Published by Associazione Teriologica Italiana
Volume 25 (2): 113–116, 2014
Hystrix, the Italian Journal of Mammalogy
Available online at:
http://www.italian-journal-of-mammalogy.it/article/view/9945/pdf
doi:10.4404/hystrix-25.2-9945

Short Note

Camera trapping ocelots: an evaluation of felid attractants

Michael V. Cove[a,1,*], R. Manuel Spinola[b], Victoria L. Jackson[a], Joel Saenz[b]

[a] *Department of Biology and Agriculture, University of Central Missouri, Warrensburg, MO 64093, USA*
[b] *Instituto Internacional en Conservación y Manejo de Vida Silvestre, Universidad Nacional, Apartado 1350-3000, Heredia, Costa Rica*

Keywords:
Attractants
camera trap
capture-recapture
detection probability
Leopardus pardalis
occupancy model
ocelot

Article history:
Received: 4 March 2014
Accepted: 28 October 2014

Acknowledgements
We thank the many private landowners that allowed us access to their property. We also thank Selva Verde Lodge, Finca Pangola, and Panthera-Costa Rica for their continued support. Funding for this research was provided by the Universidad Nacional de Costa Rica and the University of Central Missouri International Center. This manuscript greatly benefitted from comments from the editor and anonymous reviewers.

Abstract

Ocelots (*Leopardus pardalis*) and other wild cats are often surveyed using camera traps to identify individuals for density estimation via capture-recapture analyses or estimate occupancy via detection/non-detection analyses. Though attractants are sometimes used in such surveys, there have not been any evaluations of the effectiveness of common visual and olfactory attractants in field settings. As part of a medium and large mammal camera survey in the San Juan – La Selva Biological Corridor, Costa Rica, we integrated camera trap data within an occupancy modelling framework to estimate the effects of hanging compact disks (visual), cologne (olfactory), and sardines in oil (olfactory) on ocelot detection probabilities. Compact disks appeared to have the most information-theoretic model support, whereas cologne received less model support. The use of compact disks in surveys was also less time-consuming and less expensive than the olfactory attractants. Ocelots are visual hunters and using visual attractants can increase detection probabilities and therefore reduce uncertainty and/or reduce survey effort to obtain robust population or occupancy estimates, although using cologne might also have similar effects. Depending on logistic constraints, we recommend employing several attractants as the most appropriate way to survey ocelots and other rare felids in the future when detection biases are assumed to be strong, particularly as part of mammal community surveys.

The ocelot (*Leopardus pardalis*) is a medium-sized felid with a vast Neotropical distribution from the southern USA to northern Argentina. Historical exploitation for the fur and pet trade, paired with habitat loss and fragmentation warranted this species' protection in most of the countries in which it occurs (Murray and Gardner, 1997). All subspecies are now protected under Appendix 1 of Convention of International Trade in Endangered Species of Wild Fauna and Flora (CITES, 1992).

Ocelots are individually identifiable from their spots and anastomosing stripe patterns and many researchers have taken advantage of this fact to utilize camera traps to estimate abundance, movement, and density across its range (Dillon and Kelly, 2007; Gonzalez-Maya and Cardenal-Porras, 2011; Trolle and Kery, 2003, 2005). For several decades ecologists have incorporated detection probability parameters when estimating felid abundance and density within a capture-recapture modeling framework (e.g. Otis et al. 1978). The approach has also been modified for use in presence/absence (more appropriately detection/non-detection) data via occupancy modeling to model species occurrence and detection probability as a function of habitat and survey-specific covariates (e.g. MacKenzie et al. 2005). Increasing the probability of detection of individuals can reduce uncertainty and/or reduce survey effort to obtain robust density or occupancy estimates, and therefore attractants are sometimes employed to collect sufficient data for these analyses (Long et al., 2008). MacKenzie and Royle (2005) shared insight into the design of occupancy studies and revealed in their Table 1 that even slight increases in detection probability (e.g. from 0.1 to 0.2) can more than half the optimal survey effort required to obtain robust estimates.

Some studies have examined differences in detection among different camera trap types for surveying felids and other carnivores (Cove and Jackson, 2011; Kelly and Holub, 2008), but we are unaware of any that have explicitly tested and ranked attractants in a field setting. Our objective was to evaluate three commonly used attractants to estimate detection probabilities for ocelots using camera trap data in an occupancy modeling framework. Furthermore, since mammal community surveys are commonly conducted utilizing camera traps, we aimed to determine how adding attractants in such a framework compared to felid-specific surveys.

