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Small Mammal Capture Efficiencies Among Three Trap Types

Abstract

*Capture rates of small mammals were compared among live, pitfall, and snap traps to determine the relative efficiency of trap types by species and mammal groups. Three small mammal trap types were employed concurrently in each of 53 sites representing major vegetation types of Montana. Shrews (*Sorex *spp.), sagebrush voles (*Lemmiscus curtatus*), and northern pocket gophers (*Thomomys talpoides*) were captured more often than expected in pitfall traps. Chipmunks (*Tamias *spp.) and deer mice (*Peromyscus maniculatus*) were caught significantly more often by live traps. The capture rate for voles (*Microtus *spp.) did not differ significantly among trap types. We conclude that a combination of trap types must be used to accurately assess small mammal species composition, diversity, and abundance.*

Key Words: Montana, habitat, small mammals, capture efficiency, trapping, snap trap, pitfall trap, live trap, trap success, Rocky Mountains.

Introduction

Studies of small mammal trapping show that results depend on trapping methods (Laurance 1992, Slade *et al.* 1993). Cockrum (1947), MacLeod and Lethiecq (1963), and Williams and Braun (1983) agree that there are dangers inherent in many community composition and population studies that treat different trap types as unbiased across species. Trap efficiency also varies with season (Pucek, 1969), weather (Doucet and Bider 1974), animal size (West 1985), animal residency status (Boonstra and Krebs 1978), and odors of previous animals captured in the trap (Daly and Behrends 1984, Gurnell and Little 1992). Variation in community structure described in the literature may be partly due to differences in trapping methods.

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Differential capture rates of trap types have been demonstrated for some, but not all, small mammal species. Two to 36 times more individual shrews have been caught in pitfall traps than in snap traps, (MacLeod and Lethiecq 1963). Brown (1967) and Pucek (1969) also reported that masked shrews (*Sorex cinereus*), pygmy shrews (*S. hoyi*), and vagrant shrews (*S. vagrans*) have been captured almost entirely in pitfall traps. On the other hand, deer mice have been captured more frequently in snap traps than pitfall traps (Kalko and Handley 1993). The efficiencies of trap types in capturing species of other small mammal groups, such as voles and chipmunks, have not been reported as frequently.

Studies using trapping to determine species occurrence, density, community structure, population dynamics, and/or interspecific interaction may be seriously biased by inadequate knowledge of differential susceptibility to trapping. Thus, we compare success of pitfall, snap, and live traps in their ability to capture 19 small mammal species in Montana. *P*-values <0.20 are reported to show trends for species with small sample sizes. Six species and three genera show significant differences in capture frequency per trap type.

Methods

Fifty-three sites, originally chosen to represent major environmental types of Montana (Ross and Hunter 1976), were trapped over five summers between June 1977 and October 1982. These included two alpine sites dominated by tufted hairgrass (*Deschampsia caespitosa*); 19 forested sites: one limber pine (*Pinus flexilis*), six ponderosa pine (*Pinus ponderosa*), four Douglas fir (*Pseudotsuga menzesei*), three lodgepole pine (*Pinus contorta*), two subalpine fir (*Abies lasiocarpa*), one grand fir (*Abies grandis*), and two western redcedar (*Thuja plicata*); two riparian sites dominated with *Phalaris ariandinaria* (reed grass); 18 shrubland sites: 12 big sage (*Artemesia tridentata*), three greasewood (*Sarcobatus vermiculatus*), and one each of chokecherry (*Prunus virginianus*), creeping juniper (*Juniperus horizontalis*), and rocky mountain juniper (*Juniperus scopulorum*); and 12 grassland habitats: six needle-and-thread (*Stipa comata*), one bluebunch wheatgrass (*Agropyron spicatum*), three idaho fescue (*Festuca idahoensis*), and two little bluestem (*Andropogon scoparius*). Elevations ranged from 700 to nearly 3,900 meters. At each site, two independent traplines were run concurrently about 0.5 km apart. Each line had 25 trap stations placed at 10 m intervals. Each station included a sunken can pitfall trap (15.7 cm diameter by 17.6 cm deep), a folding Sherman live trap (7.6 x 8.9 x 22.9 cm, model LFATDG), and two standard commercial snap traps (5.0 x 10.0 x 1.6 cm) arranged in a diamond pattern with side lengths 1 m. The upper lips of the pitfall traps were flush with the ground and earth was filled in around the can. Cans contained approximately 4 cm of water to prevent shrew cannibalism and escape of captured animals. Both snap traps and live traps were baited with a peanut butter and rolled oat mixture. Trapping at each site spanned five consecutive nights, resulting in 1000 trap-nights per site. On two sites, only one trapline was run and/or fewer than five consecutive nights were trapped. For this reason captures are summarized as captures per 1000 trap nights. All mammals captured were removed.

