University of Arizona Citizen Science IAA Project
Development and Implementation of a Citizen Science Program for Jaguar and Ocelot Monitoring

Intra-Agency Agreement number:
G13AC00222

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Final Report Submitted to:
U.S. Fish and Wildlife Service
Arizona Ecological Services Office - Tucson

August 2015

ABSTRACT
The purpose of this project was to develop, implement, and evaluate a citizen science program to survey and monitor for jaguars (*Panthera onca*) and ocelots (*Leopardus pardalis*) within the U.S. portion of the Northwestern Recovery Unit for the jaguar. Our study was undertaken to address two important objectives. First, can we develop a protocol to train volunteer participants or citizen scientists with little or no knowledge or background in biology or wildlife conservation that will increase their knowledge of jaguars, ocelots, and their conservation, as well as scientific data collection methods? Second, can these trained citizen scientists be as effective and efficient in the pursuit of quality scientific data gathered and analyzed, identifying and documenting wildlife observations from camera data as accurately as a professional team of biologists or field team experts? Our group of nine citizen scientists successfully downloaded and sorted more than 27,400 photos from 22 cameras at 14 monitoring sites over 12 months. At the time of this writing, data from the second group of citizen scientists has not been analyzed so when we discuss the citizen scientists in the analysis we are referring only to our first group. Citizen scientists logged a total of 327 hours of fieldwork including driving, hiking, and performing camera maintenance. After finishing a site visit, citizen scientists also sorted photos, logging approximately 109 hours of data organization. In addition, 100% of our citizen scientists adhered to our protocols that we tested and implemented in the field over a one-year period. When comparing our citizen scientists to the field team experts in sorting and correctly identifying wildlife individuals and species, our analyses revealed a strong positive correlation between the two. These high positive correlations indicate that citizen scientists have been well trained and can identify wildlife from camera data, nearly as well as the field team experts, and can be an excellent surrogate for field team experts. Finally, our study provided a unique opportunity to use non-scientists to augment data collection and assessment in the scientific workplace to advance jaguar and ocelot conservation. We strongly believe that citizen scientists remain an underutilized resource for helping scientists collect and analyze data in these days of reduced funding and increasing need for long-term monitoring.

Suggested Citation:
Reynolds E., H. R. Gimblett, S. Malusa, M. Culver. 2015. Development and Implementation of a Citizen Science Program for Jaguar and Ocelot Monitoring. Final Report to the U.S. Fish and Wildlife Service under Intra-Agency Agreement Number: G13AC00222. 33 p.

INTRODUCTION

What is citizen science?

Citizen science refers to research collaborations between scientists and volunteers, particularly (but not exclusively) to expand opportunities for scientific data collection and to provide access to scientific information for community members. Citizen science typically involves projects where volunteers partner with scientists to answer real-world questions, and can be a program that enlists the public in collecting data across an array of locations over long spans of time.

Purpose and need for this citizen science program

The purpose of this project is to develop and implement a citizen science program to survey and monitor for jaguars (*Panthera onca*) and ocelots (*Leopardus pardalis)* within the U.S. portion of the Northwestern Recovery Unit for the jaguar (NRU; Figure 1) (Sanderson and Fisher 2013). Long-term monitoring is a necessary and valuable component of any study, particularly when it comes to monitoring wildlife species and/or evaluating ecosystem change over time. Frequently there is little funding allocated to continue long-term monitoring. As a result, citizen science has become an effective and popular strategy for engaging trained volunteers in data collection and, in some cases, data analysis.

Background and lessons learned from other citizen science programs

There is a growing body of literature about using citizen scientists in scientific studies. Many concerns have arisen in the scientific community because of the number of issues surrounding data integrity. Kremen et al. (2011) found in their study that while citizen scientists' data had some biases, the trends in abundance, richness, and composition presented similar trends to those obtained by professional scientists. This has been echoed in studies that have carefully measured data integrity during and after data has been collected. For example, there has been extensive work focused on the idea of how to create a successful and sustainable citizen science program. Crall et al. (2010) and Delaney et al. (2008) both found that proper sampling design, detailed data quality analyses, user-friendly tools and proper education in how to use them, and the ability to work and coordinate with experts are all necessary ingredients. Pittman and Dorcas (2006) and Oscarson and Calhoun (2007) strongly suggest that the following are all important considerations when establishing a citizen science program: targeting groups (naturalists, educators, and active community members), ensuring an expert with a comprehensive understanding is available to consult, providing organized and thorough training sessions (field visits and training are most important), providing a website or Listserv for volunteers to submit data and communicate with each other and experts, and determining volunteer satisfaction (necessary for continued involvement).

Successful approaches to ecosystem management are increasingly community-based, initiated by local people, and motivated by a "love of place." Ecosystem management generally is in the interest of most citizens, and is a means to achieve beneficial use of "natural capital" (Sexton et al. 1999). Natural capital comprises the goods and services provided by natural ecosystem functioning. Citizen science programs offer public–professional partnerships that give individuals of all ages an opportunity to participate in real scientific research and to interact with scientists in the process (Cohen 1997). These partnerships offer citizens a way to meaningfully participate in data collection and to influence decisions, and offer scientists a large group of monitors at little cost. Citizen science projects have been remarkably successful in advancing scientific knowledge, and contributions from citizen scientists now provide a vast quantity of data about species occurrence and distribution around the world (Bonney et al. 2009). Additionally, incorporating citizen scientists in management plans is an approach that has been gaining popularity with scientists and policy-makers (Trumball et al. 2000).

Figure 1 – Map of the Northwestern Recovery Unit (NRU) of the jaguar (modified from Sanderson and Fisher 2013). This citizen science program was conducted throughout the Arizona portion of the NRU. See the Recovery Outline for the Jaguar (U.S. Fish and Wildlife Service 2012) for a description of the NRU, as well as the Core and Secondary Areas.

Despite the successful contributions of citizen scientist programs, some scientists remain skeptical about whether citizen monitoring activities can reliably detect and adequately characterize ecological processes (Brossard et al. 2005). A challenge in using public participation to understand and inform issues in ecosystem management is addressing problems that embrace traditionally disparate knowledge systems (Quinn et al. 2005). Testing citizen science programs to validate the quality of the data collected is necessary to ease underlying skepticism. Another aspect of program success is measuring the changes in participants. The effectiveness of a program must be studied through assessing change in participants' knowledge and their attitudes toward science (Brossard et al. 2005).

The idea of using citizen scientists to teach others has been the focus of several studies. Balakrishnan (2010) concluded that great success was found by using targeted citizen groups who became active in the effort and helped expand the program by becoming experts and going into the community to teach others.

Citizen scientists remain an underutilized resource for helping scientists collect data in these days of reduced funding and the need to conduct long-term monitoring. A critical review of the literature has revealed many pros and cons to establishing and implementing a citizen science program. The following is a synthesis of the lessons learned from successful development and implementation of citizen science programs:

- Focused education is imperative when working with volunteers and professionals.
- Targeted citizen groups who become active in the citizen science program lead to further expansion by becoming experts and going into the community to teach others.
- The educational materials must be appropriate to location and uncomplicated if experts are to be able to effectively educate future citizen scientists.
- Setting realistic goals and expectations are important when reaching out to potential citizen scientists.
- Realizing how important the willingness, available investment in time, dedication, and commitment of citizen scientists is in building successful programs.
- Having solid and consistent financial backing is equally important to creating successful citizen science programs.
- Effective sampling design, detailed data quality analyses, user-friendly tools for data entry and proper training in how to use them, and the ability to work and coordinate with experts are essential to create successful citizen science programs.
- As citizen science programs become more popular and a legitimate technique for collecting data, there will be a reduction in the short-term nature of funding to sustain the programs.
- Targeting potential citizen scientists (naturalists, educators, and active community members) as experts with comprehensive understanding to consult, organize, and assist in comprehensive training sessions (field visits and training are most important), and a website or Listserv for volunteers to submit data and communicate with each other and experts leads to a high level of citizen scientists' satisfaction that is fundamental for continued involvement and successful programs.
- Using consistent and reliable metrics and measurement techniques is necessary to provide validity to citizen science programs.
- The design and implementation of measures for evaluating to what degree the education component of the citizen science program is conveying knowledge builds credibility and adds legitimacy to the citizen science program.

Specific objectives of this citizen science program
This citizen science program built on the *Jaguar Surveying and Monitoring in the United States* study awarded November 2011 (Contract number: F11PXO5778) to the University of Arizona (UA). The UA embarked on a three-year project to detect and monitor jaguars (and ocelots) along the northern side of the U.S. - Mexico border south of Interstate 10, from the Baboquivari Mountains in Arizona to the "boot heel" region of New Mexico. The project established and implemented a non-invasive survey and monitoring program for gathering scientific data on jaguars, ocelots, and other wildlife.

This citizen science program consisted of a phased approach to train and build capacity of citizen scientists comprised of individuals from a range of socio-demographic communities (urban vs. rural/ranching communities, K-12, high school and college students, community members, etc.). The citizen science program included a strong emphasis on education, on jaguar and ocelot conservation, and extensive training on field-based techniques, including how to collect, download, verify, and analyze data. The citizen science program team envisioned some of these citizen scientists becoming potential instructors and/or educators (e.g., ambassadors of jaguar and ocelot conservation). The citizen science program was evaluated and characterized to determine:

1. The impact and effectiveness it had on volunteer participants relative to increasing their knowledge of: 1) jaguars, ocelots, and other native wildlife, 2) ecosystem functioning, 3) conservation, 4) land management, and 5) scientific data collection methods.
2. Its effectiveness in comparison to a professional team of biologists in terms of the quality of scientific data gathered.

METHODS

Study area
This study was conducted throughout the Arizona portion of the NRU (Figure 1), a mix of urban, rural, and ranching communities. The southern Arizona landscape (specifically Pima, Santa Cruz, and Cochise counties) provides a unique area to design and implement a citizen scientist program because it has a diverse group of stakeholders. This includes a strong ranching community and a diverse urban and rural population. These counties, as well as Hidalgo County in New Mexico, are a part of the U.S. portion of the NRU for the jaguar (Figure 1).

