The impact of attractants on pocket gopher trapping

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Abstract　Pocket gophers (Geomyidae) have an extensive impact on both natural and agricultural systems. Trapping is a technique often used to sample and manage these populations. The identification of an attractant that increases capture rates of pocket gophers would greatly assist researchers and pest management professionals alike. Therefore, we tested the attractiveness of four attractants (peanut butter, anise, grapefruit attractant, and carrot) plus a control (no attractant) using uncovered and covered trap sets to determine what impact they have on visitation and capture rates of pocket gophers. We also determined how the impact of cover status and attractants differ across varying weights and gender of pocket gophers. We found no direct effect of any attractant on visitation and capture rates of pocket gophers, nor on the gender of captured individuals. However, when no attractant was used, the number of pocket gophers captured per 100 trap nights was greater when trap sets were uncovered vs. when covered, and capture rates were generally high and consistent when using peanut butter as an attractant. Additionally, we noted that covered trap sets that were baited with peanut butter yielded heavier pocket gopher captures than uncovered trap sets using this same attractant. This is key, given the difficulty associated with capturing older, more experienced individuals. Combined with data from a previous investigation, this suggests that there is no advantage to using any attractant when utilizing uncovered trap sets, but there is likely some benefit to using peanut butter in covered trap sets [*Current Zoology* 60 (4): 472–478, 2014].

Keywords　Attractant, Demographics, Pocket gopher, *Thomomys bottae*, *Thomomys talpoides*, Trapping

Rodent species are important members of almost all ecosystems throughout the world, yet they are also the cause of extensive human-wildlife conflict in many situations (Pimentel et al., 2005). Knowledge on how certain factors within their environment influence their activity patterns can be used to increase the efficacy of sampling techniques for many of these rodent species. For example, exposing rodents to undesirable environmental factors could increase visitation rates to designated areas [e.g., exposing pocket gopher (*Thomomys* spp.) burrow systems to external environmental conditions; Werner et al., 2005]. Alternatively, many natural and synthetic materials are believed to increase visitation to traps and bait stations meant to control unwanted rodent populations (Marsh, 1988). Determining factors that attract rodents to designated areas would be very useful to individuals interested in sampling or managing these species.

Trapping is a technique that has long been used for studying and managing rodent species. A variety of traps and trapping techniques exist for many species (e.g., Schemnitz, 1996). Much effort has been undertaken to determine better trapping techniques to maximize capture success (e.g., pocket gophers—Pipas et al.,

2000; Baldwin et al., 2013; small mammal assemblages—Slade et al., 1993; Anthony et al., 2005). Identifying an effective attractant is one technique to increase capture success (Proulx, 2004). However, it is important to consider how these attractants may impact visitation by different segments of the sampled population. For example, pregnant rats (*Rattus* spp.) exhibit greater salt intake than nonpregnant individuals (Barelare and Richter, 1937), so providing sources of salt may increase captures of pregnant females but may have little impact on other demographic segments of the population. Understanding how different demographic segments of a rodent population react to attractants is important in determining their utility. Unfortunately, effective and practical attractants have not been identified for many rodent species.

Pocket gophers have an extensive impact on both natural and agricultural plant communities (Laycock and Richardson, 1975; Engeman and Witmer, 2000; Reichman and Seabloom, 2002; Baldwin et al., 2014). Although some of these impacts may be positive, the presence of large pocket gopher populations is generally considered to be detrimental. When this occurs, management of these pocket gopher populations is often

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warranted. Many techniques exist for managing pocket gopher populations including trapping. Past investigations have addressed the impact that trap selection (Pipas et al., 2000; Baldwin et al., 2013) and cover status (i.e, covered or uncovered trap sets; Gamboa, 1975; Baldwin et al., 2013) can have on trap success of pocket gophers. However, it is not clear how attractants influence visitation and capture rates of pocket gophers, nor is it clear if cover status affects this relationship. Understanding the influence, if any, that attractants have on capture and visitation rates of pocket gophers should yield important insight into sampling and management programs.