To evaluate differences in species and mammal group capture rate by trap type, we used the nonparametric Kruskal-Wallis Test on the SAS statistical package (SAS Institute Inc. 1988). We rejected parametric analysis of variance evaluation because the data were not normally distibuted with equal variances.

Results

In approximately 52,000 trap-nights, 1398 individuals representing 25 species were captured. Six species with fewer than three captures were excluded from individual analysis but were included in the analysis of generic differences (Table 1). Vulnerability to capture varied among trap types for six of the 19 species and two of three mammal groups, shrews and chipmunks. (Table 1).

Shrews, overall, were most susceptible (P=0.0001) to pitfall traps, as were the two most common species, the masked (P=0.0002) and wandering shrews (P=0.02). Though they were captured too infrequently to test for significance, pygmy shrews, Merriam's shrews (*S. merriami*), and Preble's shrews (*S. preblei*) were also caught most often in pitfall traps (Table 1) .

Voles (arvicolines), as a whole, were not more easily caught in any single trap type (P=0.14). An exception, the sagebrush vole, was most susceptible to pitfall traps (P=0.05). The most abundant species, red-backed voles (*Clethrionomys gapperi*), prairie voles

Table 1. *Number caught and captures/1000 trap nights, for all small mammal species in three trap types: pitfall, live, and snap.*

No. captures	Mammal species	Live	Pitfall	Snap	*P*-value[1]
228	*Sorex* Spp. - Shrews	0 5	13.4	2.2	0.0001*
123	*S. cinereus*	0 1	6 5	1 6	0 0002*
5	*S. hoyi*		0.3		ns
3	*S. merriami*		0.2		0 1336
7	*S. preblei*		0 5		0.0663
86	*S. vagrans*	0 4	5.4	0.5	0.0216*
127	Arvicolines - Voles	2 2		2.5	0.1409
61	*Clethrionomys gapperi*	1.2	1	1.3	ns
4	*Lemmiscus curtatus*		0.3		0.0479*
5	*Microtus montanus*	0 1	0.2	0.1	ns
27	*M. ochrogaster*	0 3	0 8	0.5	ns
23	*M. pennsylvanicus*	0 6	0.6	0.3	ns
5	*Phenacomys intermedius*	0 1	0.2	0 1	ns
	Sigmodontines - Rats and Mice				
3	*Neotoma cinerea*	0 2			ns
1,009	*Peromyscus maniculatus*	39 4	4.7	17.7	0.0001*
13	*Tamias* Spp - Chipmunks	0.9		0.1	0.0027*
6	*T. amoenus*	0 5			0 0059*
4	*T. minimus*	0.2			0.1632
3	*T. ruficaudus*	0.2			ns
	Others				
11	*Perognathus fasciatus*	0 1	0.7		ns
3	*Thomomys talpoide*		0.2		0.0479*
10	*Zapus princeps*	0 2		0.2	0.1729

[1]*P*-values indicate the probability that trap efficiency does not differ among the trap types. *P*-values less than 0.20 are included to show trends, though only those below 0.05 are considered significant

(*Microtus ochrogaster*), and meadow voles (*M. pennsylvanicus*) were equally susceptible to all trap types. The montane vole (*Microtus montanus*) and heather vole (*Phenacomys intermedius*) were collected too infrequently to show significance.

