A COMPARISON OF COVERED TRACK-PLATES AND REMOTELY-TRIGGERED CAMERAS

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ABSTRACT: A study was conducted to determine the relative effectiveness of track-plates compared to cameras for detecting carnivores in California's north coast oak woodland and agriculture interface. Results from covered track-plate and remotely-triggered camera data were compared across 6 different sites. Track-plates detected fewer species, and the probability of not detecting a species that was present at a site was higher for track-plates than for camera systems. Cameras also were effective at detecting target species without bait. Use of non-baited, remotely-triggered cameras is recommended for monitoring of opossum and carnivore populations in oak woodland habitat of California.

Key words: California, carnivore, detection, oak woodland, opossum, monitoring, riparian, Sonoma County, vineyard, wildlife

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Increasing habitat destruction and fragmentation caused by expanding human activities across the landscape may threaten the viability of local and global populations of carnivores (Newmark 1996, Weaver et al. 1996). Human impact on natural habitat and carnivore populations has led state, national, and international agencies to list many carnivore populations as threatened or endangered (e.g., USFWS 1996, WCMC 1997). Successful conservation plans for carnivores necessitate collection of information such as on their distribution and use of modified habitat.

Increasing concern about the status of carnivore populations has led to the development of non-obtrusive means of gathering information including track-plates and remotely-triggered cameras (Barrett 1983, Zielinski and Kucera 1995). While track-plate use has mostly been restricted to forest carnivore detection, cameras have been used for a variety of different studies (e.g., Mace et al. 1994, Danielson et al. 1996, Hernandez et al. 1997, Jacobson et al. 1997).

There is debate in the literature about the relative merits of track-plates as compared to cameras. Some studies suggest that track-plates are more effective than cameras (e.g., Bull et al. 1992, Fowler and Golightly 1993), while other studies rank remotely-triggered cameras highest (e.g., Foresman and Pearson 1998). Some investigators emphasize that photographs not only offer the advantage of positive species identification, but also can serve to distinguish individuals when pelage coloration varies within a species (Karanth and Nichols 1998). Track-plates require bait whereas cameras may be used without bait. Where study outcome is affected by altered behavior, passive sampling, such as using non-baited detection units, may be a desirable option (Hellawell 1978). Attraction to baited units may be affected by habitat quality, hunger, learning, age, sex, population density, weather, season and other factors (Zielinski and Kucera 1995), and teasing out which variables are causing differences in detection rates among sites may be difficult.

Few published studies discuss the use of track-plates or compare track-plates and remotely-triggered cameras for non-mustelids or in habitats other than conifer forests. Establishing the relative merits of track-plates and remotely-triggered cameras in different habitats and for different species is important in order to minimize cost and improve the quality of data in future studies. This study comparing covered track-plates and remotely-triggered cameras and their utility for detecting opossums and carnivores was conducted in an oak woodland and vineyard landscape. These results are from a subset of data collected from a pilot study designed to investigate mammal use of remnant riparian zones in agricultural areas.

METHODS

The study was conducted from July through November of 1998 in an area where vineyards are interspersed through the oak savanna habitat of Sonoma Valley in Sonoma County, California. Six linear 400-m long sites were sampled including a riparian and non-riparian site within a vineyard, an oak savanna habitat fragment, and a larger undeveloped oak savanna regime (Figure 1). All riparian strips sampled were associated with creeks that drained off the Mayacmas Mountain Range into Sonoma Creek.

Covered track-plates and remotely-triggered cameras were utilized to assess species composition at each site. Track-plates were built and used following specifications in Zielinski (1995), except a mix of red carpenter's chalk and ethanol alcohol was sprayed onto each aluminum plate, rather than soot. A raw chicken leg was placed in the box, and approximately 35-g of tuna fish was spread outside the box as an attractant. At each of the 6 sites, 5 track-plates were laid out in a transect approximately 75-m apart. Each track-plate transect was baited every other day for a minimum of 12 days, and some were left up to 16 days to test whether more species would be detected over a longer period of time. Track-plates in riparian zones were set within 10-m of the creek bed.

Vancam motion infrared sensor cameras (www.cccweb.com/vancam.html) were used at all sites, with the exception of a Trailmaster TM500 dual-sensor system that was used at the oak woodland fragment for 25 days. One camera was set up at each site approximately 30 cm off the ground and perpendicular to obvious animal pathways. At riparian sites, cameras were placed within 10 m of the creek bed. Cameras remained at the same location for at least 60 days. For 48 days the cameras were left non-baited and checked every week. For 12 consecutive days cameras were baited every other day with chicken and tuna scent, and bobcat and fox urine (Cronk's Outdoor Supplies, Wiscasset, Maine) dabbed on cotton balls was added on the first day at 2 sites. At 2 camera stations the non-baited period was first, and at 4 stations the baited period was first.

