2015. Proceedings of the Indiana Academy of Science 124(1):32–37

INFLUENCE OF SCENT AND SEASON ON SHERMAN LIVE TRAP CAPTURES OF *PEROMYSCUS*

Dustin A.S. Owen[1, 2], **Timothy C. Carter** and **Stephanie A. Rutan**: Department of Biology, Ball State University, Muncie, IN 47306 USA

ABSTRACT. Identifying the ideal method to capture small mammals, and the influence of seasonal (monthly) variation on capture rates, is important for maximizing efficiency and time. This study tested the prediction that *Peromyscus leucopus* scent collected in the lab and placed in cleaned (experimental) traps would attract conspecifics with similar or higher frequency than regular clean traps or dirty traps containing the residual scent of previously captured conspecifics. There was no significant difference in capture rates of *P. leucopus* among clean, dirty, or experimental traps. However, dirty traps did have increased sexual bias, with a greater frequency of male captures. Additionally, July had higher capture rates of female *P. leucopus* than September and June, whereas males showed no significant seasonal variation. These findings document the potential influences and results of trap type and season on small mammal capture rates, and provide valuable considerations and recommendations for management practices and future studies using scented, live-capture traps.

Keywords: disease mitigation, live traps, mouse, *Peromyscus*, sexual bias, temporal, trapping

INTRODUCTION

Live traps are one of the most common methods for acquiring live, free-ranging small mammals. Techniques for maximizing small mammal captures have been highly desired in the fields of wildlife ecology and management (Gaulin & FitzGerald 1988; Slade et al. 1993; Whittaker et al. 1998; Anthony et al. 2005). To accomplish this, factors that influence capture rates, such as residual scent or season, must be identified.

Dirty traps are thought to be the preferred method for producing the largest yield in terms of small mammal captures (Boonstra & Krebs 1976; Heske 1987; Gurnell & Little 1992). It is thought that the residual scent of previously captured conspecifics entices others to investigate (Boonstra & Krebs 1976), though the exact reason for this (territorial defense, mate acquisition, curiosity) is unknown. However, the use of dirty traps has often been associated with sexually skewed capture rates (Whittaker et al. 1998; Wolf & Batzli 2002). Such biases typically involve higher male capture rates (Wolf & Batzli 2002), yet the cause of this bias remains undocumented. Territoriality of males offers one potential explanation, as males would enter the trap to defend their territory from the perceived threat of an unknown conspecific. However, female *Peromyscus* have been known to be equally, if not more, territorial than males (Metzger 1971; Korytko & Vessey 1991). Another explanation is that males are more active in their pursuit of reproductive females, and that the residual scent of females in dirty traps attracts males. While these mechanisms provide possible explanations for the prevalence of sexual biases in the literature, more empirical data are needed to understand sexually biased capture results in small mammals. Understanding and potential mitigation of this problem would be of great benefit to future studies requiring the acquisition of live, free-ranging conspecifics.

Disease transmission is another problem associated with the use of dirty traps since *Peromyscus* are known vectors for Hantavirus (Nichol et al. 1993; Mills et al. 1995). Nichol et al. (1993) documented a direct link between infection in humans and exposure to rodent excreta, particularly that of Deer Mice (*Peromyscus maniculatus*). Because dirty traps have excreta of previously captured mice, handling these traps may increase risk of human infection. Dirty traps also expose mice among and within populations to potential infections, as trappers move from one site to another. As

[1] *Current address:* Center of Excellence for Field Biology, Department of Biology, Austin Peay State University, Clarksville, TN 37044 USA.
[2] *Corresponding author:* Dustin A.S. Owen, dasowen27@gmail.com.

such, the use of dirty traps previously occupied by infected individuals could facilitate the spread of diseases to new populations, increasing population mortality (Burthe et al. 2008), and the potential transmission to additional species (Kallio et al. 2006).

Our objective was to quantify those factors that influenced capture rates of *Peromyscus* spp. We wanted to determine if artificially scented traps (experimental traps) could be substituted for dirty traps, without a significant decrease in capture rates. We tested the following predictions: 1) experimental traps would not differ from dirty traps in capture rates, 2) experimental traps would cause less sexual bias than dirty traps, and 3) that the capture rates of *Peromyscus* spp. will vary seasonally.