A variety of attractants have been proposed to increase trap visitation or bait acceptance for pocket gophers. These include pocket gopher pheromones, as well as various derivations of peanut butter, anise, carrot, and other commercial attractants (e.g., Dixon, 1922; Miller and Howard, 1951; Sullivan et al., 2001; Proulx, 2004). In a study of northern pocket gophers *Thomomys talpoides*, Proulx (2004) observed greater capture success at female-scented traps during the end of the reproductive season. However, his results only applied to a very small portion of the year. Additionally, there is no commercially-available pheromone product at this time, so utilizing this attractant is impractical. We have not found any other published studies that have formally tested the efficacy of attractants on pocket gopher visitation or capture rates. Therefore, our goal was to determine the efficacy of several different attractants on visitation and capture rates of pocket gophers (*Thomomys* spp.). We also tested how cover status might impact the efficacy of these attractants, as well as how the impact of cover status and attractants differ across varying weights (a reflection of age class and experience; Sullivan et al., 2001; Baldwin et al., 2013) and gender of pocket gophers. Collectively, these results should help identify the importance of selected attractants for both sampling and management purposes.

1 Materials and Methods

1.1 Trapping protocol

We selected 5 sites for this study. Three sites (Sites 1, 2, and 4) were located in alfalfa fields in Modoc County, CA, USA; the remaining two sites (Sites 3 and 5) were located in wine grape vineyards in Sonoma County, CA, USA (Table 1). Northern pocket gophers were present at Sites 1, 2, and 4, while Botta's pocket gophers (*Thomomys bottae*) were found at Sites 3 and 5. A two-factor analysis of variance showed no impact of species on capture or visitation rates of pocket gophers to different attractants (capture rate: $F_{9, 15} = 0.5$, $P = 0.831$; visitation rate: $F_{9, 15} = 0.4$, $P = 0.911$) or cover status (capture rate: $F_{3, 1} = 1.7$, $P = 0.503$; visitation rate: $F_{3, 1} = 0.6$, $P = 0.709$), nor did weights of captured individuals differ between species ($t_3 = 0.17$, $P = 0.863$) (Zar, 1999). Therefore, data collected for both species were combined for analysis.

Table 1 Universal Transverse Mercator coordinates for five field sites in California where we tested the impact of five attractants on capture success and visitation rate of pocket gophers during spring 2010 (Sites 1, 2, and 4) and 2013 (Sites 3 and 5)

Site	Zone	Easting	Northing
1	10T	636,189	4,648,832
2	10T	634,705	4,646,654
3	10S	513,757	4,255,617
4	10T	628,519	4,650,647
5	10S	512,940	4,257,550

We tested 4 attractants during this study: anise oil, carrot oil, peanut butter, and a commercial grapefruit-scented attractant (Lee's Gopher Getter, Wildlife Control Technology, Inc., Fresno, CA, USA). For the anise and carrot oil attractants, we infused petroleum jelly with the oil by melting the petroleum jelly in a hot water bath and adding approximately 7 cc's of the respective oil per 0.38 L container of petroleum jelly. For peanut butter we used Jif® brand (The JM Smucker Company, Orrville, OH, USA) creamy peanut butter. The grapefruit attractant came in liquid form.

We used the Gophinator trap (Trapline Products, Menlo Park, CA, USA) during this study, as a previous investigation showed these traps to be highly efficient at capturing pocket gophers (Baldwin et al., 2013). We placed traps into main tunnels of pocket gopher runways and staked them down with wire flags. For the anise oil, carrot oil, and peanut butter attractants, we placed approximately 1 cc of the attractant behind the set traps. For the grapefruit attractant, we applied approximately 20 cc's of the liquid behind the traps. We placed traps without any attractant to serve as a control. We randomly cycled through each attractant until we had approximately 40 of each trap set at each site.

We also tested if the potential impact of an attractant was influenced by whether or not the trap set was covered. For covered trap sets, we used 33 × 33 cm pieces of black canvas to cover openings. Loose soil was overlaid around the edge of the canvas squares to create

a seal that excluded light from the tunnel system. For uncovered trap sites, we followed the exact same trap-setting protocol as that defined for the covered trap sets except that we did not cover the opening with the black canvas square. We tested attractants in uncovered trap sets across three sites during March through April, 2010, and we tested attractants in covered trap sets across two sites during March through April, 2013. Capture protocols were approved by the University of California, Davis' Institutional Animal Care and Use Committee (protocol no's. 15763 and 17283).

We set traps one day and checked the next. Upon capture, we weighed individuals to the nearest gram and placed them in plastic freezer bags for identification of gender in the lab. Occasionally, we had traps where captured pocket gophers were consumed or partially consumed by predator species (4% and 15% of captures at uncovered and covered trap sites, respectively). In this situation, we noted the capture, but we were not able to include them in analyses that involved gender or weight classifications. The proportions of consumed individuals did not differ across attractants (uncovered, $\chi_4 = 5.9$, $P = 0.208$; covered, $\chi_4 = 2.0$, $P = 0.736$), and as such, had little to no impact on our results.