Citizen scientists
Selection of citizen scientists
We used a stratified sampling method to select citizen scientists from a range of stakeholders in the study area to ensure a representative sample (see *Appendix A – Volunteer Call Out*). Two citizen science groups were selected to represent the similarities and differences between highly trained volunteers and those with less experience to field team experts. These citizen science groups were chosen because they represented opposite ends of the spectrum of volunteer types involved in this project (see *Appendix B – Citizen Science Workshop Invitation*). In addition, we used an application process outlining the necessary criteria for participation in the jaguar monitoring program to choose citizen scientists. The minimum requirements for consideration were: 1) access to a 4WD vehicle, 2) ability to hike five miles over rough and uneven terrain, 3) willingness to engage in public outreach, 4) commitment of one year to the citizen science program, and 5) attendance at a weekend training workshop. Once selected, the citizen scientists received an intensive weekend course consisting of classroom and field-based education in jaguars and ocelots, equipment operation and maintenance, data analysis, safety protocol, and outreach tips for engaging the public.

Training of citizen scientists
An initial workshop was held April 4-6, 2014. This workshop brought a team of experts together to teach citizen scientists about jaguars and ocelots and provide instruction on field methods for monitoring cameras that were associated with the UA's *Jaguar Surveying and Monitoring in the United States* study (see *Appendix C – Citizen Science Workshop Agenda Workshop 1*).

Each citizen scientist received continuous feedback during training in the field from an accompanying professional scientist, who assessed the accuracy of the citizen scientist's observations and monitoring methods.

During May 2014, citizen scientist teams were assigned a route and monitoring sites and for their first field visit and were accompanied by field team experts to ground-check them on protocol. Once checked out by the field team to ensure they conformed to the field protocol, the citizen scientists began field checks in June 2014.

A second workshop was held March 28, 2015. Transects were assigned May 2015 and as of the writing of this document, citizen science teams are in the field monitoring cameras (see *Appendix D – Citizen Science Workshop Agenda Workshop 2*). At the time of this writing, data have not yet been sorted or processed from this second group of citizen scientists; therefore, <u>when we discuss the citizen scientists in the analyses we are referring only to our first group</u>.

Training feedback from citizen scientists
After the citizen scientists had been in the field for a few months, an informal evaluation was undertaken to solicit feedback on the project. We asked the citizen scientists specifically to comment on the issues of field protocols, workshops, and field safety.

Data collected by citizen scientists
After certification of training was completed and citizen scientists were check out by the field team, the citizen scientists were assigned to a route and monitoring sites for which they performed monthly monitoring (see *Appendix E – Citizen Science Protocol Guidebook* and *Appendix F – Camera Check Sheet*) downloaded data, changed camera batteries, sorted images from the cameras (see *Appendix G – Citizen Science Program Data Processing Protocol*), and reported any evidence of jaguar or ocelot presence.

Qualitative assessment of learning
To qualitatively assess how learning occurred with our citizen scientists and how successfully we conveyed science-based knowledge about jaguar and ocelot conservation, we attempted to conduct pre- and post-training assessments, to understand citizen scientists' knowledge level of jaguar and ocelot conservation. The pre-survey assessed their knowledge about the following topics: 1) jaguars, ocelots, and other native wildlife, 2) ecosystem functioning, 3) conservation, 4) land management, and 5) scientific data collection methods. The idea was to assess citizen scientists' knowledge before they received any training, and following one year of experience in the field. Unfortunately we received little to no follow up responses from our citizen scientists for unknown reasons, so we could not qualitatively evaluate the differences in learning. However, we do report on what we refer to as ongoing learning that was enabled throughout the project due in part to the citizen scientist workshop, expert field support and mentoring, and the continued informal learning and feedback sessions that were provided when the citizen scientists met with the volunteer coordinator and the data manager of the main project. In this report we rely heavily on the quantitative assessment of learning and report our findings below.

Quantitative assessment of data collected

Data integrity is the most important aspect of this project. A system of quality assurance and quality control (QA/QC) was developed to ensure that data entering the system from citizen scientists met the standards of the field team. To quantitatively assess the citizen scientists' ability to recognize wildlife when compared to field team experts, we evaluated the sorted camera data (photos) and assessed the degree to which citizen scientists could accurately identify wildlife species and individuals as compared to professional biologists. After each site visit, citizen scientists were required to sort data by species and send these data and the raw images to an expert on the field team. Each citizen science team had a designated field expert to determine their route and monitoring sites and QA/QC their data. When the expert received the data, he or she also sorted the raw images. This allowed us to directly compare the citizen scientists' ability to correctly identify individual species to that of field team experts. Data comparison was conducted through a random selection of dates from the citizen science groups and compared to the corresponding months of the experts' data. We deferred to the data from the field team experts as the correct version of the data sorting process.

Two citizen science groups were selected from our first group of nine citizen scientists to represent the similarities and differences between highly trained volunteers and those with less experience to field team experts. These citizen science groups were chosen because they represented opposite ends of the spectrum of volunteer types involved in this project. Group A was a team of two retirees with an extensive background volunteering on camera survey projects. Group A had ample resources to aid them including time, backcountry knowledge, and a 4WD vehicle. The dates of the data sampled for Group A were September-December of 2014. Group A had four camera sites located in the Huachuca Mountains. Group B was a team of three college students majoring in wildlife biology. This group had limited knowledge about camera surveys before starting the program and little free time outside of their university and work schedules. The dates of the data sampled for Group B were May-November of 2014. Group B had three camera sites in the Santa Rita Mountains. A subset of data was chosen for each group to represent the entirety of data gathered by citizen scientists. The dates for each group were chosen because these were the timeframes that field team experts sorted the same set of photos, allowing a direct comparison between citizen scientists and field team experts, as well as the data integrity and efficacy of using trained volunteers to perform these tasks to be determined.

DataAnalyze application was used to analyze all photos (Harris et al. 2010). This program uses a timeframe of 60 minutes to distinguish individual photos by the time associated with the re-named images. For all of our analyses, we used a Pearson's correlation analysis that uses a coefficient normally denoted as r, which is a statistical value that measures the linear relationship between two variables. It ranges in value from +1 to -1, indicating a perfect positive or negative linear relationship, respectively, between two variables, with 0 representing no correlation between the variables. In our analyses, we measured the correlation between citizen scientists and our field team experts in accurately identifying wildlife species, including wildlife identification, species presence-absence, and species richness. The direct comparison of citizen scientists vs. field team experts permitted a quantitative assessment of their abilities, acquired through our training, reflecting the degree to which they could accurately identify and document wildlife from camera photos, thereby providing a direct measure of the quality of the data they collected.

RESULTS

Citizen scientists

Selection of citizen scientists

Our selection of nine citizen scientists for the first workshop included UA students, retired volunteers, and those working for non-profits. Their ages ranged from 18 to 75. For the second workshop in March, we selected 10 citizen scientists. Their ages ranged between 45 and 72.

Training of citizen scientists

The first workshop was held April 4-6, 2014. The first day of this workshop focused on the project objectives, carnivore and felid ecology, sampling techniques and tracking basics, camera traps and transects, safety, and Global Positioning System (GPS) basics (see *Appendix C – Citizen Science Workshop Agenda Workshop 1*). Day two involved checking cameras and retrieving data cards, and downloading and sorting data. In May 2014, citizen scientist teams were assigned a route and monitoring sites. After an initial site visit with a field team expert, they began field checks in June 2014.

A second workshop was held March 28, 2015. Based on feedback from our first group of citizen scientists (see *Training feedback from citizen scientists*, below), we modified the workshop length and itinerary. We held a one day session, spending more time focusing on camera basics, safety, and photo sorting (see *Appendix D – Citizen Science Workshop Agenda Workshop 2*). Cameras were placed in the field the day prior to the workshop so that workshop participants could walk to the cameras as they would when they went into the field, replace memory cards, and ensure cameras were working. This walk-through approach adhering to the monitoring protocol enabled the new citizen scientists to experience what it would be like in the field. A sufficient amount of time was taken for instruction on sorting photos and identification of species. In April 2015, this second group of citizen scientists was assigned routes and monitoring sites. They are currently in the process of going through their initial site visit with one of the project field team experts or a member of the first group of citizen scientists.

Training feedback from citizen scientists

Sixty-five percent of citizen scientists responded to the informal evaluation on protocols, workshops, and field safety. Respondents had three primary concerns, including: 1) a two-day training workshop was too long and suggested it be reduced to one; 2) they did not receive enough hands-on training during the workshop to adequately complete the task of sorting photos and strongly urged more a thorough training session on photo sorting and identification with hands-on learning before they went into the field; and 3) because the cameras were in remote locations, the citizen scientists requested more training or a refresher session, at a minimum, to refresh their skills using a GPS unit.

Data collected by citizen scientists

Our group of nine citizen scientists (the first group) successfully downloaded and sorted more than 27,400 photos from 22 cameras at 14 monitoring sites over 12 months. Citizen scientists logged a total of 327 hours of fieldwork including driving, hiking, and performing camera maintenance. After finishing each site visit, citizen scientists also sorted photos, logging approximately a total of 109 hours of data organization.

Qualitative assessment of learning

Pre-training

It was important to gather citizen scientists' preconceived notions about what they knew about issues surrounding jaguar and ocelot conservation. We administered a pre-training assessment (see *Appendix*

H – Pre-training assessment) to the nine citizen scientists from the first workshop to measure their understanding of the following five topics prior to receiving any training or field experience: 1) jaguars, ocelots, and other native wildlife, 2) ecosystem functioning, 3) conservation, 4) land management, and 5) scientific data collection methods. The results of our pre-training assessment for each of these topics are described below.