METHODS

Trapping took place between 24 June 2010 and 31 October 2010 at study sites located in Muncie and Fort Wayne, IN and Miller City, IL. The Fort Wayne and Miller City study locations consisted of one site each. In Muncie there were three separate sites: Cooper Farm, Miller Wildlife Area, and Christy Woods. The study sites all consisted of stands of upland hardwood forest comprised primarily of red oak (*Quercus rubra* L.) and sugar maple (*Acer saccharum* Marshall), with relatively flat topography.

Although we could not definitively determine which species of *Peromyscus* (*P. leucopus* or *P. maniculatus*) were captured, based on the type of habitat where the trapping took place (upland hardwood forest), we believe that all individuals captured were *P. leucopus* (Whitaker & Mumford 2009), and will henceforth refer to them as such. Three adult *P. leucopus*, two males and one female, were captured and housed in individual cages lined with shredded paper towels for two weeks to collect scent. Mice were provided with pet mouse food (Extruded Global Rodent Diet, Harlan/Teklab Global) and water *ad lib*. Following scent collection, captive mice were released at their original site of capture. *Peromyscus* scent consisted of urine, feces, and other bodily odors that were absorbed into the paper towel pieces while the mice were caged. The shredded paper towels from male and female cages were placed in a sealed plastic bag, mixed, and laid in the sun for a few hours to volatilize scent chemicals to ensure an even mixture of all mice scent. Additionally, exposure to ultraviolet light reduces the vitality of infectious diseases such as Hantavirus (Prescott et al. 2005). The scented pieces were placed behind clean cotton in the back of the "experimental" Sherman traps ($22.9 \times 7.6 \times 8.9$ cm; H.B. Sherman Traps, Tallahassee, FL).

At each site, transects of 25 groups of three traps (one clean, one dirty, and one experimental) were established for each trap session, lasting three days (two nights; $n = 150$ trap nights). Trap groups were placed at least 1 m apart wherever *P. leucopus* and other small mammals were likely to be found, such as areas of high course woody debris or along fallen trees (Lee 2004; Whitaker & Mumford 2009). At each trap group, three non-folding Sherman traps were placed parallel to each other $\sim$ 2.5 cm apart, with the open ends facing the same direction. Dirty traps had previously captured *P. leucopus* and were never subjected to cleaning. Clean traps were either brand new or had been dismantled and thoroughly cleaned with Lysol® detergent (Reckett Benckiser Inc.). Experimental traps were clean traps with a large piece of *P. leucopus* scented paper towel. For each trap session, a new systematic trap-treatment order was implemented to ensure an unbiased placement of the three trap treatments throughout the course of the study. All six possible combinations were used in random order without replacement. If a clean or experimental trap captured an animal, that trap was removed and cleaned, and a trap of the appropriate treatment (clean or experimental) was set in its place. Traps were washed and scrubbed with a Lysol®-water mixture (following manufacture's directions), rinsed with water, and left to air dry. All traps were baited with sunflower seeds mixed in a small amount of peanut butter.

Traps were checked each morning from 0600–0900. Captured animals were identified by genus, sex, and recapture status. Captured animal's ventral surface was marked with a black permanent marker for short-term recapture identification and the animal's right ear was tagged (Model 1005-1; National Band and Tag, Newport, KY) for long-term recapture identification.

An Analysis of Variance (ANOVA) test was performed on the number of individuals captured per trap treatment per night to determine if differences existed among the three treatment types. Tukey's HSD tests were used post hoc

to determine which variables differed significantly. Separate ANOVAs and two-sample t-tests were also used to determine differences among and between male and female *Peromyscus* captured per trap treatment. Chi-squared goodness-of-fit tests were used on the total number of individuals captured throughout the study. ANOVAs were also used to test for differences in total (sexes combined), male, and female capture rates by month. However, because of uneven sampling effort among the months, we only analyzed capture rates and not total captures for our comparisons. All statistical tests were done using Minitab Statistical Software (Minitab Inc.) with $\alpha = 0.05$ to test for significance.

