0
	G12RL	92	35	25	D4NC	83	35	30
	G13HD	0	0	0	D5NC	28	14	13
	G14RL	54	18	17	E4NC	11	4	4
	H03BM	3	1	1	G3CR	2	1	1
	H11GO	185	77	63	I2WW	76	30	23
	I10PW	50	23	22	I3WW	169	65	54
	I12BS	15	5	5	I7MA	19	10	9
					J3LH	5	2	2
Total		720	267	218		473	191	160
Site Totals		3,779	1,306	921		1,623	591	509

Domestic Cat (*Felis catus*)

	East Site				West Site			
	Location	Photos	Bursts	Events	Location	Photos	Bursts	Events
Session 1	G05DL	0	0	0	B2NC	0	0	0
	G10VC	0	0	0	B3NC	0	0	0
	G11VC	0	0	0	B4NC	0	0	0
	H06DL	0	0	0	B6NC	0	0	0
	H07DO	0	0	0	C3NC	0	0	0
	H13SE	39	13	13	C4NC	0	0	0
	I08WC	0	0	0	C6NC	0	0	0
	J08WC	0	0	0	C7MR	0	0	0
	J09PL	0	0	0	D6NC	0	0	0
	J10SE	24	8	7	D8MR	0	0	0
					D9MR	0	0	0
					E5NC	0	0	0
					E6NC	0	0	0
					F5NC	0	0	0
					F6NC	0	0	0
Total		63	21	20		0	0	0
Session 2	F02DH	0	0	0	A3NC	0	0	0
	F11RL	0	0	0	B5NC	0	0	0
	G08VC	0	0	0	C5NC	0	0	0
	G09VC	0	0	0	D3NC	0	0	0
	G12RL	0	0	0	D4NC	0	0	0
	G13HD	685	230	207	D5NC	0	0	0
	G14RL	0	0	0	G3CR	0	0	0
	H03BM	0	0	0	G4TF	0	0	0
	H11GO	0	0	0	I2WW	18	6	4
	I10PW	52	18	13	I3WW	0	0	0
	I12BS	24	8	7	I7MA	3	1	1
					J3LH	0	0	0
					K3SC	0	0	0
					K4WW	0	0	0
Total		761	256	227		21	7	5

Domestic Cat (*Felis catus*)

	East Site				West Site			
	Location	Photos	Bursts	Events	Location	Photos	Bursts	Events
Session 3	F12RL	0	0	0	B2NC	0	0	0
	G02DH	0	0	0	B3NC	0	0	0
	G05DL	0	0	0	B4NC	0	0	0
	G10VC	0	0	0	B6NC	3	1	1
	G11VC	0	0	0	C3NC	0	0	0
	G16RL	0	0	0	C4NC	0	0	0
	H06DL	0	0	0	C6NC	0	0	0
	H07DL	0	0	0	C7MR	0	0	0
	H13SE	73	25	8	D6NC	0	0	0
	I08WC	0	0	0	D8MR	0	0	0
	J08WC	0	0	0	D9MR	0	0	0
	J09PL	0	0	0	E5NC	0	0	0
	J10SF	0	0	0	E6NC	0	0	0
					F5NC	0	0	0
					F6NC	0	0	0
Total		73	25	8		3	1	1
Session 4	F02DH	0	0	0	A2NC	0	0	0
	F11RL	0	0	0	B5NC	0	0	0
	G08VC	0	0	0	C5NC	0	0	0
	G09VC	0	0	0	D3NC	0	0	0
	G12RL	0	0	0	D4NC	0	0	0
	G13HD	61	26	24	D5NC	0	0	0
	G14RL	0	0	0	E4NC	0	0	0
	H03BM	0	0	0	G3CR	0	0	0
	H11GO	3	1	1	I2WW	0	0	0
	I10PW	117	41	34	I3WW	0	0	0
	I12BS	24	8	6	I7MA	0	0	0
					J3LH	0	0	0
Total		205	76	65		0	0	0
Site Totals		1,102	378	320		24	8	6

Domestic Dog (*Canis lupus familiaris*)

	East Site				West Site			
	Location	Photos	Bursts	Events	Location	Photos	Bursts	Events
Session 1	G05DL	0	0	0	B2NC	3	1	1
	G10VC	0	0	0	B3NC	0	0	0
	G11VC	0	0	0	B4NC	0	0	0
	H06DL	0	0	0	B6NC	6	2	2
	H07DO	0	0	0	C3NC	0	0	0
	H13SE	170	58	53	C4NC	17	8	3
	I08WC	0	0	0	C6NC	36	12	6
	J08WC	20	7	5	C7MR	12	4	2
	J09PL	3	1	1	D6NC	38	13	10
	J10SE	25	9	8	D8MR	0	0	0
					D9MR	0	0	0
					E5NC	170	63	58
					E6NC	0	0	0
					F5NC	0	0	0
					F6NC	3	1	1
Total		218	75	67		285	104	83
Session 2	F02DH	0	0	0	A3NC	0	0	0
	F11RL	0	0	0	B5NC	12	4	2
	G08VC	0	0	0	C5NC	0	0	0
	G09VC	0	0	0	D3NC	0	0	0
	G12RL	6	2	1	D4NC	0	0	0
	G13HD	23	8	7	D5NC	18	6	3
	G14RL	0	0	0	G3CR	9	3	3
	H03BM	0	0	0	G4TF	0	0	0
	H11GO	0	0	0	I2WW	3	1	1
	I10PW	170	58	45	I3WW	0	0	0
	I12BS	6	2	2	I7MA	0	0	0
					J3LH	0	0	0
					K3SC	0	0	0
					K4WW	0	0	0
Total		205	70	55		42	14	9

Domestic Dog (*Canis lupus familiaris*)

	East Site				West Site			
	Location	Photos	Bursts	Events	Location	Photos	Bursts	Events
Session 3	F12RL	0	0	0	B2NC	6	2	2
	G02DH	0	0	0	B3NC	0	0	0
	G05DL	0	0	0	B4NC	0	0	0
	G10VC	0	0	0	B6NC	0	0	0
	G11VC	0	0	0	C3NC	0	0	0
	G16RL	0	0	0	C4NC	0	0	0
	H06DL	0	0	0	C6NC	2	1	1
	H07DL	0	0	0	C7MR	0	0	0
	H13SE	145	50	44	D6NC	30	10	9
	I08WC	0	0	0	D8MR	0	0	0
	J08WC	0	0	0	D9MR	0	0	0
	J09PL	0	0	0	E5NC	34	12	12
	J10SF	0	0	0	E6NC	0	0	0
					F5NC	0	0	0
					F6NC	0	0	0
Total		145	50	44		72	25	24
Session 4	F02DH	6	2	2	A2NC	0	0	0
	F11RL	0	0	0	B5NC	0	0	0
	G08VC	0	0	0	C5NC	0	0	0
	G09VC	0	0	0	D3NC	0	0	0
	G12RL	0	0	0	D4NC	0	0	0
	G13HD	0	0	0	D5NC	0	0	0
	G14RL	0	0	0	E4NC	0	0	0
	H03BM	3	1	1	G3CR	0	0	0
	H11GO	0	0	0	I2WW	0	0	0
	I10PW	55	28	25	I3WW	3	1	1
	I12BS	0	0	0	I7MA	6	2	2
					J3LH	0	0	0
Total		64	31	28		9	3	3
Site Totals		632	226	194		408	146	119

Gray Fox (*Urocyon cinereoargenteus*)

	East Site				West Site			
	Location	Photos	Bursts	Events	Location	Photos	Bursts	Events
Session 1	G05DL	0	0	0	B2NC	0	0	0
	G10VC	0	0	0	B3NC	0	0	0
	G11VC	0	0	0	B4NC	0	0	0
	H06DL	0	0	0	B6NC	0	0	0
	H07DO	0	0	0	C3NC	0	0	0
	H13SE	51	17	11	C4NC	0	0	0
	I08WC	9	3	1	C6NC	0	0	0
	J08WC	15	5	3	C7MR	0	0	0
	J09PL	3	1	1	D6NC	0	0	0
	J10SE	49	17	12	D8MR	0	0	0
					D9MR	0	0	0
					E5NC	6	2	1
					E6NC	0	0	0
					F5NC	0	0	0
					F6NC	0	0	0
Total		127	43	28		6	2	1
Session 2	F02DH	0	0	0	A3NC	0	0	0
	F11RL	0	0	0	B5NC	0	0	0
	G08VC	0	0	0	C5NC	0	0	0
	G09VC	0	0	0	D3NC	0	0	0
	G12RL	0	0	0	D4NC	0	0	0
	G13HD	0	0	0	D5NC	0	0	0
	G14RL	0	0	0	G3CR	3	1	1
	H03BM	0	0	0	G4TF	0	0	0
	H11GO	0	0	0	I2WW	0	0	0
	I10PW	6	2	2	I3WW	0	0	0
	I12BS	0	0	0	I7MA	0	0	0
					J3LH	0	0	0
					K3SC	0	0	0
					K4WW	0	0	0
Total		6	2	2		3	1	1

Gray Fox (*Urocyon cinereoargenteus*)

	East Site				West Site			
	Location	Photos	Bursts	Events	Location	Photos	Bursts	Events
Session 3	F12RL	0	0	0	B2NC	0	0	0
	G02DH	0	0	0	B3NC	0	0	0
	G05DL	0	0	0	B4NC	0	0	0
	G10VC	0	0	0	B6NC	0	0	0
	G11VC	0	0	0	C3NC	0	0	0
	G16RL	0	0	0	C4NC	0	0	0
	H06DL	0	0	0	C6NC	0	0	0
	H07DL	0	0	0	C7MR	0	0	0
	H13SE	0	0	0	D6NC	0	0	0
	I08WC	0	0	0	D8MR	0	0	0
	J08WC	0	0	0	D9MR	0	0	0
	J09PL	0	0	0	E5NC	0	0	0
	J10SF	0	0	0	E6NC	0	0	0
					F5NC	0	0	0
					F6NC	0	0	0
Total		0	0	0		0	0	0
Session 4	F02DH	0	0	0	A2NC	0	0	0
	F11RL	0	0	0	B5NC	0	0	0
	G08VC	0	0	0	C5NC	0	0	0
	G09VC	0	0	0	D3NC	0	0	0
	G12RL	0	0	0	D4NC	0	0	0
	G13HD	0	0	0	D5NC	0	0	0
	G14RL	0	0	0	E4NC	0	0	0
	H03BM	0	0	0	G3CR	0	0	0
	H11GO	0	0	0	I2WW	0	0	0
	I10PW	24	10	10	I3WW	0	0	0
	I12BS	24	8	6	I7MA	0	0	0
					J3LH	0	0	0
Total		48	18	16		0	0	0
Site Totals		181	63	46		9	3	2

Unknown Feline

	East Site				West Site			
	Location	Photos	Bursts	Events	Location	Photos	Bursts	Events
Session 1	G05DL	0	0	0	B2NC	0	0	0
	G10VC	0	0	0	B3NC	0	0	0
	G11VC	0	0	0	B4NC	0	0	0
	H06DL	0	0	0	B6NC	0	0	0
	H07DO	0	0	0	C3NC	0	0	0
	H13SE	0	0	0	C4NC	0	0	0
	I08WC	0	0	0	C6NC	0	0	0
	J08WC	0	0	0	C7MR	0	0	0
	J09PL	0	0	0	D6NC	0	0	0
	J10SE	0	0	0	D8MR	0	0	0
					D9MR	0	0	0
					E5NC	0	0	0
					E6NC	0	0	0
					F5NC	0	0	0
					F6NC	0	0	0
Total		0	0	0		0	0	0
Session 2	F02DH	0	0	0	A3NC	0	0	0
	F11RL	0	0	0	B5NC	0	0	0
	G08VC	0	0	0	C5NC	0	0	0
	G09VC	0	0	0	D3NC	0	0	0
	G12RL	0	0	0	D4NC	0	0	0
	G13HD	0	0	0	D5NC	0	0	0
	G14RL	0	0	0	G3CR	0	0	0
	H03BM	0	0	0	G4TF	0	0	0
	H11GO	0	0	0	I2WW	0	0	0
	I10PW	3	1	1	I03WW	0	0	0
	I12BS	0	0	0	I7MA	0	0	0
					J3LH	0	0	0
					K3SC	0	0	0
					K4WW	0	0	0
Total		3	1	1		0	0	0

