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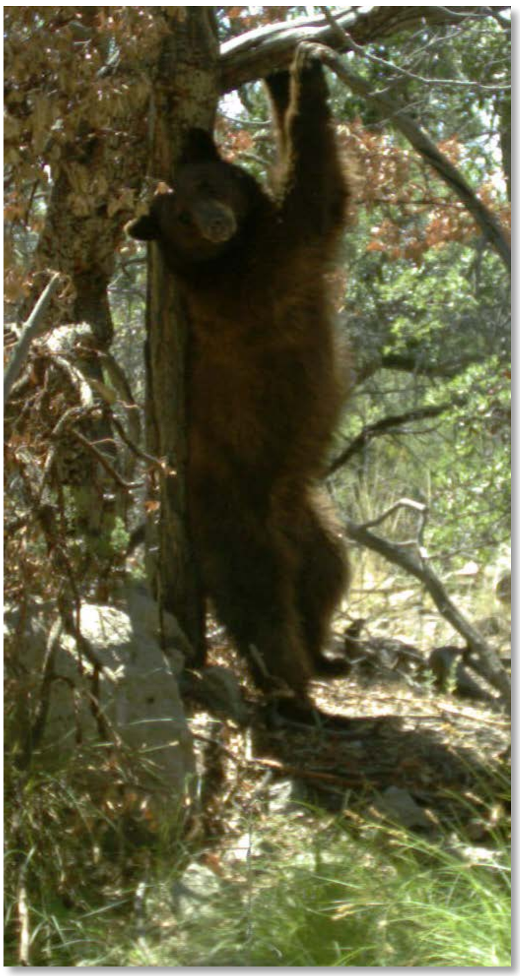
Natural Resource Stewardship and Science

Five Year Summary of Wildlife Camera Trap Monitoring across Three Parks

A systematic approach to monitoring wildlife

Natural Resource Report NPS/CHIR/NRR—2015/1069



ON THIS PAGE
Gambel's quail at Apache Drinker at FOBO
Bobcat at Apache Drinker at FOBO
Gray fox at Apache Drinker at FOBO

ON THE COVER
White-nosed coati at Stafford Cabin Dam at CHIR
Black bear from Garfield Spring at CHIR
Mountain lion from the CORO visitor center

Photographs courtesy of the SEAZ Group

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All manuscripts in the series receive the appropriate level of peer review to ensure that the information is scientifically credible, technically accurate, appropriately written for the intended audience, and designed and published in a professional manner.

This report received informal peer review by subject-matter experts who were not directly involved in the collection, analysis, or reporting of the data.

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Abstract

The Southeast Arizona (SEAZ) group, comprised of Chiricahua National Monument, Coronado National Memorial, and Fort Bowie National Historic Site, has been using wildlife camera traps intermittently for the past two decades to monitor wildlife at each of the parks. This report focuses on efforts undertaken by park staff since 2009 to create a long term monitoring program using wildlife camera traps placed at static locations at all three parks. Cameras were routinely checked every 2-3 months, providing continuous data on wildlife for about 5 years. Camera trap data provides staff with information as simple as species presence/absence statistics for each of the parks, as well as more complex information about different species' behavioral patterns and similarities between camera locations. Camera traps at static locations in the 3 park units detected 18 species at Chiricahua, 17 species at Coronado, and 17 species at Fort Bowie. We did not detect a few species that have been confirmed in the past that could be photographed by camera traps, including 3 at Chiricahua, 4 at Coronado, and 5 at Fort Bowie. It is not certain if these species are now extirpated from the park units, or could be found with additional effort. We found that daily activity of white-tailed deer is different at Fort Bowie, the only site where it co-occurs with mule deer, than at the other two sites.

Acknowledgments

The SEAZ group would like to acknowledge William Cochran and Jacob DeGayner for piloting this project in 2009. Tina Thompson continued this project when Cochran and DeGayner left. Biological science technicians Laura Fawcett, Ryan Janway, and Maura Thoenes facilitated the collection of camera cards at Coronado National Memorial and Fort Bowie National Historic Site, and installed new cameras at these parks to provide more data for this project. SCA interns Avery Shawler, Jackie Albert, Laura Livingston, Thomas Athens, Tess Wagner, Brent Llanos, and Carl Schwarz sorted over 200,000 photos collectively, and Athens assisted with the data management and quality control of sorted photos. SCA interns Amy Cadwell, Erin Lehnert, and Emily Gennrich provided feedback on report content and grammar. Jason Mateljak and Adam Springer provided support, supervision, photo sorting, and assistance with report writing. Jim Sanderson developed the software to analyze camera trap photos and provided prompt troubleshooting as well as new programs to facilitate our parks' analysis. Finally, Don Swann provided helpful revisions and suggestions through the peer review process of this report.

Introduction

Background

Biologists have been using cameras to remotely monitor animals since 1888, when George Shiras first used a camera with a trip wire to capture photos of deer (Sanderson, 2005). Since then, advances in technology combined with demand from hunters have created a solid market of affordable remote digital cameras that are triggered by an infrared sensor (Sanderson, 2005). When the camera detects a change in heat signatures, it takes a pre-set number of photos at predetermined intervals. The images are saved onto Secure Digital High-Capacity (SDHC) cards that can be easily retrieved from the field and downloaded onto a computer.

In the past 20 years, camera traps have been used to document elusive large cats in the tropics, and biologists have begun to use them more extensively to monitor mammal population size, density, and abundance (Mace, et al., 1994; Rowcliffe, et al. 2008; Sarmento, et al., 2009). Like all technologies, camera traps have both advantages and disadvantages; disadvantages include technical problems with equipment, potential effects on animal behavior, and the limitations of using the data for population estimation, since it usually difficult to identify individuals and not all species are equally detectable (Cutler and Swann, 1999).

Recent increases in the amount of illegal activities such as human and drug trafficking from Mexico into the United States has led to more strict security protocols for natural resources staff working in National Parks and Wildlife Refuges along the border (Piekielek, 2009). Camera trapping provides a safe alternative to active mammal surveys or small mammal trapping because it reduces the amount of time that staff may spend in potentially dangerous areas.

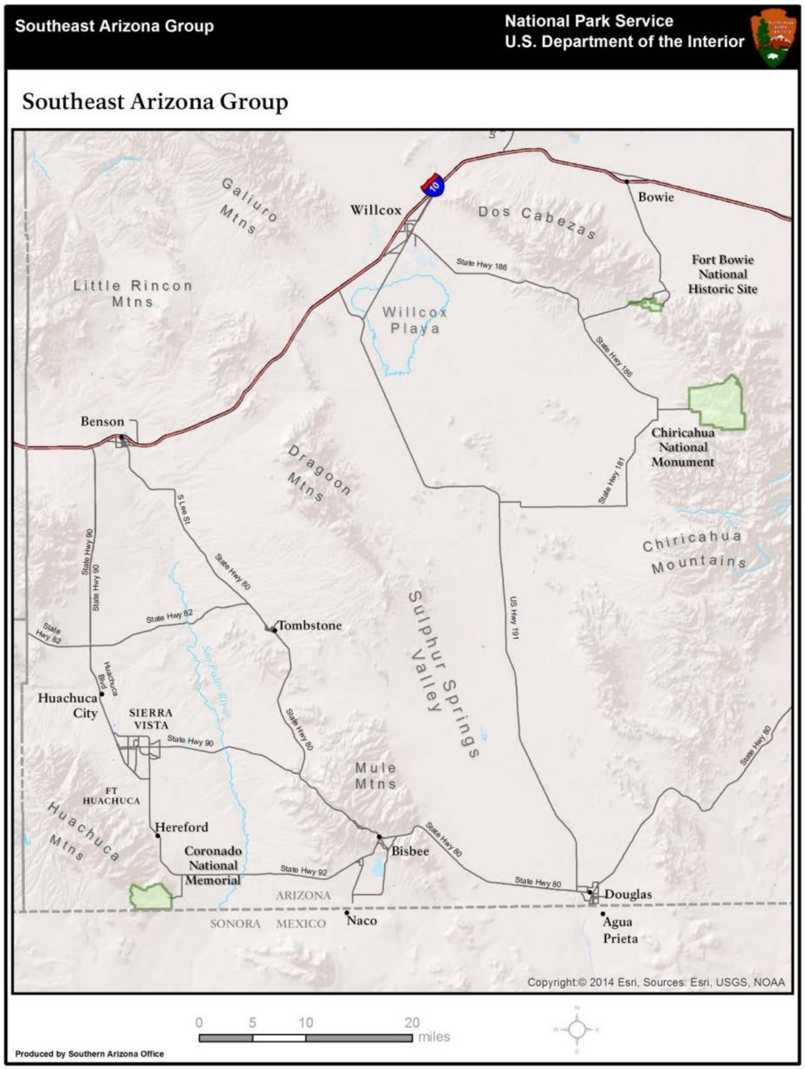

Figure 1. Vicinity map for parks in the Southeast Arizona Group.

The three parks in the Southeast Arizona Group (SEAZ) are in close proximity to the U.S.-Mexico border. One park (Coronado National Memorial) is on the border itself (see Figure 1). All parks are within the Sky Islands region of southeastern Arizona. The mountains are referred to as Sky Islands because there is a dramatic increase in elevation, from desert to grasslands to oak woodland, up to pine-juniper-fir woodland. This means that the parks experience high biodiversity due to the quick changes in elevation and vegetation type.

SEAZ Project History

Prior to 2009, and starting as early as the mid-1990s, biologists used Trailmaster cameras to document wildlife in the three park units, especially at Coronado National Memorial (Coronado) and Fort Bowie National Historic Site (Fort Bowie). These cameras used an active infrared trigger mechanism and were usually placed with a bait or lure such as cat food. All cameras produced rolls of film, which were developed and stored until 2014, when all photos were scanned into digital copies. Ultimately, these Trailmaster photos will be sorted and analyzed into a separate report.

The SEAZ group began using digital wildlife camera traps in 2009, with the original objectives of monitoring undocumented immigrants (UDIs) as they entered the park and determining whether these activities had an impact on wildlife. This project was initiated by William Cochran and Jacob DeGayner, and the goal was to document the presence and frequency of wildlife species. Two cameras were initially installed in September of 2009; one at Fort Bowie on the northern side of Siphon Canyon (hereafter Upper Siphon Canyon), and one at Chiricahua National Monument (Chiricahua) on the western portion of Whitetail Trail. These points were originally chosen because they are natural corridors for wildlife and human traffic alike.

At the end of 2009, a camera was installed on the southern side of Siphon Canyon (hereafter Lower Siphon Canyon) in order to determine if illegal traffic travelled through Siphon Canyon to exit the park. Also, a camera was installed on the west side of the park along the Butterfield Stage Route, but was permanently removed in 2010 due to hikers spotting the camera.

In July 2010, another camera was installed on the eastern Whitetail Trail at Chiricahua in order to assess the extent to which illegal traffic was using that side of the trail. A camera was also installed at the Apache Spring Drinker at Fort Bowie at the same time to determine if UDIs used it as a water source.

Coronado has many abandoned mines, many of which have been retrofitted to act as wildlife water tanks. When the mines fill during the summer rains, they automatically fill up these shallow drinkers, which wildlife frequently use. The first camera was installed at a mine drinker near the State of Texas mine in 2012; however, this camera was active for less than a week. Staff then installed a camera at the Clark Smith mine drinker and at Fern Grotto, another developed drinker. In 2014, SCA interns reinstalled one camera at the drinker near the State of Texas mine complex and another camera on a vernal pool near the agave restoration area. (See Appendix A for a map of all camera locations)

In addition to the aforementioned drinkers, the interpretive staff at the Coronado visitor center maintains a small pond. There has been a camera trap actively capturing photos since 2010. The staff uses the photos to engage visitors, and they also share all of the photos with the resources staff for scientific analysis.