Deer mice were most frequently captured with live traps (P=0.0001). Because too few were captured, no trend was demonstrated for the bushy-tailed woodrat (*Neotoma cinereus*), the only other sigmodontine caught more than twice.

Although chipmunks were rarely caught, they were captured most frequently in live traps (P=0.003) for the group as a whole. The most common chipmunk species, the yellow-pine chipmunk (*Tamias amoenus*), was most frequently caught in live traps (P=0.006). Least chipmunks (*Tamias minimus*) and red-tailed chipmunks (*T. ruficaudus*) were rare and sample sizes were too small to show significant associations.

Three pocket gophers, 10 western jumping mice (*Zapus princeps*), and 11 olive-backed pocket mice (*Perognathus fasciatus*) were caught during the study. Pocket gophers were caught only in pitfall traps (P=0.05) while western jumping mice and olive-backed pocket mice did not show a significant susceptibility to any particular trap type (P=0.17; P>0.20, respectively).

Note that species with the same number of captures may have different P-values in the analysis. Also, species with the same P-values after analysis have different capture numbers. This results from different variances of capture rates between species because different numbers were captured on different sites (i.e. if the number captured is three for a species, different P-values will result if all three were captured at a single site making the variance higher than if one specimen was taken at each of three different sites).

Discussion

Mechanistically, any number of variables could contribute to a species' susceptibility to a particular trap type. Animal size has been found to be a factor (West 1985), so animal species and age may be expected to contribute also . Other factors, like body form, dietary preferences, response to enclosure and/ or foreign material also contribute to differences in susceptibility (Laurance 1992). A mammal species' lack of jumping ability, attraction to baits, or lack of trap avoidance could increase capture rates. We hypothesize mechanisms that may have produced the observed results, though this study was not designed to test the validity of those mechanisms.

Body size was seemingly the primary factor in species' predisposition to capture in pitfall traps. Pitfall traps captured the smallest individuals and non-jumping species as opposed to larger and/or more athletic species. Shrews, the smallest mammals captured in this study, and less acrobatic species, like voles and pocket gophers, were very susceptible to pitfall traps. Chipmunks, being larger than the other small mammals discussed here, could jump out of cans at will. Similarly, more agile mammals like deer and jumping mice, were not often captured by pitfall traps containing only 4 cm of water. The few deer mice caught in pitfalls were juveniles or sub-adults, which increases our confidence that animal size may be the most important factor. It has been suggested that a higher water level would increase captures of deer mice (Kirkland, unpublished data from New Mexico and Pennsylvania) by increasing the size an animal must be to reach bottom and jump out.

Live traps baited with peanut butter and oatmeal were expected to attract omnivores/granivores but not be very successful with browsers or insectivores. Chipmunks are omnivores and were captured most often in live traps. Other omnivores, deer and jumping mice, were also captured more frequently than the availability of live traps would suggest. The browsing voles were not captured more frequently in live traps than other trap types. Also, few insectivorous shrews were caught in live traps (3 percent of shrew captures), supporting the hypothesis that dietary preference plays some role in species' susceptibility to live traps.

Other studies, however, have been very successful in capturing shrews in live traps (Douglass, pers. comm. 1993) when they are the only trap type used. Live trap trigger sensitivity may also play a role in the numbers of shrew captures (Kirkland, pers. comm. 1995).

Live traps have been modified and/ or specifically designed to improve measurement of densities of smaller mammals trapped poorly with the Sherman live trap we used. Modifying trigger sensitivity may increase shrew captures in Sherman live traps. The Longworth live trap, designed for mammals smaller than 4 grams, has been used successfully in England to capture shrews (Kirkland, pers. comm. 1996).