Unknown Feline

	East Site				West Site			
	Location	Photos	Bursts	Events	Location	Photos	Bursts	Events
Session 3	F12RL	0	0	0	B2NC	0	0	0
	G02DH	0	0	0	B3NC	0	0	0
	G05DL	0	0	0	B4NC	0	0	0
	G10VC	0	0	0	B6NC	0	0	0
	G11VC	0	0	0	C3NC	0	0	0
	G16RL	0	0	0	C4NC	0	0	0
	H06DL	0	0	0	C6NC	0	0	0
	H07DL	0	0	0	C7MR	0	0	0
	H13SE	0	0	0	D6NC	0	0	0
	I08WC	0	0	0	D8MR	0	0	0
	J08WC	0	0	0	D9MR	0	0	0
	J09PL	0	0	0	E5NC	0	0	0
	J10SF	0	0	0	E6NC	0	0	0
					F5NC	0	0	0
					F6NC	0	0	0
Total		0	0	0		0	0	0
Session 4	F02DH	0	0	0	A2NC	0	0	0
	F11RL	0	0	0	B5NC	0	0	0
	G08VC	0	0	0	C5NC	0	0	0
	G09VC	0	0	0	D3NC	0	0	0
	G12RL	0	0	0	D4NC	0	0	0
	G13HD	0	0	0	D5NC	0	0	0
	G14RL	0	0	0	E4NC	0	0	0
	H03BM	0	0	0	G3CR	0	0	0
	H11GO	0	0	0	I2WW	0	0	0
	I10PW	0	0	0	I3WW	0	0	0
	I12BS	0	0	0	I7MA	0	0	0
					J3LH	0	0	0
Total		0	0	0		0	0	0
Site Totals		3	1	1		0	0	0

Striped Skunk (*Mephitis mephitis*)

	East Site				West Site			
	Location	Photos	Bursts	Events	Location	Photos	Bursts	Events
Session 1	G05DL	0	0	0	B2NC	0	0	0
	G10VC	108	37	11	B3NC	8	3	3
	G11VC	15	5	5	B4NC	0	0	0
	H06DL	76	27	22	B6NC	0	0	0
	H07DO	0	0	0	C3NC	15	5	5
	H13SE	0	0	0	C4NC	3	1	1
	I08WC	15	5	3	C6NC	0	0	0
	J08WC	284	96	81	C7MR	30	10	8
	J09PL	3	1	1	D6NC	0	0	0
	J10SE	0	0	0	D8MR	6	2	2
					D9MR	0	0	0
					E5NC	12	5	5
					E6NC	0	0	0
					F5NC	0	0	0
					F6NC	0	0	0
Total		501	171	123		74	26	24
Session 2	F02DH	3	1	1	A3NC	0	0	0
	F11RL	15	5	4	B5NC	0	0	0
	G08VC	0	0	0	C5NC	0	0	0
	G09VC	58	20	6	D3NC	9	3	3
	G12RL	0	0	0	D4NC	3	1	1
	G13HD	0	0	0	D5NC	6	2	1
	G14RL	0	0	0	G3CR	0	0	0
	H03BM	9	3	3	G4TF	21	7	4
	H11GO	6	2	2	I2WW	0	0	0
	I10PW	0	0	0	I3WW	3	1	1
	I12BS	33	11	9	I7MA	0	0	0
					J3LH	3	1	1
					K3SC	0	0	0
					K4WW	0	0	0
Total		124	42	25		45	15	11

Striped Skunk (*Mephitis mephitis*)

	East Site				West Site			
	Location	Photos	Bursts	Events	Location	Photos	Bursts	Events
Session 3	F12RL	0	0	0	B2NC	0	0	0
	G02DH	59	20	17	B3NC	0	0	0
	G05DL	0	0	0	B4NC	0	0	0
	G10VC	9	3	2	B6NC	0	0	0
	G11VC	18	6	6	C3NC	6	2	2
	G16RL	0	0	0	C4NC	0	0	0
	H06DL	3	1	1	C6NC	9	3	3
	H07DL	0	0	0	C7MR	15	5	2
	H13SE	21	7	4	D6NC	0	0	0
	I08WC	21	7	4	D8MR	0	0	0
	J08WC	0	0	0	D9MR	0	0	0
	J09PL	0	0	0	E5NC	0	0	0
	J10SF	0	0	0	E6NC	0	0	0
					F5NC	0	0	0
					F6NC	0	0	0
Total		131	44	34		30	10	7
Session 4	F02DH	0	0	0	A2NC	0	0	0
	F11RL	0	0	0	B5NC	0	0	0
	G08VC	30	10	9	C5NC	0	0	0
	G09VC	0	0	0	D3NC	3	1	1
	G12RL	0	0	0	D4NC	0	0	0
	G13HD	0	0	0	D5NC	9	5	5
	G14RL	18	6	5	E4NC	9	3	3
	H03BM	3	1	1	G3CR	0	0	0
	H11GO	3	1	1	I2WW	0	0	0
	I10PW	0	0	0	I3WW	0	0	0
	I12BS	0	0	0	I7MA	0	0	0
					J3LH	0	0	0
Total		54	18	16		21	9	9
Site Totals		810	275	198		170	60	51

Raccoon (*Procyon lotor*)

	East Site				West Site			
	Location	Photos	Bursts	Events	Location	Photos	Bursts	Events
Session 1	G05DL	295	104	56	B2NC	255	92	67
	G10VC	0	0	0	B3NC	253	85	55
	G11VC	481	165	105	B4NC	813	274	119
	H06DL	812	286	168	B6NC	280	95	56
	H07DO	60	21	13	C3NC	493	164	109
	H13SE	16	6	4	C4NC	695	238	185
	I08WC	146	50	25	C6NC	1229	425	293
	J08WC	6	2	2	C7MR	57	20	16
	J09PL	18	6	3	D6NC	464	158	141
	J10SE	3	1	1	D8MR	62	22	9
					D9MR	99	34	13
					E5NC	214	73	64
					E6NC	306	103	69
					F5NC	55	35	16
					F6NC	195	66	44
Total		1,837	641	377		5,470	1,884	1,256
Session 2	F02DH	162	54	37	A3NC	121	41	23
	F11RL	165	55	29	B5NC	519	173	144
	G08VC	87	29	13	C5NC	1039	351	194
	G09VC	221	74	36	D3NC	103	35	22
	G12RL	126	42	29	D4NC	16	6	5
	G13HD	17	6	6	D5NC	21	7	4
	G14RL	201	68	23	G3CR	321	112	67
	H03BM	22	8	5	G4TF	0	0	0
	H11GO	9	3	3	I2WW	18	6	6
	I10PW	6	2	2	I3WW	121	41	37
	I12BS	34	12	12	I7MA	15	5	4
					J3LH	9	3	2
					K3SC	3	1	1
					K4WW	51	17	7
Total		1,050	353	195		2,357	798	516

Raccoon (*Procyon lotor*)

	East Site				West Site			
	Location	Photos	Bursts	Events	Location	Photos	Bursts	Events
Session 3	F12RL	37	13	4	B2NC	563	189	146
	G02DH	27	9	6	B3NC	6	2	2
	G05DL	60	20	3	B4NC	15	5	5
	G10VC	15	5	3	B6NC	51	17	10
	G11VC	232	79	60	C3NC	215	72	59
	G16RL	42	18	16	C4NC	270	90	82
	H06DL	3	1	1	C6NC	808	271	257
	H07DL	189	63	28	C7MR	0	0	0
	H13SE	24	8	7	D6NC	495	175	171
	I08WC	6	2	2	D8MR	36	12	10
	J08WC	27	9	4	D9MR	0	0	0
	J09PL	1	1	1	E5NC	82	28	26
	J10SF	0	0	0	E6NC	39	13	9
					F5NC	15	5	4
					F6NC	23	9	8
Total		663	228	135		2,618	888	789
Session 4	F02DH	108	38	25	A2NC	191	65	44
	F11RL	127	43	21	B5NC	114	48	34
	G08VC	87	30	20	C5NC	729	333	279
	G09VC	39	13	9	D3NC	121	41	24
	G12RL	189	69	45	D4NC	13	5	4
	G13HD	12	5	5	D5NC	12	5	3
	G14RL	58	19	12	E4NC	66	22	16
	H03BM	18	6	6	G3CR	166	61	43
	H11GO	73	29	25	I2WW	26	12	9
	I10PW	6	2	1	I3WW	247	97	65
	I12BS	189	74	44	I7MA	0	0	0
					J3LH	58	23	12
Total		906	328	213		1,743	712	533
Site Totals		4,456	1,550	920		12,188	4,282	3,094

Mesocarnivore Camera Trapping Summary

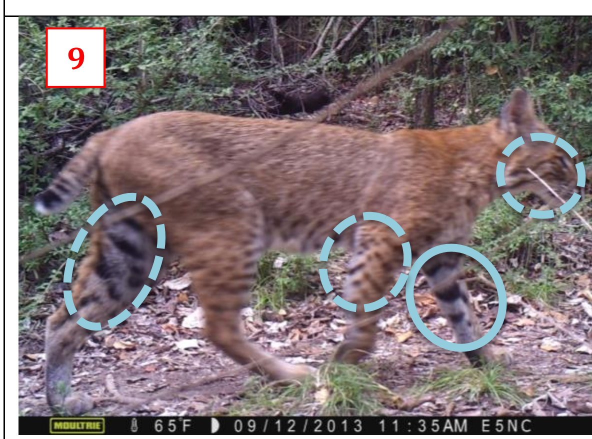
		East Site			West Site		
	Species	Photos	Bursts	Events	Photos	Bursts	Events
Session 1	bobcat	390	134	97	406	139	83
	coyote	311	113	99	910	327	176
	Virginia opossum	855	292	214	433	157	127
	domestic cat	63	21	20	0	0	0
	domestic dog	218	75	67	285	104	83
	gray fox	127	43	28	6	2	1
	unknown felid	0	0	0	0	0	0
	striped skunk	501	171	123	74	26	24
	raccoon	1,837	641	377	5,470	1,884	1,256
Session 2	bobcat	126	42	33	51	17	17
	coyote	327	115	99	269	93	60
	Virginia opossum	1,105	375	260	257	87	77
	domestic cat	761	256	227	21	7	5
	domestic dog	205	70	55	42	14	9
	gray fox	6	2	2	3	1	1
	unknown felid	3	1	1	0	0	0
	striped skunk	124	42	25	45	15	11
	raccoon	1,050	353	195	2,357	798	516
Session 3	bobcat	160	58	47	146	50	45
	coyote	461	162	83	262	94	62
	Virginia opossum	1,099	372	229	460	156	145
	domestic cat	73	25	8	3	1	1
	domestic dog	145	50	44	72	25	24
	gray fox	0	0	0	0	0	0
	unknown felid	0	0	0	0	0	0
	striped skunk	131	44	34	30	10	7
	raccoon	663	228	135	2,618	888	789
Session 4	bobcat	117	46	40	39	18	13
	coyote	313	119	99	93	46	42
	Virginia opossum	720	267	218	473	191	160
	domestic cat	205	76	65	0	0	0
	domestic dog	64	31	28	9	3	3
	gray fox	48	18	16	0	0	0
	unknown felid	0	0	0	0	0	0
	striped skunk	54	18	16	21	9	9
	raccoon	906	328	213	1,743	712	533
Totals		13,168	4,588	3,197	16,598	5,874	4,279