Objectives

The purpose of this report is to synthesize data collected from September 2009 to March 2014, to establish baseline wildlife monitoring data based on camera traps in the SEAZ group parks. The analysis is aimed at answering the following questions of resource management concern:

1. What species are most commonly detected? What species are least commonly detected?
2. What species from the parks' species lists were not detected at all?
3. What can the activity patterns tell us about a species' life history, specific to our region?
4. Does UDI usage of wildlife corridors or water sources impact wildlife usage?

These questions can be initially addressed in the preliminary analyses of this report, and then revisited within future annual reports as more data is collected. Another large summary report should be completed in 2019, when there are 10 years of data to analyze. Longer term questions add:

1. Have hard-to-detect species been detected on camera traps? Or is there the potential for them to have been extirpated?
2. What are the trends in the number of photos of each species over time?

Methods

SEAZ staff deployed cameras at locations which were presumed to have high volumes of UDI traffic. UDI traffic trends were obtained from Visitor and Resource Protection staff, to which park staff sends all photos of UDIs. Cameras were set up to photograph either the water source itself or a game trail running near the water. Regardless of initial objectives for deploying wildlife camera traps throughout these three parks, all of the data procured over the past 5 years provides useful information about presence, absence, and activity trends of various species. This information is based on natural animal behavior, since no artificial baits or lures were used in this project.

Camera Models and Locations

Table 1. A summary of camera models, installation dates, etc.

Park	Location Name	Camera Model	Date Installed	Date Removed	Water Availability	Used in Analysis?	Vegetation Type
CHIR	Garfield Spring	Reconyx HC600 Hyperfire HO Covert IR	10/26/2011		Intermittent	Y	Riparian
CHIR	East Whitetail Trail	Reconyx HC600 Hyperfire HO Covert IR	7/8/2010		None	Y	Juniper-oak Woodland
CHIR	West Whitetail Trail	Reconyx RC-60	9/25/2009		None	Y	Juniper-oak woodland
CHIR	Shake Spring	Reconyx HC600 Hyperfire HO Covert IR	8/28/2011		Year Round	Y	Riparian
CHIR	Stafford Cabin Dam	Reconyx HC600 Hyperfire HO Covert IR	10/22/2012		Intermittent	Y	Riparian
FOBO	Apache Drinker	Reconyx RC-60	7/26/2010		Year Round	Y	Riparian
FOBO	Lower Siphon Canyon	Reconyx HC600 Hyperfire HO Covert IR	12/1/2009		None	Y	Riparian
FOBO	Upper Siphon Canyon	Reconyx RC-60	9/23/2009	2/24/2010	None	N	Riparian
FOBO	West Butterfield	Reconyx RC-60	11/24/2009	2/24/2010	None	N	Grassland
FOBO	Apache Spring	Bushnell Trophy Cam	4/25/2014		Year Round[1]	N	Riparian

Park	Location Name	Camera Model	Date Installed	Date Removed	Water Availability	Used in Analysis?	Vegetation Type
CORO	Clark Smith Drinker	Reconyx HC600 Hyperfire HO Covert IR	6/7/2011		Year Round	Y	Oak woodland
CORO	Fern Grotto	Reconyx HC600 Hyperfire HO Covert IR	11/26/2012, 3/12/2014	10/18/2013[2]	Year Round	Y	Grassland
CORO	Visitor Center	Reconyx RC-60	2/15/2010		Year Round	Y	Oak woodland
CORO	State of Texas Seep	Reconyx RC-60	3/5/2010,	3/23/2010	Year Round	N	Grassland
CORO	Forest Lane Seep	Reconyx RC-60	2/2/2010	2/11/2010	Intermittent	N	Grassland
CORO	Blue Waterfall	Reconyx RC-60	3/2/2012	4/9/2012	Intermittent	N	Riparian
CORO	Cottonwood Seep	Bushnell Trophy Cam	3/28/2014		Intermittent	N	Grassland

[1]Apache Spring has experienced a great reduction in water flow due to erosion. The progress of restoration could later be compared to animal activity in this location.

[2]Fern Grotto camera was vandalized, probably by UDIs, sometime after this date. A new camera (Bushnell Trophy Cam HD) was installed on 3/12/2014.

Camera Settings

Although a few different camera models were used throughout the parks, staff kept the camera settings as similar as possible. Camera settings can be readjusted to fix runaway triggers or a lack of photos at a location, though some camera settings are overall better for any circumstance. The exact settings differ by camera model, but the general camera setup was to set sensitivity at Auto, if that was an option, or High; take 3 or 5 pictures per trigger; set a one second interval between pictures in a series; and take 5 megapixel pictures. Additionally, the Bushnell Trophy Cam HD setting to control the number of LED lights that flash when a night picture is taken was set to Low, and the setting to control shutter speed for Night Vision was set to Medium.

The SEAZ group recently invested in over 40 new Bushnell Trophy Cams, both for static wildlife monitoring and for a short term census of the mammal populations. In order to most effectively use these cameras, staff members have been testing the different camera settings to have a better understanding of the cameras' functionality.

Data Management

When the camera trapping program began around 1996, biologists used an Access database to catalog each photo. Initially, false triggers (hereafter referred to as ghosts) were deleted, and only photos containing animals were used for this database. Staff manually recorded the time, species, and number of animals for every photo. This database was searchable, but it is unclear whether staff had the ability to run analysis on the photos at the time. Around 2013, staff stopped using this database in favor of a new method developed by Jim Sanderson, Ph.D., to expedite processing and analyzing surplus photos.

Sanderson has been working around the world to help biologists store, sort, and analyze photos from wildlife camera traps. His program is able to run statistical analyses on a species' activity patterns based on wildlife camera trap photos (Sanderson, 2013). In order to minimize data loss, it implements a streamlined chain of events through which the picture must travel in order to progress from the camera to the final analysis. Assuming the pictures have been stored correctly, one executable file can organize the data in less than a minute, and a different program can then run analysis in seconds, producing a text file of results. The organizational battle is thus with storing and sorting photos, rather than with extracting information from them.

The data management process integrates an untouched backup copy of all photos. Since there are many steps (see Figure 2), this process can be prone to error. Having a "RAW" folder retains untouched copies of all photos in case a mistake occurs further down the process line. Staff copies photos from the "RAW" folder to begin manipulating. The first step is typically to remove all false triggers from the file of folders.

At the start of this project, most ghosts were deleted before uploading photos to the computer. This increased the risk of data loss; therefore the new policy is to delete ghosts after a backup has been created. There are also some issues with burst photos and renaming, so removing ghosts at this point can make it quicker to rename. However, with cameras that do not get many ghosts, this step was integrated with species sorting.

The second step is to rename the photos using the program ReNamer (Kozlov, 2011), which extracts the metadata from the photo and uses the timestamp to rename each photo in the "YYYY MM DD HH MM SS.jpg" format. Photos must be renamed in this format—including the spaces, two digits for month and day, and using the 24-hour clock. For example, a photo taken on June 3, 2012 at 4:45.36 P.M. will be renamed as "2012 06 03 16 45 36.jpg". Any deviations from this format produces errors in DataOrganize.

Once the photos are renamed, the process was handed over to anyone able to identify different species. This included volunteers, SEAZ employees, and SCA interns. At the start of this project, the almost four years of digital camera trapping created a backlog of about 250,000 photos. The sorting process is straightforward and, with practice and training, became an easy process for anyone to learn. The ease of use enabled staff to quickly resolve the backlog of photos.

Photos were sorted into the hierarchy depicted in Figure 3. For every image, we identified the species and number of individuals in the photo, then copied it into the appropriate folder. For example, a picture of one bobcat at Fern Grotto is placed into the "FernGrotto/bobcat/1" folder. An image with a bird and a cottontail will be copied into both the "birds/1" folder and the "cottontail/1" folder.

Species groupings were as specific as possible while tailored to the level of identification experience of the sorters. Due to varied levels of birding experience, all species of birds were lumped into a "birds" category. "Insects" and "reptiles" were also broad categories, due to the cameras' inability to take photos with enough detail to distinguish species. Furthermore, several unknown categories are used for photos where only part of animal can be seen, or for animals where the distinguishing characteristic of a species cannot be seen (i.e. inability to see the tail of a female deer when the mule deer and white-tailed deer are distinguishable solely by their tails or antlers.)

After photos are sorted, designated employees perform quality control before importing the sorted photos into the AllCameraTrapData folder. This serves two purposes: to correct any misidentified species and to ensure that the organization exactly matches the format necessary for DataOrganize to run correctly.

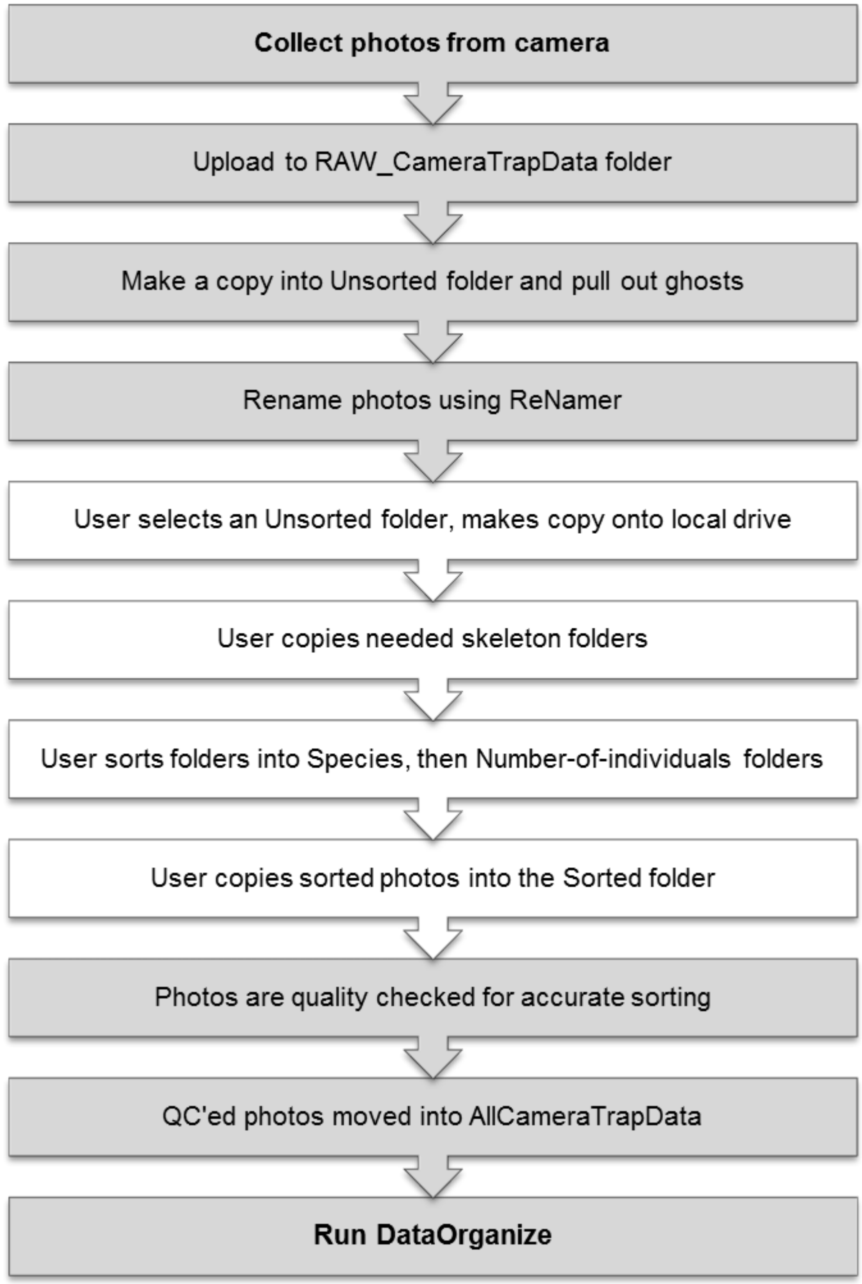

Figure 2. Flowchart depicting the progression from camera to analysis. Grey boxes are performed by 1-2 designated staff members to ensure consistent organization and quality control. White boxes performed by all staff and volunteers.

