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Transect versus grid trapping arrangements for sampling small-mammal communities

Dean E. Pearson and Leonard F. Ruggiero

Abstract We compared transect and grid trapping arrangements for assessing small-mammal community composition and relative abundance for 2 years in 2 forest cover types in west-central Montana, USA. Transect arrangements yielded more total captures, more individual captures, and more species than grid arrangements in both cover types in both years. Differences between the 2 methods tended to be greatest when small mammals were least abundant, suggesting that advantages of transect arrangements for obtaining basic community information may be greatest when sampling returns are poorest. Our results suggest that transect arrangements are more efficient than grids for small-mammal surveys and studies of small-mammal community composition because transects provide better resolution of community structure for a given effort.

Key words community composition, relative abundance, sampling methods, small mammals, species richness

Trapping methods employed in small-mammal research can affect conclusions regarding community composition. For example, trap types can vary greatly in capture efficiency by species and habitat (Beacham and Krebs 1980, Slade et al. 1993, Shore et al. 1995, Whittaker et al. 1998). As a result, indices such as relative abundance and species richness commonly used to assess the effects of human impacts on habitat quality for small mammals (Morrison and Anthony 1989, Trnka et al. 1990, Sullivan and Boateng 1996, Pearson et al. 2000) can be sensitive to sampling method.

Although a great deal of emphasis has been placed on the effects of trap type, relatively little effort has been expended to understand the equally important influence of trap arrangement (Stickel 1948a, Petticrew and Sadleir 1970, Steele et al. 1984, Read et al. 1988). Two spatial designs are primarily used to deploy traps in the field: grids and transects. Differences in geometry between methods can result in differences in effective sampling area that affects number of animals and species

trapped. For instance, if we assume that each trap effectively samples the unit it lies within plus any adjacent unit, then 25 traps placed in a line will sample 65% more area than 25 traps placed in a grid (Figure 1). This is due to redundancies in sampling that result from greater overlap in effective sampling area of traps set in grid arrangements. This difference will decrease as trap spacing increases until there is no overlap among traps and transect and grid arrangements converge on the same effective sampling area. However, even when traps are independently spaced, transect arrangements may sample more unique microhabitats and more small-mammal home ranges due to similar effects of geometry as they relate to small-mammal and habitat dispersion. Therefore, a transect arrangement equal in trap number and interval to a grid may sample more small-mammal home ranges and microhabitats, resulting in more individuals and species of small mammals being captured.

The notion that transect arrangements should capture more individual animals and provide a better

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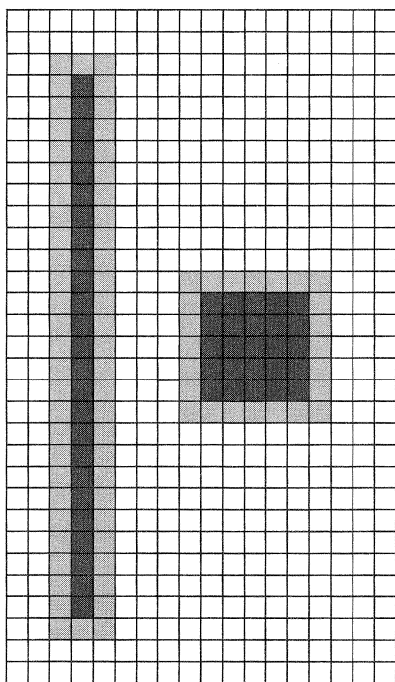


Figure 1. Schematic showing effective trapping area sampled by transect and grid arrangements of equal trap number and spacing where it is assumed that each trap effectively samples the cell it lies within and any adjacent cell. Dark-colored cells indicate those with traps, and light-colored cells indicate adjacent cells also sampled by the trap.

tool than grids for surveying small-mammal communities seems intuitive. Yet, literature reviews by Read et al. (1988) and Steele et al. (1984) indicate that grids are used more often than transects, even in cases where the objective is to survey small-mammal communities. We suggest that this situation results from a lack of consensus among studies comparing trapping arrangements for sampling small-mammal communities. For example, Stickel (1948a) and Bujalska (1989) concluded that transects ineffectively sampled small-mammal populations compared to grids, whereas Read et al. (1988) and Steele et al. (1984) determined that transects generated indices of higher species richness and greater diversity of small mammals than grids. Additional research is needed to determine costs and benefits associated with different trapping arrangements so researchers can select methods that maximize sampling returns for a given set of study objectives. Our objective was to compare grid and transect arrangements to determine whether population and community indices such as total captures, number of individuals captured, and species richness differed between methods.

