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A COMPARISON OF 2 ACTIVITY MEASURES FOR NORTHERN POCKET GOPHERS

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The northern pocket gopher (*Thomomys talpoides*) is a major pest species to the timber industry in the western U.S. (Barnes 1973). Assessment of population levels is of considerable value when determining if a control program is necessary or if it has been effective. However, fossorial pocket gopher activity is difficult to assess. Because radiotelemetry is labor and resource intensive, sample sizes are frequently insufficient to provide precise assessments. Two indirect measures of activity have been widely applied, the open-hole method (Richens 1967, Barnes et al. 1970) and the plot-occupancy or mound-count method (Anthony and Barnes 1983). Pocket gopher mounding is a highly variable activity (Miller 1948, Laycock 1957, Miller and Bond 1960) and thus calls into question the value of the plot-occupancy measurement. However, Anthony and Barnes (1983) recommended that forest managers use plot occupancy as a reliable index to pocket gopher abundance. More information is needed on the comparative reliability of these 2 methods and on the effect of plot size on these activity measures. This is especially true when considering field efficacy studies for toxicant registration via the U.S. Environmental Protection Agency (EPA), that requires 2 activity measurements.

During a study to provide field efficacy information on strychnine baits to the EPA (Evans et al. 1990), we compared 2 plot sizes and the open-hole versus plot-occupancy methods.

METHODS

The study was conducted in August 1989 in eastern Idaho on lodgepole pine (*Pinus contorta*) regeneration units in the Ashton Ranger District of the Targhee National Forest. In a large clearcut area (approximately 40 ha) 2 experienced gopher researchers each established 30 5.1-m-radius (0.008-ha, 0.02-acre) circular plots (60 total plots). Each plot was placed over an area with abundant gopher sign (mounds, feeder plugs) and was separated by ≥36.6 m (120 feet) from the other plots. Each plot was evaluated for activity using plot occupancy (PO). Fifteen of each researcher's 30 plots also were evaluated for activity using open-hole (OH) assessments. Although use of a defined plot is not required for OH measurements, we found that it facilitates sampling to have physically specified experimental units that can be observed over time and that can be measured by >1 method. Similarly, OH and PO could be compared by using 30 plots and, using these in combination with the other 30, we could determine whether the presence or absence of OH measurements had an effect on the PO measurements, either by affecting the behavior of the animals or by influencing the observations of the researchers.

To study whether smaller, more easily observed plots provide the same quality of data as the 0.008-ha plots, each of the 60 plots was divided into 2 0.004-ha subplots comprised of an inner 3.6-m-radius circular subplot and a surrounding ring 1.5 m in width. This permitted a comparison of plot size and plot design. Plot-occupancy measurements were made in both subplots, as were the OH measurements in the 30 plots designated to receive that measurement.

Plot-occupancy measurements were made by first erasing (levelling) all mounds and feeder plugs within each plot. Forty-eight hours later the inner and outer subplots were observed for gopher sign. A subplot was recorded as positive for gopher activity if ≥1 gopher sign was observed after the 48-hour period. Open-hole measurements were made by opening 2 burrows each in the inner and the outer subplots. After 48 hours, a subplot was recorded as positive for activity if either or both of the holes were plugged. For both measure-

Table 1. Summary of plot-occupancy (PO) and open-hole (OH) paired measurements and results from McNemar's test Trial 1, where a '+' indicates detection of pocket gopher sign and a '−' indicates lack of detection, eastern Idaho, August 1989. Trial 2 data are in parentheses.

		PO inner plot +	PO inner plot −	OH outer plot +	OH outer plot −
PO outer plot	+	2 (3)	9 (4)	10 (6)	1 (1)
	−	5 (4)	14 (19)	15 (17)	4 (6)
Trial 1		$P > 0.400$		$P = 0.0003$	
Trial 2		$P > 0.400$		$P = 0.00014$	
		+	−	+	−
OH inner plot	+	7 (7)	19 (20)	22 (23)	4 (4)
	−	0 (0)	4 (3)	3 (3)	1 (3)
Trial 1		$P < 0.00001$		$P > 0.400$	
Trial 2		$P < 0.00001$		$P = 0.0313$	

		PO total plot +	PO total plot −
OH total plot	+	16 (11)	13 (16)
	−	0 (0)	1 (3)
Trial 1		$P = 0.00024$	
Trial 2		$P = 0.00003$	

ments, the combined plot was considered active if either subplot indicated activity.

Readings of the plots were made on 23–25 August (Trial 1). To confirm the results from this trial, the experiment was repeated using the same plots on 29–31 August (Trial 2). Accordingly, the data from each trial were analyzed separately.