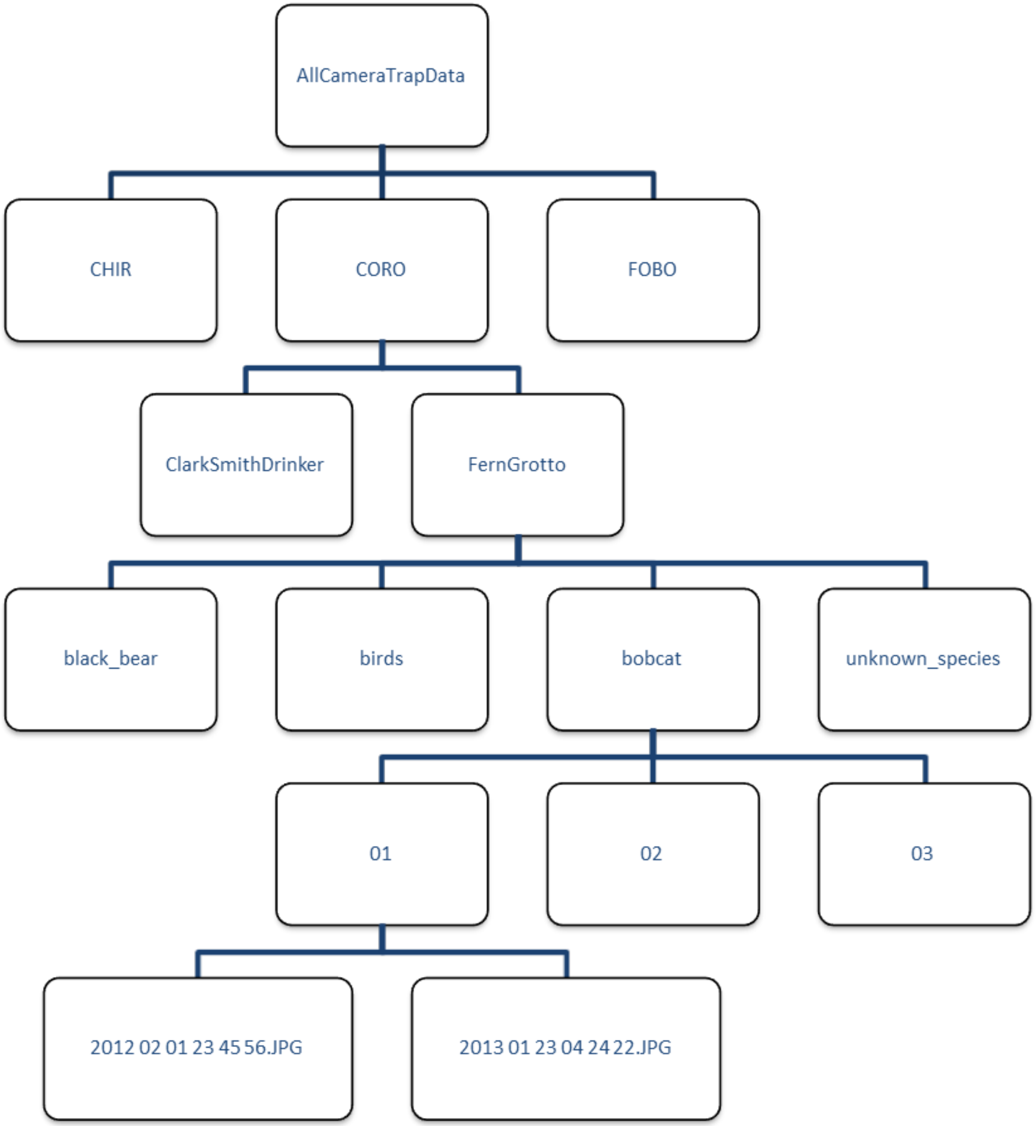

Figure 3. Hierarchical diagram demonstrating the folder organization. Each box represents a folder name, and the lowest tier contains the renamed images.

Data Organization

DataOrganize is an executable file written by Jim Sanderson and is the first step in the data analysis process. It takes the location, species, date and time, and number of individuals from each photo and compiles it into one text file, called AllPictures.txt. DataOrganize terminates early if it detects any errors in folder's organization, so it is crucial to be diligent about the organization and naming of photos. Since we analyze each park separately, there is a separate text file produced for each park. The program Concatenate.exe was designed to combine AllPictures.txt from each park into one file for a SEAZ Group level analysis.

DataOrganize also produces an Input.txt file which allows the user to control the exact parameters (location, species, date ranges, GPS coordinates) to be used in the final analysis. Staff can also use the UpdateInput.exe to reuse previous Input.txt files after sorting and adding more photos to the analysis. For the purposes of this report, only sites that have data for more than 6 months were included in the activity analysis. Upper Siphon, West Butterfield, and Apache Spring were omitted from Fort Bowie, and Blue Waterfall, Forest Lane Seep, State of Texas Seep, and Cottonwood Seep at Coronado were omitted. Future annual reports will include activity analysis using Apache Spring, State of Texas, and Cottonwood Seep.

Once AllPictures.txt and the matching Input.txt are created and edited to desired specifications, DataAnalyze.exe can be run. This program requires no manual input in the command prompt; everything must be specified in Input.txt. DataAnalyze produces an Output.txt file, which can be opened in Excel and manipulated into tables and graphs. The Output is calculated using 60 minutes as the event length. For example, if there is a series of photos of white-tailed deer in which three individuals trigger the camera repeatedly for an hour, the program will only register three individuals for that 60 minute interval, rather than analyzing it as hundreds of deer.

Results and Analysis

Figure 4. Photo of western spotted skunk taken at Garfield Spring.

Chiricahua National Monument

Camera Trap Statistics

Wildlife camera traps at Chiricahua captured 18 identifiable species, not including seven unknowns (unknown rodent, unknown skunk, unknown squirrel, unknown mammal, unknown rabbit, unknown lizard, and unknown species) or general categories for birds, bats, reptiles, and insects. Species included on the USGS species list (Powell, 2008) but not photographed include: American badger, eastern cottontail, spotted ground squirrel, and black-tailed jackrabbit. There are 28 other rodents and shrews as well as bats on the species list, although wildlife cameras are not likely to provide definitive photos of these small species. (See Appendix B for a species list by year).

The camera trap program used 33,169 total photos in analysis across 1,629 camera-days. Only 2,779 photos were used in the activity calculation analysis.

Species most commonly photographed (most to least) include: white-tailed deer, black bear, birds, and common gray fox. The least frequently photographed animals were the northern raccoon, Mexican fox squirrel, coyote, desert cottontail, and western spotted skunk (Figure 4).

Camera Trap Analysis

In central Arizona, black bears hibernate from November to March with males emerging first, then females, then females with cubs (LeCount, 1983). This general pattern is apparent in the species abundance calculations by month, which only analyzes one photo of a species per 60 minute period. This eliminates a bias towards time frames when an individual spends many minutes. Figure 5 shows the number of adjusted photos by month, showing that bear activity declines after November and does not increase until April.

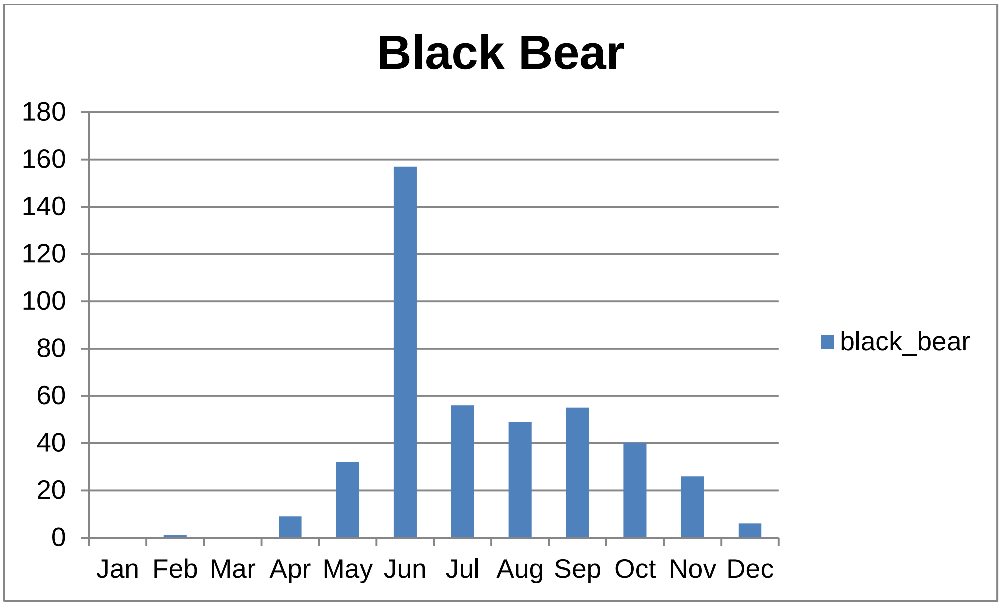

Figure 5. Number of black bear photos by month, adjusted per 60 minutes period

Unusual Findings

The western spotted skunk has been documented in Pinery Canyon (Hoffmeister, 1986), and visitors have observed them in Chiricahua. However, this project provides the first documentation of the western spotted skunk within the park.

Coronado National Memorial

Camera Trap Statistics

Wildlife camera traps at Coronado captured 17 identifiable species, not including four unknowns (unknown rodent, unknown skunk, unknown squirrel, and unknown species), as well as the general categories for birds, bats, reptiles, and insects. Species included on the USGS species list (Schmidt, 2007) but not photographed include: American badger, mule deer, spotted ground squirrel, western spotted skunk, and black-tailed jackrabbit. However, the mule deer was only included on the species list as a single observation from a reliable staff observation, but otherwise has not been officially documented in the park. There are 21 other rodents as well as bats on the species list, but the wildlife cameras would not capture photos where such small animals could be distinguishable to the species level.

Camera traps captured 123,161 total photos in analysis 1,480 camera-days. Only 5,111 photos were used in the activity calculation analysis. The high amount of raw photos taken is mainly due to the visitor center camera, where white-tailed deer would sometimes stay at the drinker for an hour and constantly trigger the camera, resulting in hundreds of photos of the same animal(s).

Species most commonly photographed (most to least) include: white-tailed deer, birds, hooded skunk, common gray fox, and collard peccary. The least frequently photographed animals were the striped skunk, bobcat, and northern raccoon. (See Appendix C for a species list by year)

Unusual Findings

In 2011, a law enforcement camera captured a male bighorn sheep travelling through the park (Figure 6). This species has not been documented at the park before and was not found on any other cameras, though Coronado does fall within the historic range of the bighorn sheep.