Methods

The study area consisted of 9 forest stands located across west-central Montana, USA. Five stands were dominated by old-growth ponderosa pine (*Pinus ponderosa*) and 4 stands by mature western larch (*Larix occidentalis*). Stand boundaries were determined from aerial photographs. Stands included a variety of microhabitats, especially within ponderosa pine, where seeps and ravines provided mesic sites within the generally xeric habitat and large openings resulted in bunchgrass-dominated patches. Western larch stands were more homogeneous but also contained topographic relief that resulted in a mixture of shady, mesic microsites and dry ridges.

We placed 3 transects and 3 grids of 25 trap stations in each forest stand by randomly selecting starting points and randomly orienting the grid or transect to a cardinal direction. Trap spacing was 10 m, resulting in 40 × 40-m grids and 240-m transects. We used Sherman live traps (approximately 8 × 9 × 23 cm) and Tomahawk # 201 wire-mesh live traps (Tomahawk Live Trap Company, Tomahawk, Wis.) to survey a range of small-mammal species. We placed Sherman traps at all stations except where Tomahawk traps were placed. We set Tomahawks at the 4 corners of each grid (40-m interval) and at 40-m intervals along transects, beginning with trap station 1 and extending for 120 m (4 Tomahawk traps). Due to limited availability of Tomahawk traps, only 2 of 3 grids and transects on each site included these traps.

We baited all traps with a mixture of peanut butter and whole oats and ran traps for 8 consecutive days. We also baited Tomahawk traps with strawberry jam to target northern flying squirrels (*Glaucomys sabrinus*). We trapped grids and transects concurrently in each stand. We checked traps each morning and ear-tagged captured small mammals with #1005-1 monel ear tags (National Band and Tag Company, Newport, Ky.). We identified small mammals to species and determined age, mass, sex, and reproductive condition before animals were released at the trap station. Animal handling followed guidelines set forth by the American Society of Mammalogists (American Society of Mammalogists, Animal Care and Use Committee 1998), except that bedding material was not provided. The purpose of using no bedding was to reduce contact with rodent excreta as a safety precaution against hantavirus infection. We trapped stands in 1997 and 1998 from May through July.

We assessed the relative effectiveness of trapping arrangements using capture indices: total number of captures, total number of individuals marked, and total number of species captured. We used generalized linear models that assumed a Poisson distribution of the data using SAS PROC MIXED with the GLIMMIXED macro (SAS Institute 1990) to determine whether transects differed from grids with regard to the 3 indices. We treated cover type, sampling method (i.e., transect or grid), and year as fixed factors, and study site (forest stand) as a random factor within cover type.

Results

In 22,752 trap nights at 54 sampling locations (27 transects and 27 grids), we captured 2,007 individuals of 16 species 4,311 times over 2 years. Transects generated 2,459 captures of 1,170 individuals and 15 small-mammal species, and grids produced 1,852 captures of 837 individuals and 15 species. Deer mice (*Peromyscus maniculatus*), southern red-backed voles (*Clethrionomys gapperi*), and red-tailed chipmunks (*Tamias ruficaudus*) were the 3 most common species captured in descending order of abundance (Figure 2). Seven species—northern flying squirrel, Columbian ground squirrel (*Spermophilus columbianus*), western jumping mouse (*Zapus princeps*), bushy-tailed woodrat (*Neotoma cinerea*), cinereus shrew

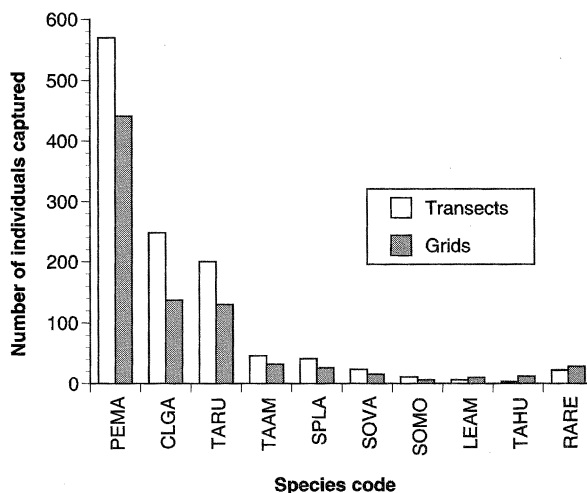


Figure 2. Capture frequencies for small-mammal species from 27 grids and 27 transects in western Montana 1996–1997. (PEMA = *Peromyscus maniculatus*; CLGA = *Clethrionomys gapperi*; TARU = *Tamias ruficaudus*; TAAM = *T. amoenus*; SPLA = *Spermophilus lateralis*; SOVA = *Sorex vagrans*; SOMO = *S. monticolus*; LEAM = *Lepus americanus*; TAHU = *Tamiasciurus hudsonicus*. RARE = 7 species with ≤ 12 individuals captured).