RESULTS

A total of 1650 trap nights (25 groups of 3 traps each night for 22 nights) resulted in 96 individual animals captured during the study. Two *P. leucopus* escaped from dirty traps before identification and were not included in any analyses. Clean traps captured 22 animals, experimental traps captured 28, and dirty traps captured 46. *Peromyscus leucopus* were the primary mammal captured ($n = 71$), with total captures of 20 clean, 22 experimental, and 29 dirty (Table 1). No recaptures occurred during this study. Of the total animals captured, 23 were non-mouse species, including 10 Eastern Chipmunks (*Tamias striatus*), nine Northern Short-tailed Shrews (*Blarina brevicauda*), and four Red Squirrels (*Tamiasciurus hudsonicus*).

There was no significant difference in capture rates (number captured per night) of *P. leucopus* among the different trap types ($F_{2,63} = 1.02$, $p = 0.366$; Table 1), nor was there a difference in the total number of *P. leucopus* captured over the duration of the study ($X^2 = 1.887$, *d.f.* = 2, $p = 0.389$; Table 1). There was also no significant difference in capture rates between males and females in clean ($t_{36} = 1.69$, $p = 0.100$) or experimental ($t_{38} = 1.56$, $p = 0.128$) traps; however, dirty traps caught more males than females ($t_{39} = 5.51$, $p < 0.001$; Table 1; Fig. 1). July had a higher total (both sexes) capture rate per night than September ($F_{4,17} = 2.96$, $R^2_{adj} = 0.272$, $p = 0.050$), with no significant differences among any other months. Separately, July had a higher capture rate of females than September and June ($F_{4,17} = 3.73$, $R^2_{adj} = 0.342$, $p = 0.023$; Fig. 2), whereas males showed no difference in

Table 1.—Results from Sherman live trap captures of *Peromyscus leucopus* ($n = 71$) based on trap treatment and gender. Averages were calculated from the number of mice captured per night with 25 trap stations per site ($n = 1650$ trap nights).

	Dirty			Clean			Experimental		
Gender	Male	Female	Total	Male	Female	Total	Male	Female	Total
n	25	4	29	14	6	20	14	8	22
Mean ± SE captured/night	1.14 ± 0.14	0.18 ± 0.11	1.32 ± 0.20	0.64 ± 0.18	0.27 ± 0.12	0.91 ± 0.25	0.64 ± 0.14	0.36 ± 0.11	1.00 ± 0.19

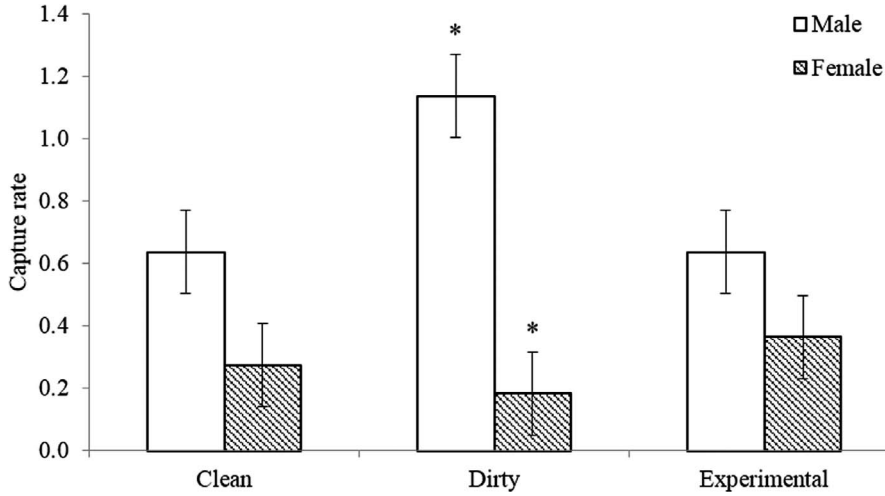

Figure 1.—Nightly ($n = 22$ nights; $n = 1650$ trap nights) capture rates for male ($n = 53$) and female ($n = 18$) *Peromyscus leucopus* among trap types (Mean $\pm$ SE). *Dirty traps had significantly higher male capture rates compared to females.

capture rates among months ($F_{4,17} = 2.00$, $p = 0.140$; Fig. 2).

DISCUSSION

Our results provide evidence that experimental traps represent a viable substitute for dirty traps in studies involving *P. leucopus*. These data (Table 1; Fig. 1) support our predictions that experimental traps would not differ significantly from dirty traps in the capture of *P. leucopus*, and that experimental traps would not have the sexual biases often associated with dirty traps (Fig. 1). It was clear that dirty traps had a much more prominent sexual bias, with a ratio of nearly 5:1 (males to females) compared to 2.3:1 in clean traps and 1.75:1 in experimental traps. These results provide supportive evidence that artificially scented traps represent a viable surrogate for dirty traps.