Figure 6. Bighorn sheep captured on camera at Coronado in 2011.

The Virginia opossum was captured on the visitor center camera from 2010-2012, with 6 animals in 2010, 15 animals in 2011, and 1 animal in 2012. According to Babb et. al (2004), the subspecies of Virginia opossum (*Didelphis virginiana californica*) native to northern Mexico appears to be shifting their population northward into the US. Conversely, there are reports of release of opossums of the non-native subspecies *D. v. virginiana* in southeastern Arizona, meaning that both subspecies could potentially occur in our parks. Upon investigation of the characteristics distinguishing the two subspecies, photos captured on the camera are most likely of the *D .v. californica* subspecies, providing further evidence of that subspecies moving north from Mexico.

The raccoon is also a rare occurrence at Coronado, though it is native to Arizona (Hoffmeister, 1986). Like the opossum, it has only been captured at the visitor center camera, with 4 animals in 2010, 4 in 2011, and 2 in 2013.

Finally, a single individual of an American bullfrog appeared at the visitor center pond in September 2013. Bullfrogs are an introduced and species in the southwest; it is invasive and eats almost anything it can fit into its mouth, including many native aquatic vertebrates.

Fort Bowie National Historic Site

Camera Trap Statistics

Wildlife camera traps at Fort Bowie captured 17 identifiable species, not including eight unknowns (unknown mammal, unknown deer, unknown skunk, unknown rodent, unknown squirrel, unknown rabbit, unknown lizard, and unknown species), as well as general categories for birds, bats, reptiles, and insects. Species included on the USGS species list (Powell, 2005) but not photographed include: American badger, northern porcupine, round-tailed ground squirrel, Harris’ antelope squirrel, antelope jackrabbit, and black-tailed jackrabbit. There are 21 other rodents and one shrew, as well as bats, on the species list, but these wildlife cameras would not capture photos where such small animals could be distinguishable to the species level.

Camera traps captured 60,331 total photos during 1,568 camera-days. Only 4,307 photos were used in the activity calculation analysis.

Species most commonly photographed (most to least) include: white-tailed deer, black bear, birds, and common gray fox. The least frequently photographed animals were the northern raccoon, Mexican fox squirrel, coyote, desert cottontail, and western spotted skunk. (See Appendix D for a species list by year)

Camera Trap Analysis

Fort Bowie is the one park in the SEAZ group that has documented both mule deer and white-tailed deer, providing a unique look at the differences between two deer that occupy the same area but have different habits. Activity pattern analysis from Fort Bowie shows two distinct daily patterns for each species: mule deer activity peaks in the mid-morning and late afternoon, whereas white-tailed deer activity peaks late evening and tapers off throughout the daylight hours (Figure 7). This pattern remains fairly consistent for white-tailed deer regardless of season (Figure 9), but mule deer activity is less consistent throughout the year (Figure 8).

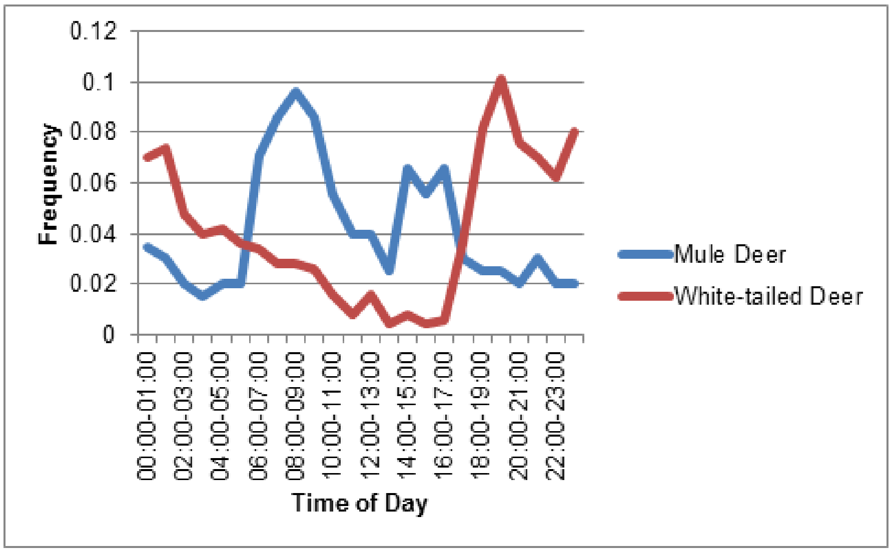

Figure 7. Frequency of mule deer and white-tailed deer photos hourly at Fort Bowie.

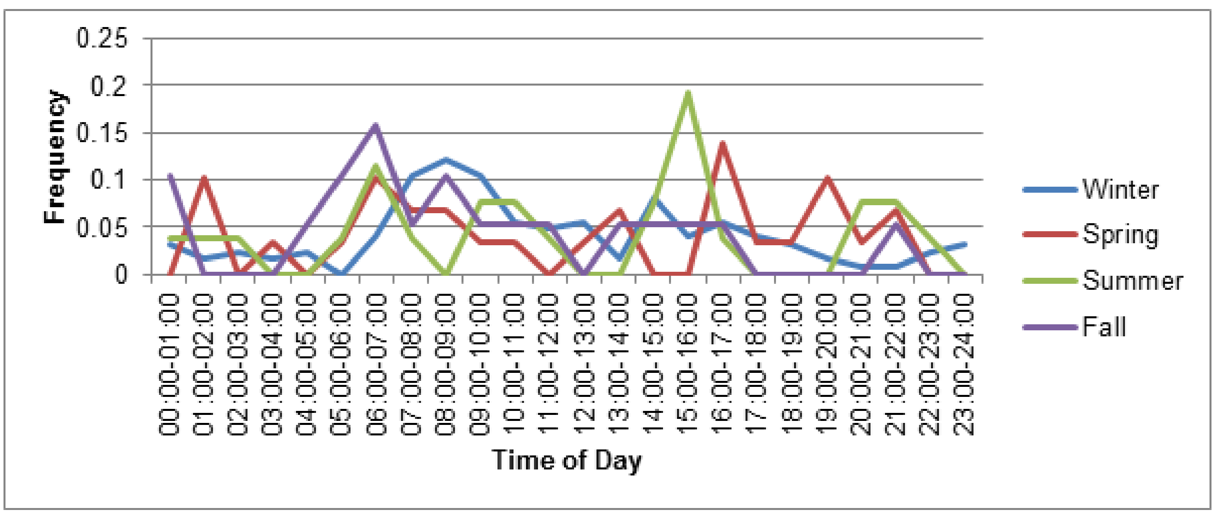

Figure 8. Mule deer activity by season at Fort Bowie.

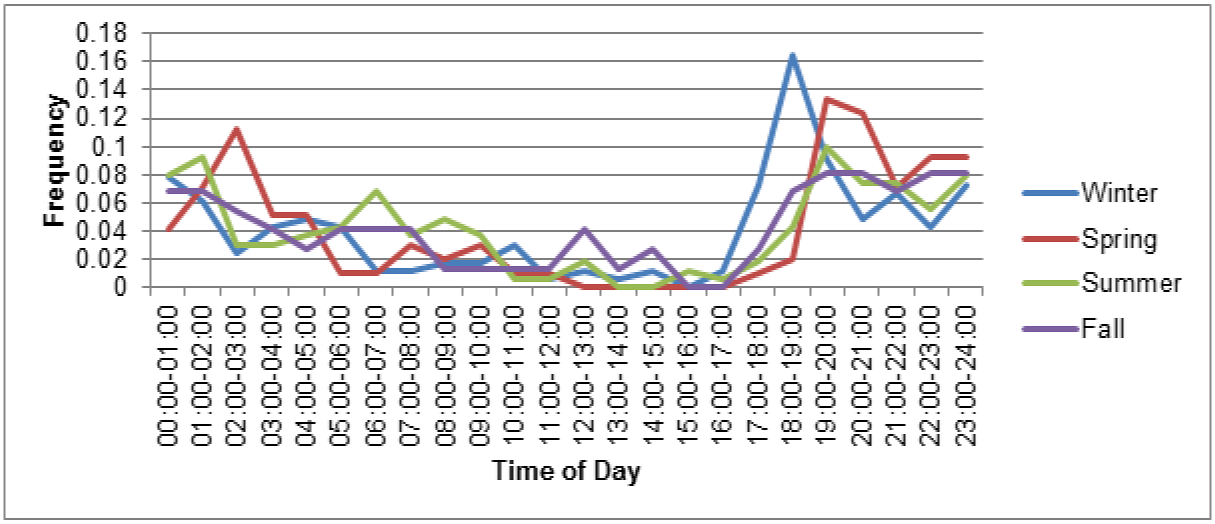

Figure 9. White-tailed deer activity by season at Fort Bowie.

Unusual Findings

The camera at Apache Spring, installed in April 2014, captured a photo of a Gila monster shortly after being deployed. The Gila monster, which is near the eastern edge of its range in eastern Arizona, is listed as near-threatened due to habitat loss (Hammerson, 2007). The observation of one individual near the spring along with staff sightings of others near housing and the northwest corner of the parade grounds is valuable information for park scientists.

On the other hand, starting in 2014, the Apache Drinker camera has captured images of Eurasian collared-doves, an invasive species. This species had not been documented at Fort Bowie before (Powell, 2005), and staff should continue to monitor this site for any increase in Eurasian collared-doves, as well as for a decrease in any of the native doves which also regularly use the drinker (mourning dove, white-winged dove).

SEAZ Group Parks Combined

Camera Trap Statistics

Wildlife camera traps across the SEAZ group captured 22 identifiable species. Species most commonly photographed (most to least) include: white-tailed deer, birds, common gray fox, black bear, and hooded skunk. The least frequently photographed animals were the Mexican fox squirrel, western spotted skunk, and northern raccoon.

Camera traps captured 215,934 total photos during 1,636 camera-days. 12,038 photos were used in the activity calculation analysis.

Table 2. Raw numbers of photos of each species by park.

Species	CHIR	CORO	FOBO
Arizona gray squirrel	0	961	0
Black bear	5807	815	851
Bobcat	208	40	91
Cliff Chipmunk	94	0	11
Collared peccary	920	9668	533
Common gray fox	958	6683	16371
Coyote	6	1800	457
Desert cottontail	13	550	247
Hooded skunk	39	3868	8
Mexican fox squirrel	5	0	0
Mountain lion	983	277	200
Mule deer	0	0	6682
Northern raccoon	1	269	0
Ringtail	3	239	161
Rock squirrel	166	181	10
Striped skunk	202	68	10
Viriginia opossum	0	171	0
Western spotted skunk	10	0	5
White-backed hog-nosed skunk	117	424	20
White-nosed coati	449	503	135
White-tailed deer	9817	82772	14239

Camera Trap Analysis

An interesting approach to SEAZ group level analysis is to see if certain species behave similarly at each park. Comparing activity patterns for white-tailed deer for all three parks shows distinct patterns for each park: Coronado white-tailed deer are most active during the day, Fort Bowie white-tailed deer are most active after 8-9 PM with activity tapering off throughout the day, and Chiricahua deer are most active around 9-10 AM (figure 10).

In contrast, running the same analysis for the common gray fox produces a similar pattern for activity between the three parks: highest activity levels occur at night, with less frequent appearances during the day (Figure 11).