APPENDIX II: BOBCAT REFERENCE LIBRARY

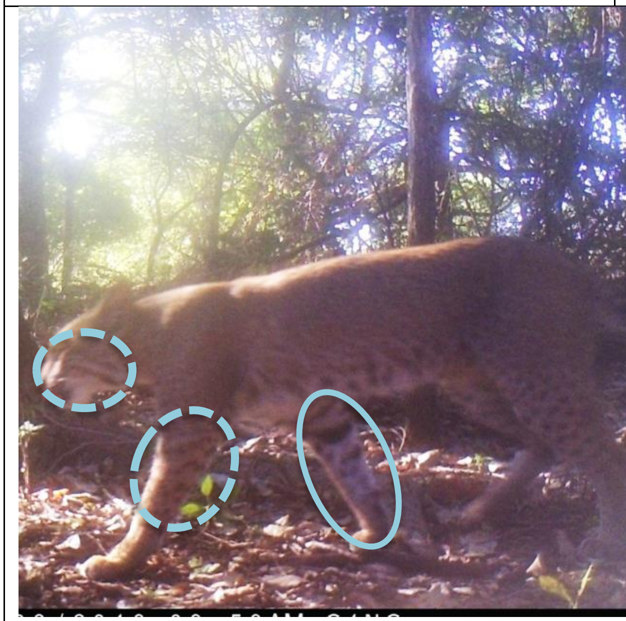
Here, we have documented all 79 bobcat individuals that were identified throughout the duration of our digital game camera study. Each individual is presented in the following format:

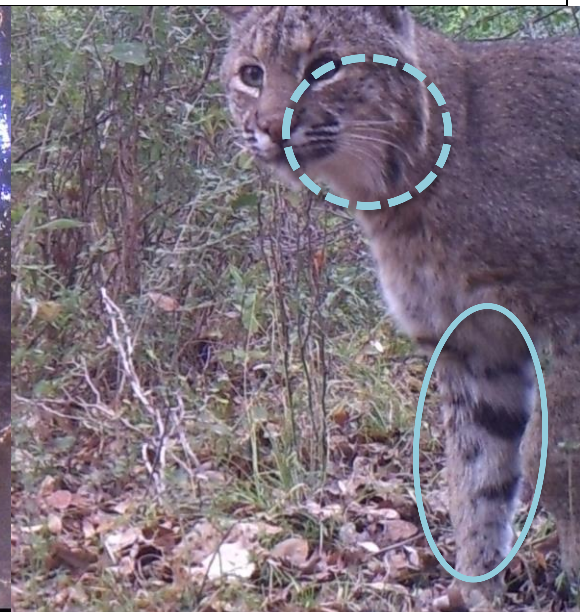
1. The identification number to an individual in sequential order.
2. The study site associated with the individual as either the East site or West site.
3. Whenever possible, the sex associated with that individual as either male or female.
4. Whenever possible, the age class associated with that individual as either juvenile or adult.
5. The session(s) the individual was captured in, respective of the study site.
6. The camera location(s) the individual triggered, respective of the study site.
7. The lateral side used to assess pelt characteristics to identify the individual as either left or right, respective of the individual's position in relation to the camera unit. In cases where the individual was identified on both the left and right lateral sides, we documented this scenario as 'both'.
8. The hours in which the individual triggered a camera unit, based on a 24-hour clock.
9. A clear reference photo of one primary identifying factor illustrated with a solid blue circle and at least three secondary identifying factors represented with a broken blue circle.
10. Additional angles of the individual beneficial for identifying additional pelt characteristics.

1 ID: BOBC010	2 Study Site: West	3 Sex: Female	4 Age Class: Adult
Session(s) Captured: 1, 3 5		Camera Location(s): B2NC, C4NC, D6NC, E5NC 6	
Side(s) Visible: Right 7		Activity: 2:00-3:00; 6:00-7:00; 11:00-12:00; 15:00-16:00; 18:00-19:00 8	



ID: BOBC001	Study Site: West	Sex: Male	Age Class: Adult
Session(s) Captured: 1, 2, 4		Camera Location(s): C4NC, D4NC, D6NC	
Side(s) Visible: Left		Activity: 0:00-1:00; 9:00-10:00	

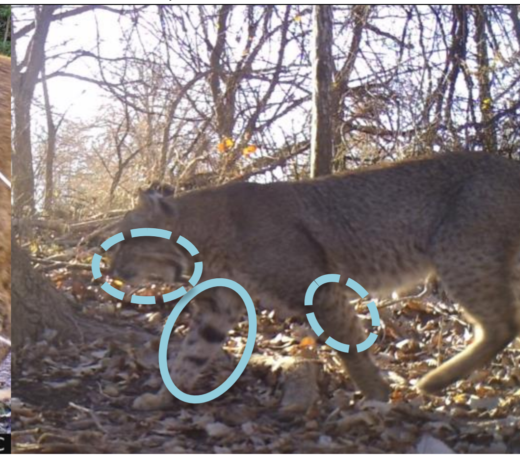




ID: BOBC002	Study Site: West	Sex: Male	Age Class: Adult
Session(s) Captured: 1, 3		Camera Locations(s): B2NC, D6NC, C4NC	
Side(s) Visible: Both		Activity: 0:00-7:00; 18:00-0:00	

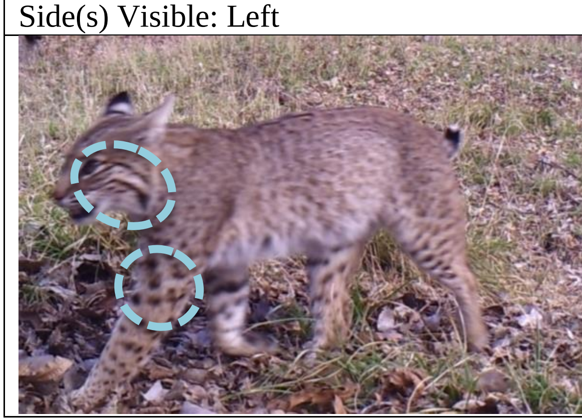
ID: BOBC003	Study Site: West	Sex: Male	Age Class: Adult
Session(s) Captured: 1		Camera Location(s): C6NC	
Side(s) Visible: Right		Activity: 11:00-1:00	

ID: BOBC004	Study Site: West	Sex:Male	Age Class: Adult
Session(s) Captured: 1, 3		Camera Location(s): B2NC, C3NC, C4NC, D6NC, E5NC	
Side(s) Visible: Left		Activity: 9:00-11:00; 13:00-15:00; 16:00-18:00; 20:00-22:00	



ID: BOBC005	Study Site: West	Sex: N/A	Age Class: Juvenile
Session(s) Captured: 1, 4		Camera Location(s): B5NC, B6NC	
Side(s) Visible: Left		Activity: 8:00-9:00; 18:00-19:00	


ID: BOBC006	Study Site: West	Sex: N/A	Age Class: Juvenile
Session(s) Captured: 1		Camera Location(s): B6NC	
Side(s) Visible: Left		Activity: 14:00-15:00	




ID: BOBC007	Study Site: West	Sex: Female	Age Class: Adult
Session(s) Captured: 1		Camera Location(s): C6NC	
Side(s) Visible: Both		Activity: 5:00-6:00; 11:00-14:00	



Note: Individual linked from posterior angle and spotting patterns

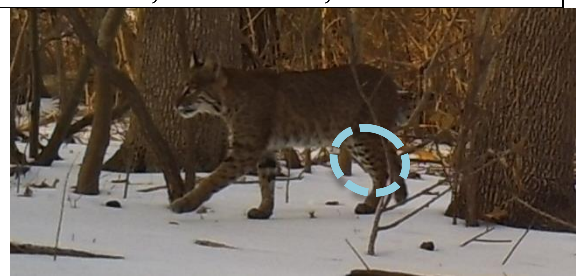
ID: BOBC008	Study Site: West	Sex: Male	Age Class: Adult
Session(s) Captured: 1		Camera Location(s): C6NC	
Side(s) Visible: Left		Activity: 13:00-14:00	

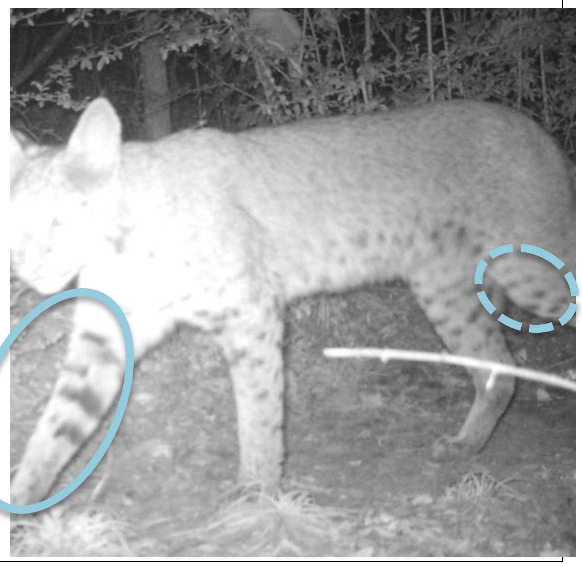

ID: BOBC009	Study Site: West	Sex: Female	Age Class: Adult
Session(s) Captured: 1		Camera Location(s): D9MR	
Side(s) Visible: Both		Activity: 5:00-6:00	

Note: Individual presented both sides in a single trigger event

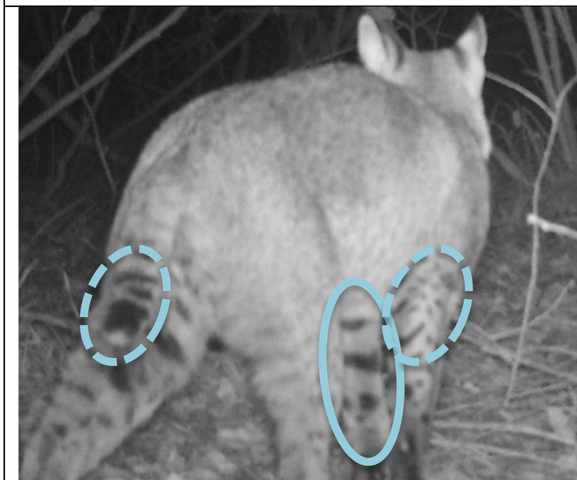
ID: BOBC010	Study Site: West	Sex: Female	Age Class: Adult
Session(s) Captured: 1, 3		Camera Location(s): B2NC, C4NC, D6NC, E5NC	
Side(s) Visible: Right		Activity: 2:00-3:00; 6:00-7:00; 11:00-12:00; 15:00-16:00; 18:00-19:00	

ID: BOBC011	Study Site: West	Sex: Female	Age Class: Adult
Session(s) Captured: 1, 2, 3, 4		Camera Location(s): B4NC, D4NC, D6NC, E5NC, F6NC	
Side(s) Visible: Left		Activity: 1:00-3:00; 6:00-8:00; 9:00-11:00, 15:00-17:00; 20:00-0:00	





ID: BOBC012	Study Site: West	Sex: Male	Age Class: Adult
Session(s) Captured: 1, 2, 3, 4		Camera Location(s): B6NC, C5NC, D5NC, E5NC, E6NC	
Side(s) Visible: Both		Activity: 0:00-1:00; 2:00-4:00; 10:00-11:00; 21:00-22:00; 23:00-0:00	



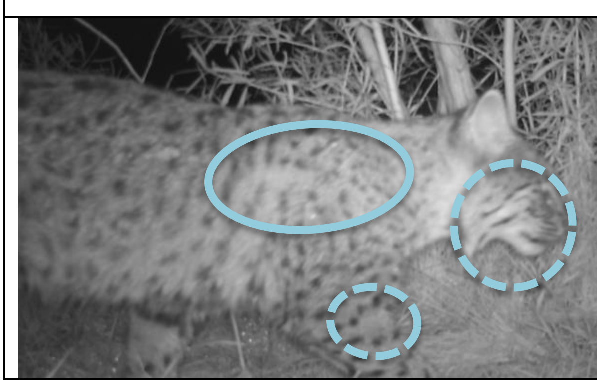
Note: Individual presented both sides in a single trigger event

ID: BOBC013	Study Site: West	Sex: N/A	Age Class: Adult
Session(s) Captured: 1, 4		Camera Location(s): C5NC, E6NC	
Side(s) Visible: Both		Activity: 6:00-7:00; 17:00-18:00; 19:00-20:00	