Except where specified, all analysis was conducted on the standard 12-day by 5 track-plate survey and 60-day by 1 camera survey. Effort-per-site, the number of units at each site multiplied by the number of nights used, was a total effort of 360 days for each method across sites. The assumption was made that effort-per-site was more important than the time period over which devices functioned, 60 days for cameras and 12 days for track-plates, but further studies should explore the importance of functional time period. Detection-per-unit-effort was calculated by dividing the total number of tracks found by total trap nights or dividing photos of interest by camera nights. The Student's two-sample two-tailed t-test assuming unequal variance was used at the $\alpha = 0.05$ significance level to identify differences in numbers of species detected by each method, and differences in numbers of species detected during baited versus non-baited camera periods. False negatives were calculated as the number of species detected by one method but not detected

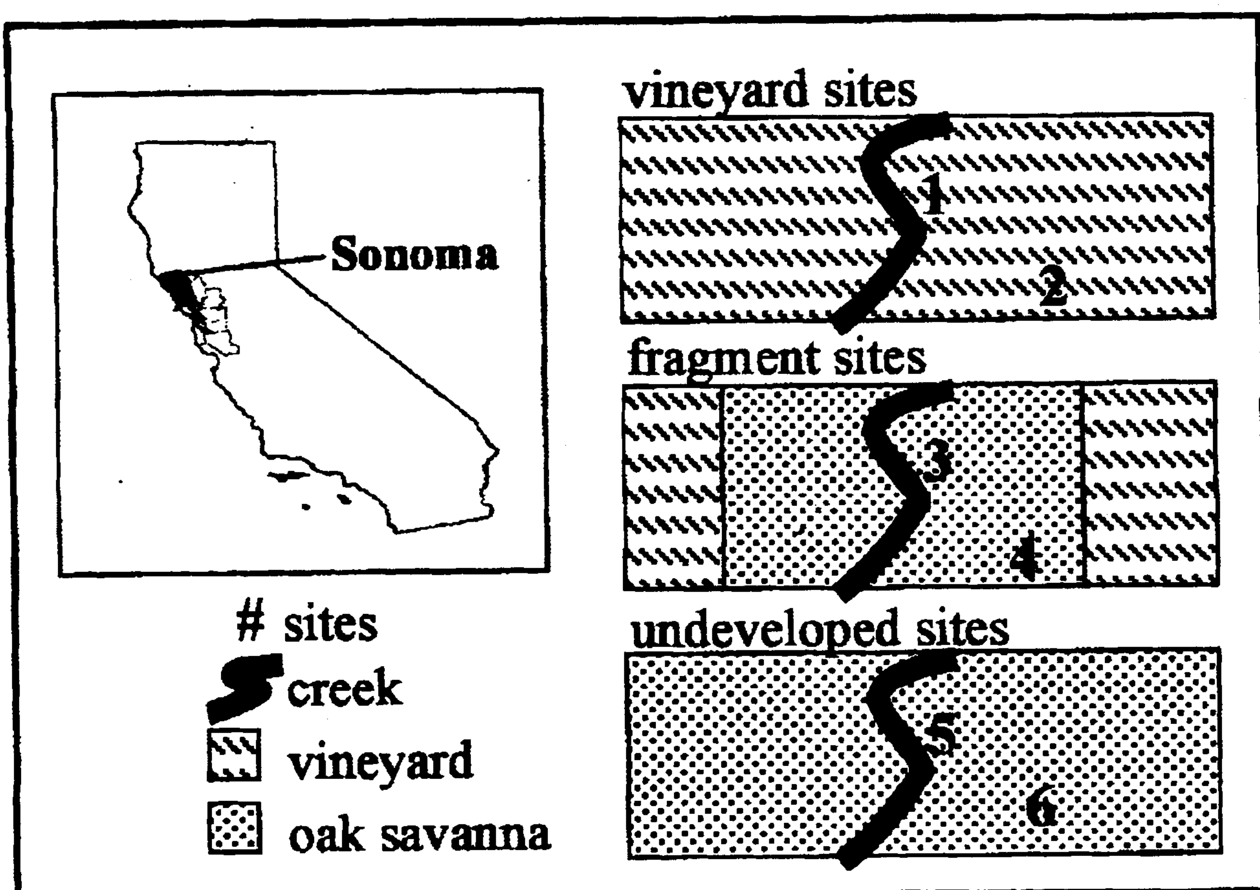

Figure 1. Location and site types

using the other method at the same site. The Student's two-sample one-tailed t-test assuming unequal variance was used at the $\alpha = 0.05$ significance level to determine if the rate of species return to track-plates increased with time.

RESULTS

Track-plates and cameras were used for the equivalent of 360 days of effort each. The track-plate monitoring effort resulted in 220 animal tracks of which 182 were identifiable prints of 5 different species. Cameras took 159 animal photographs, 114 pictures that included all 7 target species. Track-plates had a higher detection per-unit-effort of 0.51 as compared to 0.32 for cameras. Both track-plates and cameras detected domestic cats (*Felis domestica*), opossums (*Didelphis virginiana*), raccoons (*Procyon lotor*), striped skunks (*Mephitis mephitis*), and gray foxes (*Urocyon cinereoargenteus*), but only cameras detected coyotes (*Canis latrans*) and bobcats (*Lynx rufus*). Camera units detected more species than track-plate transects ($t = -3.3786$, 9 *df*, $P = 0.0081$). Among 5 of the 6 sites, 13 false negatives occurred for track-plates, and at least 1 false negative occurred for each of the 7 target species. Cameras only had 1 false negative, a raccoon, at 1 site.