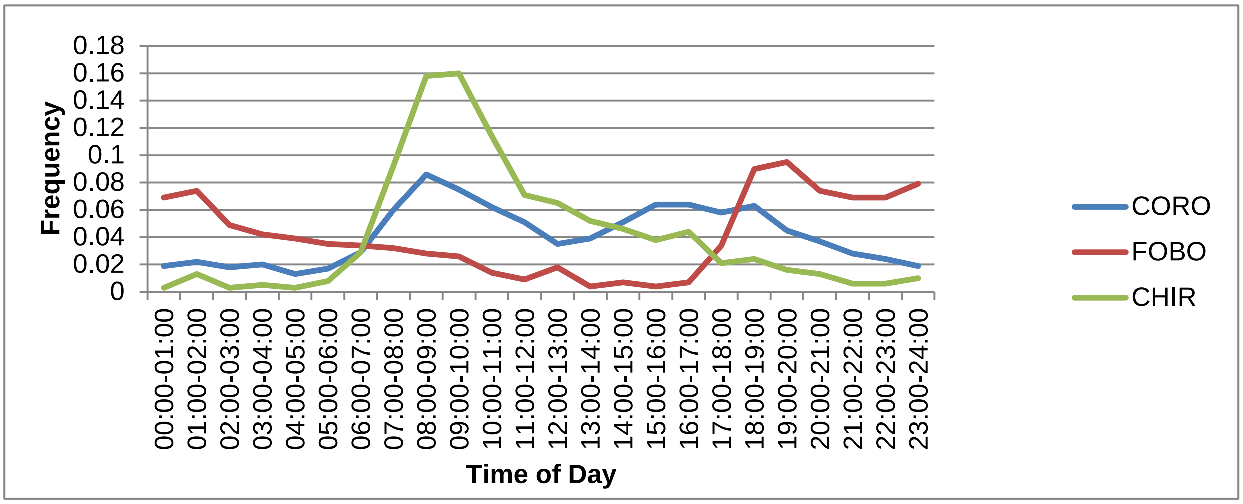

Figure 10. White-tailed deer activity by season across parks.

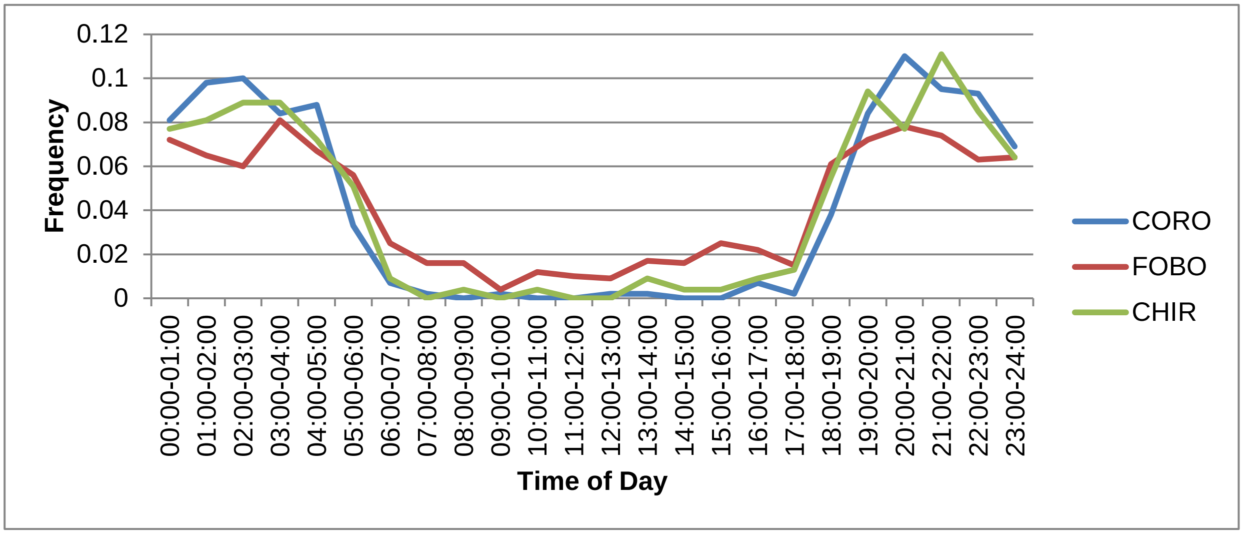

Figure 11. Common gray fox activity across parks.

Discussion

Inherent Issues with Camera Trapping

Placing motion sensor cameras at wildlife waters can be an effective way of monitoring medium and large mammals in parks, though there are inherent concerns that need to be acknowledged before implementing a program at a new park or a new location within a park. The first concern is the cost of new equipment. Digital remote sensor cameras have greatly decreased in price over the years, with good quality cameras available for less than $200. Acquired knowledge about the wildlife of an area can greatly outweigh this cost, especially when compared to hiring staff or interns to conduct yearly mammal surveys.

Another widespread issue with camera trapping is accounting for detectability, i.e. the likelihood of detection if the species is actually present at the location, since this varies between species and over different sampling approaches. Varying detection rates between species and across situations (seasons, habitats) requires building detectability functions for each species – an approach that the multi-year SEAZ dataset can eventually provide. Since this detectability is currently unaccounted for, raw photo data used in this report provides species *presence*, but not *absence* or any change in population parameters or species richness over time and space. The ultimate goal of the project is to develop a routine camera trap protocol with our USFWS partners that incorporates detectability and occupancy (see "Future Directions").

An issue specific to SEAZ parks is the presence of UDIs. UDIs see the cameras on water sources, think that the camera is part of law enforcement monitoring, and tamper with or vandalize the cameras. Coronado had one camera essentially destroyed by UDIs; the camera was placed on a water source that was frequented by UDI scouts as much as it was by white-tailed deer and birds. Park staff is now more aware of the need to mitigate the risks of UDI vandalism and do so by using camera lock boxes, disguising cameras and lock boxes with camouflage tape, placing cameras in hard-to-see locations, surrounding them by brush and rocks, or placing cameras in hard to reach places (i.e. up in a tree). Making efforts to disguise cameras proves valuable in reduced staff time reinstalling cameras and less money wasted purchasing replacements.

Species Not Photographed

SEAZ

One problem with the current method of deploying cameras is that it does not capture small mammals, or if it does, the photos are not of high enough quality to identify animals to the species level. This is primarily a result of the placement of cameras about 15 feet away from water sources. It is far enough away that medium to large mammals will trigger the camera and the whole animal will be captured in the photo, but it is too far away for animals smaller than a squirrel to trigger the camera. Also, some small mammals, like kangaroo rats, don't need to drink water, and thus would not show up at the water source. If presence/absence for a certain small mammal species is the goal, then a short term census aimed at capturing small mammals would be a better alternative than long term water source monitoring. This effort has been undertaken once at Fort Bowie in the fall/winter of 2013, with 40 motion sensor cameras installed at random and non-random points across the 1,000 acre park for six weeks. When conducting this project, staff had problems placing cameras too high off the ground to capture small mammals, and many cameras were directed at grass, resulting in many thousands of ghost photos through which to sort. However, cameras set up pointing across downed logs captured many small rodents who use these downed logs as runways. This census will next be conducted at Chiricahua, and park staff will be more experienced regarding how to optimally place and program cameras in order to capture pictures of animals with the highest rate of success. Results from the census at Chiricahua will further the development of an inventory and monitoring protocol for use by southwestern parks and wildlife refuges.

It may be necessary to install additional cameras at more diverse locations in order to capture all mammal species, similar to what was suggested for the aforementioned mammal census. A camera set low to the ground for multiple months would be better for capturing small mammals. However, in some cases, it takes many years to capture a presumably common mammal on camera; for example, it took 4 years to capture a kit fox on camera at a wildlife refuge where kit foxes were known to exist based on staff observations (Jim Sanderson, personal comm., March 4, 2014). Therefore, a combination of continuous monitoring at current locations as well as installation at new locations can provide management with a more complete species list. One suggestion for installing at new locations is to increase the diversity of habitats chosen for camera placement; i.e. if there are already 3 cameras placed at permanent water fixtures in a riparian area, choose to install a camera in an open grassland.

One species lacking photographic evidence in any park is the porcupine. Historically found in forested and mountainous areas of Arizona (Hoffmeister, 1986), the perceived threat to forests and the increased number of porcupines in the 20's and 30's (tied to the reduction of mountain lions) led to serious efforts to curtail the porcupine population in Northern Arizona. A recent study found only 314 confirmed observations of porcupines from land management agencies in Arizona from 2000-2007. The majority of observations were from northern Arizona forests, though Saguaro National Park reported hundreds of observations from the subalpine coniferous forest parts of the park (Brown, 2009). This decrease in porcupine numbers can be due to the reestablishment of predator populations as well as an increase in vehicle traffic through forested areas resulting in more road kill (Brown, 2009). The record from Fort Bowie included three incidental sightings along roads outside of the park boundary (Swann et al., 2001).

Another species lacking at all three parks is the American badger. Badgers are a rarely-sighted species within any park, likely due to their primary habitat being flat areas adjacent to mountains (Hoffmeister, 1986), areas that are being developed outside all three parks. All three parks provide some of this habitat, but none of the cameras are placed in this habitat type.

If certain mammals still are not captured, it may be necessary to conduct live mammal trapping surveys to assess whether or not certain species have been extirpated from the parks or simply aren't showing up on the cameras.

Chiricahua

There was only one photo of the northern raccoon, taken in 2011, which is unusual considering Chiricahua is within the range of raccoons in Arizona and specimens have been found within the Chiricahua Mountains (Hoffmeister, 1986). Chiricahua provides the appropriate habitat for raccoons and there have been many visitor observations, so it was expected that more photo evidence of raccoons in the park would have been captured.

Other species missed on these wildlife cameras include the American badger, black-tailed jackrabbit, eastern cottontail, and mule deer. We would expect black-tailed jackrabbits and mule deer in the western grasslands of the park, so there are no photos due to a lack of cameras in appropriate habitat. The eastern cottontail was likely captured on camera, but it is indistinguishable from the desert cottontail from photos alone and needs a specimen collection in order to make a confident identification (Swann, 2010).

Coronado

Species not detected at Coronado from 2009-2014 include the black-tailed jackrabbit, western spotted skunk, American badger, and mule deer. The mule deer is included on the species list since there are staff observations of it occurring in the park; however, the wildlife cameras currently deployed at Coronado may not capture the lower elevations of the park, in which we might expect to see the mule deer. The American badger has been confirmed at Coronado by roadkill in 2004 (Swann, 2010), but otherwise has not been documented in an inventory or through this study. The western spotted skunk is known to occur in the oak belt of the Huachuca Mountains (Hoffmeister, 1986), so it is unusual that the skunk has still not appeared on camera recently, since the Clark Smith mine camera should be within preferred habitat.

Fort Bowie

Species not detected at Fort Bowie from 2009-2013 include the black-tailed jackrabbit, antelope jackrabbit, round tailed ground squirrel, Harris' antelope squirrel, common raccoon, North American porcupine, and American badger. It is unusual to not have photos of the jackrabbits, since they are still sighted along the roads into and within the park. However, the cameras at Fort Bowie focus on water sources or riparian areas, where we would not necessarily expect jackrabbits to commonly occur. Ground squirrels are small and are rarely captured on wildlife cameras except when they are placed near their burrow entrances.

Management Implications

Camera trapping is an effective method for monitoring wildlife in border parks, especially since safety concerns can limit the amount of time staff spends in the field. Installing cameras reduces risk as opposed to hiring a field crew to manually survey for small to large mammals for extended periods of time. This was not an issue in the past, as evidenced by references to previous studies conducted personally by staff; however, even visiting many of the camera locations at present requires a law enforcement escort, necessitating extensive coordination between divisions. It should be noted that the few visits required to camera locations demand less of law enforcement's time than would be required for escorting staff on long surveys.