Aside from the Malpai Borderlands Group (a grassroots, landowner-driven nonprofit organization attempting to implement ecosystem management on nearly one million acres in southeastern Arizona and southwestern New Mexico), the citizen scientists knew little about what individuals or organizations were and are doing to conserve the jaguar and ocelots. Only one citizen scientist noted that he had seen a jaguar previously (a photo he captured on one of his personal trail cameras in the Santa Rita Mountains before starting this project). A few citizen scientists indicated that, after reading a book by Jack Childs, they were aware of historical events that surrounded the life of a jaguar that ventured into Arizona and Northern Sonora and was killed (Childs 1998). All citizen scientists were concerned about the future of the jaguar and its habitat, noting continued human presence, urban encroachment, and loss of habitat as the causes of dwindling populations. Citizen scientists thought that between ½ to over one million dollars goes into funding conservation of the jaguar from conservation groups in the United States, and they thought that amount is annually raised by these groups to conserve the jaguar.

Citizen scientists responded that the number of jaguars has decreased over time and noted the following trends might have caused a decrease in the jaguar population:

1. Habitat loss, elimination of corridors connecting Sky Islands, human encroachment, urban sprawl;
2. Poaching, increased run-ins with ranchers;
3. Possible loss of prey items or decrease in prey number

The citizen scientists unanimously supported conservation of the jaguar and unequivocally agreed that jaguar habitat in Arizona has dramatically decreased over time. Notable reasons they noted for what caused jaguar habitat to decrease were:

1. Human population growth, increased in residential areas and urbanization;
2. Elimination of corridors and open space, including ranch lands connecting the sky islands;
3. Decrease in prey numbers.

Finally, the citizen scientists noted that the environment in Arizona has changed jaguar habitat due to the following reasons:

1. Increased urban growth that limits the movement between mountain ranges;
2. Climate has shifted towards warmer temperatures and dryer conditions with loss of flowing water;
3. Human caused habitat degradation and habitat connectivity.

When it came to whether Arizona's precipitation has changed over the last 25 years, most citizen scientists agreed a prolonged drought or less precipitation, especially snowpack and loss of winter monsoon rains, are notable changes. These changes can negatively impact the jaguar by causing a decrease in prey and habitat and altering habitats, which in turn can affect travel routes of jaguars. Most of the citizen scientists had no idea of how the current mechanisms for protection of the jaguar and its associated habitat in Arizona actually work, but most felt that the federal agencies are making progress towards jaguar conservation. There were mixed feelings from the citizen scientists as to what will happen to the jaguar if we continue to do exactly what we are doing now. Some felt like the status of

the jaguar will remain the same, others noted that jaguars will become extinct without protection. Aside from supporting conservation groups, research and education were ways the citizen scientists thought they could conserve the jaguar.

To summarize, prior to receiving our training, most citizen scientists had heard about the jaguar but knew very little about its biology and ecology. Only one had ever seen a jaguar (in a photo captured on one of his personal trail cameras) in the NRU, but all citizen scientists were concerned about the future of the jaguar and its habitat, noting continued human presence, urban encroachment, and loss of habitat as the causes leading to dwindling populations, or even extinction. The reasons noted for wanting to be a citizen scientist were to do their part in helping to understand the occurrence of jaguars, and to help in the conservation and protection of the jaguar. Very little was known about how to conduct a scientific study to gather data on jaguars, which was one reason why citizen scientists became involved in the project, to learn more about this process.

Quantitative assessment of data collected

Wildlife identification analyses

To determine differences in wildlife identified by field team experts vs. Group A and Group B, we compared 252 photos collected and sorted by Group A from four monitoring sites between September 2014 and December 2014, and 590 photos collected and sorted by Group B from three monitoring sites between May 2014 and November 2014, with the same photos as sorted by field team experts (Figures 2a and 2b, 3a and 3b). All photos collected and sorted by Group A and Group B were highly correlated with those sorted by field team experts (r=0.9991 for Group A and r=0.9968 for Group B). Only eight inconsistencies (3.2% of all photos) were detected between Group A and the field team experts, including “Ghost,” “Bird,” “Bear,” “Coyote,” “Fox,” and “Unknown” photos. Group B had 74 inconsistencies (12.5% of all photos) detected, including “Squirrels,” “Human,” “Bear,” “Fox,” “Test,” “Skunks,” “White-tailed Deer,” “Lizards,” “Coati,” “Birds,” “Coyote,” “Unknown,” “Rodents,” “Cottontail,” and “Mule Deer.”

The most important aspect throughout this project was to ensure that data integrity collected by citizen scientists would be at a high enough level acceptable to field team experts. The best way to represent data integrity is to ensure that the species present at each monitoring site were properly identified and categorized. A second, species-only analysis (with “Ghost” and “Test” images removed; “Ghost” images are photos with no identifiable species in the frame and “Test” images are photos of the field team experts or citizen scientists checking the sites) also showed a high correlation between photos collected and sorted by Group A (134 species-only photos) and Group B (252 species-only photos) and those collected and sorted by field team experts (r=0.9945 for Group A and r=0.9723 for Group B) (Figures 4 and 5). Only eight inconsistencies (6.0% of species-only photos) were detected between Group A and the field team experts, which included discrepancies in the “Bird,” “Bear,” “Coyote,” “Fox,” and “Unknown” species image folders. For Group B, 36 inconsistencies (14.3 of species-only photos) were detected, including “Squirrels,” “Human,” “Bear,” “Fox,” “Skunks,” “White-tailed Deer,” “Lizards,” “Coati,” “Birds,” “Unknown,” “Rodents,” “Cottontail,” and “Mule Deer.” Additionally, the r-value for Group B was lower because this group incorrectly put images of the field team experts or citizen scientists checking the sites in the “Human” folder rather than the “Test” folder, which accounts for the disparity of images in those categories (Figure 5; note that “Test” is included in this figure to show this disparity).

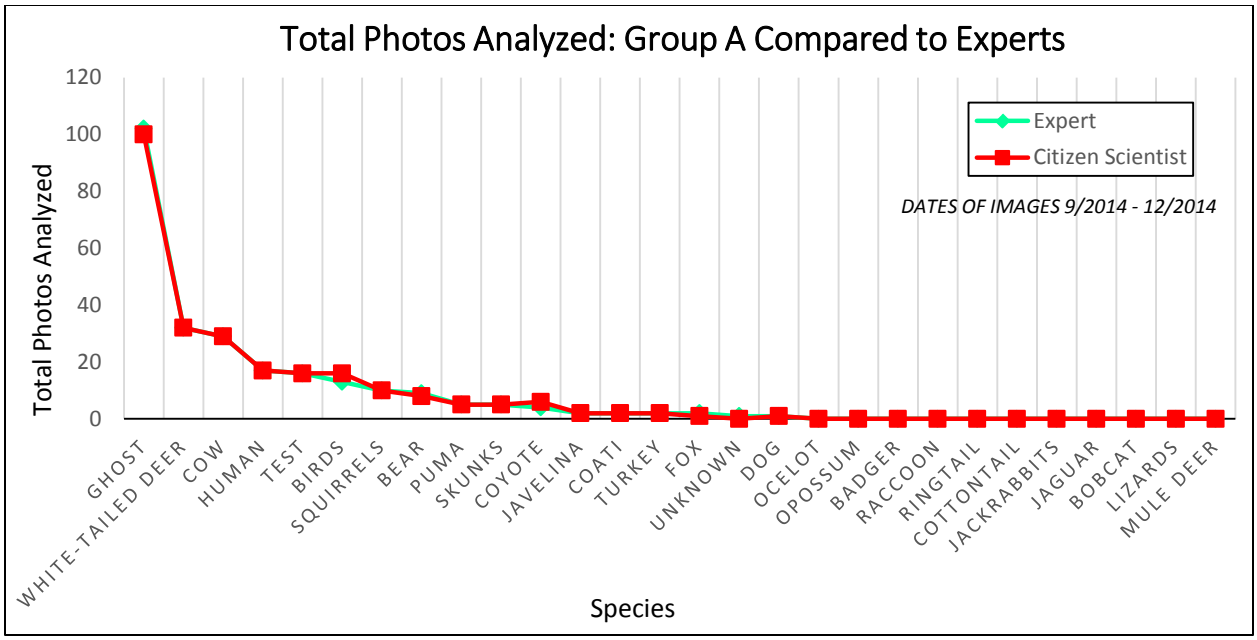

Figure 2a – Comparison of the amount of photos analyzed between field team experts and citizen scientists in Group A. Each species is represented in the graph with the corresponding total number of images sorted by the field team experts or citizen scientists over the selected timeframe (September 2014-December 2014) (r-value=0.9991). "Ghost" images are photos with no identifiable species in the frame; "Test" images are photos of the field team experts or citizen scientists checking the sites.