As part of a mammal community survey, we deployed camera stations at 14 forested study areas in the San Juan – La Selva Biological Corridor, Costa Rica (Cove et al., 2013). Each study area contained an array of either four or six single-camera stations spaced at >250m apart. Each camera station consisted of a remotely triggered infrared camera (Scout Guard SG550, HCO Outdoor Products, Norcross, GA, USA) or a remotely triggered traditional flash camera (Stealth Cam Sniper Pro Camera 57983, Stealth Cam, LLC, Grand Prairie, TX, USA) secured 0.25-0.5 m off the ground. We directed each camera at opposing trees, 3-4 m away, baited with a secured can of sardines in oil 1-1.5 m off the ground as a general scent lure for all native carnivores. At a random subset of camera locations, we also hung compact disks from tree branches with monofilament line to specifically attract ocelots and other felids. At other random stations, we attached small portions of carpet to trees near the sardines and saturated them with cologne (Calvin Klein® Obsession for Men - Long et al. 2008). Although felid-specific camera trap studies often set cameras along human trails and roads (Dillon and Kelly, 2007; Trolle and Kery, 2003, 2005), we avoided areas of high human use due to high threat of theft and focused

[*] Corresponding author
Email address: m.cove3@gmail.com (Michael V. Cove)
[1] Current institution: Department of Applied Ecology, North Carolina State University, Raleigh, NC 27695, USA

survey efforts on animal game trails. Camera traps continuously collected data when triggered at each site for 24-38 days.

We detected ocelots with at least one camera station at 7 of the 14 study areas. With this information, we were able to fix our occurrence probabilities to 1.0 for these areas, because ocelots were known with certainty to occur there (i.e. within or adjacent to multiple home-ranges). Thirty-two camera stations (sites in our model) were located across the seven study areas, with 14 stations baited with only a can of sardines in oil, and 18 stations each with additional compact disks or cologne (9 of each). We first used raw detection data to calculate latency to initial detection (LTD – Cove et al. 2012; Gompper et al. 2006) at each site with detections for the three attractant types. This metric is simply calculated as the mean number of trapnights required to first detect the species of interest. We compared the LTD values for each attractant with a one-way ANOVA and $\alpha = 0.05$.

We then used all photos to create binary detection histories (1= detected, 0= not detected) for three 10-day sampling occasions for each camera station. We tested three *a priori* hypotheses to predict the effectiveness for the different attractants. Although, we initially considered including the different camera types and habitat structure as covariates in our models, the cameras were of comparable make and obtained similar raw detections and the habitats at the camera locations were all along game trails and homogenous among study areas, so we chose to test more parsimonious models. It was likely that as visual hunters, cats would be most attracted to hanging disks, followed by the novel scent of cologne, and then the scent of only sardines in oil (Tab.1). We compared the three detection models by ranking them within an information-theoretic framework, to determine the relative support and strength of evidence for each covariate and then explored model-averaged parameter effects (Burnham and Anderson, 2002). We considered attractants to be effective for detecting ocelots if they contained high model support with summed Akaike weights ($\Sigma\omega_i$ - Burnham and Anderson 2002). Furthermore, we compared the derived detection probabilities for each attractant with a one-way ANOVA and $\alpha = 0.05$.

Because we could not find any published values for detection probabilities for ocelots from occupancy studies, we could only make limited inference regarding capture-recapture estimates of detection, even though these are obtained from a different input (i.e., an individual capture-recapture level). Finally, we calculated estimates of time and financial inputs to implement each attractant for an occupancy survey of 100 sites to make recommendations for future studies.

We obtained 14 independent photographs of ocelots from nine separate 10-day occasions, with 3 captures at sardine only sites, 5 captures at cologne sites, and 6 captures at compact disk sites (Fig. 1). The LTDs were highly variable for all three attractant treatments (mean ± SE: sardines = 13.67±3.84, compact disks = 11.75±4.57, and cologne = 9.50±8.50), with no significant differences (one-way ANOVA: $F_{(2,6)} = 0.383$, $p = 0.697$). The visual attractant detection model was the top-ranking model (Table 1). Use of compact disks to attract ocelots received the vast majority of the model support ($\Sigma\omega_i = 0.760$), while the olfactory attractant of cologne received less model support ($\Sigma\omega_i = 0.563$ – Tab.1). Beta coefficients suggested strongest effects of compact disks, followed by cologne, and then sardines. However, after averaging effects across all three competing models, detection probabilities for the three attractants had overlapping confidence intervals (Table 1), with no significant differences (one-way ANOVA: $F_{(2,11)} = 2.284$, $p = 0.148$). The implementation of each attractant at a site added minimal time to camera set up, with only 5-10 minutes on average to attach and secure them, yet the cologne required extra prep time to cut carpet squares to soak with cologne prior to fieldwork. The upfront costs for the attractants were variable, with the compact disks having the overall least cost to implement (particularly if using recycled materials), followed by cologne, and then sardine (Tab.2). However, utilizing cologne as an olfactory attractant required preparation time prior to field work and typically required the site to be revisited to reapply the scents (Tab.2).