The results of long term monitoring give insight into many aspects about wildlife in the parks. This provides staff with a fairly complete species list based on presence/absence data obtained from the cameras. However, not all small mammal species were captured, and cameras may need to be adjusted or added in order to obtain quality photos of small mammals. Analyzing photo data gives general activity patterns for each species at the daily, monthly, and yearly levels. This allows staff to disseminate information about the habits of animals to the public, such as that black bears at Chiricahua come out of hibernation in April, or that we haven't seen raccoons or opossums at the Coronado visitor center recently.

Border Impacts

The close proximity to the US-Mexico border has impacted resources management strategies in recent years. Certain areas of each park are deemed high risk areas, and staff either cannot go in these areas in small numbers or must request a law enforcement escort. Even in high visitor use areas, there has been an assault on a park employee, spurring the implementation of stronger safety nets such as increased employee tracking using radios and SPOT tracking devices, the recommendation to conduct field work with at least two people, and a general avoidance of high risk areas whenever possible.

Fern Grotto, as a water source with documented repeat usage by UDIs, was a camera location that necessitated 3-4 staff members to complete camera maintenance. When the first camera was vandalized, staff then increased group size or requested law enforcement escorts. After the second camera disappeared, RM staff has discontinued this site as a wildlife camera location indefinitely or until border activity decreases.

While employee and volunteer safety is the highest priority in all of SEAZ RM's work, it should be noted the significant time and financial impact created by these heightened security measures. Staff spends extra hours preparing GARs, acting as point of contact for field personnel, and participating in extra field work to increase group size. What was once accomplished by one staff member now requires two to three, which can detract from time spent working on an employee's primary project work. Financial impacts include the costs of extra security gear for cameras, such as lock boxes and cable locks, purchases of SPOT trackers and satellite phones, and extra employee hours spent participating in tasks that are not their primary project work.

Table 3. Percent of total of UDI photos by location.

Location	Percent
Lower Siphon	10.59
East Whitetail	5.07
Garfield Spring	3.63
West Whitetail	2.41
Fern Grotto	1.26

Photo documentation of UDIs does occur, which is to be expected considering three (Lower Siphon, West Whitetail and East Whitetail) of 11 cameras were installed with the intention of documenting potential UDI impacts on wildlife in known wildlife corridors. There are 1,427 photos of UDIs across the five years, which is 0.78% of all photos. UDI photo numbers increased from 2010 to 2012, and then decreased from 2012 to 2014. Park staff should continue to monitor yearly and monthly trends to see if UDI activity increases overall or at any one location. Evaluating whether UDI use impacts wildlife is difficult to determine based on the design of this study. As this project continues, a larger dataset may provide the data necessary to make conclusions about this objective.

Future Directions

This system of data management is merely the first steps in making the camera trap program organized and streamlined for staff to easily access and analyze data. There are still many potential uses for the existing data, as well as different ways to sort the existing photos to discover new information about the wildlife.

One way to further use existing photos is to sort bird photographs to the species level. This was attempted during the initial sorting, but inconsistencies between birding abilities of various staff and interns resulted in errors or a majority of birds being sorted as “unknown”. Therefore, intentionally sorting birds broadly was an attempt to get all of the photos sorted quickly without spending excess time attempting to identify birds to the species level. If the SEAZ group hires a biological science technician or SCA intern with extensive southwestern bird experience, then this person could take photos from the existing “birds” folder and sort them to the species level. This could provide valuable information about migratory birds in the parks, as well as provide the interpretative division with photos to display to the numerous birders that flock to these parks to view Neotropical migrant birds.

An alternative method of sorting deer is to sort out does, bucks, and first year fawns. This would be a relatively straightforward process with many of the photos that we obtain from cameras, since one can distinguish bucks from does based on antlers and body size, and first year fawns are distinguishable by spots or remnants of spots on the coat. Sorting out sexes and fawns will give us information about the life history of white-tailed deer and mule deer.

Furthermore, there are separate pilot programs in progress being conducted by biologists for the southwestern region of the U.S. Fish and Wildlife Service and the NPS Sonoran Desert Network which are aimed at investigating camera trapping as an inventory and monitoring tool for parks and refuges. SEAZ park staff should consult these biologists to see if our data can assist them with their project.

Analysis Possibilities

This project provides a massive amount of data that can be analyzed in many ways besides Sanderson’s activity analysis program. There are multiple software programs that can provide more information about occupancy, presence and absence, and abundance. With more years of data, presence, absence, and occupancy data will become even clearer, and comparisons can be made between the first five years of the program to the next five years with a focus on population trends.

There is also work to be done using more advanced GIS spatial analysis. GIS tools can provide heat range maps for different species at each park, make species composition comparisons to vegetation data, or even provide graduated symbol maps for different times of the year.

Furthermore, there have been many other camera trap inventories conducted at the three parks both as part of park inventory and monitoring as well as part of the inventories conducted by the Sonoran Desert Research Station (Powell, 2006; Powell, 2008; Schmidt, 2007). This historic data should be compared to new data as it is collected to provide a comprehensive analysis of wildlife trends and make staff aware of any species' extirpation from a park.

The comparison of historical data is especially important in order to monitor the ecosystem level changes happening at Coronado and Chiricahua. This is the result of two recent fires altering vegetation composition within the parks, thus changing the vegetative structures of those parks. Due to the relatively low number of photos from 2009-2011 as the program was started, it is imperative to include other studies' data in order to successfully assess any changes from before to after the fires. Furthermore, mammal species populations prior to and after the fires should be analyzed on a species-by-species basis, since different species will respond differently to direct and indirect effects of wildfire.

Conclusion

Continued monitoring of wildlife at parks in the SEAZ group will provide staff with a greater understanding of wildlife within the park. More data will result in increasingly accurate activity patterns, especially for species of which very few pictures are captured. Longer monitoring with a variety of camera locations at varying heights above the ground should provide staff with a more complete species list, since installing cameras in a wider variety of habitats make it more likely to capture the jackrabbits and ground squirrels that we have not yet seen.

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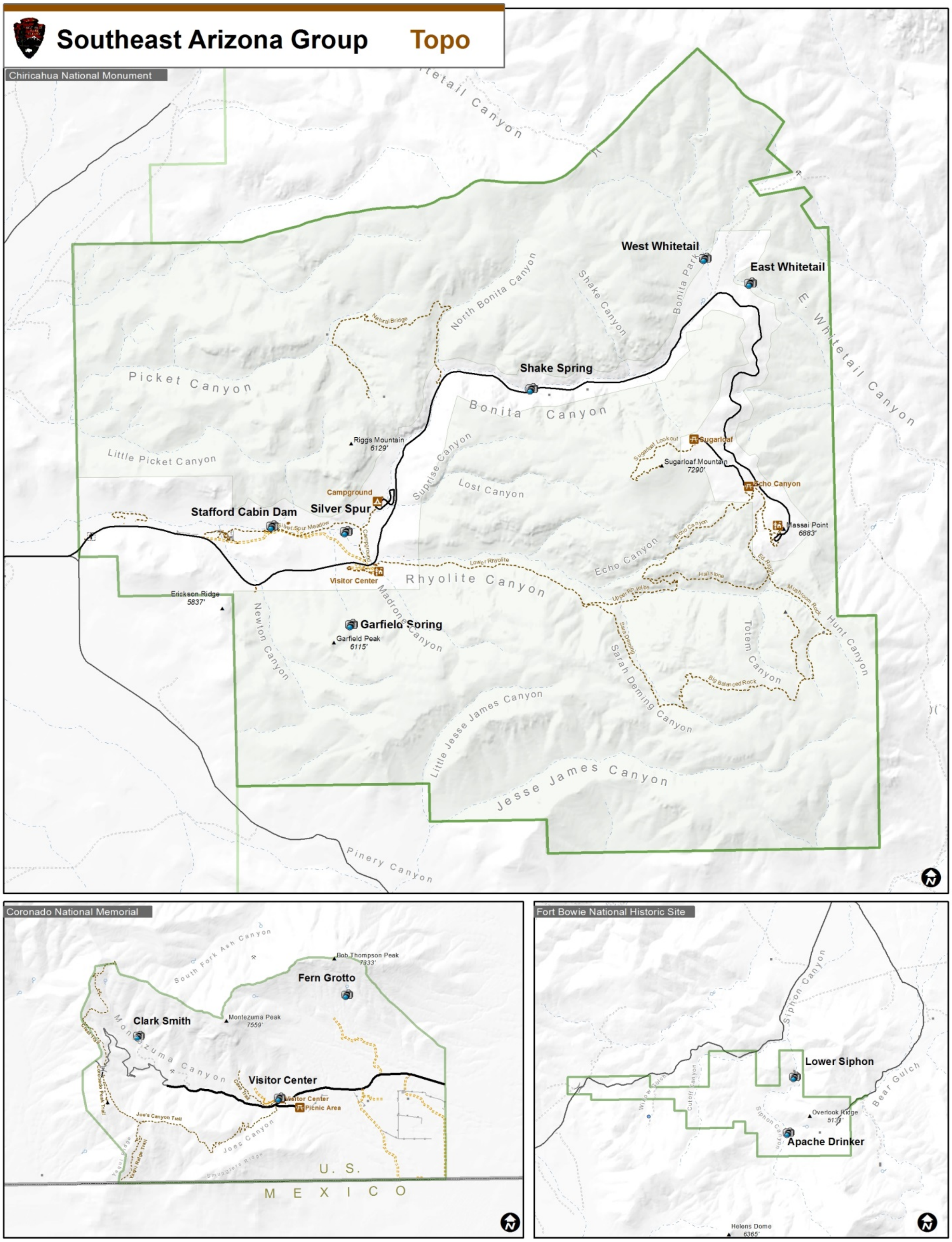
Appendix A: Maps of Camera Locations



Appendix B: Species Detected for Chiricahua NM

Common Name	Scientific Name	1990 (Duncan)	2002-2004 (Powell)	2009	2010	2011	2012	2013	2014
American black bear	*Ursus americanus*	x	x		x	x	x	x	
Northern raccoon	*Procyon lotor*	x	x			x			
White-nosed coati	*Nasua narica*	x	x	x		x	x	x	x
Ringtail	*Bassariscus astutus*	x	x		x	x			x
American badger	*Taxidea taxus*	x							
Striped skunk	*Mephitis mephitus*	x	x			x	x	x	x
Hooded skunk	*Mephitis macroura*	x	x				x	x	x
White-backed hog-nosed skunk	*Conepatus mesoleucus*		x				x	x	
Spotted skunk	*Spilogale gracilis*						x		
Coyote	*Canis latrans*		x				x	x	
Common gray fox	*Urocyon cinereoargenteus*	x	x		x	x	x	x	x
Feral cat	*Felis catus*	x							
Domestic dog	*Canis lupus familiaris*					x	x	x	
Mountain lion	*Puma concolor*	x	x		x	x	x	x	x
Bobcat	*Lynx rufus*		x	x	x	x	x	x	x
Rock squirrel	*Spermophilus variegatus*	x	x		x	x	x	x	
Spotted ground squirrel	*Spermophilus spilosoma*	(specimen only)							
Cliff chipmunk	*Neotamis dorsalis*	x	x			x	x		
Mexican fox squirrel	*Sciurus nayaritensis*	x	x					x	
Black-tailed jackrabbit	*Lepus californicus*	x							
Eastern cottontail	*Sylvilagus floridanus*	x							
Desert cottontail	*Sylvilagus audubonii*	x					x	x	
Collared peccary	*Pecari tajacu*	x			x	x	x	x	x
White-tailed deer	*Odocoileus virginianus*	x		x	x	x	x	x	x
Mule deer	*Odocoileus hemionus*								

