Use of Camera Traps in Mohave Ground Squirrel Studies

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Camera traps have been used effectively in recent years to detect Mohave ground squirrels (*Xerospermophilus mohavensis*). This technique has great promise as an alternative or supplement to traditional live trapping. However, there is no generally accepted methodology for use of camera traps in Mohave ground squirrel (MGS) studies. We would like to present suggestions to standardize camera trapping methods based upon our field experience since 2009. We also present other recommendations related to the more effective use of camera traps for MGS studies.

These recommendations are not intended to supplant the current presence-absence survey protocol, which calls for traditional live-trapping. However, camera trapping can efficiently establish presence of MGS with less labor than would be required for a CDFW-protocol trapping array and may obviate the need to complete a protocol trapping survey. These techniques may also be useful in long-term monitoring of conservation lands.

This document starts with standard recommendations which apply to any camera trapping scenario. Next are recommendations for long-term site monitoring, and then additional considerations for all situations. Below is a summary list of camera trap basics for any situation. Keep in mind that ***all camera trap studies are site- and situation-specific, with many things to consider. We recommend reading the entirety of this document before designing any camera trap study***.

1. Camera specifications:
    a. At least 1 photo per second when triggered
    b. Trigger speed of <0.5 seconds
    c. Recovery speed of ≤1 second
    d. Minimum 60 Mb/s download speed on SD card
2. Camera trap setup
    a. 24-hour camera operation
    b. Face camera north
    c. Keep shrubs and other potential wind-triggers out of field of view
    d. Place bait approx. 4-5 ft from camera
    e. Place bait in center of field of view
    f. Test camera trigger at bait location before leaving
3. Bait must be present every day
4. 10 cameras per 160 acres (=835ft /254m apart)
5. March 15- May 15
6. Minimum two 5 full-day sessions (see description below) with three weeks between (or longer sessions as equipment and budget permit)

Standard Recommendations

It is important that there be consistency in how camera trap data are collected. This consistency includes, but is not limited to, uniformity in: 1) the type of camera traps used and the specifications; 2) how cameras are setup in the field; 4) the timing and duration of trap sessions; and 3) the method that bait is distributed to animals in the field. All of these variables can strongly influence the detectability of ground squirrels and other animals of interest, as well as the quantity and quality of the data being collected.

Camera Specifications and Settings

Cameras differ in many aspects, from recording medium (still photo and/or video), recording duration per trigger, color and/or b&w, detection range, picture/video quality, trigger speed, flash or infrared, delay between triggers (i.e., recovery time), detection sensitivity, cost, power draw, memory storage, durability, and reliability. These differences can lead to variations in animal detectability and reduce consistency in data collection. It is important to use cameras that have been shown to be effective under harsh field environments and will last over multiple years. Trigger speeds, recovery times and the number of photos taken per second vary between cameras which take photos, with the fastest cameras triggering in 0.05 sec with a recovery time of 0.50 sec, versus slower versions triggering in 2.0 sec with recovery times upwards of 8.0 sec. Cameras that record video have even slower trigger speeds and recovery times between triggers which needs to be considered if using video.

To effectively detect MGS presence, we suggest that camera traps have fast trigger speeds (less than 0.50 sec) and recovery times (about 1.0 sec or less), and take at least 1 photo per second to reduce the chances of missing MGS visits. Consider also the downloading speed of the secure digital (SD) card that is used within the camera unit. Download speed will influence how many photos can be taken per second. Cards with at least 60 MB/sec downloading speed are recommended. Card reliability is also essential to ensure that data collection is not compromised. We therefore recommend speaking with researchers who have used SD regularly in the field to determine which brands offer the best reliability. To minimize the number of field visits to maintain camera trap sites, it is recommended to use larger storage SD cards if possible, especially for camera sites placed in remote areas. It may also be important to collect data 24 hours/day if possible to identify all ground squirrel activity, as well as other animals in the area, especially potential predators and food competitors.