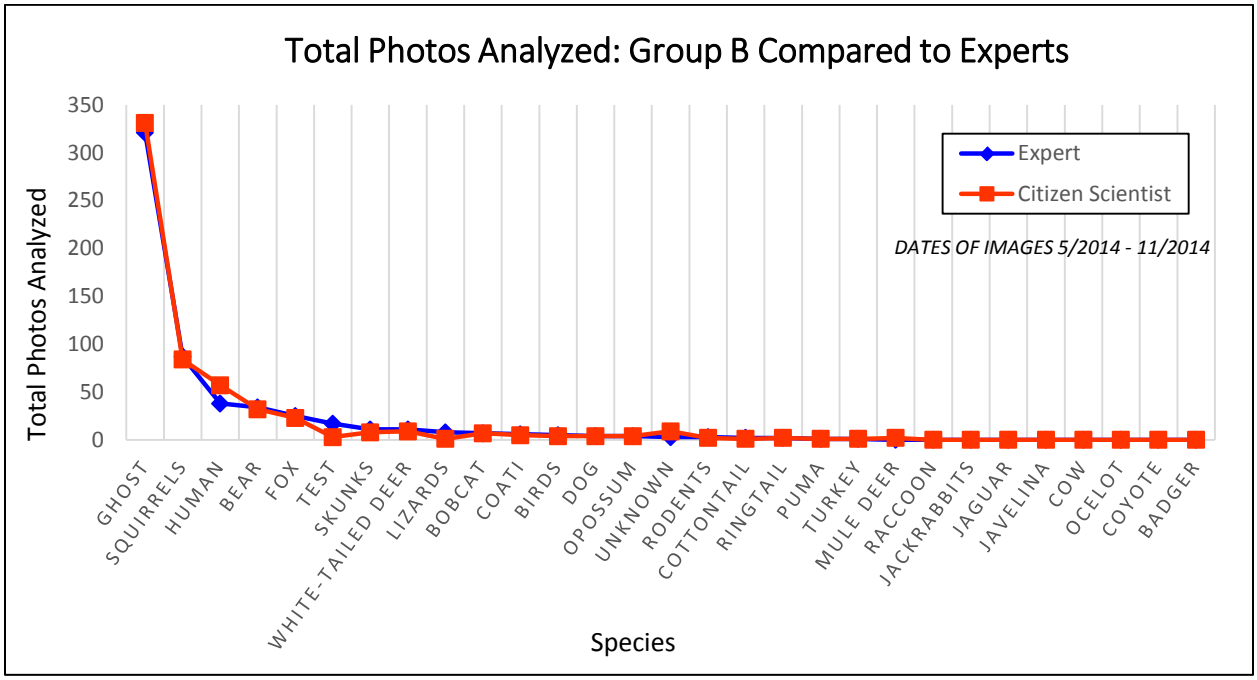

Figure 2b – Comparison of the amount of photos analyzed between field team experts and citizen scientists in Group B. Each species is represented in the graph with the corresponding total number of images sorted by the field team experts or citizen scientists over the selected timeframe (May 2014-November 2014) (r-value=0.9968). "Ghost" images are photos with no identifiable species in the frame; "Test" images are photos of the field team experts or citizen scientists checking the sites.

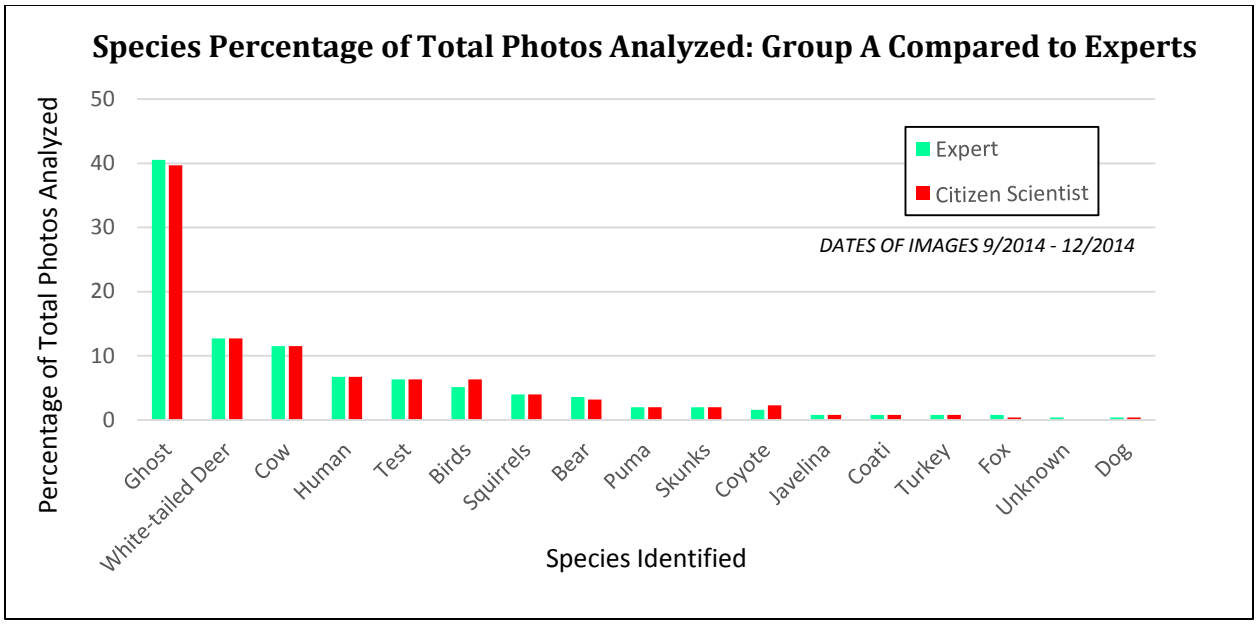

Figure 3a – Comparison of the representation of species identified at camera sites by percentage between field team experts and citizen scientists in Group A (r-value=0.9992). "Ghost" images are photos with no identifiable species in the frame; "Test" images are photos of the field team experts or citizen scientists checking the sites.

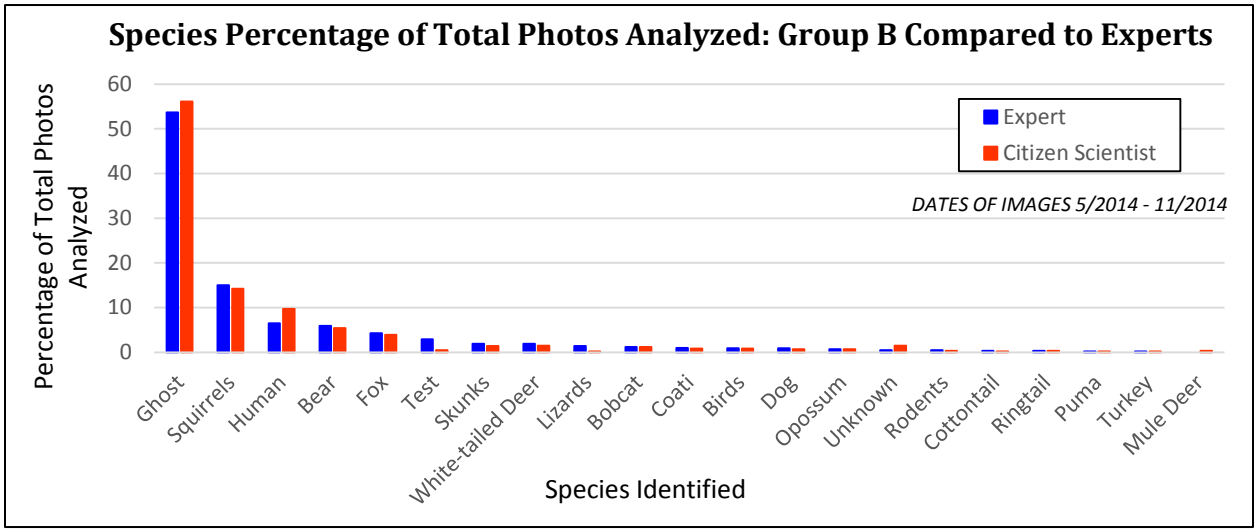

Figure 3b – Comparison of the representation of species identified at camera sites by percentage between field team experts and citizen scientists in Group B (r-value=0.9967). "Ghost" images are photos with no identifiable species in the frame; "Test" images are photos of the field team experts or citizen scientists checking the sites.

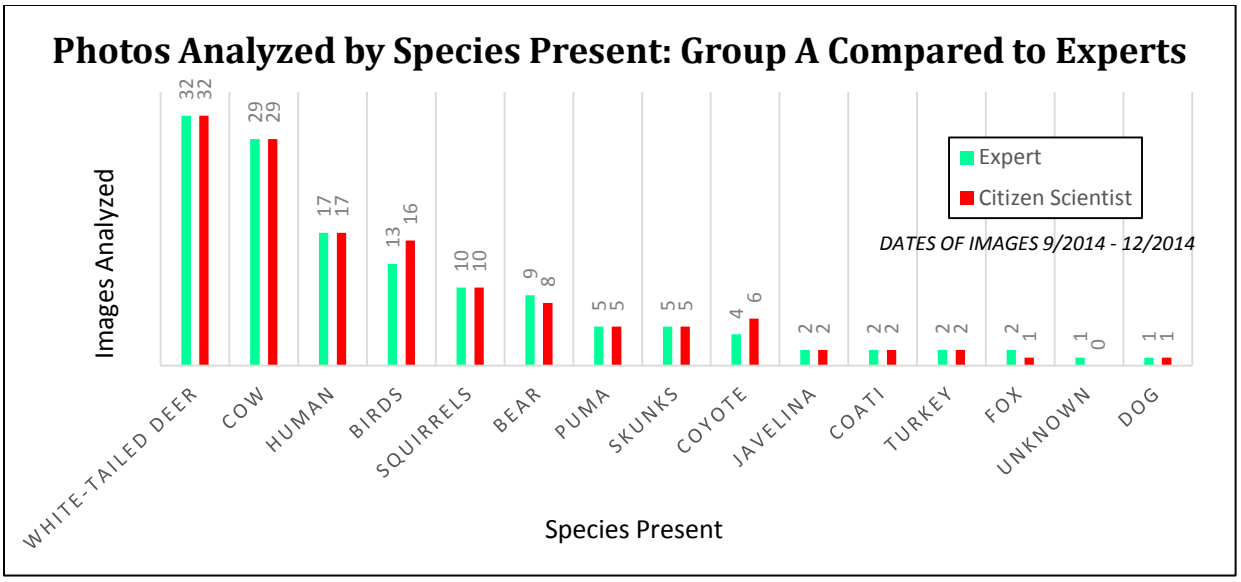

Figure 4 – Comparison of the total amount of photos of species represented at the sites over the timeframe sampled between field team experts and citizen scientists in Group A. Animal species not present at the sites were not included. "Ghost" (i.e., photos with no identifiable species in the frame) and "Test" (i.e., photos of the field team experts or citizen scientists checking the sites) categories were not included because they do not represent an animal species (r-value=0.9945).