Appendix C: Species Detected at Coronado NMEM

Common Name	Scientific Name	1977-1978 (Petryszyn)	2007 (Schmidt)	2010	2011	2012	2013	2014
Black-tailed jackrabbit	*Lepus californicus*	x	x					
Desert cottontail	*Sylvilagus audubonii*	x	x	x	x	x	x	
Arizona gray squirrel	*Sciurus arizonensis*		x	x	x	x	x	
Spotted ground squirrel	*Spermophilus spilosoma*		x					
Rock squirrel	*Spermophilus variegatus*		x		x	x	x	
Coyote	*Canis latrans*		x		x	x	x	
Common gray fox	*Urocyon cinereoargenteus*		x	x	x	x	x	x
Black bear	*Ursus americanus*		x	x	x	x	x	
Ringtail	*Bassariscus astutus*		x			x	x	x
White-nosed coati	*Nasua narica*		x		x	x	x	x
Common raccoon	*Procyon lotor*		x	x		x	x	
Common hog-nosed skunk	*Conepatus mesoleucus*		x		x	x	x	x
Hooded skunk	*Mephitis macroura*		x	x	x	x	x	
Striped skunk	*Mephitis mephitis*		x		x	x		
Western spotted skunk	*Spilogale gracilis*		x					
American badger	*Taxidea taxus*							
Bobcat	*Lynx rufus*		x	x	x	x	x	
Mountain lion	*Puma concolor*		x		x	x	x	
Collared peccary	*Pecari tajacu*		x	x	x	x	x	
Mule deer	*Odocoileus hemionus*							
White-tailed deer	*Odocoileus virginianus*		x	x	x	x	x	x
Virginia opossum	*Didelphis virginiana*		x	x	x	x		

Appendix D: Species Detected at Fort Bowie NHS

Common Name	Scientific Name	1976 (Roth)	2001 (Swann)	1997-2002 (Hermann-Reese)	2002-2003 (Powell)	2009	2010	2011	2012	2013
Black-tailed jackrabbit	*Lepus californicus*	x	x		x					
Antelope jackrabbit	*Lepus alleni*	x								
Desert cottontail	*Sylvilagus audubonii*	x	x				x	x	x	x
Round tailed ground squirrel	*Spermophilus tereticaudus*									
Harris' antelope squirrel	*Ammospermophilus harrisii*	x	x							
Cliff chipmunk	*Neotamis dorsalis*	x	x			x		x		
Rock squirrel	*Spermophilus variegatus*	x	x	x	x				x	
Coyote	*Canis latrans*	x	x	x			x	x	x	x
Common gray fox	*Urocyon cinereoargenteus*	x	x	x	x		x	x	x	x
Black bear	*Ursus americanus*			x	x		x	x	x	x
Ringtail	*Bassariscus astutus*	x		x		x	x	x	x	x
White-nosed coati	*Nasua narica*	x		x	x	x	x	x	x	
Common raccoon	*Procyon lotor*	x								
Common hog-nosed skunk	*Conepatus mesoleucus*	x			x					x
Hooded skunk	*Mephitis macroura*				x		x	x		
Striped skunk	*Mephitis mephitis*	x		x	x				x	x
Western spotted skunk	*Spilogale gracilis*	x								x
American badger	*Taxidea taxus*	x	x							
Bobcat	*Lynx rufus*	x	x	x	x		x	x	x	x
Mountain lion	*Puma concolor*		x	x	x		x	x	x	x
Collared peccary	*Pecari tajacu*	x	x	x	x		x		x	x
Mule deer	*Odocoileus hemionus*	x	x	x	x	x	x	x	x	x
White-tailed deer	*Odocoileus virginianus*	x	x				x	x	x	x
North American porcupine	*Erethizon dorsatum*		x							

SOP1 – Renaming Images

<u>Introduction</u>
In 2013, the SEAZ Resource Management Division adopted a new method for processing wildlife camera photos that is being utilized across land management agencies. This collaborative effort enables regional wildlife camera information to be analyzed simultaneously. After visiting a camera trap and removing the memory card, the images are brought back and uploaded onto the computer. The photos are then renamed and sorted into appropriate folder structures, which will be important for both storage and data analysis. This SOP is step 1 of 5 of the camera trap image management process.

<u>Uploading and Renaming Wildlife Image Files</u>

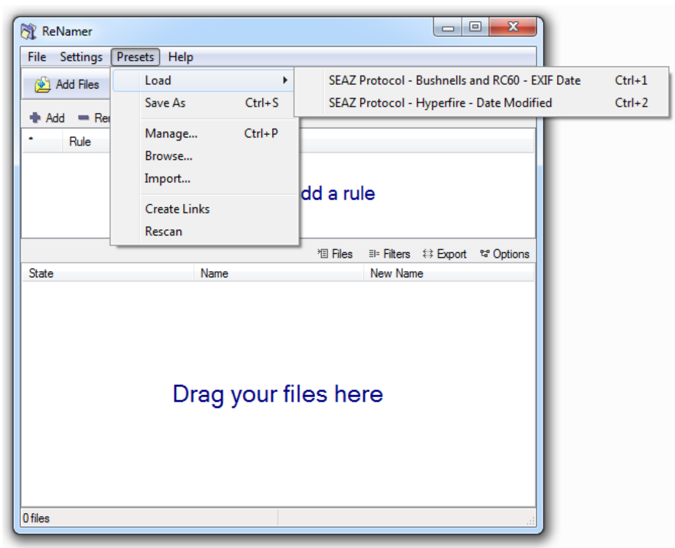
1. Navigate to the RAW_CameraTrapData folder.

2. Navigate to the PARK, Location folder. Create a new folder using the dates during which the camera was deployed, e.g. YYYY-MM-DD to YYYY-MM-DD. This format will be consistent with how the images themselves are renamed.

3. Copy photos from the memory card to this new folder. Keep a copy of the images in another location such as the memory card or an external hard drive for one month before erasing.

4. Copy this folder into the Unsorted folder. Remove ghosts if necessary.

5. Rename the files in the Unsorted folder with the date and time the image was taken using the program ReNamer:



   a. In the ReNamer folder, open the ReNamer application ReNamer and hit Run.

   b. Click Presets→Load→SEAZ Protocol, and select for the type of camera you are using (hotkey Ctrl+1 or Ctrl+2).

   c. Select all photos to rename and drag them to the “Drag your files here” section.

   d. If you received the duplicate warning box… EITHER

      i. Find the yellow exclamation marks next to the files which indicate duplicate names.

      ii. Click on the file you wish to rename.

iii. Hit F2 or right click and select Edit New Name

iv. Offset the seconds to allow for a unique name while maintaining the image order. For instance if images 0023 and 0024 both fall at 15 seconds, you would rename the seconds on image 0024 to 16 to maintain the sequence of images. Be sure to take into consideration the seconds of images before and after (0022 and 0025).

v. If the series of images falls at the end of a minute (e.g. two photos with seconds at 04:04:59), make sure to have the second image go to the next minute (04:05:00) and not 04:04:60, because DataOrganize does not recognize 60 in the seconds column.

vi. Hit enter when done renaming the file.

OR see the "SpecialRenamer" section in the *Trouble Shooting Guide* below.

e. Click "Rename" when you are satisfied with all the files' new names.

6. Verify that the new file names correspond correctly with the date and time stamp on the image: Preview an image and compare the new file name with the date/time on the image. If *yyyy mm dd hh mm ss* do not align, see the "MyRenamer" section in the *Trouble Shooting Guide* below.

7. If the camera malfunctioned for whatever reason and the date and timestamp on the photos is incorrect, set these photos aside into a folder within AllCameraTrapData called "SpecialCases", and then consult the SpecialRenamer guide below.

8. If the files were renamed correctly with the format *yyyy mm dd hh mm ss* you are ready to sort, see the Camera Trap Image Sorting SOP.

<u>Using SpecialRenamer</u>

1. SpecialRenamer is a program that automatically calculates the offset for renaming photos from a camera with the incorrect timestamp. It was designed because MyRenamer can only add time to an offset camera; if the camera for some reason jumps to the future, MyRenamer would not work.

2. To use SpecialRenamer, make sure that you have the time that the camera was collected and the time that the camera displayed at that moment. For example, if you collect a camera on 2013 12 25 04 05 06, but the camera displayed 2020 12 25 04 05 06, record both times.

3. Run SpecialRenamer.exe. It will prompt for the folder name (usually SpecialCases), time that the camera was set to, and the time that the camera should be. After inputting all of these, SpecialRenamer will automatically calculate the offset and rename the photos to the correct time.

SOP2 – Sorting Images

Introduction

This SOP is step 2 of 5 of the camera trap image management process. After camera trap images have been renamed they need to be sorted into appropriate folders. These folders are where the images are stored, but they will also play an important role in the data analysis process. Proper sorting is vital to the program's ability to run the statistical analysis on the images. Reference the file structure in Figure 1 for this sorting process; each renamed image will be stored in a Site\Location\Species\ Number-of-Individuals folder.

- "Site" refers to the park unit (i.e. CORO, CHIR, FOBO) where the camera is located.
- "Location" is a place where a camera trap is set (e.g. ShakeSpring, FernGrotto). Names should be unique and are limited to 25 characters with no spaces.
- "Species" are folders in each "Location" folder named for a specific species found in the park (e.g. mule_deer, ringtail, Mexican_jay). Pre-made Species folders are in the SkeletonFolders for each site. If the species in the image is not in the Location folder or SkeletonFolders for the site, see "Adding new species to SkeletonFolders."
- "Number-of-Individuals" are folders in each species folder labeled to represent the Number-of-Individuals in the image: 1, 2, 3, etc. Image files will reside in this type of folder. It does not matter if some folders are empty.
- Each Location folder will contain a folder "unknown_species" with a Number-of-Individuals folder "1" where all unidentified images are stored. A folder called "ghost" will also be in the Location folder for image series that do not have any animals (no animal trigger). This "ghost" folder will often be used when vegetation triggers the camera.

Checking out Photo Folders

1. Open the Excel spreadsheet for unsorted photos, located on the Google drive.
    a. Photos are organized by different Sites in different sheets, found at the bottom of the screen.
2. Each row in the spreadsheet represents one folder of photos and reflects that folder's location within the Unsorted folder, as well as its Status within the entire photo management process.
3. Choose a folder that is either of the Status "Needs renamed" or "Needs sorted". If the folder needs to be renamed, see the Camera Trap Image Renaming SOP. (Ideally, images will be renamed before being put into the Unsorted folder).
4. Make a copy of the folder onto a local drive (either My Documents or Desktop).

Sorting Wildlife Images

1. Navigate to your copied unsorted photos. Make a copy of the park's Skeleton Species Folders with the unsorted photo folder on your local drive.

2. For the images within:

    a. Identify the species

    b. Count the number-of-individuals of each species

3. Drag-and-drop images to the Number-of-Individuals folder within the appropriate Species folder (e.g. CORO\FernGrotto\Ringtail\1). Sort all images in the trigger series together, even the ones where the animal may have walked out of the shot. NOTE: It is easy to accidentally drop images in adjacent folders, so pay close attention to where you drop images.

4. If the species you ID does not have a Species folder under the Site\Location folder, navigate to the SkeletonFolders and copy the species from there.