Camera Trap Setup in the Field

We suggest that camera traps have identical setup configurations, or as similar as possible if using different cameras, so that data collection will be more uniform in nature. We have found that 5 foot U-posts (about 3-3.5 inches wide) work well for securing cameras, though other methods could be used. Cameras can be attached to clips on the posts using wire. If the location is not too steep or rocky, posts can be hammered into the ground and then tilted at an angle to get the desired field of view. We suggest that the field of view not be too large because vegetation movement within the detection zone can cause many false detections. Most cameras allow for remote triggering of activity to allow the person setting up the equipment to know that their activity simulating the animal's presence is working, but that doesn't necessary guarantee that the picture is centered. A variety of devices capable of reading SD cards (e.g., laptops, cellular phones, electronic tablets, etc.) can be used to record images and make sure that pictures are centered. We suggest that bait stations be located about 4-5 ft in front of cameras in a centered position. It is important to center the bait to give the camera the most time available to detect animal movement through the detection zone. It is also important to keep cameras away from any vegetation that could sway in front of the camera during windy conditions. Of course for security purposes, sometimes it is necessary to hide cameras behind vegetation and limit proximity to any used trails or roads when possible. To lessen the chances of someone stealing cameras, lock boxes and ground anchors can be used. Cameras should be placed in a northerly facing direction to lessen the impact of direct sun onto the recorded images.

Equipment and Site Maintenance

Cameras will have to be periodically visited to replace data storage cards, batteries, and bait. We suggest using lithium batteries if possible to extend the operational life of the camera trap. Some SD cards can store as much as 32 GB of data, allowing the camera to run for weeks at a time depending on the amount of animal activity. The most limiting factor associated with camera traps is the availability of bait to draw animals to the cameras. There are at least four methods that could be used to distribute bait during camera trapping sessions (daily placement of small piles of loose bait such as 4-way livestock feed, blocks of bait for extended use, automated feeders, and perforated PVC pipe containing grain), though no specific large scale testing has been done to test which type of bait or which method of bait presentation is the most effective for detecting MGS. It is important that this information be documented because these factors may influence species detectability. It is also important to limit personnel time entering study areas which may influence animal behavior. If possible it is best to visit sites during early morning hours when ground squirrels are not active.

Methods of Bait Presentation

Manual placement of small bait piles (e.g., 4 way horse feed) onto the ground requires replacement each day. There is concern that food placed at camera trap stations throughout the desert might draw in ravens and other potential predators. To possibly reduce this issue, it has been suggested that pvc tubes filled with bait could be used to lessen the likelihood of ravens or other predators visiting the site due to the lack of a food reward. However, it is also possible that without a food reward, ground squirrels might not visit as readily as with other methods thereby reducing detectability. Also, squirrels might be more focused on getting at food within the tubes and not as vigilant in watching for predators as with other methods. Others have used bait blocks at camera traps to lessen personnel time in resupplying feed stations on a daily basis, though this method still has potential issues with predators congregating on site. Automated feeders are also starting to be field tested as a way to reduce human presence and logistical costs, but results are limited at this point. This method will likely have issues with predator presence as well.

Season

Camera trap sessions should occur between March 15 and May 15 so as to assess presence of resident adults, especially females. It may be tempting to set traps during the juvenile dispersal period (May 15-June 15) to determine whether a site is functioning as a habitat linkage. However, camera traps will not provide the data to make that determination. Camera trapping during juvenile dispersal is not recommended because detections may be of juveniles from natal sites very near the camera(s) (i.e. not dispersing) or from as much as several kilometers away. Detections of juveniles would tell us only that juveniles were detected and would shed no light on where they came from or where they were going.

Duration

We recommend two 5-day trapping sessions (i.e., where traps are placed on the 1st day and then started early the 2nd day and run for 5 full days, being removed early on the 7th day)Allow at least three weeks between sessions to capture variability in surface activity during the post-mating season. Cameras can always be left out longer if bait remains in place or is supplemented, battery life and camera memory are not limiting factors, and one has the capacity to process and review the additional photos that will be collected. If sessions are longer than 5 days, or one long session is selected instead of two, then the session(s) should span at least 31 days from start to end (equal to 5 days + three weeks + 5 days) to encompass variability in surface activity through the season. Where weekend recreational traffic causes concern of camera theft or damage, five-day sessions may have to be broken into multiple periods with cameras being removed for the weekend in between in order to have the cameras deployed for five *full* days.