1.2   Analysis

We calculated capture rates at each study site for each attractant by dividing the number of captures by the number of trap sets receiving a visit by a pocket gopher (a visit constituted sites that resulted in captures, as well as traps that were sprung or plugged by pocket gophers), and we calculated visitation rates for each attractant by dividing the number of visits to trap sets by the number of trap sets placed at each study site. We tested for differences in the proportion of captures for male and female pocket gophers using a binomial exact test (Zar, 1999) to help characterize the overall pocket gopher population.

We used logistic regression to help determine what impact cover status, attractants, and the interaction of cover status and attractants might have on both visitation and capture rates of pocket gophers (Hosmer and Lemeshow, 2000). For visitation rates, action or no activity were the binary response, while for capture rates, capture or no capture was the binary response. Gender was not used as a factor because we could not know the gender of animals visiting the traps unless they were captured. However, we did assess the impact that cover status, attractants, and the interaction of cover status and attractants might have on the gender of captured pocket gophers through the use of logistic regression (Hosmer

and Lemeshow, 2000). For this analysis, gender was the binary response.

It is possible that the cumulative effect of various visitation and capture rates from differing attractants used at both covered and uncovered trap sets could influence response rates of pocket gophers. To determine this, we first calculated the mean number of pocket gophers we expected to visit 100 trap sets (100 was selected to provide the basis for easily calculating the percentage of trap sets expected to result in a capture) by multiplying mean visitation rates for each attractant and cover status combination ($n = 10$) by 100. We then multiplied this proportion by the mean capture percentage for each attractant to determine the mean number of pocket gopher captures expected per 100 trap sets. We calculated standard errors for these values through bootstrapping (Efron and Tibshirani, 1993). Lastly, we utilized a randomization test (bootstrapping; Efron and Tibshirani, 1993) to determine if the estimated number of captures would differ between the attractant and cover status combinations. We ran 1,000 bootstrap iterations of the mean difference in number of captures between these combinations, and determined the proportion of values in the resultant ranked frequency distribution below 0. This proportion indicated the probability of a difference in the number of captures between the differing attractant and cover status combinations.

Lastly, we tested for differences in the weights of captured pocket gophers across all gender, cover status, attractant, and interaction (gender × cover status, gender × attractant, cover status × attractant, gender × cover status × attractant) categories using a three-factor analysis of variance (Zar, 1999). If the model was significant, we used Fisher's least significant difference (LSD) post hoc test to determine which values were different (Zar, 1999), although we only compared differences in pocket gopher weights within cover-status groupings and between covered and uncovered trap sites for each individual attractant, as these were the only comparisons of practical interest.

2   Results

We captured 391 pocket gophers out of 612 total uncovered trap sets, and 226 pocket gophers out of 403 total covered trap sets. We did not observe any impact of cover status or attractant on the gender of captured pocket gophers ($\chi^2 = 3.7$, $P = 0.928$) although we did capture a greater number of male pocket gophers during this study (male captures = 327, female captures = 240; exact binomial test, $P < 0.001$).

We observed no impact of cover status or attractant on visitation (χ^2 = 12.6, P = 0.180) or capture rates (χ^2 = 6.5, P = 0.691) of pocket gophers (Table 2). However, we did observe a difference approaching statistical significance in the number of pocket gophers captured per 100 trap nights between covered and uncovered trap sites when using no attractant (P = 0.065) indicating that a greater number of captures of pocket gophers occurred in uncovered trap sets if no attractant is used (Table 3). We did not observe any significant differences for any other attractants between covered and uncovered trap-sets ($P \geq 0.178$, Table 3). We also did not observe a significant difference in the number of pocket gophers captured per 100 trap nights across all attractants for both covered and uncovered trap sets ($P \geq 0.123$, Table 3).