5. When finished sorting, no photos should be remaining in the dated folder, and leave the empty folder in place.

Checking in Photo Folders

1. In the Sorted folder, make a folder with your last name.

2. Make a folder of the location you were sorting.

3. Copy your sorted species folders into the location folder.

4. Open the SEAZ Wildlife Photo Sorting Google doc.

5. For the folder you just sorted, change the status to "Needs QC".

Special Cases

Q: What if two individuals visit the location in a single event but only one individual is captured on the camera at a time?

A: File in the "2" folder for that species

NOTE: A single event here describes a series of continuous images all recorded as a result of one initial trigger. For instance, if you have 30 images of javelinas over a continuous 20 minute period, this is considered a single event. If during that event you count 8 javelinas, then you would sort all 30 images into the javelina\8 folder.

Q: What if two different species are in a single photo?

A: In the event that two or more species are recorded, store a copy for each species in the proper Species\Number-of-individuals folder.

Q: How do I sort cars?

A: Sort cars in the “1” Number-of-individuals folder under the species: Human_CarOwner (Ex. Human_NPS for a NPS vehicle).

Q: What do I do if there are thousands of ghost images?

A: Ideally, ghosts will be sorted out of the Unsorted folder before species sorting occurs. But if this isn’t the case, then sort ghosts into one “ghost” folder. These ghosts will later be pulled out and put into the Unsorted/Ghosts folder. (Ghosts are not part of the Camera Trap Analysis at this time).

Adding New Species to SkeletonFolders

If the species you identify is not in the Site\Location folder, or in the SkeletonFolder for the site, a new species folder may be created in the site’s SkeletonFolder. Always be sure to read over all the species folders in the SkeletonFolders *before* adding a species to insure another common name is not being used.

1. Navigate toSkeletonFolders.
2. Open the Site folder you need to add the new Species folder to.
3. Navigate through the subfolders to the category your species fits into (e.g. CORO\BIRDS).
4. Find the common name of the species in the USGS Vascular Plant and Vertebrate Inventory for the park, and use it to create and name the new Species folder; note capitalization. Names are limited to 25 characters with no spaces. Use the other Species folders as examples for proper formatting.
5. Create ten subfolders in Number-of-individuals folders labeled 1 through 10. See other Species folder for examples. It does not matter if some Number-of-individuals will be empty.

NOTE: It is important to ensure proper naming for statistical analysis. If names are misspelled or multiple aliases are used throughout the SkeletonFolders, the statistics will not reflect the species numbers correctly.

SOP3 – Image Quality Control

Introduction

This is step 3 of 5 in the photo sorting process and should be delegated to at least two people. The quality control aspect of this process ensures that animals were identified correctly and sorted into the folder hierarchy properly. This greatly reduces the number of errors obtained during the DataOrganize process. At least two people should know how to quality check so that they can perform QC for each other's sorting.

Checking Sorted Photos

1. Make sure all photos were renamed correctly: "YYYY MM DD HH MM SS.jpg"
    a. Any accidental duplicates ("YYYY MM DD HH MM SS (2).jpg") will create errors in DataOrganize.
    b. Sometimes ReNamer might use hyphens instead of spaces. This can be fixed in ReNamer by adding a rule to Replace, find - and replace with a space.
2. Make sure there aren't any photos in the wrong level. Move photos into the appropriate number-of-individuals folder.
    a. For example, sometimes someone may accidentally put a photo into the common_gray_fox folder when it should go into the common_gray_fox →"1" folder.
3. Make sure the mammal identification is correct
    a. Common mistakes including confusing a coyote with a fox or mule deer with white-tailed deer.
    b. Depending on how many photos of a species there were, either:
        i. Look through them all if there are fewer than 50.
        ii. Skim through 10-20% to determine that they identified animals correctly.
            1. Since most cameras take multiple-shot bursts, the best way to skim is to scroll through photos and randomly click every 5-10 photos to get a representative photo from each burst. If there are thousands of photos, use the page down key to scroll through more at a time while reducing hand strain.
4. Try to identify species in the unknown folders.

Importing into AllCameraTrapData

When confident that the folders are sorted correctly and any mistakes have been fixed, drag the species folders from the Sorted folder into the Location's folder. Click "Yes" to merge with existing folders (this will merge the species names and number-of-individuals folders.)

SOP4 – Camera Trap Data Creation

<u>Introduction</u>

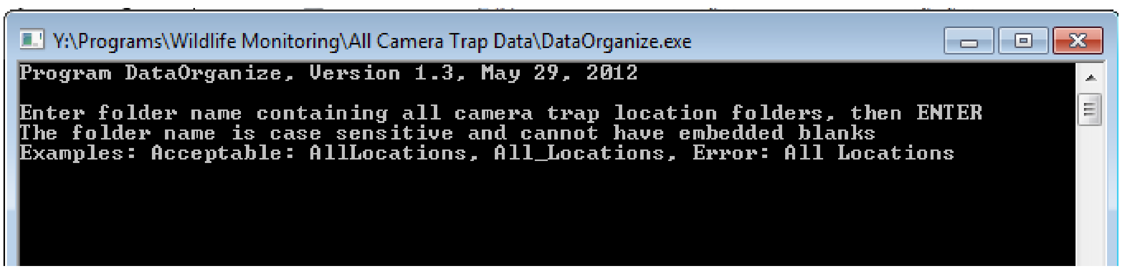
Step 4 of 5: After camera trap images have been renamed and sorted, data needs to be extracted for analysis. Data is extracted based on folder structures using the program DataOrganize. If image data is properly organized and labeled, DataOrganize will create two files: *AllPictures.txt* and *InputTemp.txt*. The *InputTemp.txt* file is important because it will be used by a subsequent program, DataAnalyze, to run statistical analysis of the wildlife images (see step 5, Data Analysis SOP).

<u>Data Extraction Process</u>

1. Navigate to the All Camera Trap Data folder.

2. Open the DataOrganize application and hit Run.

3. Type in the name of the site (park) you want to extract data from (e.g. CHIR) and hit Enter. Make sure that the spelling matches the folder name exactly. Allow the program to run to completion; it may take some time.



4. If the program ends with the message "TERMINATING NORMALLY," then the two files *AllPictures.txt* and *InputTemp.txt* have been created in the All Camera Trap Data folder.

5. If DataOrganize does not terminate normally, there is an error in the folder structures. Most likely the error occurred in the way you renamed or sorted some of the image files, which causes DataOrganize to abort prematurely. DataOrganize attempts to show you where the error occurred with two files: *AllFoldersFiles.txt* and *AllInfo.txt* (If you are successful, these two files do not appear).

    a. Open *AllInfo.txt* in the All Camera Trap Data folder.

    b. Go to the end of the document and find the storage error or file name error.

    c. Navigate to the folder where the error occurred and fix it.

    d. Rerun DataOrganize.

e. Repeat the process until you see the “TERMINATING NORMALLY” message. *AllInfo.txt* and *AllFoldersFiles.txt* are automatically deleted when you are successful.

6. Save a copy of the *AllPictures.txt* file into ”Input and Output files” folder, as *AllPicturesPARK.txt*.

SOP5 – Camera Trap Data Analysis

Introduction

This SOP is the last step of 5 in the camera trap image management process. During step 4, DataOrganize created two files: *AllFoldersFiles.txt* and *InputTemp.txt*. A new document will be created from the *InputTemp.txt* document. This new document, *Input.txt,* will be used by the DataAnalyze program to produce the camera trap statistics.

InputTemp.txt Editing to Create Input.txt

InputTemp.txt file contains the site name, a list of locations, the number of locations, a list of species, and the number of species. It defaults the camera trap's start and stop times, and also the UTM coordinates and elevation of each location. This file can be edited to run specific analysis in the DataAnalyze program:

1. Open the *InputTemp.txt* file in the All Camera Trap Data folder.

2. The first line can be edited to be meaningful to you (Site name, current date, etc.). Keep your label to one line.

3. Delete any data you do not want statistically analyzed (camera locations, dates, species, etc). Be sure to maintain the file's structure when deleting data and be sure to recalculate the total counts. Examples:

    a. Camera location and date and time can be edited; maintain character spacing.

    b. The species "bobcat" could be deleted, but you then need to reduce the number of species by 1.

    c. The folder "unknown/1" is usually reserved for unidentifiable species recorded in poor images. Unknown therefore can be deleted from the *InputTemp.txt* document.

4. When done editing, hit Save As and save the file as *Input.txt*.

5. Save a copy into "Input and Output files" folder as *InputPARK.txt*.

Remember: Keep the original format of the *InputTemp.txt* document (including spaces, tabs, etc.)

Managing Existing AllPictures.txt and Input.txt files

Previous iterations of the organization and analysis are stored in "Input and Output files" folder.

1. Every time you run DataOrganize on a park, save the updated AllPictures.txt file into the Input and Output folder.

2. When extracting a previous *AllPicturesPARK.txt* file out of the folder, open the text file and click "Save As" and save as *AllPictures.txt* into the AllCameraTrapData folder.

Running Data Analyze

The DataAnalyze program uses the *AllPictures.txt* and *Input.txt* files to analyze the photo data.

1. Navigate to the All Camera Trap Data folder.

2. Open the DataAnalyze application and hit Run.

3. The file *Output.txt* is created in the All Camera Trap Data folder and contains the full analysis of your data.

4. Save a copy of *Output.txt* as *OutputPARK.txt* into the Input and Output folder.

Running Data Analyze on All Parks

The program Concatenate.exe is located within ”Input and Output files” folder and will combine *AllPictures.txt* from all three parks into one *AllPictures.txt* for running DataAnalyze.

1. Double click on Concatenate.exe in the Input and Output folder.

2. Type AllPicturesCHIR.txt, hit enter. Then type AllPicturesCORO.txt, hit enter. Type AllPicturesFOBO.txt, hit enter. Finally, type DONE and press enter. Press enter again to terminate.

3. This produces an AllPictures.txt file that can be copied over to AllCameraTrapData for analysis.

Preserving Changes in Input.txt when More Data Is Added

Program UpdateInput is used to create a new *Input.txt* file from an old *Input.txt* file so that you do not have to retype the UTMS, elevations, and start times over again.

1. Copy an *InputPARK.txt* as *InputOld.txt* into AllCameraTrapData.

2. Run DataOrganize to produce new *AllPictures.txt* and *InputTemp.txt*.

3. Run UpdateInput. This produces *InputNew.txt* which preserves the first line, all UTM and elevation information, and start dates you have entered. Note that the species list is not preserved since it is replaced when new pictures are included. New stop times and new locations are added by DataOrganize. You must now edit and rename *InputTemp.txt* to produce the *Input.txt* file that will be used in the analysis with DataAnalyze.

Creating Multiple Start-Stop Times

Program CorrectInput uses AllPictures.txt and Input.txt to create a new list of start-stop times for each camera trap location. Users can input the number of days, and CorrectInput will assume that gaps longer than the specified number of days are due to an inactive camera trap. This dead-time gives rise to multiple start-stop times. File DateList.txt contains the list that of start-stop dates that can be substituted into InputTemp.txt.

AllPictures.txt Info

The second text file created by Data Organize, *AllPictures.txt*, is a list of all image files that are labeled with the location name, species name, year, month, day, hour, minute, second, and number-of-individuals. Note that location and species names are 25 characters, left justified and blank filled:

```
Loc01                    Deer                     2009 11 27 13 55 45 01
```

AllPictures.txt can be imported and stored by a spreadsheet such as Excel. The *AllPictures.txt* and *Input.txt* files contain all the information used by the analysis program DataAnalyze to complete an analysis of all the camera trap data.

The Department of the Interior protects and manages the nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors its special responsibilities to American Indians, Alaska Natives, and affiliated Island Communities.

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