Note: Individual presented both sides in a single trigger event

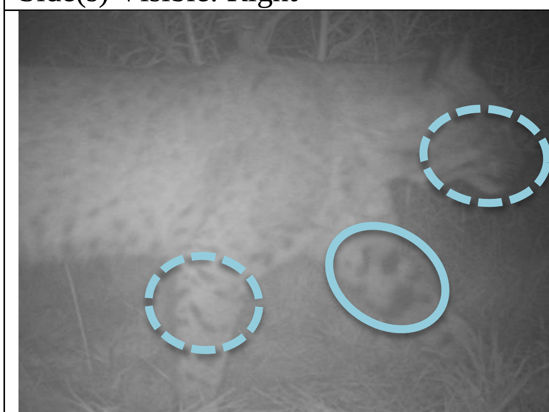
ID: BOBC014	Study Site: East	Sex: Female	Age Class: Adult
Session(s) Captured: 1, 2, 3, 4		Camera Location(s): G11VC, G12RL, H11GO	
Side(s) Visible: Right		Activity: 10:00-12:00; 15:00-18:00; 19:00-20:00	

ID: BOBC015	Study Site: East	Sex: N/A	Age Class: Adult
Session(s) Captured: 1, 2		Camera Location(s): G11VC, G12RL	
Side(s) Visible: Right		Activity: 1:00-2:00; 13:00-14:00; 23:00-0:00	



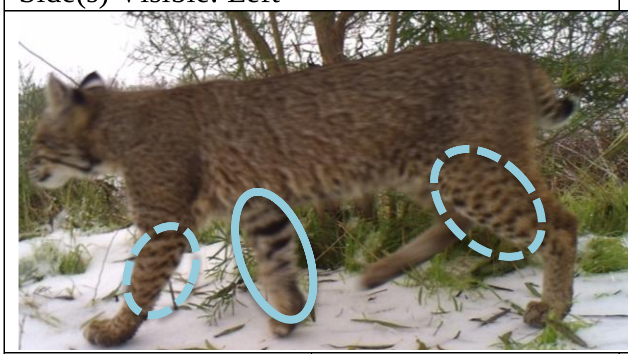
ID: BOBC016	Study Site: East	Sex: Male	Age Class: Adult
Session(s) Captured: 1		Camera Location(s): G11VC	
Side(s) Visible: Right		Activity: 12:00-13:00	

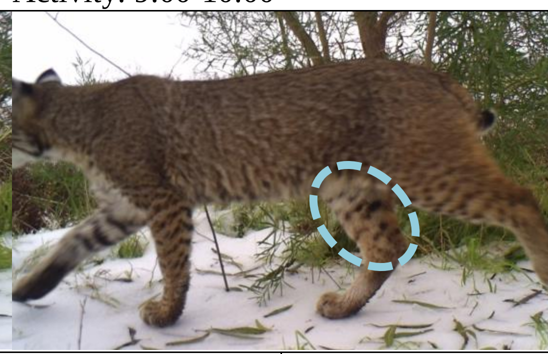
ID: BOBC017	Study Site: East	Sex: N/A	Age Class: Adult
Session(s) Captured: 1		Camera Location(s): G11VC	
Side(s) Visible: Right		Activity: 4:00-6:00; 18:00-19:00	



ID: BOBC018	Study Site: East	Sex: Female	Age Class: Adult
Session(s) Captured: 1		Camera Location(s): G11VC	
Side(s) Visible: Left		Activity: 7:00-8:00	

ID: BOBC019	Study Site: East	Sex: Female	Age Class: Adult
Session(s) Captured: 1		Camera Location(s): G11VC	
Side(s) Visible: Left		Activity: 9:00-10:00	

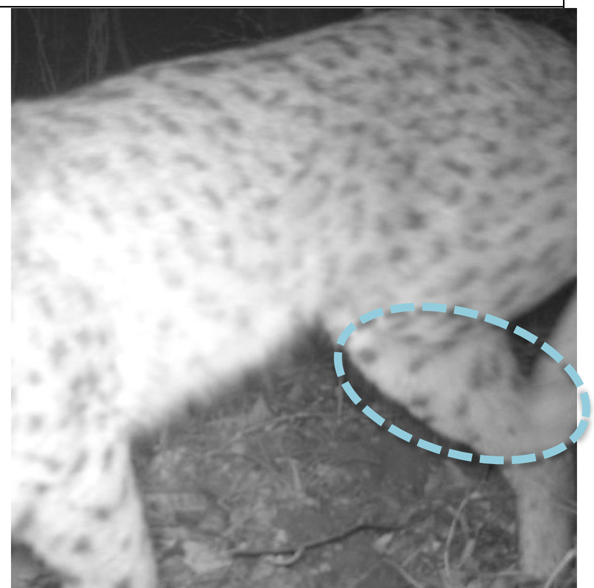




ID: BOBC020	Study Site: East	Sex: N/A	Age Class: Adult
Session(s) Captured: 1, 2, 4		Camera Location(s): G11VC, G12RL	
Side(s) Visible: Both		Activity: 0:00-2:00; 16:00-17:00; 18:00-20:00; 21:00-22:00	

Note: Both sides linked by posterior angle and spotting identified on tail

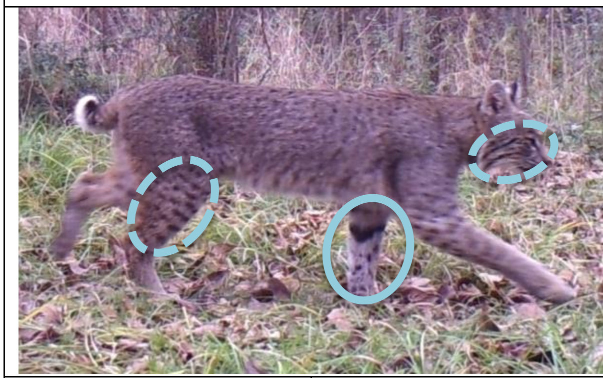
ID: BOBC021	Study Site: East	Sex: N/A	Age Class: Adult
Session(s) Captured: 1, 2, 4		Camera Location(s): G11VC, G12RL	
Side(s) Visible: Left		Activity: 5:00-8:00; 10:00-11:00; 18:00-19:00	

ID: BOBC022	Study Site: East	Sex: Female	Age Class: Adult
Session(s) Captured: 1, 2, 3, 4		Camera Location(s): F11RL, G11VC, G14RL	
Side(s) Visible: Left		Activity: 4:00-5:00; 6:00-7:00; 14:00-15:00; 17:00-18:00; 19:00-20:00	

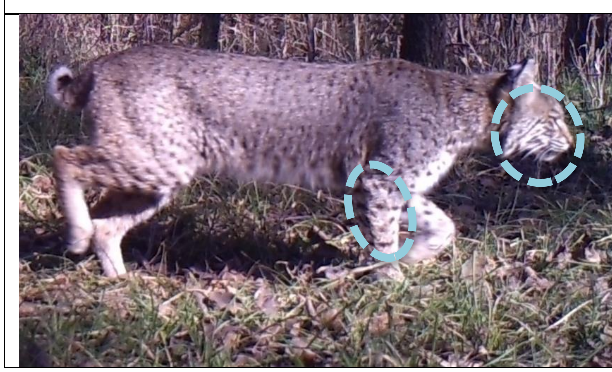
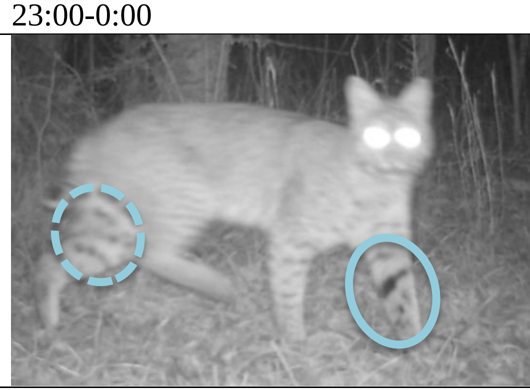

ID: BOBC023	Study Site: East	Sex: N/A	Age Class: Adult
Session(s) Captured: 1		Camera Location(s): G11VC	
Side(s) Visible: Right		Activity: 20:00-21:00	

ID: BOBC024	Study Site: East	Sex: Female	Age Class: Adult
Session(s) Captured: 1, 2, 4		Camera Location(s): H06DL, G14RL	
Side(s) Visible: Right		Activity: 4:00-5:00; 8:00-11:00; 13:00-14:00; 15:00-18:00; 23:00-0:00	

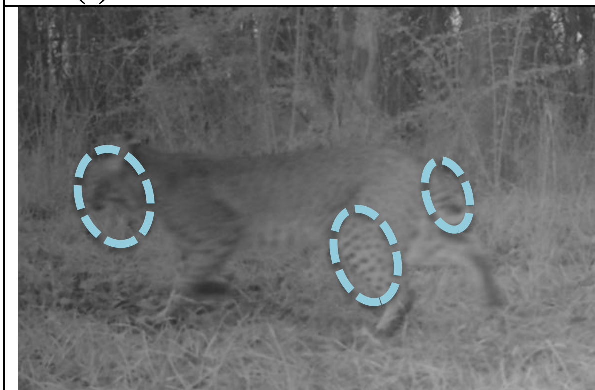


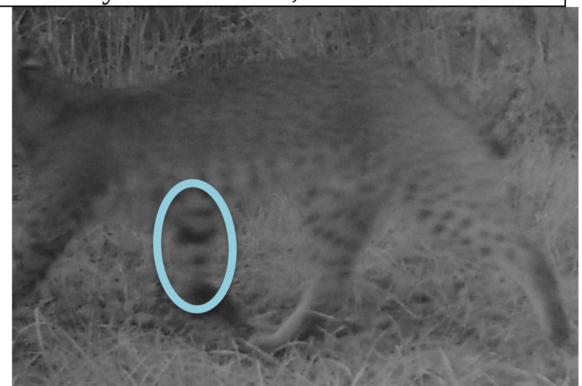

ID: BOBC025	Study Site: East	Sex: N/A	Age Class: Adult
Session(s) Captured: 1		Camera Location(s): H06DL	
Side(s) Visible: Left		Activity: 17:00-19:00	

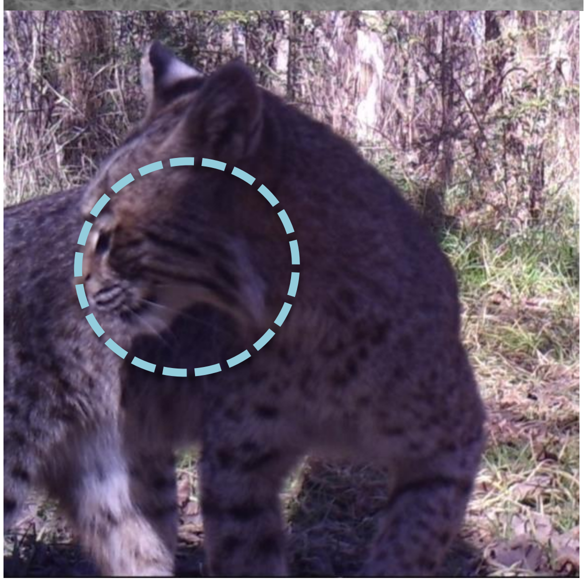

ID: BOBC026	Study Site: East	Sex: N/A	Age Class: Adult
Session(s) Captured: 1		Camera Location(s): H06DL	
Side(s) Visible: Right		Activity: 2:00-3:00; 7:00-8:00; 10:00-11:00; 12:00-13:00; 17:00-18:00; 23:00-0:00	

ID: BOBC027	Study Site: East	Sex: Female	Age Class: Adult
Session(s) Captured: 1		Camera Location(s): H06DL	
Side(s) Visible: Both		Activity: 13:00-14:00; 17:00-18:00	