(*Sorex cinereus*), long-tailed vole (*Microtus longicaudus*), and montane vole (*M. montanus*)—were considered rare, with ≤ 12 individuals captured for transects and grids combined.

Generalized linear model results indicated that transects captured more total small mammals ($F=7.76$; $df=1, 7$; $P=0.027$), more individuals ($F=14.74$; $df=1, 7$; $P=0.006$), and more species ($F=6.87$; $df=1, 7$; $P=0.034$) on average than grids after controlling for cover type and year (Figure 3). Cover type did not differ for total captures ($F=3.14$; $df=1, 7$;

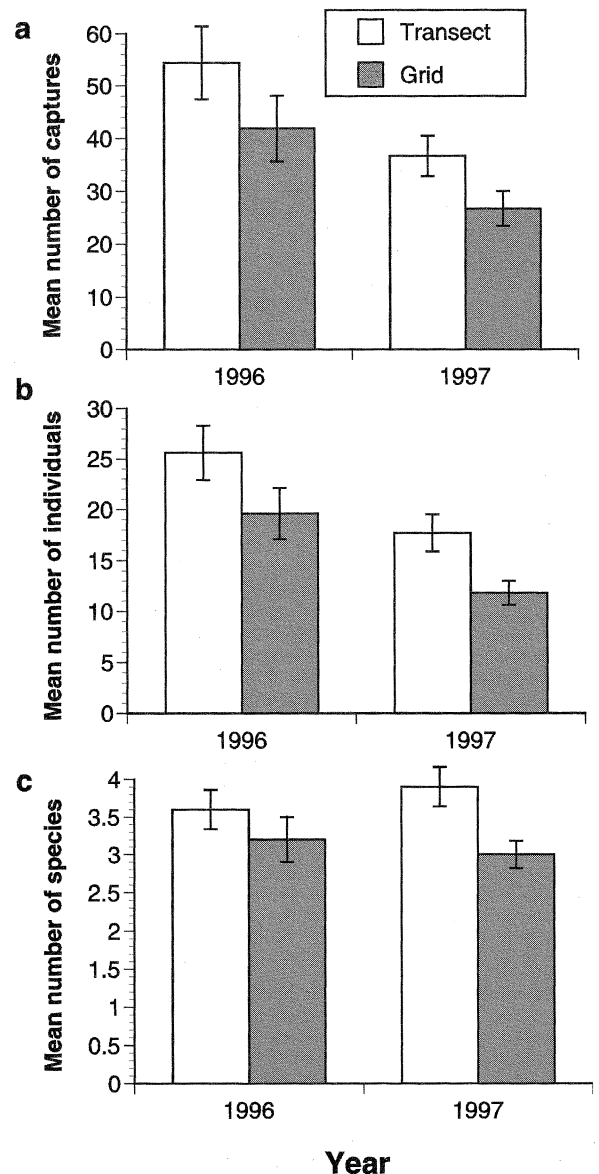


Figure 3. Means and standard errors for (a) total number of small mammals captured, (b) number of individual small mammals captured, and (c) number of small-mammal species captured using 27 grids and 27 transects in western Montana 1996–1997.

$P=0.118$), number of individuals captured ($F=2.70$; $df=1, 7$; $P=0.144$), or number of species captured ($F=2.16$; $df=1, 7$; $P=0.185$). However, year differed, with more individuals captured ($F=27.85$; $df=1, 14$; $P<0.001$) and higher total captures ($F=16.11$; $df=1, 14$; $P=0.001$) in 1996 than in 1997, though number of species captured did not differ between years ($F=0.00$; $df=1, 14$; $P=0.988$). Interactions were significant at the $P=0.05$ level for cover type and year for all analyses, but interactions were not significant between method and cover type, method and year, or method and year and cover type for any of the analyses.

Discussion

Although numerous studies have examined the effects of trap type (Beacham and Krebs 1980, Slade et al. 1993, Shore et al. 1995, Whittaker et al. 1998), trapping period (Gentry et al. 1968, Olsen 1975, Steele et al. 1984), and trap bait (Stickel 1948b, Fitch 1954, Fowle and Edwards 1954, Hansson 1972) on small-mammal trapping results, relatively little work has addressed the effect of trap arrangement on small-mammal community sampling. Moreover, literature published on this subject indicates a lack of consensus among studies addressing this question. Our results suggest that this lack of consensus is more a function of differing study designs than variability in outcomes resulting from effects of trap arrangement.