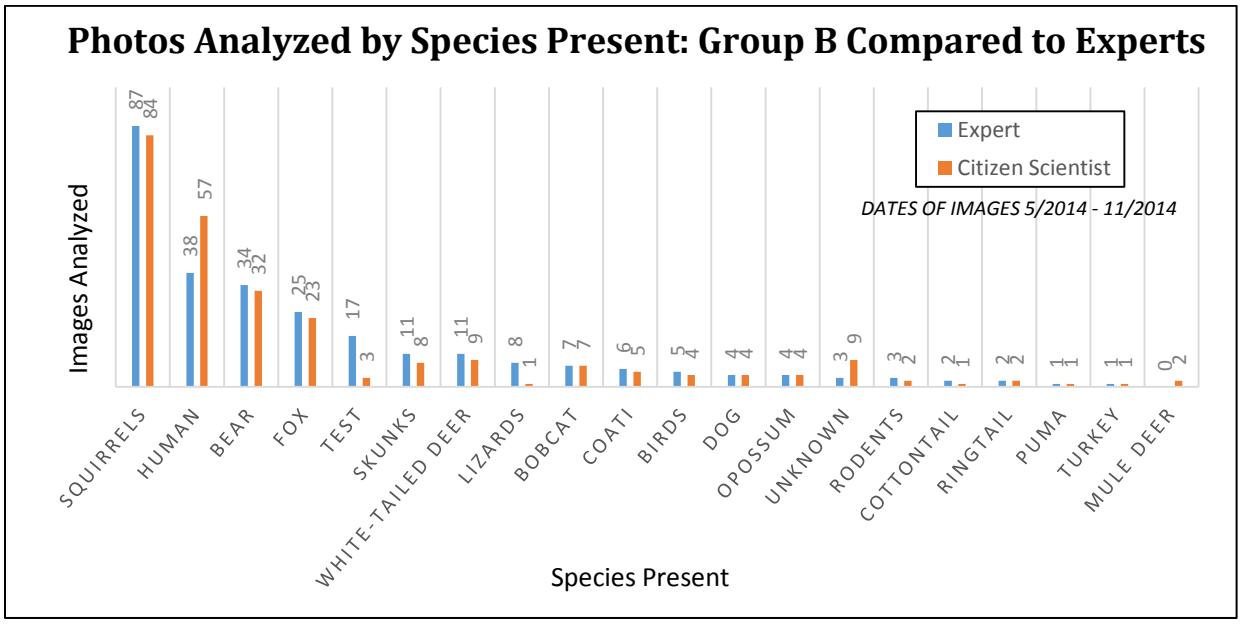

Figure 5 – Comparison of the total amount of photos of species represented at the sites over the timeframe sampled between field team experts and citizen scientists in Group B. Animal species not present at the sites were not included. "Ghost" (i.e., photos with no identifiable species in the frame) and "Test" (i.e., photos of the field team experts or citizen scientists checking the sites) categories were not included in this analysis because they do not represent an animal species (r-value=0.9723); however, note that the "Test" category is included in this figure to show the disparity between photos sorted as "Human" rather than "Test" by Group B. See text for further explanation.

Presence-absence analyses
To determine differences in species presence-absence detected by field team experts vs. Group A and Group B, we compared 134 species photos analyzed by Group A over four monitoring sites for four months and 252 species photos analyzed by Group B over three monitoring sites for six months with the same photos as analyzed by field team experts (Tables 1 and 2). All species photos analyzed by Group A and Group B were highly correlated with those analyzed by field team experts (r=0.9723 for Group A and r=0.9945 for Group B). Of the few inconsistencies detected between field team experts and Group A and Group B, two discrepancies were found between Group A and field team experts ("Squirrels" and "Unknown"), and three discrepancies were found between Group B and field team experts ("Bear," "Mule Deer," and "Skunks").

Species richness analyses
To determine differences in species richness as detected by field team experts vs. Group A and Group B, we compared 252 species photos analyzed by Group A over a four month period and 590 species photos analyzed by Group B over a seven month period (Tables 3 and 4) with the same photos as analyzed by field team experts. All species photos analyzed by Group A and Group B were highly correlated with those analyzed by field team experts (r=0.9850 for Group A and r=0.9808 for Group B). Of the few inconsistencies detected between field team experts and Group A and Group B regarding species richness, 20 (7.9%) discrepancies were found between Group A and field team experts over four monitoring sites and 101 (17.1%) discrepancies were found between Group B and field team experts over three monitoring sites. Discrepancies in the monthly number of photos (Total photos in Tables 3 and 4) analyzed by field team experts vs. Group A and Group B may be due to several factors. One factor may be that some images were copied and put in multiple folders (e.g., an image of a horse with a rider may have been copied and put into "Horse" folder and "Human" folder, resulting in two copies of the same photo). Another factor may be that field team experts and Groups A and B may not have sorted the images the same way (e.g., Group A or B sorted an image as Unknown and an expert was able to distinguish the object in the photo as the correct animal species). Yet another factor may be based on the analysis conducted of all images by the DataAnalyze application we used to analyze all photos. This program uses a timeframe of 60 minutes to distinguish individual photos by the time associated with the re-named images, meaning that if images were put in different folders by Groups A and B and field team experts, the program could have counted different numbers of photos over a sequence of images due to different time periods associated with how the images were sorted.

DISCUSSION
The purpose of our project was to develop, implement, and evaluate a citizen science program to survey and monitor for jaguars and ocelots within the U.S. portion of the NRU for the jaguar. Through the process of selecting and training citizen scientists during the development and implementation portion of our study, our citizen scientists provided valuable feedback from which we gained insight into structuring our trainings and protocols. Additionally, the evaluation portion of our study addressed two important objectives. First, can we develop a protocol to train volunteer participants or citizen scientists (as we are calling them) with little to no knowledge or background in biology or wildlife conservation that will increase their knowledge of jaguars, ocelots, and their conservation, as well as scientific data collection methods? Second, can these trained citizen scientists be as effective and efficient in the pursuit of quality scientific data gathered and analyzed, identifying and documenting wildlife observations from camera data as accurately as a professional team of biologists or field team experts?

Table 1 – Comparison between the presence-absence of species analyzed by the field team experts (light gray) and citizen scientists of Group A (dark gray). "Ghost" (i.e., photos with no identifiable species in the frame) and "Test" (i.e., photos of the field team experts or citizen scientists checking the monitoring sites) categories were not included because they do not represent an animal species (r-value=0.9723).

Presence-Absence Matrix: Expert and Citizen Scientist Group A								
Species	Site 1		Site 2		Site 3		Site 4	
Badger	0	0	0	0	0	0	0	0
Bear	1	1	0	0	1	1	0	0
Birds	1	1	1	1	1	1	1	1
Bobcat	0	0	0	0	0	0	0	0
Coati	0	0	1	1	0	0	1	1
Cottontail	0	0	0	0	0	0	0	0
Cow	1	1	1	1	0	0	0	0
Coyote	1	1	0	0	0	1	1	1
Dog	0	0	0	0	1	1	0	0
Fox	0	0	0	0	1	1	0	0
Human	1	1	1	1	1	1	1	1
Jackrabbits	0	0	0	0	0	0	0	0
Jaguar	0	0	0	0	0	0	0	0
Javelina	1	1	0	0	0	0	0	0
Lizards	0	0	0	0	0	0	0	0
Mule Deer	0	0	0	0	0	0	0	0
Ocelot	0	0	0	0	0	0	0	0
Opossum	0	0	0	0	0	0	0	0
Puma	1	1	0	0	1	1	1	1
Raccoon	0	0	0	0	0	0	0	0
Ringtail	0	0	0	0	0	0	0	0
Skunks	1	1	1	1	1	1	0	0
Squirrels	1	1	0	0	1	1	0	1
Turkey	0	0	1	1	0	0	0	0
Unknown	0	0	0	0	1	0	0	0
White-tailed Deer	1	1	1	1	1	1	1	1

Table 2 – Comparison between the presence-absence of species analyzed by the field team experts and citizen scientists of Group B. "Ghost" (i.e., photos with no identifiable species in the frame) and "Test" (i.e., photos of the field team experts or citizen scientists checking the monitoring sites) categories were not included because they do not represent an animal species (r-value=0.9945).

Presence-Absence Matrix: Expert and Citizen Scientists Group B						
Species:	Site 1		Site 2		Site 3	
Badger	0	0	0	0	0	0
Bear	1	1	1	1	1	0
Birds	0	0	1	1	0	0
Bobcat	1	1	1	1	0	0
Coati	1	1	1	1	0	0
Cottontail	1	1	0	0	0	0
Cow	0	0	0	0	0	0
Coyote	0	0	0	0	0	0
Dog	1	1	1	1	0	0
Fox	1	1	1	1	0	0
Human	1	1	1	1	1	1
Jackrabbits	0	0	0	0	0	0
Jaguar	0	0	0	0	0	0
Javelina	0	0	0	0	0	0
Lizards	0	0	1	1	0	0
Mule Deer	0	0	0	0	0	1
Ocelot	0	0	0	0	0	0
Opossum	0	0	1	1	0	0
Puma	1	1	0	0	0	0
Raccoon	0	0	0	0	0	0
Ringtail	0	0	1	1	0	0
Rodents	0	0	1	1	0	0
Skunks	0	0	1	1	1	0
Squirrels	1	1	1	1	0	0
Turkey	0	0	1	1	0	0
Unknown	1	1	1	1	0	0
White-tailed Deer	1	1	1	1	1	1

Table 3 – Comparison between species richness analyzed by field team experts (light gray) and citizen scientists Group A (dark gray) (r=0.9850). "Ghost" (i.e., photos with no identifiable species in the frame) and "Test" (i.e., photos of the field team experts or citizen scientists checking the sites) categories were not included because they do not represent an animal species. Discrepancies in total pictures between field team experts and Group A may be due to multi-species images copied to multiple folders, differences in sorting photos, and/or the program used to distinguish individual photos.