For track-plates, a single species marked more track-plates per transect in the final day than the initial day ($t = -2.0979$ 9 *df*, $P = 0.0327$). For cameras, numbers of species detected during the 12-day baited and first 12-day period of the non-baited device, and the 12-day baited and total 48-day non-baited period were similar (I= -0.3194, 10 *df*, $P = 0.7559$ and $t = -1.536$, 10 *df*, $P = 0.1556$, respectively). Coyotes were only detected at non-baited camera stations.

DISCUSSION

Track-plate and camera monitoring indicated different species composition across all sites because cameras detected more species per site than track-plates, despite greater detection-per-unit-effort with track-plates. Similar to the results of Foresman and Pearson (1998), track-plates failed to detect some species, bobcats and coyotes, that were detected by remotely-triggered cameras. Others studies have detected bobcats using track-plates (Zielinski and Kucera 1995) suggesting that site characteristics or geographic location may influence the relative effectiveness of these detection techniques. Track-plates not only completely failed to detect bobcats and coyotes, but randomly failed to detect all the other species at least once across all the sites. No obvious pattern explains the false negatives, and sole dependency on track-plates for this study would have led to inaccurate species composition for the sites. Because cameras only failed to detect 1 species at 1 site, use of multiple cameras per site in future studies could possibly decrease already minimal camera detection error. The large number of false negatives for track-plates made it impossible to make comparisons using latency-to-first-detection, a metric used in other track-plate studies that assumes detection if species are present (Zielinski and Stauffer 1996).

Although the sampling effort was the same for both methods (360 days), the differences in the period of time each device type functioned in the field (12 days for track-plates versus 60 days for camera stations) is a potentially significant variable. The extra time in the field may increase the likelihood that less abundant, more far-ranging animals will be detected. For example, the cameras detected coyotes and bobcats whereas the track-plates did not. Track-plates may have detected more species at each site if left out for an extended time or if more track-plates were used per site. In other studies, greater than 12 sampling days increased the number of species detected by track-plates (Foresman and Pearson 1998). At the undeveloped oak woodland site, an opossum was detected for the first time on the sixteenth day, but no new species were detected when other track-plate transects were left for periods up to 14 days at other sites. Increasing track-plate effort, a time intensive monitoring method, would require considerable additional labor as track-plates already require considerably more field effort than using cameras (Foresman and Pearson 1998). Because it is beneficial to minimize field time and number of visits to sites when working on private land, as with this study, cameras are easier to use.

A further difference between cameras and track-plates relates to baiting. The data indicate that animals underwent a learning period where baited track-plates attracted the same species and most likely the same individual to return to the same transect with increased frequency. Whereas covered track-plate units realistically must be baited to attract animals, remotely-triggered cameras setup perpendicular to trails can be left non-baited and appear to obtain similar numbers of species during the non-baited as the baited period. Whereas baiting requires frequent visits to the devices, non-baiting reduces the need for visits, which may improve the detection of wary species like coyotes that were only documented at non-baited cameras in this study.

The results suggesting equivalent species detection with baited and non-baited cameras may have occurred because of different monitoring periods, affects of previously used bait, or the use of natural pathways. Non-baited cameras functioned for 36 days longer than baited cameras, and the number of species detected during the total 48-day non-baited period was slightly higher than the 12-day baited period, suggesting that extended monitoring may be the most effective way to increase species detection. Another factor, that 4 of the 6 camera stations were baited first, may have increased visitation during following non-baited periods through residual scent or habituated visits by animals. However, both units not baited in the first period detected an equivalent number of species as other sites, with one non-baited camera detecting the most species found at any site. Additionally, continued research using non-baited cameras has had high detection success providing further evidence that non-baited devices may be appropriate for some studies (Hilty in prep). A third factor is that non-baited devices may work particularly well where animals travel along landscape elements, such as the waterways in this study (Harris 1988), although variables such as habitat, animal density, and mobility may determine the effectiveness of passive sampling. Passive sampling, however, might not be important depending upon research objectives.

Because of the low cost (Foresman and Pearson 1998), track-plates may continue to be used in carnivore studies. Our results in oak woodlands indicate that track-plates should be used with caution. If track-plates are to be used in future studies with the same target species and habitat, studies should explore options such as more intensive sampling, different bait types, or open track-plates to minimize false negatives. Alternately, use of multiple remotely-triggered camera units may provide more accurate results with less effort, although cameras are more expensive (Bull et al. 1992). The advantages of using cameras include species and even individual identification, opportunity for passive sampling, ability to detect more species, and lower false negative rates. Based on the outcome of the pilot study, extended research focusing on differences in species composition using non-baited cameras at independent oak woodland sites across multiple seasons is underway.

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