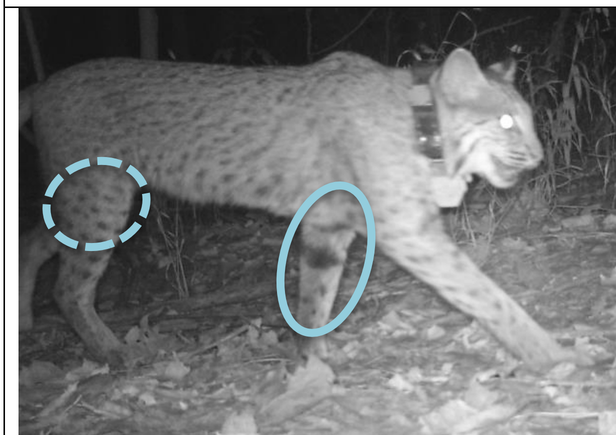




Note: Individual presented both sides in a single trigger event

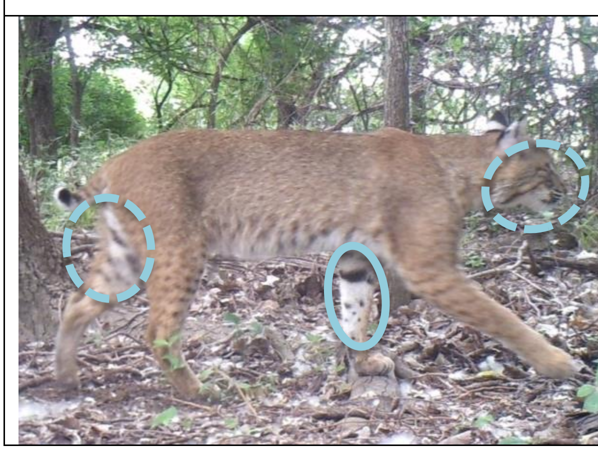
ID: BOBC028	Study Site: East	Sex: N/A	N/A
Session(s) Captured: 1		Camera Location(s): H06DL	
Side(s) Visible: Right		Activity: 13:00-14:00; 22:00-23:00	

ID: BOBC029	Study Site: East	Sex: Male	Age Class: Adult
Session(s) Captured: 1, 3, 4		Camera Location(s): G05DL, H06DL, G08VC, G09VC	
Side(s) Visible: Both		Activity: 6:00-7:00; 8:00-9:00; 10:00-12:00; 15:00-17:00; 19:00-21:00; 23:00-0:00	

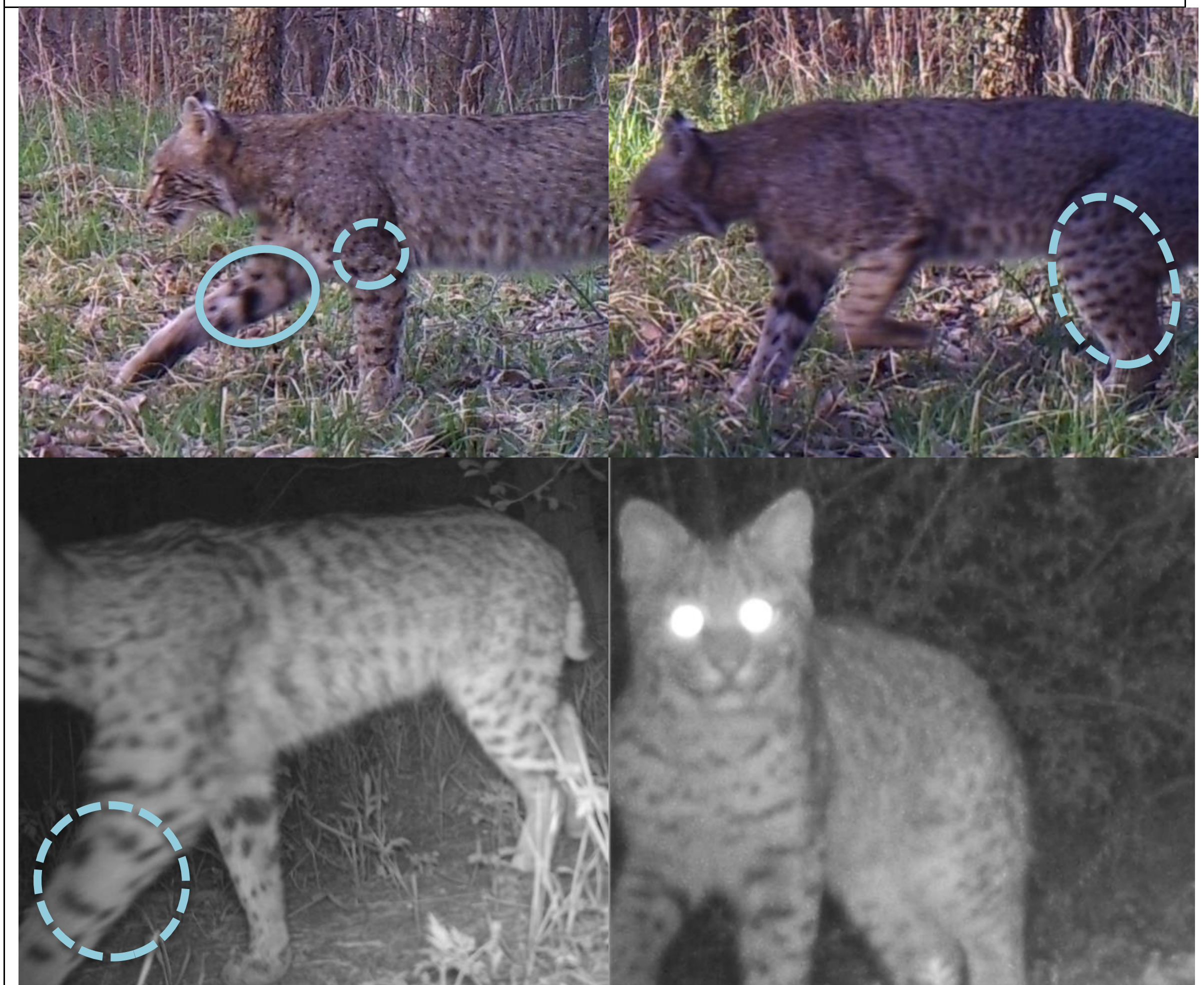


Note: Linked the two sides from the cheek tuffs and tail banding

ID: BOBC030	Study Site: West	Sex: Male	Age Class: Adult
Session(s) Captured: 3, 4		Camera Location(s): B2NC, C3NC, C4NC, D3NC	
Side(s) Visible: Right		Activity: 5:00-6:00; 8:00-10:00; 12:00-1:00; 19:00-21:00	



ID: BOBC031	Study Site: East	Sex: Male	Age Class: Adult
Session(s) Captured: 1, 2, 4		Camera Location(s): F11RL, G08VC, G12RL, H06DL	
Side(s) Visible: Both		Activity: 2:00-3:00; 17:00-18:00; 20:00-21:00	

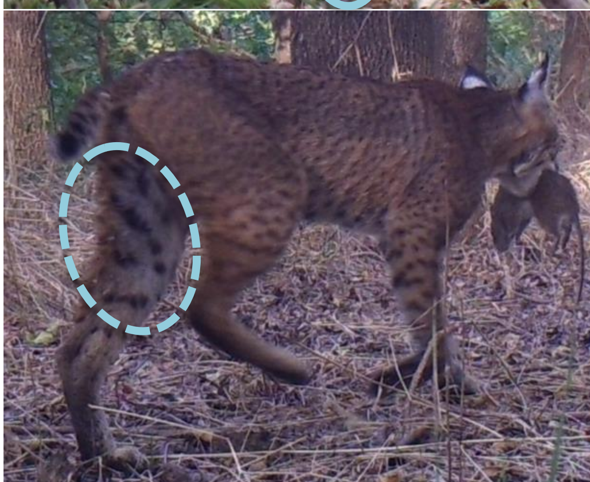


Note: Individual presented both sides in a single trigger event

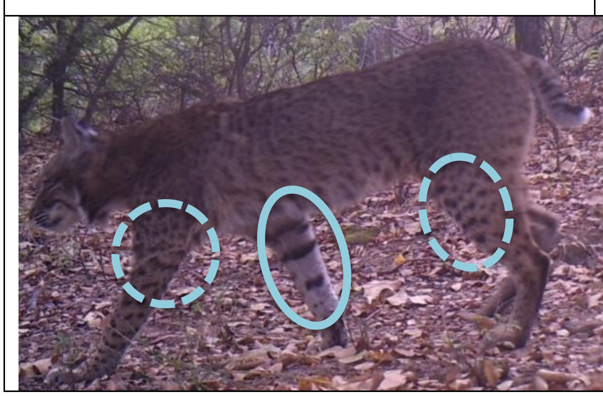
ID: BOBC032	Study Site: West	Sex: Male	Age Class: Adult
Session(s) Captured: 1, 2		Camera Location(s): C4NC, G3CR	
Side(s) Visible: Right		Activity: 10:00-11:00; 17:00-18:00	

ID: BOBC033	Study Site: West	Sex: N/A	Age Class: Adult
Session(s) Captured: 1		Camera Location(s): C4NC	
Side(s) Visible: Right		Activity: 17:00-18:00	
			
ID: BOBC034	Study Site: West	Sex: Female	Age Class: Adult
Session(s) Captured: 1		Camera Location(s): C3NC, C4NC	
Side(s) Visible: Right		Activity: 0:00-1:00; 13:00-14:00	
			

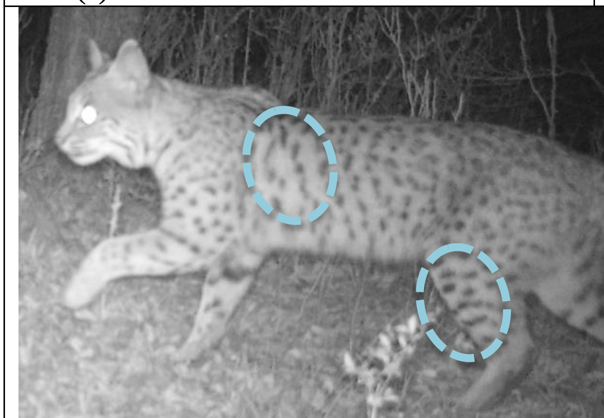
ID: BOBC035	Study Site: East	Sex: Female	Age Class: Adult
Session(s) Captured: 1, 3		Camera Location(s): I08WC, J08WC	
Side(s) Visible: Right		Activity: 7:00-8:00; 11:00-12:00; 15:00-16:00; 18:00-19:00	



ID: BOBC036	Study Site: East	Sex: Female	Age Class: Adult
Session(s) Captured: 1, 3, 4		Camera Location(s): H03BM, I08WC, J08WC	
Side(s) Visible: Left		Activity: 0:00-2:00; 7:00-8:00; 10:00-11:00; 13:00-14:00; 21:00-22:00	

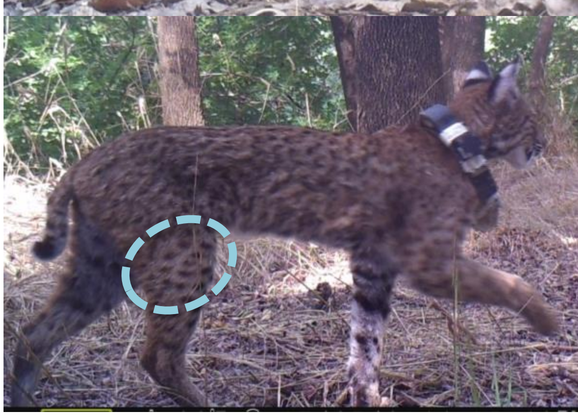


ID: BOBC037	Study Site: West	Sex: Female	Age Class: Adult
Session(s) Captured: 2		Camera Location(s): D4NC	
Side(s) Visible: Left		Activity: 21:00-22:00	