Ocelots and other felids are typically visual hunters. This was supported by the data that ocelots appeared to be more attracted to the hanging compact disks than to the novel scent of sardines in oil or to the cologne. From their capture-recapture study, Trolle and Kery (2003) observed a detection probability of 0.16 per week of sampling with cameras set along human trails and roads with sardines as attractants. In their Costa Rican capture-recapture survey, Gonzalez-Maya and Cardenal-Porras (2011) observed capture probabilities of 0.077 for constant detection model and 0.117 for a heterogeneity model for a five-day sampling period. These detection probabilities were similar to our estimates given that our sampling occasions were 10 days long; but our surveys avoided human trails and roads suggesting that the use of attractants could be even more effective with placement along such corridors (e.g. felid-specific versus mammal community surveys). Although Gonzalez-Maya and Cardenal-Porras (2011) did not use any lures or bait, they observed ocelots most commonly among all mammals captured and this was likely result of strategic camera placement specific for ocelots. Our study was part of a medium and large mammal survey and not explicitly designed to survey ocelots, therefore our cameras were not as strategically placed, but attractants were used to help accommodate this difference in study design. Scent attractants, particularly sardines, were effective for surveying other carnivores including coyotes (*Canis latrans*) and tayras (*Eira barbara*), but also for attracting ungulates such as collared peccaries (*Pecari tejacu* – Cove et al. 2012, 2013).

Trolle and Kery (2005) used sardines in oil and set most cameras along roads, which had notably higher detections of ocelots than on animal game trails. This is likely the explanation for the daily detection probability of 0.127 observed in that study, with 15 of the total 16 photographs taken on roads. We avoided roads due to threat of theft, and although our detection probabilities were lower as a result, attractants did improve captures on game trails in our study. Additionally, attractants might help retain individuals at a site for longer than if the cat was passing through, which is beneficial for individual identification in capture-recapture studies.

Use of visual attractants increases detection probabilities with minimal effort and cost and therefore reduces uncertainty and survey ef-

Table 1 – Model selection statistics, untransformed coefficients, and detection probability estimates (10-day survey periods) for ocelot (*Leopardus pardalis*) detection models used to evaluate effectiveness of attractants from camera trap surveys in the San Juan-La Selva Biological Corridor, Costa Rica, 2009-2010.

				Intercept[e]		Compact Disk		Cologne	
Model	Δ_i[b]	ω_i[c]	**K**[d]	β_0	***p* (SE)**	β_1	***p* (SE)**	β_2	***p* (SE)**
$\psi^a(1)$, p (CD)	0.00	0.437	2	-2.031	0.11(0.03)	0.779	0.22(0.08)	–	0.11(0.03)
ψ (1), p (CD,CL)	0.60	0.323	3	-2.565	0.07(0.04)	1.312	0.22(0.08)	1.083	0.18(0.07)
ψ (1), p (CL)	1.20	0.240	2	-1.897	0.13(0.04)	–	0.13(0.04)	0.416	0.18(0.07)
Model Avarage				-2.171	**0.11(0.04)**	0.764	**0.20(0.07)**	0.449	**0.15(0.06)**

[a] ψ is constant and fixed at 1.0 because ocelots occurred with certainty at all sites in this analysis.
[b] Δ_i is AICc difference.
[c] ω_i is the Akaike weight.
[d] K is the number of model parameters.
[e] Intercept represents cameras with only sardines as an attractant.

Figure 1 – Camera trap photos of ocelots at different attractant sites: (a) hanging compact disk, (b) sardines in oil, (c) carpet saturated with cologne in top left corner, and (d) visible hanging compact disk and can of sardines in oil, in the San Juan – La Selva Biological Corridor, Costa Rica, 2009-2010.

Table 2 – Comparison of different attractant materials, costs, and labor (in addition to camera set-up and travel between sites) for a hypothetical ocelot camera trapping occupancy survey of 100 sites.

Method	Upfront Materials	Cost (US$)	Labor (per site)	Comments
Compact disk	100 pack of CDs, reel of monofilament	35	5-10 min	Method does not require revisits and can use recycled materials
Cologne	Calvin Klein®cologne, carpet squares, hammer, nails	70	5-10 min, 10 min prep, 5-10 min revisits	Method requires pre-field preparation and site revisits to reapply attractant to carpet
Sardines	100 cans of sardines, hammer, nails	105	5-10 min	Method does not require revisits or preparation time

fort required to obtain robust population and occupancy estimates. Using cologne and sardine scent lures might have similar effects, but the upfront costs and effort are more substantial. We recommend utilizing felid specific attractants in conjunction with mammal community surveys, particularly when efforts are focused on animal game trails as opposed to roads and human trails. Furthermore, given the lack of published occupancy studies focused on the ocelot, we recommend researchers try to adopt this modeling procedure in addition to capture-recapture methods. Depending on logistical restraints, employing several attractants (felid-specific, olfactory, and visual) is likely the most appropriate way to survey ocelots and other felids in the future when detection biases are assumed to be strong, particularly for studies designed to assess mammal communities and not specifically designed for cats.

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Associate Editor: P. Ciucci