Species Richness by Month: Expert and Citizen Scientist Group A										
Species	Sep		Oct		Nov		Dec		Total	
Bear	3	2	0	0	6	6	0	0	9	8
Birds	5	6	2	2	6	8	0	0	13	16
Coati	0	0	1	1	1	1	0	0	2	2
Cow	23	23	6	6	0	0	0	0	29	29
Coyote	1	2	0	0	3	4	0	0	4	6
Dog	1	1	0	0	0	0	0	0	1	1
Fox	1	1	0	0	1	0	0	0	2	1
Human	7	7	1	1	9	9	0	0	17	17
Javelina	1	1	1	1	0	0	0	0	2	2
Puma	2	2	1	1	2	2	0	0	5	5
Skunks	2	2	1	1	1	1	1	1	5	5
Squirrels	4	4	0	0	6	6	0	0	10	10
Turkey	2	2	0	0	0	0	0	0	2	2
Unknown	0	0	0	0	1	0	0	0	1	0
White-tailed Deer	20	20	3	3	9	9	0	0	32	32
Total pictures	72	73	16	16	45	46	1	1	134	136
Species richness	13	13	8	8	11	9	2	2	NA	NA

Table 4 – Comparison between species richness analyzed by field team experts (light gray) and citizen scientists Group B (dark gray) (r=0.9808). "Ghost" (i.e., photos with no identifiable species in the frame) and "Test" (i.e., photos of the field team experts or citizen scientists checking the sites) categories were not included because they do not represent an animal species. Discrepancies in total pictures between field team experts and Group B may be due to multi-species images copied to multiple folders, differences in sorting photos, and/or the program used to distinguish individual photos.

Species Richness by Month: Expert and Citizen Scientist Group B																
Species	May		Jun		Jul		Aug		Sep		Oct		Nov		Total	
Bear	7	7	15	14	5	5	1	0	0	0	1	1	5	5	34	32
Birds	0	1	3	3	2	0	0	0	0	0	0	0	0	0	5	4
Bobcat	1	1	3	3	1	1	0	0	1	1	1	1	0	0	7	7
Coati	0	0	2	1	1	1	2	2	0	0	1	1	0	0	6	5
Cottontail	0	0	0	0	2	1	0	0	0	0	0	0	0	0	2	1
Dog	0	0	0	0	0	0	3	3	1	1	0	0	0	0	4	4
Fox	3	3	3	3	0	0	0	0	0	0	8	6	11	11	25	23
Human	1	6	7	12	11	11	3	6	8	11	8	10	0	1	38	57
Lizards	2	0	1	1	0	0	0	0	0	0	0	0	5	0	8	1
Mule Deer	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	2
Opossum	0	0	3	3	1	1	0	0	0	0	0	0	0	0	4	4
Puma	0	0	1	1	0	0	0	0	0	0	0	0	0	0	1	1
Ringtail	2	2	0	0	0	0	0	0	0	0	0	0	0	0	2	2
Rodents	2	1	1	1	0	0	0	0	0	0	0	0	0	0	3	2
Skunks	1	1	4	4	4	2	0	0	1	1	1	0	0	0	11	8
Squirrels	17	24	26	26	23	15	0	0	0	0	2	1	19	18	87	84
Turkey	0	0	0	0	1	1	0	0	0	0	0	0	0	0	1	1
Unknown	1	3	1	2	1	1	0	2	0	1	0	0	0	0	3	9
White-tailed Deer	2	2	4	4	2	0	0	0	1	1	2	2	0	0	11	9
Total pictures	39	51	74	78	54	41	9	13	12	16	24	22	40	35	252	256
Species richness	11	11	14	14	12	11	4	4	5	6	8	7	4	4	NA	NA

Citizen scientists

Our group of nine citizen scientists (from the first group) successfully downloaded and sorted more than 27,400 photos from 22 cameras at 14 monitoring sites over 12 months. Citizen scientists logged a total of 327 hours of fieldwork including driving, hiking, and performing camera maintenance. After finishing a site visit, citizen scientists also sorted photos, logging approximately 109 hours of data organization. In addition, 100% of our group of citizen scientists adhered to our protocols that we tested and implemented in the field over a one-year period. We believe that our classroom and field training were instrumental in this success.

Qualitative assessment of learning

Ongoing learning was enabled throughout the project due to the structure of the citizen scientist workshop, expert field support and mentoring, and the continued informal learning/feedback sessions that were provided when the citizen scientists met with the volunteer coordinator and the data manager of the main project. Moreover, this situation provided the leadership team with ongoing feedback to continuously tweak or adjust our teaching methods and content.

Per the protocol of the data collection and storage, all images and data were backed up on the servers at the UA, School of Natural Resources and the Environment. This backup occurred both with the volunteer coordinator and the data manager of the main project. Visits to back up data were a natural segue for informal learning and provided an opportunity for continued training and feedback regarding field experiences. The feedback and questions the volunteer coordinator and data manager received were indicative of the learning curve. As the project progressed, volunteers would proudly share their newly learned expertise with their volunteer cohorts and the coordinator.

This informal setting provided a relaxed venue in which to review and spot-check data protocol and scientific data collection methods. As data was uploaded to the servers, spot checks were done and feedback was provided. The citizen scientist learning went beyond wildlife biology, and, as the project progressed and they spent time in the field, an appreciation for stakeholder diversity and sensitivity was heightened. This was conveyed as citizen scientists came to share data on a monthly or bimonthly basis, articulating their highlights reflecting on the increased environmental awareness.

Quantitative assessment of data collected

The findings of our study lead us to strongly conclude that citizen scientists can be trained to identify and document wildlife in remote settings with a high degree of confidence and accuracy. Our analyses revealed a strong positive correlation between Groups A and B of the citizen scientists and field team experts when it came to the total number of individual wildlife identified ($r=0.9991$ for Group A and $r=0.9968$ for Group B) and the species identified in photos ($r=0.9945$ for Group A and $r=0.9723$ for Group B). These high positive correlations indicate that citizen scientists have been well trained and can identify wildlife from camera data nearly as well as the field team experts.

Our presence-absence and species richness analyses highlight the importance of identifying and sorting the correct animal species to maintain data integrity in measuring and understanding the distribution of species across the landscape. The presence-absence analyses allow a cursory comparison between the species identified at each monitoring site by the field team experts and Groups A and B of the citizen scientists. These analyses show which species were detected at the monitoring sites and if citizen scientists were able to properly sort photos to represent all species. Our results indicate that the citizen scientists' ability to sort photos is highly correlated to that of the field team experts, as demonstrated by the high r-value scores ($r=0.9723$ for Group A and $r=0.9945$ for Group B). While presence-absence does not indicate species abundance or density, we chose this measure because it provides an easy quantitative analysis to measure and understand the distribution of species across the landscape.

Species richness further aids in measuring and understanding the distribution of species across the landscape. This more advanced analysis measured the total number of individual animals that field team experts and Groups A and B of the citizen scientists were able to identify by month. The correlation between the field team experts and Groups A and B was high ($r=0.9850$ for Group A and $r=0.9808$ for Group B), indicating that highly trained volunteers may be able to correctly identify and categorize species images similar to that of a field expert.

Our study provided an opportunity to use non-scientists to augment data collection and assessment in the scientific workplace to advance jaguar and ocelot conservation. As discussed in the **INTRODUCTION**, common concerns about using citizen scientists have arisen in the scientific community because of the number of issues surrounding data integrity. Our study comparing Group A and Group B to field team experts in their ability to accurately identify wildlife individuals and species provides a measure that evaluates those differences. The high positive correlations that we found are strong evidence that Group

A and Group B can be excellent surrogates for field team experts. This finding contradicts some of the literature that tends to suggest that data accuracy and integrity is an issue and growing problem when using citizen scientists.

In summary, we believe our success was based on a combination of factors. First, constant feedback using both informal and formal surveys of all citizen scientists regarding our protocols allowed us to refine and improve them, and to match citizen scientists' abilities with appropriate routes and monitoring sites, contributing to a high degree of compliance with the protocols. Second, our protocol that evolved from these training sessions enabled our citizen scientists to follow an easily comprehended and implemented set of field procedures and data downloading, sorting, and analysis methods. Third, a direct comparison between field team experts and Group A and Group B demonstrated the quality of data processed by both groups was highly correlated with the data processed by field team experts. Finally, the strong collaboration and communication between the Group A and Group B and field team experts regarding their experience and expertise, knowledge of jaguar and conservation education, and advanced data management skills contributed to the success of using citizen scientists to collect and analyze wildlife data. We strongly believe and conclude that the high positive correlations that we found are strong evidence that citizen scientists such as those represented in Group A and Group B can be excellent surrogates for field team experts to collect and analyze wildlife data from remote cameras.

CONCLUSION

Many concerns have arisen in the scientific community about the use of citizen scientists because of the number of issues surrounding data integrity. We have found the opposite in our study and have confidence that our protocols could be transferred to other studies to evaluate wildlife being monitored using camera technology.

In addition, there has been an extensive amount of research that has focused on the idea of how to create a successful and sustainable citizen science program. Keys for success include proper sampling design, detailed data quality analyses, user-friendly tools and proper education in how to use them, and the ability to work and coordinate with field team experts. We agree with these findings. Our work demonstrates that teaming citizen scientists with field team experts on their first outing can provide a check and balance on the citizen scientists' physical and technical skills. Additionally, field team experts can share the vast experience they have in the field and provide the required knowledge to accomplish stated goals. We also found it was imperative to have a bench mark to compare how well our citizen scientists and professional biologists sorted data to obtain and maintain a high degree of data integrity.

The findings of our study lead us to strongly conclude that citizen scientists can be trained to identify and document wildlife in these remote settings with a high degree of confidence and accuracy. This finding contradicts the literature that tends to downplay the use of citizen scientists because of data accuracy issues. Undoubtedly, our study provided a rare and unique opportunity to use non-scientists to augment data collection and assessment in the scientific workplace to advance jaguar and ocelot conservation. However, we strongly believe that citizen scientists remain an underutilized resource for helping scientists collect and analyze data in these days of reduced funding and the need for long-term monitoring.

Disclaimer: Any use of trade, firm, or product names is for descriptive purposes only and does not imply endorsement by the U.S. Government.