The average weight of pocket gophers was influenced by several factors ($F_{19, 577}$ = 13.7, $P < 0.001$). Not surprisingly, gender had a significant influence on the weight of captured pocket gophers ($F_{1, 577}$ = 182.6, $P < 0.001$), with males ($\bar{x}$ = 171 g) far outweighing females ($\bar{x}$ = 127 g). The attractant used ($F_{4, 577}$ = 2.2, P = 0.072), as well as a cover status $\times$ attractant interaction ($F_{9, 577}$ = 3.2, P = 0.014) also influenced the weight of captured pocket gophers. Due to the significance of the

cover status $\times$ attractant interaction term, we will not discuss the significance of the attractants as a main effect variable (Zar, 1999). Pocket gophers captured at uncovered trap sets baited with anise oil were substantially heavier than individuals captured at uncovered peanut butter sites (Fig. 1). For covered sites, pocket gophers captured using peanut butter as an attractant were substantially heavier than those captured at grapefruit and carrot oil trap sets (Fig. 1). Covered trap sets that utilized anise oil or no attractant also resulted in heavier pocket gopher captures than sites that used the commercial grapefruit attractant. Only covered and uncovered trap sets baited with peanut butter yielded different weights of pocket gophers (Fig. 1), with heavier individuals captured at covered trap sets.

3　Discussion

An effective attractant has the potential to increase trapping efficiency. Many pest control operators throughout California utilize attractants, as they feel they increase capture rates (S. Albano, Trapline Products, personal communication). Unfortunately, as with many other studies with rodents (e.g., roof rat *Rattus norvegicus*, Witmer et al., 2008; house mouse *Mus musculus*, Robards and Saunders, 1998), none of the attractants we

Table 2　The number (n) of uncovered (Unc) and covered (Cov) pocket gopher trap sets, capture percentage (number of captures/number of trap sets visited [Cap %]), and visitation percentage (number of trap sets visited/number of trap sets [Vis %]) for 5 different attractants

	Site	Anise oil			Carrot oil			Grapefruit attractant			Peanut butter			No attractant		
		n	Cap %	Vis %	n	Cap %	Vis %	n	Cap %	Vis %	n	Cap %	Vis %	n	Cap %	Vis %
Unc	1	39	79	74	39	74	69	39	81	67	41	86	68	41	85	83
	2	41	88	80	41	86	85	43	87	91	42	82	90	44	90	91
	3	42	89	64	40	88	63	40	91	55	40	81	78	40	85	68
	Comp	122	85	73	120	83	72	122	86	71	123	83	79	125	87	80
Cov	4	41	86	71	42	83	57	40	87	58	40	77	75	41	96	63
	5	40	69	73	40	72	80	41	71	76	38	87	82	40	78	68
	Comp	81	78	72	82	78	69	81	79	67	78	82	78	81	87	65

Sites 1–3 were trapped during spring 2010, while Sites 4–5 were trapped during spring 2013. Composite (Comp) data are also provided for both uncovered and covered trap sets.

Table 3　The mean number of pocket gopher captures per 100 trap nights based on capture and visitation rates observed for 5 different attractant options for uncovered (Unc) and covered (Cov) trap sets

	Anise oil		Carrot oil		Grapefruit		Peanut butter		No attractant	
	$\bar{x}$	SE	$\bar{x}$	SE	$\bar{x}$	SE	$\bar{x}$	SE	$\bar{x}$ [a]	SE
Unc	62.0	8.9	59.3	12.6	60.4	18.5	64.7	10.7	70.0	11.4
Cov	55.4	13.0	52.2	19.4	51.7	17.2	63.9	9.3	56.9	13.0

[a] mean values between uncovered and covered trap sets differed when using no attractant (P = 0.065). Uncovered and covered trap sets were operated during spring 2010 and 2013, respectively.
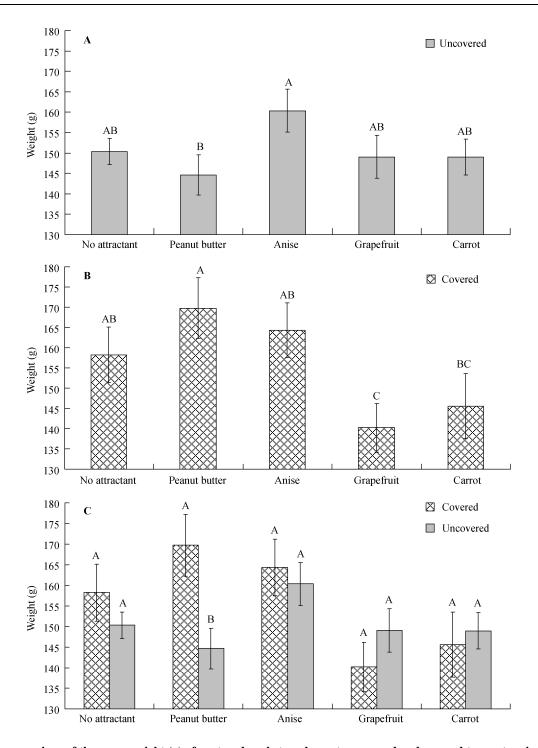
Fig. 1   A comparison of the mean weight (g) of captured pocket gophers at uncovered and covered trap sets using four attractants (peanut butter, anise oil, commercial grapefruit attractant, and carrot oil) and a control (no attractant)