Camera Spacing

The basic issue regarding intensity of camera spacing is whether to completely sample a property with cameras or to site cameras so that some percentage of the property is surveyed. The sampling approach (5%, 50%, 100%) doesn't necessarily have to be the same for all sites. Spacing and coverage will depend on the goals of the study. Smaller parcels (e.g., 160 acres) could receive 100% coverage while larger properties (e.g., 2000 acres) might be sampled to a lesser extent if the goal is not to determine presence across the whole site in a given year. If the habitat on larger parcels is relatively uniform, it would be reasonable to monitor by deploying cameras on a random basis. However, if different habitat types are present, there should be an effort to sample all habitats in proportion to their area within the property.

Harris and Leitner (2004) have reported on the movements of radio-tagged adult female MGS during the period from mid-March to the end of June. The maximum recorded within-day movements ranged from 24-371 m (median 205 m). These data suggest that MGS living within a distance of 150-200 m from a camera could be detected, especially given that cameras are operated for at least 5 days and are provided with a bait attractant. The assumptions discussed here about the area of camera coverage could be tested rigorously by radio-telemetry of adult MGS.

In the interest of standardizing data collection across different survey areas, and recognizing that the duration of camera trap-sets can likely ameliorate a potentially lowered detection rate caused by a low camera trap density, we recommend placing cameras in arrays of 10 per 160 acres, or 835ft (254m) apart. Some situations, such as long-term monitoring of a large-scale mitigation site, may not call for full coverage surveys. If it is not considered necessary to achieve 100% coverage of a larger parcel, cameras could be spaced farther apart or arrays of cameras could be located randomly, or according to other criteria, such as stratifying samples by plant community, and/or setting cameras at different locations between years to achieve full coverage over time.

Camera Traps for Long-Term Site Monitoring

Camera traps should be a useful tool for long-term monitoring of MGS populations on mitigation lands. The most appropriate application would be to determine presence within years rather than abundance; however, the number of camera sites at which MGS are detected could provide a relative index of abundance over time if camera trap methods are consistent across years within a site.

The frequency of camera monitoring should be guided by what we know about year-to-year fluctuations in MGS numbers. The only continuous record we have of MGS abundance was developed at two Coso study sites (Leitner 2015). The graph (Figure 1) below shows the record from 1990 through 2015. (The numbers of adult MGS captured in 2016 were slightly higher as compared to 2015.)