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APPENDIX A –Volunteer Call Out

Participate in jaguar and ocelot conservation

A partnership between the U.S. Fish & Wildlife Service and the University of Arizona has an exciting opportunity to volunteer as a **Citizen Scientist** in jaguar and ocelot conservation. Learn and work with experts in non-invasive sampling techniques including camera monitoring, tracking, and data analysis.

Contact

Research Assistant: Emily Reynolds

E-mail: earreynol@email.arizona.edu

Citizen Scientist Requirements:

- Ability to hike MINIMUM 5 miles over rough terrain
- Personal transportation and comfort on 4WD roads
- Commit to training workshop T.B.D (Feb 20-22)
- Commit to monitoring cameras every 30 days
- Adhere to strict safety and confidentiality protocol

University of Arizona
Wild Cat Research
& Conservation Center

Name: Emily Reynolds
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APPENDIX B– Citizen Science Workshop Invitation

Jaguar & Ocelot Research

Citizen Science

4-6 April 2014

Workshop Invitation

Santa Rita Experimental Station

(directions included)

Space is limited to *invited participants only* – please RSVP by 20 March.

Questions? RSVP- Email Emily
earevnol@email.arizona.edu

Friday April 4: Arrive at Santa Rita Experimental Station by 6 PM
Introduction to the project and each other – followed by a potluck

Saturday April 5: An all-day training event
Jaguar and ocelot natural history and ecology
Training in camera traps and other equipment

Sunday April 6: A half day training event
Field protocols and data entry
Finished by approximately 3PM

What to Bring:
- Potluck item for Friday night BYOB
- Clothes (including field attire)
- Toiletry items
- Notebook and pen
- Headlamp/flashlight
- Bedding (sleeping bag and pillow)

Optional:
- GPS
- Binoculars
- Camera
- Compass
- Multi-tool

The Santa Rita Experimental Station has kindly provided use of their facilities. All meals and snacks (excluding the Friday night potluck) will be provided. Sleeping quarters will be bunkhouse style with facilities. Citizen Scientists will be asked to participate in a short survey.

APPENDIX C – Citizen Science Workshop Agenda – Workshop 1

Jaguar Citizen Science Workshop Agenda
April 2014

Date/Time: 4-6 April 2014
Location: Santa Rita Experimental Range

OBJECTIVE
To develop citizen scientists who are proficient in jaguar ecology and camera trap monitoring.

ROLES/RESPONSIBILITIES
Primary coordinator: Randy
Schedule coordinator & content: Aletris
Contact person: Emily
Classroom setup: Emily
Food set-up: All
Beverages: Randy
SRER: Mark

SCHEDULE
Friday

6:00 - 6:30	Participants arrive-given name tags & pre-survey & waiver	Emily
6:30 - 7:00	Welcome, overview of project & housekeeping	Randy & Mark
7:00 - 7:15	Introductions by participants & staff	Aletris
7:15 - 7:45	Wild Cat Center Intro & Rancher Importance	Lisa
7:45 - 8:45	Dinner and refreshments	TBD
8:45 - ?	Refreshments & great conversation around the fire	Randy

Saturday

7:00 - 7:45	Breakfast buffet, coffee & tea	TBD
8:00 - 8:15	Pass out materials & daily overview	Randy
8:15 - 9:45	Jaguar Project Objectives/Overview	Jack
9:45 - 10:00	Break	
10:00 - 11:45	Southern AZ Carnivore Ecology	Aletris
11:45 - 12:30	Spotted Cat Ecology	Jack
12:30 - 1:30	Lunch	TBD
1:30 - 2:00	Non-invasive sampling & scat collection	Melanie
2:00 - 2:30	Tracking basics	Aletris
2:30 - 3:00	Break & group photo	
3:00 - 4:30	Camera trap basics, setting & checking camera traps	Jack, Chris, Tom
4:30 - 5:00	Safety and hazards on the trail	Robert Fink
5:00 - 5:30	Transect options & select transect	Chris & Aletris
5:30 - 6:30	GPS basics & scavenger hunt	All
6:30 - 8:00	Dinner	TBD
8:00 - 8:30	Introduction to jaguar education project	Aletris
8:30 -	Campfire discussions and beverages	Randy

Sunday

7:00 - 7:30	Breakfast buffet	TBD
7:30 - 8:00	Check group camera trap and retrieving cards	Chris
8:00 - 9:30	Downloading and data sorting	Chris & Sue
9:30 - 10:00	Field protocol	Emily, Randy, Aletris
10:00 - 12:00	Field excursion, tracking, check camera	All
12:00 - 1:00	Lunch and cleanup	TBD
1:00 - 2:00	Wrap-up and adjourn and post survey	Emily and Randy

APPENDIX D – Citizen Science Workshop Agenda – Workshop 2

Date/Time: Saturday March 28, 2015 8:30 A.M.
Location: Sabino Canyon Visitor Center (Conference Room)

Objective
To develop citizen scientists that are proficient in jaguar ecology and camera trap monitoring with high data integrity.

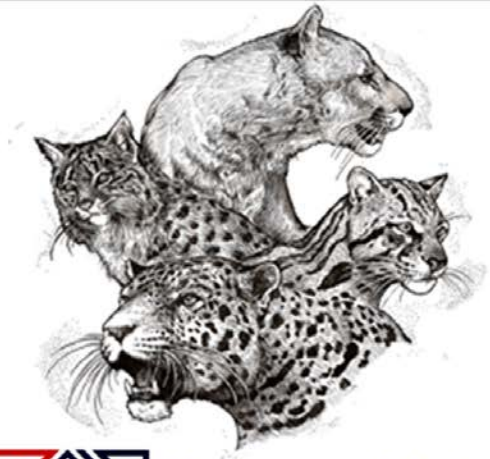
Schedule

Saturday

8:30-9:00	Participants arrive- name tags and waivers (Coffee and tea)	Emily
9:00:9:30	Welcome, Introductions, Overview of C.S. program	Emily
9:30-10:00	Project Objectives/Overview	Lisa
10:00-10:15	Coffee Break	
10:15-10:45	Monitoring Protocol (go over booklets)	Emily
10:45-11:45	Camera basics, setting & checking cameras	Tim/Tom/Lisa
11:45-12:30	Jaguar Ecology presentation over lunch	Jack
12:30-1:00	Safety & Hazards on the Trail	Tim
1:00-2:00	Check cameras (Field excursion)	All
2:00-3:30	Downloading and data sorting	Sue
3:30-4:00	Wrap-up and adjourn	Emily & Randy
5:00-	Dinner (Gimblett home- 6123 E. Hampton St.)	

APPENDIX E– Citizen Science Protocol Guidebook

Citizen Scientist Protocol Guidebook



University of Arizona
Wild Cat Research
& Conservation Center

APPENDIX F –Camera Check Sheet

JAGUAR - OCELOT CITIZEN SCIENCE PROJECT
Camera Check Sheet

Date: _____ Start Time: _____ GPS Coordinates:_____
SITE ID: _____ Battery Replaced Y/N: _____
Replaced Card Y/N: _____ Stop Time: _____ # IMAGES: _____
Researchers present: _____
MyRenamer Ran Y/N: _____ Data to Emily Y/N: _____

Date: _____ Start Time: _____ GPS Coordinates:_____
SITE ID: _____ Battery Replaced Y/N: _____
Replaced Card Y/N: _____ Stop Time: _____ # IMAGES: _____
Researchers present: _____
MyRenamer Ran Y/N: _____ Data to Emily Y/N: _____

Date: _____ Start Time: _____ GPS Coordinates:_____
SITE ID: _____ Battery Replaced Y/N: _____
Replaced Card Y/N: _____ Stop Time: _____ # IMAGES: _____
Researchers present: _____
MyRenamer Ran Y/N: _____ Data to Emily Y/N: _____

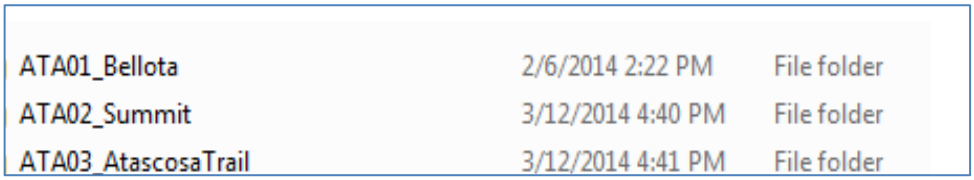
Date: _____ Start Time: _____ GPS Coordinates:_____
SITE ID: _____ Battery Replaced Y/N: _____
Replaced Card Y/N: _____ Stop Time: _____ # IMAGES: _____
Researchers present: _____
MyRenamer Ran Y/N: _____ Data to Emily Y/N: _____

APPENDIX G – Citizen Science Program Data Processing Protocol

- Begin by inserting flashdrive into computer
- The flashdrive will have one option: **AllCameraTrapData** – double click this folder
- There will be six folders, double click **Unsorted_Raw** to open
- Upload photos to Unsorted_Raw (all folders that teams are monitoring have been labelled according to the place name and site code)