Each plot produced 3 PO activity measurements: from the inner subplot, the outer subplot, and the entire (combined) plot. Half of the plots had an additional 3 measurements for OH. Eight hypotheses were considered for each of the 2 trials: (1) the proportion of inner subplots where PO resulted in a positive reading was the same as the proportion positive for the outer subplots, (2) the proportion of inner subplots with positive readings was the same for the PO and OH methods, (3) the proportion of outer subplots with positive readings was the same for the PO and OH methods, (4) the proportion of combined plots with positive readings was the same for the PO and OH methods, (5) the proportion of inner subplots where OH resulted in a positive reading was the same as the proportion positive for outer subplots, (6) the proportion of inner subplots where PO resulted in a positive reading was the same whether OH measurements were present or not, (7) the proportion of outer subplots where PO resulted in a positive reading was the same whether OH measurements were present or not, and (8) the proportion of the complete plots where PO resulted in a positive reading was the same whether OH measurements were present or not. Because the first 5 comparisons use repeated measurements from each plot (inner, outer, and combined for both PO and OH), McNemar's test was applied (Sokal and Rohlf 1981:768–773). The *P*-values were calculated using binomial probabilities (Sokal and Rohlf 1981:774). The final 3 comparisons were made using Pearson's chi-square test (Snedecor and Cochran 1980:125–126).

Table 2. Summary of plot-occupancy results with and without open-hole (OH) measurements for northern pocket gophers, eastern Idaho, August 1989.

Trial	Plot	Positive results: With OH (n = 30)	Positive results: Without OH (n = 30)	χ^2 (1)[a]	P
1	Inner	7	8	0.089	0.77
	Outer	11	6	2.052	0.15
	Combined	16	12	1.071	0.30
2	Inner	7	7	0.000	1.00
	Outer	7	5	0.300	0.52
	Combined	11	9	0.417	0.58

[a] Pearson's chi-square test statistic with 1 degree of freedom

RESULTS

For both trials, a substantial difference resulted between OH and PO activity measurements for the inner subplots, the outer subplots, and the combined plots (Table 1). In each case the OH measurement detected more positive results than the PO measurement.

The PO measurement indicated activity in 28 of the 60 (47%) combined plots (0.008 ha) in Trial 1 (Table 2). Of these 28, 15 (54%) also were recorded as active for the inner subplots and 17 (61%) were recorded as active for the outer subplots (Table 2). In Trial 2, 20 (33%) of the combined plots were recorded as active (Table 2). Activity was detected in 14 (70%) inner subplots, while activity was detected in 12 (60%) outer subplots (Table 2).

In contrast to the PO results, the OH measurements for Trial 1 produced positive observations in 29 of 30 (97%) combined plots (Table 1). Of these, activity was observed in

26 of 29 (90%) inner subplots (Table 1) and in 25 of 29 (86%) outer subplots (Table 1). The results from Trial 2 were comparable, with activity indicated in 27 of 30 (90%) combined plots (Table 1). Activity was detected in all 27 (100%) inner subplots and in 23 (85%) of the outer subplots (Table 1).

No evidence indicated that the use of the OH measurement in the same plot as the PO measurement affected the results for the PO measurement (Table 2).

DISCUSSION

We assumed that no (or few) false positive readings occurred. No other animal in the region would plug holes in gopher burrows or produce feeder plugs or mounds indistinguishable from those made by pocket gophers. The substantial differences between the PO and OH measurements on the combined plots and each of the 2 subplot areas were caused by the PO method failing to measure activity when the OH method was successful. The OH method was a more sensitive measure of activity in our experimental conditions. The OH measure has in the past been accepted as the most reliable indirect activity measure (Miller and Howard 1951) and our data support that conclusion.

Plot size is an important factor for the PO measurements. The subplots provided nearly as effective measurement results for OH as the combined plot did (85–100%). The PO measurements in subplots were 50–70% of values from the combined plots. Small plots did not provide an adequate measure of activity using the PO technique. The PO technique is not as sensitive because a response is not being elicited. Differences were not detected between the inner and outer subplots, so a circular plot would be more practical (easier to construct in the field) than an annular plot of the same area. The ring-shaped subplot provided no appreciable advantage for detecting activity.

During our concurrent study on the efficacy of strychnine grain baits for pocket gopher control (Evans et al. 1990), we also used circular plots where both OH and PO measurements were taken. We noted that potential bias existed with less experienced observers when taking OH and PO measurements in the same plots, especially when many observations were required. If the less labor-intensive OH reading was positive, more effort was made to locate gopher sign for the PO reading. If the OH reading was negative, little effort was made to search for sign that likely was not there. Based on our data (Table 2), we suggest that the opening of burrows to make OH observations does not influence the animal's behavior such that the PO activity measurements in the same plot would be biased. Similarly, we suggest that when using experienced observers, the OH results are not likely to bias the observations for PO. This issue has the potential to arise when conducting chemical registration field studies for the EPA because 2 measures of activity usually are required.

The OH and PO activity measures probably will continue to be the standards by which abundances and activities of northern pocket gophers are assessed in reforestation efforts. We have provided some insight into the OH and PO activity measures, but more information is needed to answer additional questions concerning these methods, such as optimal plot size, especially for PO measurements. Of potential interest would be the optimal lag time between preparing the plots and taking the readings; the number of holes to open for the OH measurements; whether to count all gopher sign in each plot (more labor intensive) or use a yes-no measure of activity; the effect of climate, habitat, and season on gopher activity levels and the investigator's ability to observe in different conditions; and the potential for bias among observers for each method.

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