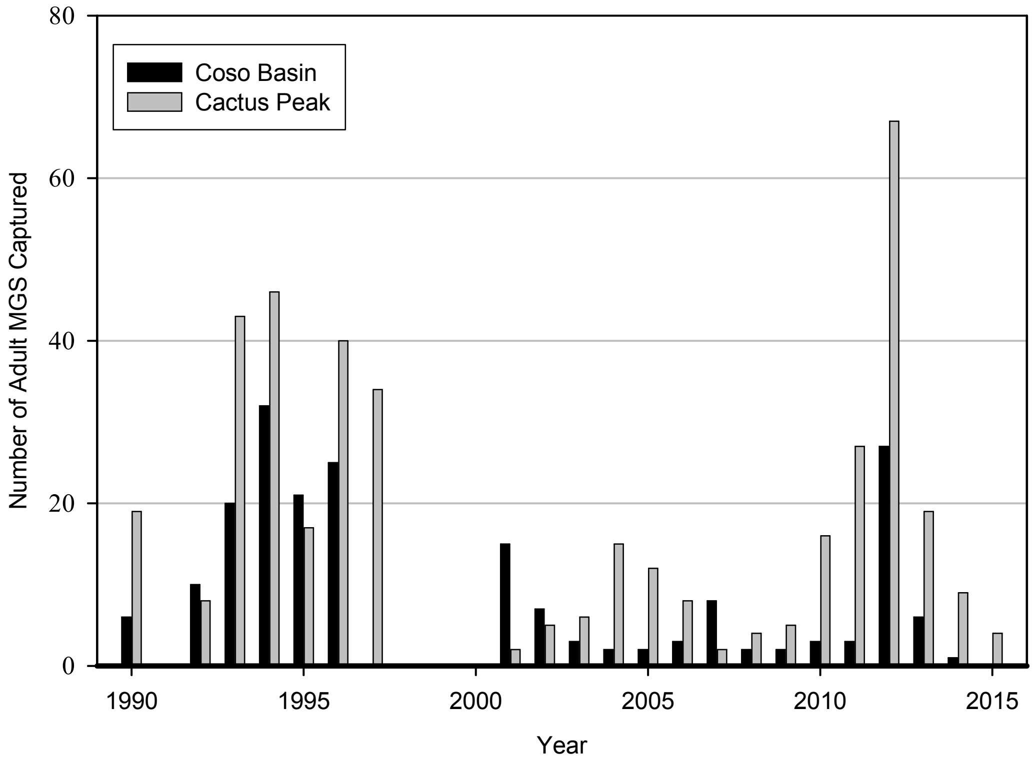

Figure 1. Mohave ground squirrel captures at the Coso Basin and Cactus Peak study sites in March-May during the period 1990-2015.

By examining these data, it can be seen that MGS numbers can change rapidly over the course of just a few years. For example, if sampling were conducted every 5 years (from 2010 to 2015 for example) the record-breaking high of 2012 would have been missed completely. As a result, it seems wise to conduct monitoring at least every 2-3 years. Annual monitoring would be the best approach but may not be feasible because of logistic or financial considerations.

Other Recommendations

1) Suggest collecting vegetation data, especially on shrubs, in combination with camera trapping, where this will help achieve study goals. It is important to not only understand where MGS are distributed on the landscape, but if other factors influence their presence and sustainability on the landscape. Vegetation is an important factor in species presence and it would be beneficial to collect such data in concert with large-scale camera trapping. A greater understanding of the relationship between MGS presence and vegetation is especially important when considering climate change issues. The method that we have employed at 10-camera arrays is to set up a 2x25 m belt transect at each camera at a random angle from the camera. We identify all living shrubs to species and measure greatest canopy extent, distance across canopy at right angles to that measure, and the shrub height. This gives density and

cover for each species. At this time we do not recommend collecting data on herbaceous vegetation because results fluctuate wildly with annual precipitation and little is known about relationships between annual vegetation production, composition, and MGS habitat suitability. It would be desirable though to sample herbaceous vegetation if assessing those relationships are an important goal of the study.

2) Suggest field testing different bait methods (bait in the open, bait in PVC tubes, bait blocks, or automated feeding stations) to see which method is most effective.

3) It is important to determine the relative number and spacing of camera traps needed to adequately sample conventional trapping grid sizes to compare detection rates with conventional live trapping surveys. At what point is there a diminishment in return based on MGS detection rate as a function of the number of cameras used for a specific sized grid?

4) It is important to test if camera traps can be used to determine bait preferences of ground squirrels to various food samples to improve catchability at live traps.

5) It is important to test if PIT tag readers can be effectively used to identify PIT-tagged individuals that visit feeding stations.

6) Suggest utilizing camera traps first in an area before live trapping to detect MGS presence to improve the cost effectiveness of future live-trapping surveys.

7) Suggest using human-based listening stations to survey for ground squirrel presence along transects using playback calls of MGS vocalizations and their responses to human presence heard by surveyors.

8) Suggest using camera trapping to document MGS presence during times of the year outside conventional trapping periods for the species (i.e., mid to late winter and mid-summer). Equipment use is not restricted by weather conditions like trapping surveys are.

9) It is important to determine aboveground MGS behavioral activity patterns using camera traps. Cameras could be placed at known burrow entrances to document above/below ground activity. This could be used in concert with weather stations to better understand the thermoregulatory behavior of MGS.

Literature Cited

Harris, J.H. and P. Leitner. 2004. Home-range size and use of space by adult Mohave ground squirrels, *Spermophilus mohavensis*. Journal of Mammalogy, 85:517-523.

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