* Upload SD card photos to corresponding individual site specific folders

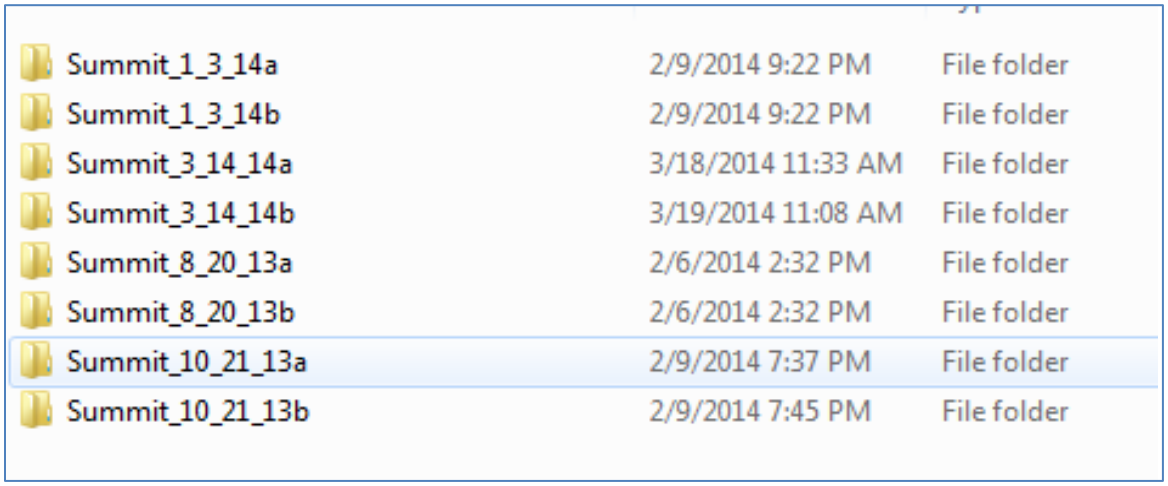
Example: In this example, there will be at least five separate SD cards (10 if cameras are paired) and they must be uploaded to their corresponding folder



ATA01_Bellota	2/6/2014 2:22 PM	File folder
ATA02_Summit	3/12/2014 4:40 PM	File folder
ATA03_AtascosaTrail	3/12/2014 4:41 PM	File folder

- After identifying the correct site that corresponds to the SD card, click to open
- Every flashdrive has a template to begin sorting data
- When uploading new photo data, create new folder with **Site Name and Date Data was Collected**

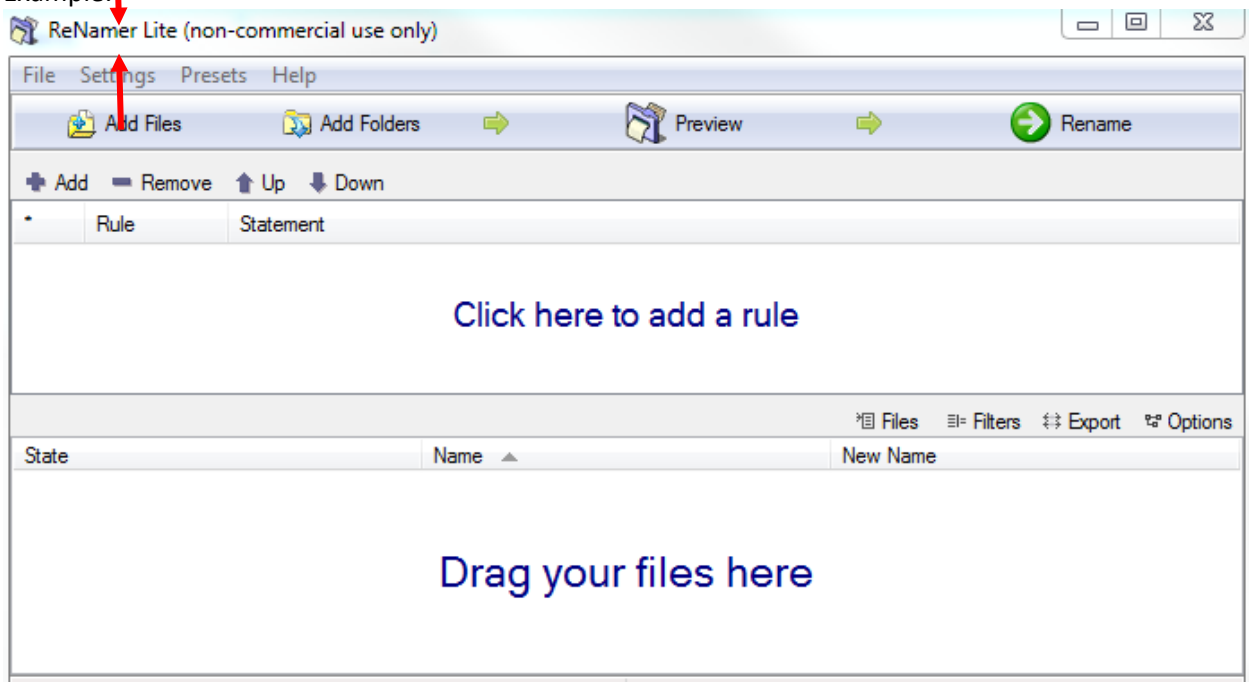
Example: This example has four separate dates that data was collected. An individual folder was made for every site



Summit_1_3_14a	2/9/2014 9:22 PM	File folder
Summit_1_3_14b	2/9/2014 9:22 PM	File folder
Summit_3_14_14a	3/18/2014 11:33 AM	File folder
Summit_3_14_14b	3/19/2014 11:08 AM	File folder
Summit_8_20_13a	2/6/2014 2:32 PM	File folder
Summit_8_20_13b	2/6/2014 2:32 PM	File folder
Summit_10_21_13a	2/9/2014 7:37 PM	File folder
Summit_10_21_13b	2/9/2014 7:45 PM	File folder

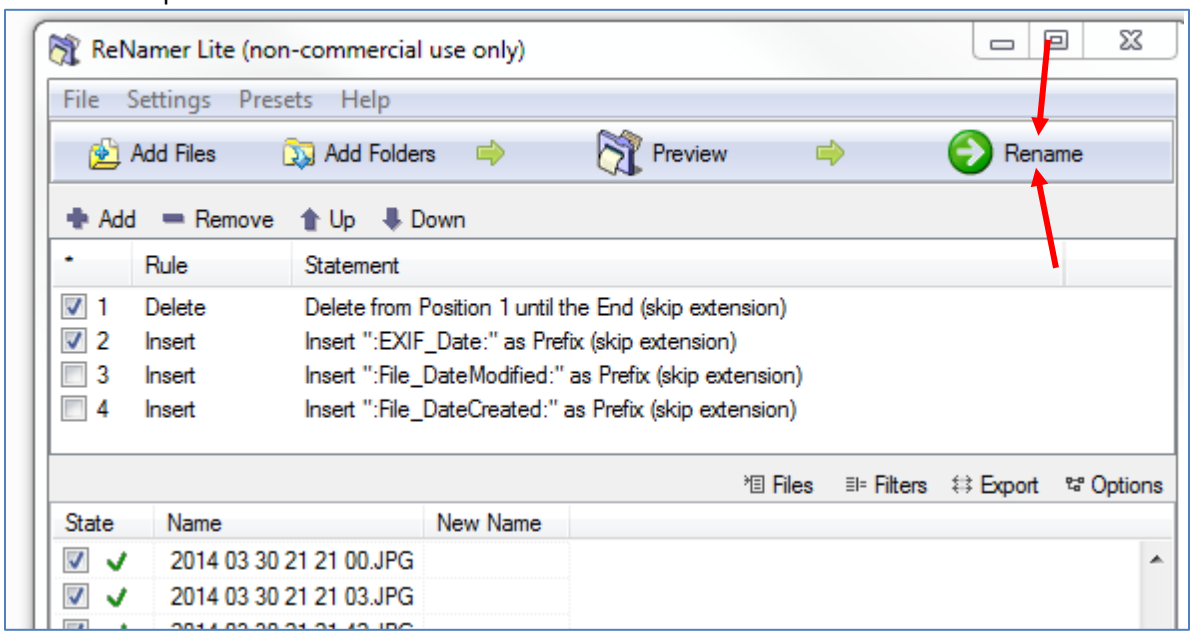
- After photos have been uploaded to their corresponding folder, open the program **MyRenamer.exe**
- This program will rename the photos or files to be sorted into folders

- Click on **Presets** (located in upper left corner)
  Example:



- Select **Load** from dropdown options; and "JaguarRenamer" will appear to the right.
- Select **JaguarRenamer**
- Keep instance of Renamer open (loaded with proper presets) on one side of monitor; and refresh your directory (a second small reduced window) on the other side.
- Drag entire files into this Renamer window (one at a time).
- Click on **Rename** (located in upper right)

Example:



- Put a copy of renamed photos into the corresponding folder in AllLocations
- Each site in AllLocations has a template of species folders (including one for unsorted)
- The Renamed photos are placed in the **Unsorted** folder
- Double click on unsorted folder and view large images in a pane to the right
- Drag and drop photos into the species subfolders
- Each species will have a subfolder to represent group size (01, 02, etc.), drop folder into corresponding group size photo
- If there is more than one species in a folder, put photo into EACH folder
- If it cannot be determined, do not guess – put in **Unknown** folder
- You can start and stop the sorting process as you please

* If wrong date/time is displayed: put photos in “Special Cases” instead of Unsorted_Raw, open MyRenamer, directions are in progress.

Appendix H – Pre-training assessment

Jaguar Assessment Questions

Events:

1. What are people doing to protect the jaguar?
2. What have you heard people are doing to protect the jaguar?
3. Have you ever seen a Jaguar?
4. What historic events are you aware of about jaguar?
5. What do you see happening to jaguar and habitat?
6. How much funding goes into protecting the jaguar?
7. How much funding is raised to protect the jaguar?

Behavior over time

1. Have numbers of Jaguar increased or decreased over time?
2. What types of trends have happened that might have caused an increase or a decrease in the Jaguar population?
3. What feelings do you have about protecting Jaguar?
4. Has jaguar habitat increased or decreased over time?
5. Has our population increased or decreased over time?
6. Has urbanization and loss of habitat increased or decreased?
7. How has the environment changed?
8. Are you aware of any trends in our precipitation over the last twenty five years?
9. Are you aware of any trends in our temperatures over the last twenty five years?
10. Are you aware of any pollution increases or decreases over the last twenty five years?

Underlying structures

1. What trends or data affects what?
2. How does the data affect each other?
3. Can you illustrate or explain how the trends negatively or positively connect?

Mental Models

1. How do you view our current protection of the Jaguar and their associated habitat?
2. What is your opinion about the current status of the Jaguar protection?
3. What do you believe will happen to the Jaguar if we continue to do exactly what we are doing now?
4. Do you think that you could do anything to protect the Jaguar?