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Economic Effectiveness, Efficiency, And Selectivity Of Fox Squirrel Trapping In Pecan Groves

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ABSTRACT: Trapping is the most common damage management practice employed by pecan growers suffering fox squirrel (*Sciurus niger*) depredation. The author evaluated the economic effectiveness of foot-hold trapping fox squirrels in native pecan groves from 1988 to 1991. Trapping significantly reduced squirrel damage the first and second year of treatment in all three study areas relative to the initial untreated year. This reduction was valued at $38.63 to $279.51/ha. In 1990 the author tested the relative efficiency and selectivity of five trap types. Number 110 body traps performed with the best combination of efficiency, selectivity, and cost of the trap types tested.

KEY WORDS: animal damage control, fox squirrel, pecan, *Sciurus niger*, trapping

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INTRODUCTION

Fox squirrels are significant depredators of pecan production (Leppla 1980; Hall 1984), especially in native pecan groves (Huggins 1991). Foot-hold trapping is one of the most widely practiced damage management methods by pecan growers (Mullenax et al. 1984; Boyd 1988). This paper examines the economic effectiveness of this practice, and compares the efficiency and selectivity of five fox squirrel trap types.

METHODS

Economic Effectiveness

Native pecan groves on the Noble Foundation's Red River Demonstration and Research Farm (RRDRF) in Love County, Oklahoma were used to assess the economic impacts of foot-hold trapping fox squirrels from 1988 to 1991. The RRDRF is beyond the western edge of the gray squirrel (*Sciurus carolinensis*) range. A pilot study was conducted in 1988 to establish pecan damage levels in a year in which hunting and other damage management methods were not implemented. Three, 4.3-ha (91- x 466-m) sampling areas (Areas 1-3) were established in the perimeter of groves adjacent to woodland. The methods of Huggins (1991) were used to estimate fox squirrel nut damage using ground plots. During the pilot study only, 10 rather than 15 trees were monitored and ground plots were established adjacent to each tree's trunk rather than midway between the trunk and outer canopy of the tree as in the remainder of the project.

In 1989, two additional Areas (4 and 5) were established for a total of five Areas monitored. In Areas 1 and 2, fox squirrel hunting was allowed from June 1 to December 31 and foot-hold trapping was conducted approximately five days per week from June 22 through December 8.

In 1990, no squirrel hunting was allowed in any Area and trapping was conducted in Areas 1, 2, and 4. Due to low relative trap efficiency during June and July 1989, trapping was not initiated until August 13 but continued seven days per week through December 13. All trap sets in both years were made with unbaited number 1 single long-spring foot-hold traps set on L-shaped wooden platforms nailed 1.2 to 1.8 m above ground. Twenty-five traps were used in each area, with sets made on perimeter trees adjacent to woodland. Unsuccessful traps were periodically moved to other pecan trees within the same Area to increase effectiveness. All captured squirrels were killed.

In 1991, squirrel damage was again monitored in all Areas, but no squirrel damage management practices were implemented which provided the opportunity to observe any carryover effects from previous years' practices. All data were analyzed as a nested analysis of variance design (2 plots per tree, 10 or 15 trees per Area) and multiple comparisons were made with Duncan's multiple range test (SAS Institute, Inc. 1988).

Trap Types

Trapping was conducted in the Griffith and Rutledge pecan groves comprising approximately 40 ha in Carter County, Oklahoma, from October 2 through December 20, 1990. Five trap methodologies were evaluated: 1) baited number 110 single-spring body traps, 2) baited 14- x 14- x 41-cm wire mesh cage traps, number 1 single long-spring foot-hold traps either 3) unbaited, 4) baited, or 5) unbaited and padded with Victor Soft Catch® number 1.5 replacement pads epoxied to the jaws. The padded traps were evaluated as an economical alternative to commercially available padded traps. Whole pecans were used as bait at all baited traps.