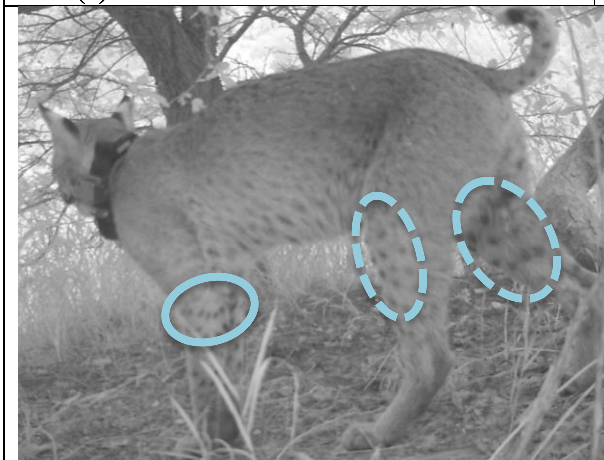


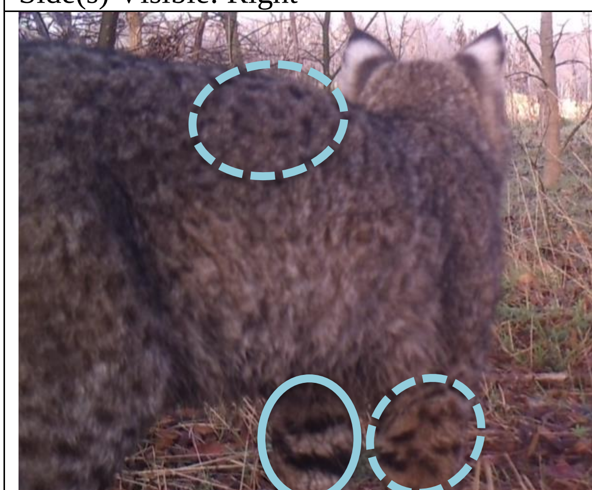

ID: BOBC038	Study Site: East	Sex: Female	Age Class: Adult
Session(s) Captured: 2, 3		Camera Location(s): G08VC, G09VC, H06DL, I08WC	
Side(s) Visible: Both		Activity: 12:00-14:00; 15:00-16:00; 17:00-18:00; 22:00-23:00	





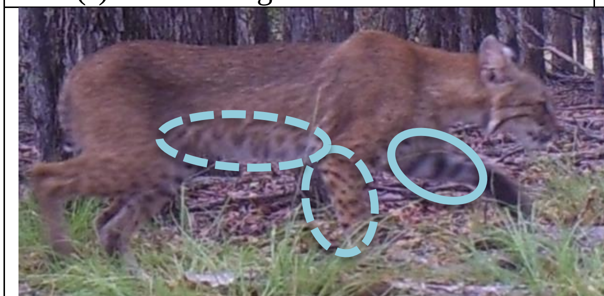
Note: Individual presented both sides within a trigger event

ID: BOBC039	Study Site: East	Sex: Female	Age Class: Adult
Session(s) Captured: 1, 2		Camera Location(s): G08VC, H06DL	
Side(s) Visible: Left		Activity: 7:00-8:00; 9:00-11:00	
			

ID: BOBC040	Study Site: East	Sex: N/A	Age Class: Juvenile
Session(s) Captured: 1		Camera Location(s): J08WC	
Side(s) Visible: Right		Activity: 6:00-8:00; 9:00-11:00	
			

ID: BOBC041	Study Site: East	Sex: N/A	Age Class: Juvenile
Session(s) Captured: 4		Camera Location(s): F02DH, G08VC	
Side(s) Visible: Left		Activity: 19:00-20:00	
			

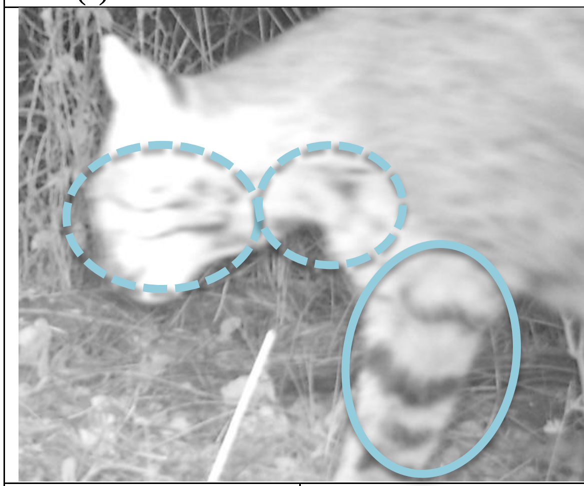
ID: BOBC042	Study Site: West	Sex: N/A	Age Class: Adult
Session(s) Captured: 4		Camera Location(s): D5NC	
Side(s) Visible: Right		Activity: 18:00-19:00	



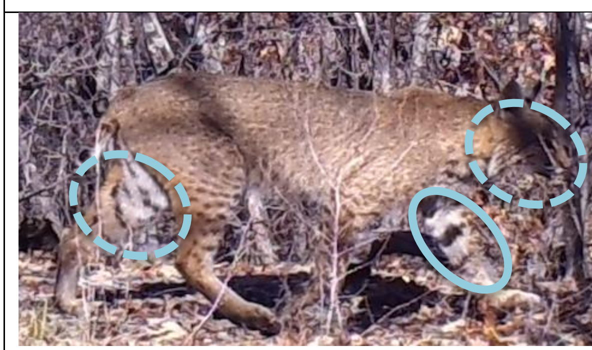
ID: BOBC043	Study Site: West	Sex: N/A	Age Class: Adult
Session(s) Captured: 4		Camera Location(s): I3WW	
Side(s) Visible: Right		Activity: 8:00-9:00	


ID: BOBC044	Study Site: West	Sex: N/A	Age Class: Adult
Session(s) Captured: 4		Camera Location(s): J3LH	
Side(s) Visible: Right		Activity: 21:00-22:00	

ID: BOBC045	Study Site: West	Sex: N/A	Age Class: Adult
Session(s) Captured: 4		Camera Location(s): J3LH	
Side(s) Visible: Left		Activity: 8:00-9:00	

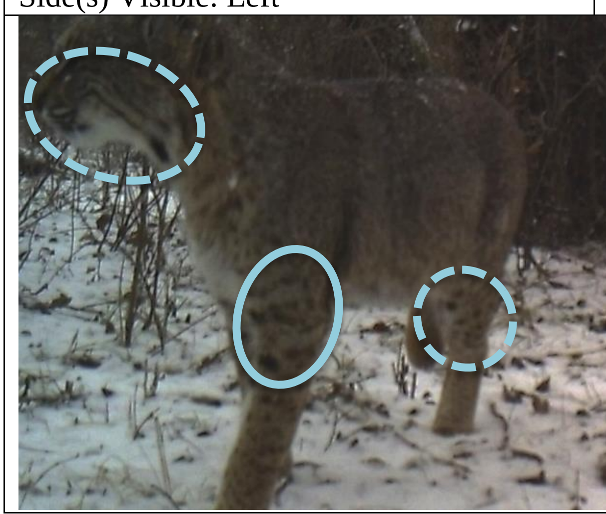


ID: BOBC046	Study Site: West	Sex: Female	Age Class: Adult
Session(s) Captured: 1, 2, 3		Camera Location(s): C5NC, C6NC, C7MR	
Side(s) Visible: Both		Activity: 2:00-3:00; 8:00-9:00; 12:00-14:00; 15:00-16:00	



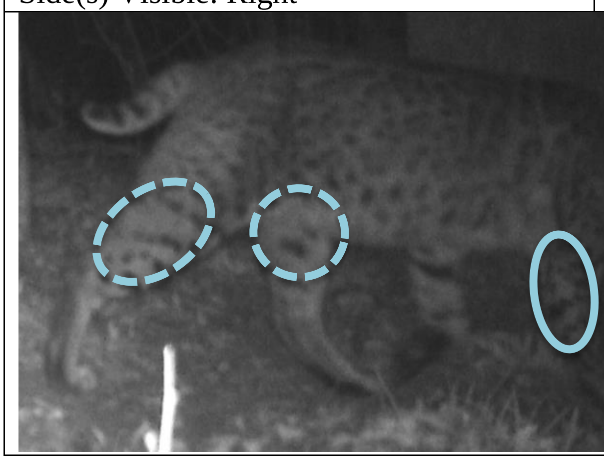
Note: Individual identified by the cheeck tuffs and forearm spotting

ID: BOBC047	Study Site: West	Sex: Female	Age Class: Adult
Session(s) Captured: 2		Camera Location(s): D4NC	
Side(s) Visible: Left		Activity: 9:00-10:00	

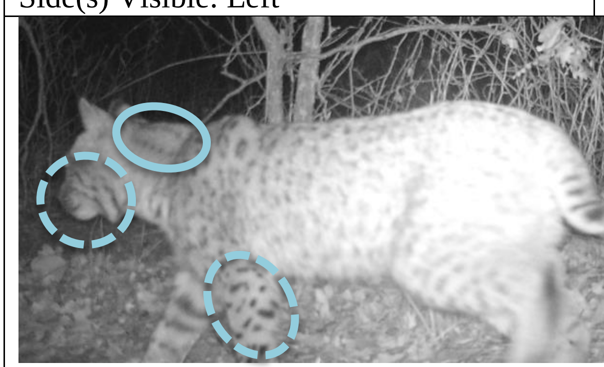


ID: BOBC048	Study Site: West	Sex: N/A	Age Class: Adult
Session(s) Captured: 2		Camera Location(s): G3CR	
Side(s) Visible: Left		Activity: 8:00-9:00	

ID: BOBC049	Study Site: West	Sex: N/A	Age Class: Adult
Sessions captured: 2		Camera Location(s): K4WW	
Side(s) Visible: Right		Activity: 1:00-2:00	



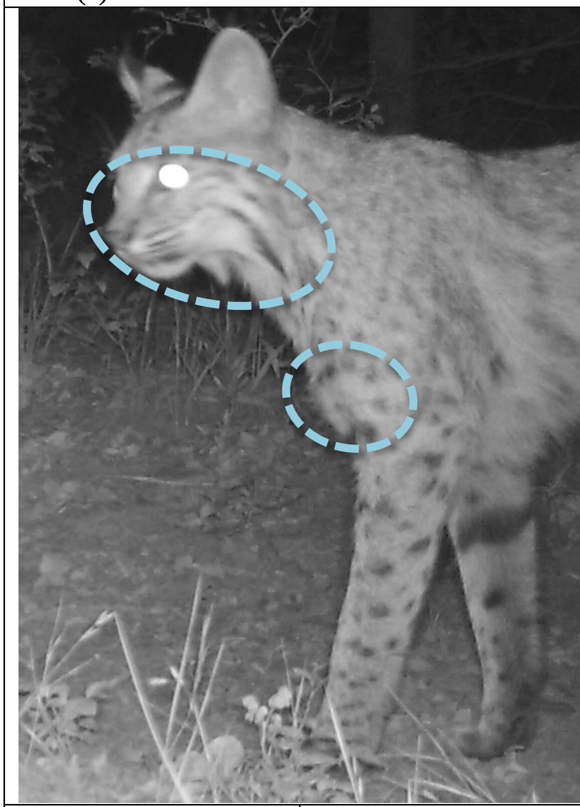
ID: BOBC050	Study Site: West	Sex: Female	Age Class: Adult
Session(s) Captured: 2		Camera Location(s): I3WW, J3LH	
Side(s) Visible: Left		Activity: 2:00-3:00; 15:00-16:00	



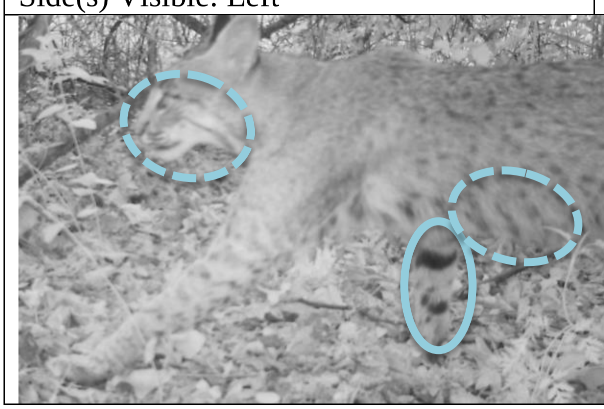
ID: BOBC051	Study Site: East	Sex: Female	Age Class: Adult
Session(s) Captured: 2		Camera Location(s): F02DH	
Side(s) Visible: Left		Activity: 10:00-11:00	

ID: BOBC052	Study Site: East	Sex: N/A	Age Class: Adult
Session(s) Captured: 1, 2		Camera Location(s): F02DH, J08WC	
Side(s) Visible: Left		Activity: 8:00-9:00; 12:00-13:00	