Comparisons are provided across attractants for uncovered (A) and covered trap sets (B), as well as comparisons between uncovered vs. covered trap sets for each attractant (C). Significant differences ($P < 0.10$) are denoted by different letters.

tested increased visitation or capture rates in our study. However, the combined impact of these two rates did result in a difference in the number of captures expected per 100 trap nights between uncovered and covered trap sets when no attractant was used (Table 3). This is an important consideration given that there are circumstances in which both covered and uncovered trap sets may be preferred. For example, during cooler weather, uncovered trap sets are as efficient as their covered counterparts, but uncovered trap sets require less time to operate (Baldwin et al., 2013). As such, uncovered trap sets are often preferred during cool weather. In contrast,

during warmer temperatures, capture efficiency may be slightly higher for covered trap sets (Baldwin et al., 2013), so covered sets may be preferred during warm weather. Based on our findings, there appears to be little evidence to support the need to utilize any attractant when using uncovered trap sets. In fact, the greatest number of captures in uncovered trap sets occurred when no attractant was used. However, we would not expect to see the same efficiency if utilizing a covered trap set with no attractant given the substantially lower number of captures observed following this trap-set design.

This suggests there may be a benefit to using an attractant with covered trap sets. Peanut butter resulted in a noticeably greater number of captures when compared to other attractants at covered trap sets (Table 3), although this difference was not statistically significant given high variability associated with having only two sampled locations for covered sites. When Baldwin et al. (2013) compared capture rates between covered and uncovered trap sets, they used peanut butter as an attractant. Our current study showed very little difference in capture rate between covered and uncovered trap sets when using peanut butter. This may explain why little difference was observed in capture rates between uncovered and covered trap sets during cooler weather from the Baldwin et al. (2013) study. Perhaps if no attractant had been used, they might have observed a greater disparity in capture rates between covered and uncovered trap sets.

Although capture rates of male and female pocket gophers did not differ between attractants, we did observe a substantial difference in the weight of pocket gophers captured in uncovered and covered trap sets when using peanut butter as an attractant. Size is often used as a surrogate of age, and subsequently experience, in pocket gophers (Sullivan et al., 2001, Baldwin et al., 2013). The fact that we captured substantially larger pocket gophers in covered burrow systems when using peanut butter suggests this approach may be more successful in capturing the more experienced individuals that are difficult to capture. Capturing these individuals is important for both research and management efforts. For most research projects, one assumption of many sampling designs is that the captured population is representative of the population as a whole. This is not possible if you cannot capture the more experienced individuals with the same efficiency that you do juveniles and subadults. Likewise, for a pocket gopher management program to be effective, the larger, more

experienced individuals need to be removed, as they are responsible for much of the reproduction that occurs in the population (Miller, 1946). As such, there appears to be a benefit to using peanut butter as an attractant when using covered trap sets. This benefit would likely be most apparent during summer when covered trap sets have proven more efficient than their uncovered counterparts (Baldwin et al., 2013). For much of the rest of the year, uncovered trap sets appear to be as effective and more time efficient than their covered counterparts.

Interestingly, heavier pocket gophers were consistently drawn to anise-oil baited trap sets (Fig. 1). Anise oil has long been reported as a potential attractant to pocket gophers (Dixon, 1922), although no studies have been published on its efficacy as an attractant at trap sets. The ability to attract and increase captures of larger, more experienced pocket gophers at both covered and uncovered trap sets could be a benefit to trapping programs. For example, it is often larger pocket gophers that trigger traps without getting captured (Baldwin et al., 2013). This makes capturing them in subsequent trapping events more difficult (i.e., they become trap-shy). The use of an attractant, such as anise oil, that draws in larger pocket gophers could increase the odds of trapping such difficult-to-capture individuals. This is a potential research avenue that could be explored in the future.

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