Our results support previous results that dirty traps cause sexual bias in capture results (Whittaker et al. 1998; Wolf & Batzli 2002). Such biases can result in erroneous population and demographic information (Burger et al. 2009) sufficient to raise questions about the legitimacy of previous studies reporting sex ratios. However, such biases were weakest in experimental traps, further supporting their use. What little difference was noted in sex ratios was likely the result of either random variation or seasonal variation in capture rates, possibly because of inactivity of breeding females. However, the underlying cause(s) of this sexual bias (territoriality, mate searching, etc.) remains unknown. Future studies should employ controlled experiments on both sexes, with various trap types, to determine the proximate cause(s) of sexually biased trap results.

The use of experimental traps also provides a mechanism to mitigate the transmission and spread of infectious diseases. Because *P. leucopus* are known vectors of infectious diseases, such as Hantavirus (Nichol et al. 1993; Mills et al. 1995), mitigating transmission between and among populations would be highly beneficial. Experimental traps are essentially clean traps; therefore, they are less likely to facilitate the spread of infectious diseases. Confirming that mice are free of infectious diseases prior to collection of the scented material also can reduce disease transmission. Additionally, exposing the scented material to ultraviolet light (i.e., sun or lamp), combined with previously mentioned methods, helps mitigate disease transmission to humans and wildlife.

Our results also document season (month) as a potential influence on the capture rates of small mammals (Fig. 2). Female *P. leucopus* were captured more frequently in July than either September or June. These trends are likely the result of cyclic breeding. Because *P. leucopus* from Indiana breed throughout the year with gestation periods of $\sim$ 21–25 days (Whitaker & Mumford 2009), females are likely less active

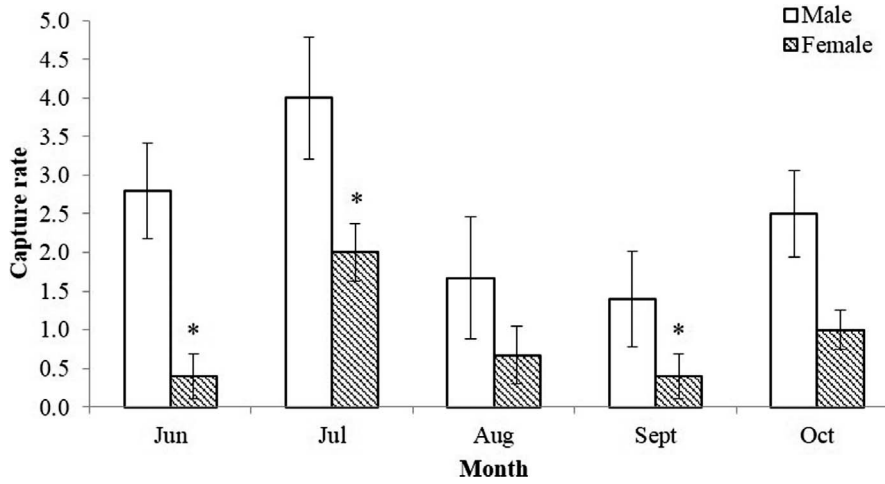

Figure 2.—Nightly (n = 22 nights; n = 1650 trap nights) capture rates for male (n = 53) and female (n = 18) *Peromyscus leucopus* for each month (Mean ± SE). *Female capture rates were significantly higher in July compared to June and September.

during peak periods of birthing. This could result in decreased capture rates some months. This likely explains the variation among monthly capture rates in female, but not male *P. leucopus*, as they are able to remain relatively active throughout the year. As such, special consideration should be given when interpreting capture data of *P. leucopus* with respect to season.

In summary, this study demonstrates that experimental traps can attract small mammals at rates equivalent to dirty traps. Reduced sexual bias, reduced risk of disease transmission, and similar capture rates clearly support the use of experimentally scented traps in field biology. Additionally, influence of season on the capture rate of *P. leucopus* should be considered when planning general surveys and interpreting data. Our results provide evidence for the efficacy of scented trap methodology and for the influence of season on small mammal trapping, and should encourage further investigations into questions relating to trapping protocols, such as whether potent or increased amounts of scented paper would increase capture yield.