ID: BOBC053	Study Site: East	Sex: Male	Age Class: Adult
Session(s) Captured: 2, 4		Camera Location(s): H03BM, I10PW	
Side(s) Visible: Left		Activity: 0:00-2:00; 21:00-22:00	



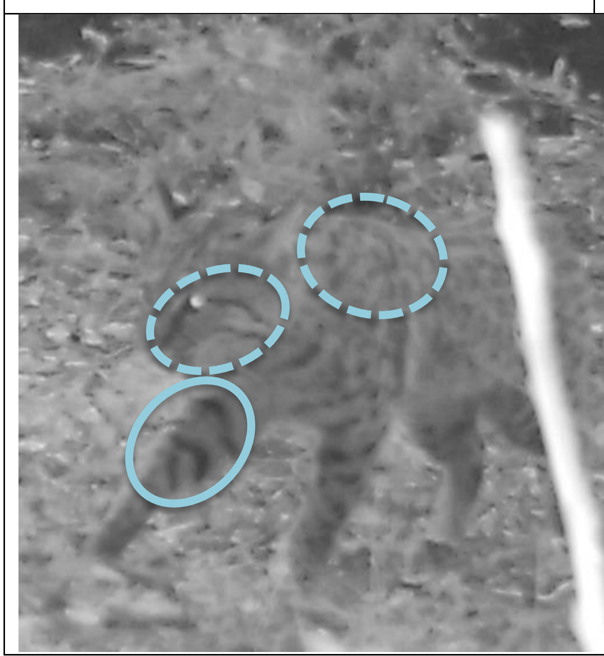
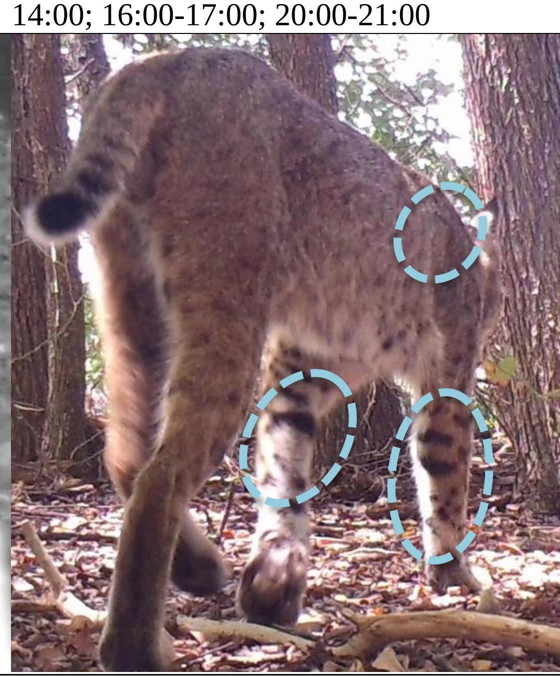
ID: BOBC054	Study Site: East	Sex: Female	Age Class: Adult
Sessions captured: 2		Camera Location(s): H11GO	
Side(s) Visible: Left		Activity: 8:00-9:00	



ID: BOBC055	Study Site: East	Sex: N/A	Age Class: Adult
Session(s) Captured: 1, 2		Camera Location(s): I10Pw, J08WC	
Side(s) Visible: Right		Activity: 2:00-4:00; 8:00-9:00	

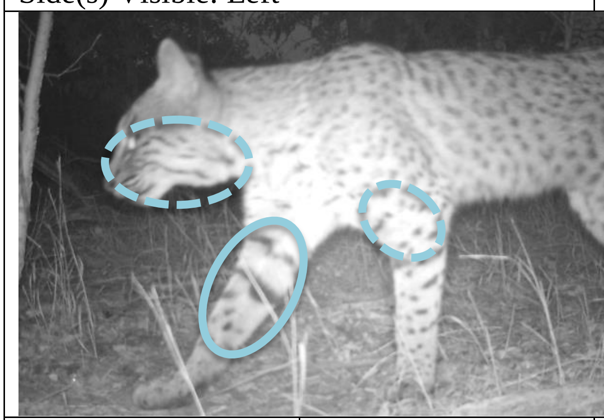


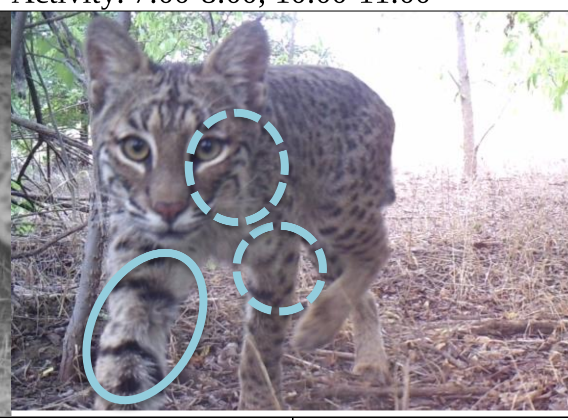
ID: BOBC056	Study Site: East	Sex: Male	Age Class: Adult
Session(s) Captured: 2, 3, 4		Camera Location(s): G16RL, I12BS	
Side(s) Visible: Both		Activity: 3:00-4:00; 5:00-6:00; 13:00-14:00; 16:00-17:00; 20:00-21:00	

ID: BOBC057	Study Site: East	Sex: Female	Age Class: Adult
Session(s) Captured: 3		Camera Location(s): G02DH	
Side(s) Visible: Right		Activity: 2:00-3:00; 15:00-16:00	

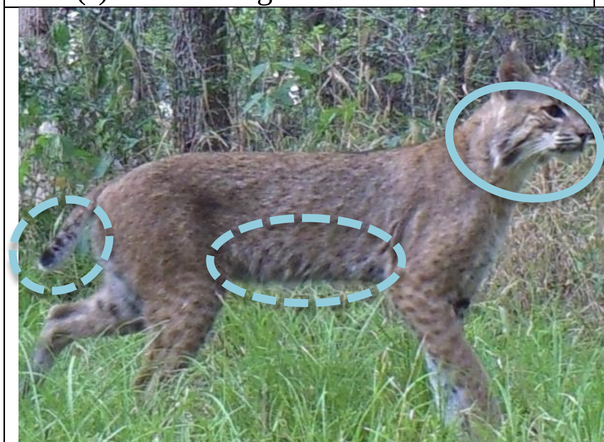
ID: BOBC058	Study Site: East	Sex: N/A	Age Class: N/A
Session(s) captured: 3		Camera Location(s): J08WC	
Side(s) Visible: Left		Activity: 7:00-8:00; 10:00-11:00	





ID: BOBC059	Study Site: East	Sex: Female	Age Class: Female
Session(s) Captured: 3		Camera Location(s): G11VC	
Side(s) Visible: Left		Activity: 18:00-21:00	

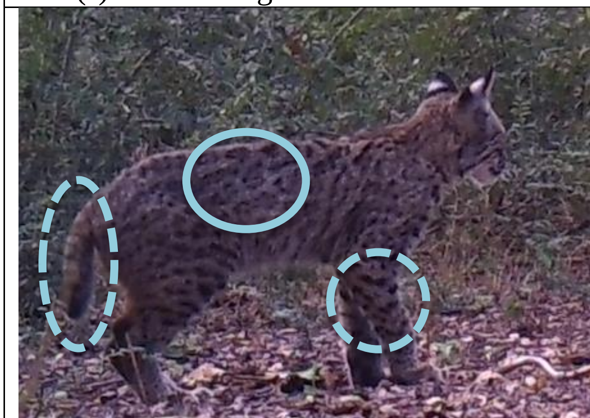
ID: BOBC060	Study Site: East	Sex: N/A	Age Class: Adult
Session(s) Captured: 3		Camera Location(s): H06DL	
Side(s) Visible: Right		Activity: 17:00-18:00	



ID: BOBC061	Study Site: East	Sex: N/A	Age Class: Adult
Session(s) captured: 3		Camera Location(s): H06DL	
Side(s) Visible: Right		Activity: 8:00-9:00	

ID: BOBC062	Study Site: East	Sex: N/A	Age Class: Juvenile
Session(s) Captured: 4		Camera Location(s): F02DH	
Side(s) Visible: Left		Activity: 18:00-19:00	

ID: BOBC063	Study Site: East	Sex: N/A	Age Class: Juvenile
Session(s) Captured: 4		Camera Location(s): F11RL	
Side(s) Visible: Right		Activity: 18:00-19:00	

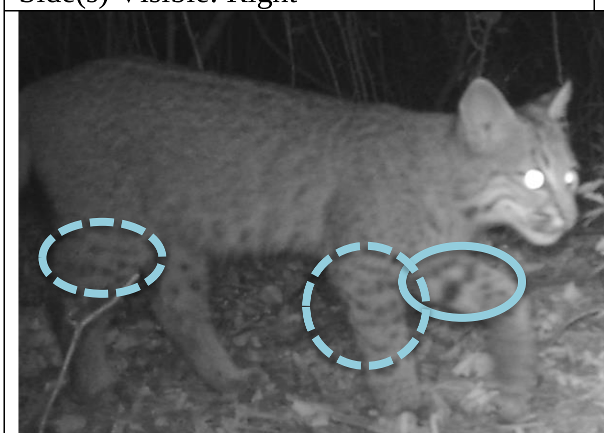


ID: BOBC064	Study Site: East	Sex: N/A	Age Class: Adult
Session(s) Captured: 4		Camera Location(s): G12RL	
Side(s) Visible: Right		Activity: 15:00-16:00	

ID: BOBC065	Study Site: East	Sex: N/A	Age Class: Adult
Session(s) Captured: 4		Camera Location(s): G14RL	
Side(s) Visible: Right		Activity: 11:00-12:00	

ID: BOBC066	Study Site: East	Sex: Female	Age Class: Adult
Session(s) Captured: 2, 4		Camera Location(s): G14RL, H11GO	
Side(s) Visible: Left		Activity: 9:00-10:00; 20:00-21:00	

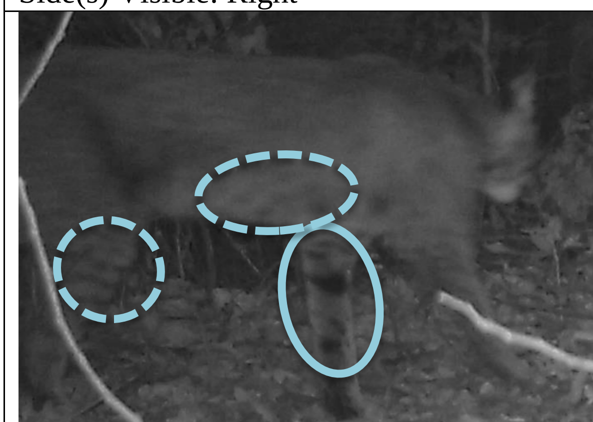

ID: BOBC067	Study Site: East	Sex: N/A	Age Class: Juvenile
Session(s) Captured: 4		Camera Location(s): H11GO	
Side(s) Visible: Right		Activity: 4:00-5:00	



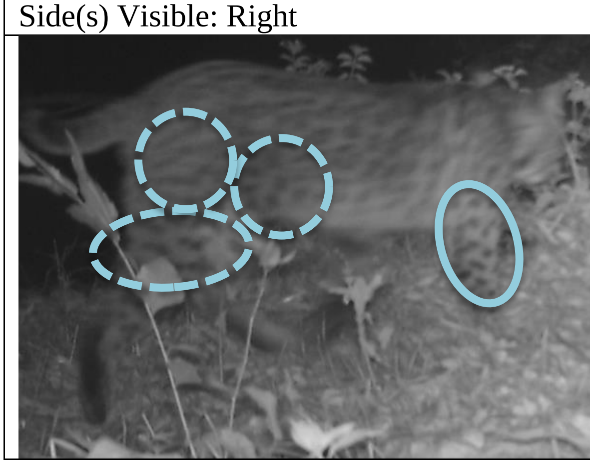
ID: BOBC068	Study Site: East	Sex: N/A	Age Class: Adult
Session(s) Captured: 4		Camera Location(s): F11RL	
Side(s) Visible: Left		Activity: 15:00-16:00	