We believed snap traps would capture the same species as live traps because they also were baited. We did expect differences in capture numbers due to the smaller size of the snap trap and its less obtrusive nature than Sherman live traps. Thus, in comparison to live trap success, we expected fewer chipmunk captures, since the animal is relatively large, and increased mouse, vole, and shrew captures due to the smaller and less conspicuous nature of the snap trap. Only chipmunks and shrews conformed to our expectations. Chipmunks were caught significantly fewer times in snap traps than live traps. Shrews, overall, were caught four times more often in snap traps than in live traps. Masked shrews were caught 16 times more often in snap traps than live traps. Voles, western jumping mice, and deer mice showed no significant increase in captures over those caught in live traps.

Implications of our work for small mammal sampling are: (1) not all species present at a site may be detected in small mammal surveys, especially if all three trap types are not used, (2) biased estimates of density or presence may result from trapping with inappropriate trap types, such as using snaptraps for chipmunks or trapping shrews with too-large live traps, and (3) abundance comparisons between studies must be based on consistently collected capture/recapture data or validated indices (Kaufman *et al* 1978, Schroder 1981).

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Literature Cited

Boonstra, R., and C. J. Krebs. 1978. Pitfall trapping of *Microtus townsendii*. J. Mammal. 59:136-148.

Brown, L. N. 1967. Ecological distribution of six species of shrews and comparison of sampling methods in the Central Rocky Mountains. J. Mammal. 48: 617-623.

Cockrum, E. L. 1947. Effectiveness of live traps versus snap traps. J. Mammal. 28186.

Daly, M., and P. Behrends. 1984. Effect of moving traps between trapping stations upon rodent retrapping data. Am. Midl. Nat. 112:205-207.

Doucet, G. J., and J. R. Bider. 1974. The effect of weather on the activity of the masked shrew. J. Mammal. 55:348-363.

Gurnell, J., and J. Little. 1992. The influence of trap residual odour on catching woodland rodents. Animal Behavior 43:623-632.

Kalko, E. K. V., and C. O. Handley, Jr. 1993. Comparative studies of small mammal populations with transects of snap traps and pitfall arrays in southwest Virginia. Virginia J. Sci. 44:3-18.

Kaufman, D. W., J. B. Gentry, G. A. Kaufman, M. H. Smith, and J. G. Wiener. 1978. Density estimation of small mammals: comparison of techniques utilizing removal trapping. Acta.Theriol. 23: 147-171.

Laurance, W. F. 1992. Abundance estimates of small mammals in Australian tropical rainforest: A comparison of four trapping methods. Wildl. Res. 19: 651-655.

MacLeod, C. F., and J. L. Lethiecq. 1963. A comparison of two trapping procedures for *Sorex cinereus*. J. Mammal. 44:277-278.

Pucek, Z. 1969. Trap response and estimation of numbers of shrews in removal catches. Acta Theriol. 14:403-426.

Ross, R. L., and H. E. Hunter. 1976. Climax vegetation of Montana based on soils and climate. USDA, Soil Conservation Service, Bozeman, MT. 64 pgs.

SAS Institute Inc. 1988. SAS/STAT User's Guide, Release 6.03 Edition. SAS Institute Inc., Cary, NC 1028 pgs.

Schroder, G. D. 1981. Using edge effect to estimate animal densities. J. Mammal. 62: 568-573.

Slade, N. A., M. A. Eifler, N. M. Gruenhagen, and A. L. Davelos. 1993. Differential effectiveness of standard and long Sherman livetraps in capturing small mammals. J. Mammal. 74:156-161.

West, S. D. 1985. Differential capture between old and new models of the museum special snap trap. J. Mammal. 66:798-800.

Williams, D. F., and S. E. Braun. 1983. A comparison of pitfall and conventional traps for sampling small mammal populations. J. Wildl. Manage. 47:841-845.