ACKNOWLEDGMENTS

We are grateful for the time several Ball State University students spent in the field with us setting and checking traps. This work was supported through an Undergraduate Ecology Research grant at Ball State University. All animals were handled and cared for following approved University IACUC protocol # 122330-4.

LITERATURE CITED

Anthony, N.M., C.A. Ribic, R. Bautz & T. Garland. 2005. Comparative effectiveness of Longworth and Sherman live traps. Wildlife Society Bulletin 33:1018–1026.

Boonstra, R. & C.J. Krebs. 1976. The effect of odor on trap response in *Mircorus townsendii*. Journal of Zoology 180:467–476.

Burger, J.R., A.S. Chesh, R.A. Castro, L.O. Tolhuysen, I. Torre, L.A. Ebensperger & L.D. Hayes. 2009. The influence of trap type on evaluating population structure of the semifossorial and social rodent *Octodon degus*. Acta Theriologica 54:311–320.

Burthe, S., S. Telfer, M. Begon, M. Bennett, A. Smith & X. Lambin. 2008. Cowpox virus infection in natural field vole *Microtus agrestis* populations: significant negative impacts on survival. Journal of Animal Ecology 77:110–119.

Gaulin, S.J. & R.W. FitzGerald. 1988. Home-range size as a predictor of mating systems in *Microtus*. Journal of Mammalogy 69:311–319.

Gurnell, J. & J. Little. 1992. The influence of trap residual odor on catching woodland rodents. Animal Behaviour 43:623–632.

Heske, E.J. 1987. Responses of a population of California voles, *Microtus californicus*, to odor-baited traps. Journal of Mammalogy 68:64–72.

Kallio, E.R., J. Klingström, E. Gustafsson, T. Manni, A. Vaheri, H. Henttonen, O. Vapalahti & Å. Lundkvist. 2006. Prolonged survival of *Puumala hantavirus* outside the host: evidence for indirect transmission via the environment. Journal of General Virology 87:2127–2134.

Korytko, A.I. & S.H. Vessey. 1991. Agonistic spacing behavior in white-footed mice, *Peromyscus leucopus*. Animal Behavior 42:913–919.

Lee, S.D. 2004. Population dynamics and demography of deermice (*Peromyscus maniculatus*) in heterogeneous habitat: role of course woody debris. Polish Journal of Ecology 52:55–62.

Metzger, L.H. 1971. Behavioral population regulation in the wood mouse *Peromyscus leucopus*. American Midland Naturalist 86:434–448.

Mills, J.N., T.L. Yates, J.E. Childs, R.R. Parmenter, T.G. Ksiazek, P.E. Rollin & C.J. Peters. 1995. Guidelines for working with rodents potentially infected with hantavirus. Journal of Mammalogy 76:716–722.

Nichol, S.T., C.F. Spiropoulou, S. Morzunov, P.E. Rollin, T.G. Ksiazek, H. Feldmann, A. Sanchez, J. Childs, S. Zaki, & C.J. Peters. 1993. Genetic identification of a hantavirus associated with an outbreak of acute respiratory illness. Science 262:914–917.

Prescott, J., C. Ye, G. Sen & B. Hjelle. 2005. Induction of innate immune response genes by Sin Nombre hantavirus does not require viral replication. Journal of Virology 79:15007–15015.

Slade, N.A., M.A. Eifler, N.M. Gruenhagen & A.L. Davelos. 1993. Differential effectiveness of standard and long Sherman livetraps in capturing small mammals. Journal of Mammalogy 74:156–161.

Whitaker, J.O. & R.E. Mumford. 2009. Mammals of Indiana. Indiana University Press, Bloomington, Indiana. 688 pp.

Whittaker, J.C., G.A. Feldhamer & E.M. Charles. 1998. Captures of mice, *Peromyscus*, in two sizes of Sherman live traps. Canadian Field-Naturalist 112:527–529.

Wolf, M. & G.O. Batzli. 2002. Relationship of previous trap occupancy to capture of white-footed mice (*Peromyscus leucopus*). Journal of Mammalogy 83:728–733.

Manuscript received 10 January 2015, revised 12 September 2015.