ID: BOBC069	Study Site: East	Sex: N/A	Age Class: Adult
Session(s) Captured: 4		Camera Location(s): I10PW	
Side(s) Visible: Left		Activity: 22:00-23:00	

ID: BOBC070	Study Site: East	Sex: Male	Age Class: Adult
Session(s) Captured: 4		Camera Location(s): I10PW	
Side(s) Visible: Right		Activity: 19:00-20:00	

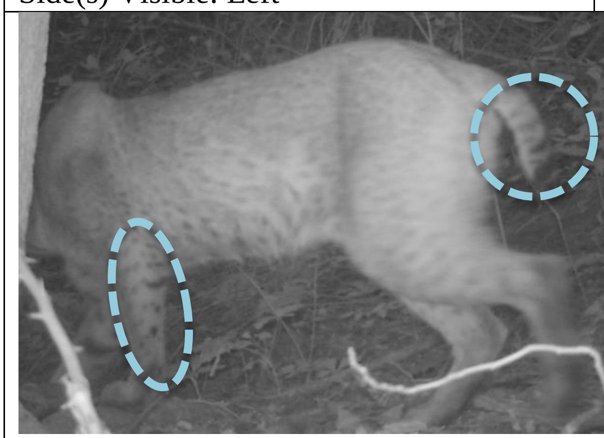


ID: BOBC071	Study Site: East	Sex: Male	Age Class: Adult
Session(s) Captured: 2, 4		Camera Location(s): I12BS	
Side(s) Visible: Right		Activity: 3:00-4:00; 8:00-9:00; 21:00-22:00	

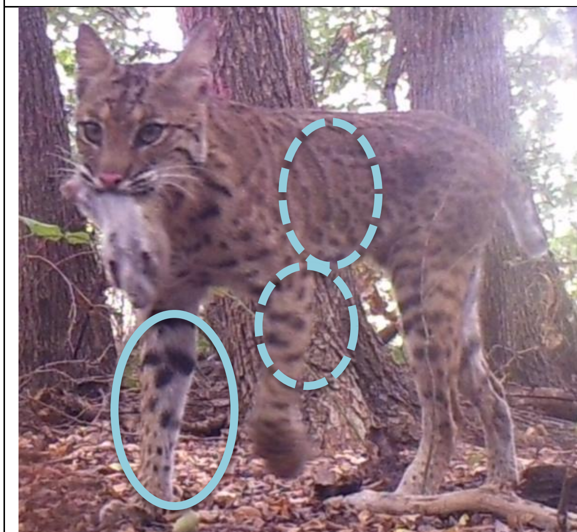


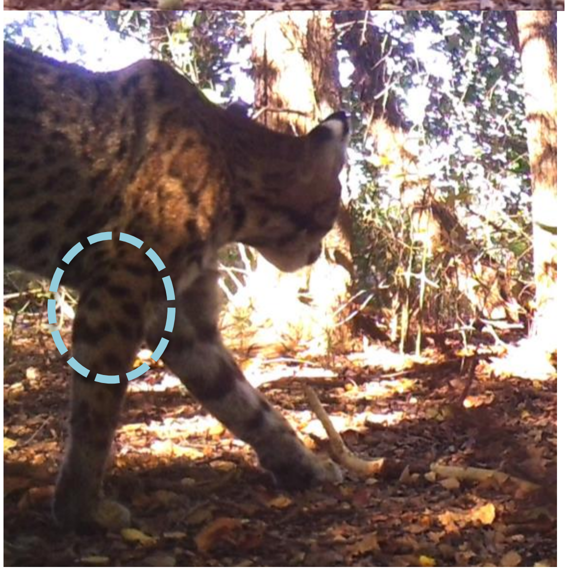
ID: BOBC072	Study Site: East	Sex: Male	Age Class: Adult
Session(s) Captured: 4		Camera Location(s): I12BS	
Side(s) Visible: Right		Activity: 2:00-3:00; 8:00-9:00; 13:00-14:00 20:00-21:00	


ID: BOBC073	Study Site: East	Sex: Male	Age Class: Adult
Session(s) Captured: 3		Camera Location(s): G05DL, H06DL, H07DL	
Side(s) Visible: Left		Activity: 2:00-3:00; 5:00-7:00	



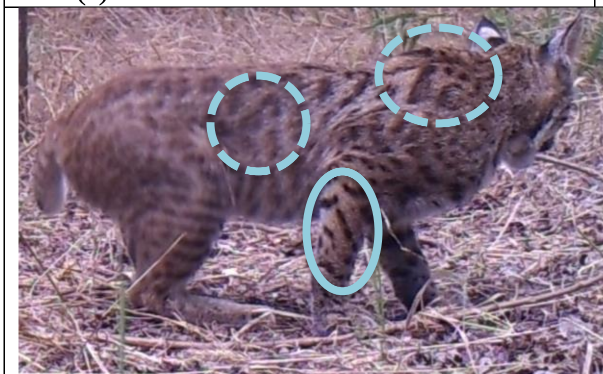

ID: BOBC074	Study Site: East	Sex: Female	Age Class: Adult
Session(s) Captured: 3		Camera Location(s): G16RL	
Side(s) Visible: Both		Activity: 9:00-11:00; 12:00-13:00; 20:00-22:00	





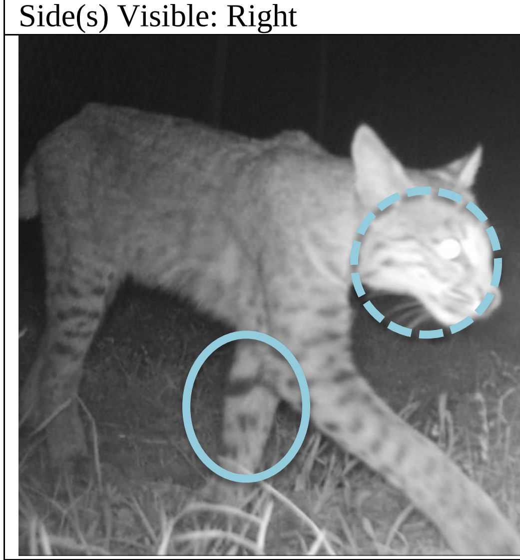
Note: Individual presented both sides in the same trigger event

ID: BOBC075	Study Site: East	Sex: Female	Age Class: Adult
Session(s) Captured: 3		Camera Location(s): I08WC	
Side(s) Visible: Both		Activity: 15:00-16:00	

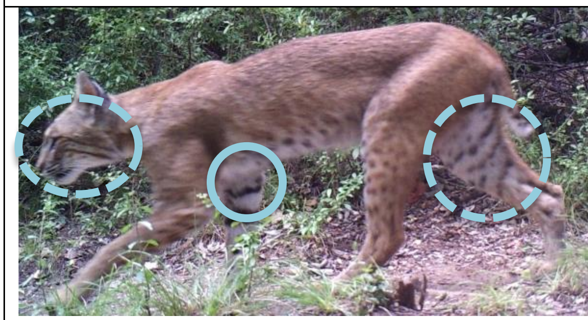
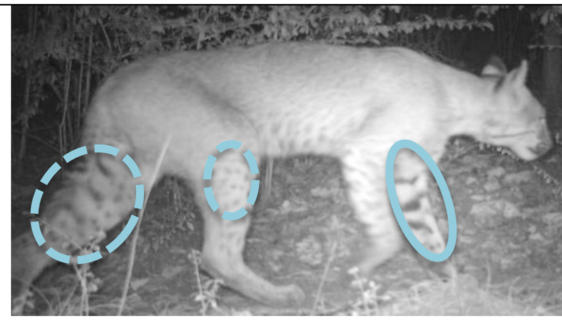



ID: BOBC076	Study Site: East	Sex: N/A	Age Class: Juvenile
Sessions captured: 1, 3		Camera Location(s): J09PL	
Side(s) Visible: Left		Activity: 1:00-2:00; 5:00-6:00	

ID: BOBC077	Study Site: East	Sex: Female	Age Class: Adult
Session(s) Captured: 3		Camera Location(s): J10SF	
Side(s) Visible: Right		Activity: 4:00-5:00	

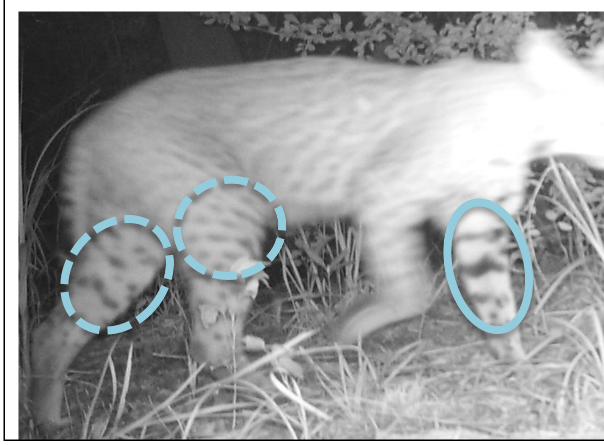
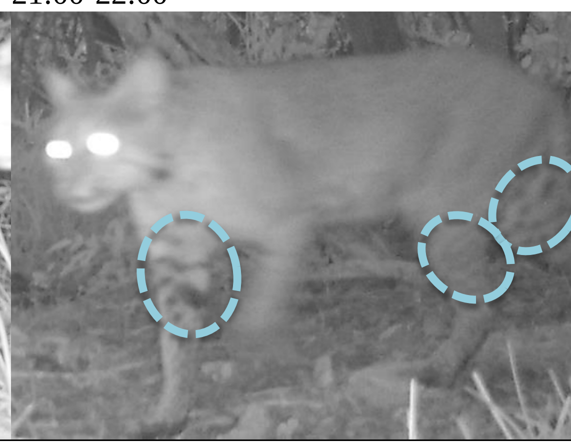



ID: BOBC078	Study Site: West	Sex: Male	Age Class: Adult
Session(s) Captured: 1, 3		Camera Location(s): B2NC, E5NC	
Side(s) Visible: Both		Activity: 0:00-1:00; 3:00-4:00; 5:00-6:00; 10:00-11:00; 15:00-16:00; 17:00-18:00; 19:00-21:00	

Note: Individual presented both sides within the same trigger event

ID: BOBC079	Study Site: West	Sex: Male	Age Class: Adult
Session(s) Captured: 3		Camera Location(s): B2NC	
Side(s) Visible: Both		Activity: 6:00-7:00; 17:00-18:00; 21:00-22:00	

VITA

Personal Background

Melissa A. Mills
Gardner, Kansas
Daughter of Billy and Michelle Mills

Education

Gardner Edgerton High School **Diploma**	May 2007
Purdue University, West Lafayette, Indiana **Bachelor of Science, Agriculture, Wildlife**	December 2011
Texas Christian University, Fort Worth, Texas **Master of Science, Environmental Science**	August 2015

Experience

TCU School of Geology, Energy, & the Environment
Graduate Teaching Assistant — January 2013 – December 2014

Texas Parks and Wildlife Department
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Texas Christian University
Wind Farm Bird and Bat Field Technician — July 2012 – September 2012

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ABSTRACT

CAN A NONINVASIVE CAMERA
TRAPPING TECHNIQUE BE USED TO
MONITOR URBAN BOBCATS (*Lynx rufus)?*

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We examined the effectiveness of using digital game cameras to survey urban wildlife, utilizing bobcats (*Lynx rufus*) as a focal species. Bobcats display unique pelt characteristics that allow surveyors to identify individuals in a population through the detection of pelt characteristics. At two study sites in Tarrant County, Texas, we randomly selected and surveyed 60 camera trap locations from September 2013 to December 2014. From this, we identified 79 bobcat individuals from 376 bobcat trigger events. Cameras at our East site recorded higher averages of bobcat activity (averaged 6.21 bobcat trigger events per 100 trap nights), in comparison to the West site (2.82 bobcat trigger events per 100 trap nights). Furthermore, using digital game cameras, we were able to gather additional information on spatial and temporal activity patterns of these bobcat populations. This study illustrates the capabilities of cameras to effectively monitor urban wildlife for long-term monitoring.