For example, Stickel (1948a) and Bujalska (1989) concluded that transects provided poor population indices when compared to grids. However, both authors superimposed transects onto large grids that differed in number of traps, trap spacing, and times the sites were trapped, rendering these studies inappropriate comparisons of transect versus grid trapping. Steele et al. (1984) compared transects and grids while controlling for trap number and spacing. They determined that for arrangements of 25 traps at 15-m intervals, transects were more effective than grids for estimating small-mammal species richness, but both methods produced similar results for abundance indices. Like Stickel (1948a) and Bujalska (1989), Steele et al. (1984) compared their smaller "sample" transects and grids to a large baseline grid. This approach assumes that the large baseline grid provides the true population and community parameters. In truth, data from the baseline grid are also samples, and since the baseline data come from a grid arrangement, this design

potentially instills a grid-bias into such comparisons. Brant (1962) and Petticrew and Sadleir (1970) concluded that transects generated abundance indices comparable to grids, but both studies used fewer traps on transects and trapping was not concurrent between the different methods. From an intensive study in Australia that directly compared transects with grids while controlling for trap number and spacing, Read et al. (1988) determined that transects of 7.5-, 10-, and 20-m trap spacing produced better estimates for 4 diversity indices than grids of 7.5-, 10-, and 20-m spacing, but that concentrated grids of 5-m intervals were comparable to transects of the same trap spacing. They also concluded that results from transects were less sensitive to trap spacing than results from grids.

Our results are consistent with the hypothesis that transects sample more individuals and more species of small mammals than grids of equal trap number and spacing due to differences in geometry that result in a larger effective trapping area for transects. We found that transects generated more total captures of small mammals, more individuals of abundant species, and greater species richness compared to concurrently trapped grids of equal trap number and spacing. This outcome held for western larch- and ponderosa pine-dominated cover types and for years that differed greatly in small-mammal abundance. In fact, in 1997, when the number of individual small mammals captured was significantly lower than the previous year, differences between sampling methods tended to be more pronounced, though the interactions were not significant (Figure 3). These data suggest that the advantages of transects over grids for obtaining basic community information may be greatest when sampling returns are poorest.

Our results are consistent with Read et al.'s (1988) conclusion that diversity was higher for transects than grids, and Steele et al.'s (1984) findings that species richness was higher for transects. Our results also corroborate observations by Brant (1962) and Petticrew and Sadleir (1970) where transects produced relative abundance indices comparable to grids, even when trapping effort was substantially higher for grids. We contend the assertions made by Stickel (1948a) and Bujalska (1989) that transects ineffectively sample small-mammal populations compared to grids are incorrect and are the product of uncontrolled study designs.

Choice of trapping arrangement will involve a tradeoff between the relative benefits of grids versus

transects. Grids provide better spatial resolution for estimating population density, depicting home ranges, and determining small-mammal dispersion. However, transects better reflect community composition and provide better samples for examining demographic attributes such as age and sex ratios and habitat relationships due to greater numbers of captures, individuals captured, and species captured. Transects also will likely encompass greater microhabitat diversity, and habitat data likely will exhibit less autocorrelation than data from grids for conducting microhabitat selection studies. Moreover, despite the spatial limitations of transects, methods have been developed for estimating small-mammal density on transects (O'Farrell et al. 1977), and some aspects of dispersion can be studied with transects. For example, Brant (1962) and Petticrew and Sadleir (1970) found that transects produced relative abundance estimates comparable to grids with substantially less trapping effort, and Pearson et al. (2001) used transects to identify habitat partitioning between male and female deer mice that resulted from differential dispersion of the sexes across microhabitats.

Studies comparing transect and grid trapping arrangements provide conflicting results regarding which method is more effective for obtaining various population and community indices. Although it seems intuitive that transects would perform better than grids for studies of community composition, literature reviews (Steele et al. 1984, Read et al. 1988) indicate that grids are used more often than transects, even when the study objective is to survey small-mammal communities. Whereas grids are arguably the optimal arrangement for studies of dispersion, home-range use, and population estimation, our results clearly indicate that transects provide greater trapping returns for a given effort in terms of total captures, individual animals captured, and species richness.

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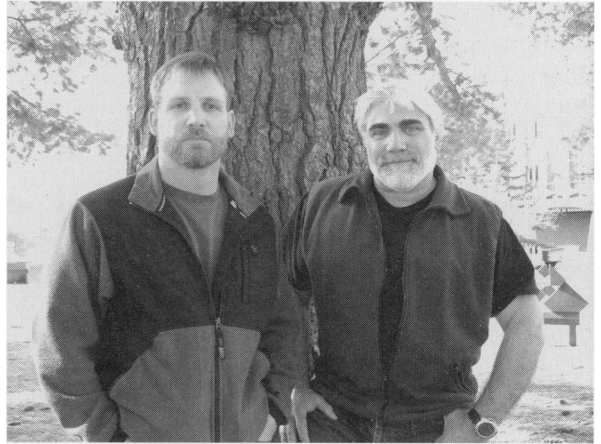
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