All traps were set on L-shaped wooden trapping boards nailed 1.2 to 1.8 m above ground to pecan tree trunks within 30 m of the grove-mixed timber habitat edge. Huggins and Gee (1995) found that cage trap sets made on trapping boards exhibited the best combination of efficiency and selectivity of the fox squirrel sets tested. A randomized block design with 25 blocks of 5 traps each (1 trap of each type) was used employing a total of 125 traps in the study. Five consecutive pecan trees within the 30-m zone along the edge of the grove formed a block, with 1 of the 5 trap types randomly assigned to individual trees. All trap sets were oriented on the trunk toward the woodland. Set traps were inspected a minimum of once per day, and all captured fox squirrels were killed. Means were evaluated using analysis of variance of a randomized block design and multiple comparisons were made using Duncan's multiple range

test (SAS Institute, Inc. 1988).

RESULTS

Economic Effectiveness

A total of 205 fox squirrels were removed by trapping (176) and hunters (29) from the combined 8.6 ha of Areas 1 and 2 in 1989. Trapping efficiency peaked in September (Figure 1) and averaged 3.71 squirrels per 100 trap days (TD). The overall trap efficiency of 0.71 fox squirrels per 100 TD in 1990 was fairly constant but greatly diminished relative to 1989. In 1990, only 46 squirrels were trapped in Areas 1 and 2 combined, with another 19 trapped in Area 4 for a total of 65 from the combined 12.9 ha of Areas 1, 2, and 4.

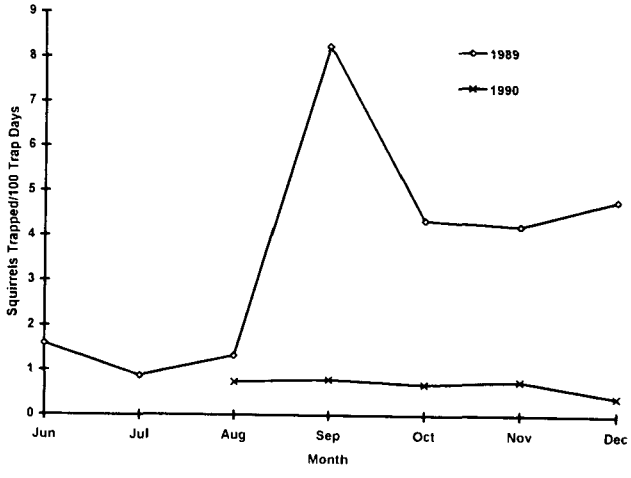

Figure 1. Fox squirrel trapping efficiency using unbaited number 1 single long-spring foothold traps set on L-shaped trapping boards in Love County, Oklahoma, native pecan groves.

Overall nontarget trapping rate was 0.74 and 0.30 per 100 TD in 1989 and 1990, respectively. Raccoons (*Procyon lotor*) and opossums (*Didelphis marsupialis*) together comprised 66% of the nontarget catches, but southern flying squirrels (*Glaucomys volans*), *Peromyscus* spp., eastern woodrats (*Neotoma floridana*), eastern bluebirds (*Sialia sialis*), barred owls (*Strix varia*), and blue jays (*Cyanocitta cristata*) were also caught. Approximately 37% of the nontarget captures were either killed by capture or were judged to have sustained serious enough injury that they had to be killed.

In untreated Areas, squirrel nut damage ranged from 13.3 to 425.5 kg/ha, a value of $26.03-403.33/ha (Table 1). This damage exceeded harvested pecans in 5 of the 10 untreated Area-year combinations sampled. Within an Area, significant differences ($P<0.05$) were detected in fox squirrel damage levels between years for the trapped Areas 1, 2, and 4, but no differences were found among years in untreated Areas 3 and 5 (Table 2). Trapping significantly ($P<0.05$) reduced fox squirrel damage the first and second year of treatment relative to the initial untreated year in Areas 1, 2, and 4. A second year of trapping in Areas 1 and 2 reduced damage relative to the first treatment year an average of 54%, but this difference was not significant ($P>0.05$). However, this reduction was important relative to the average damage increase of 51% in untreated Areas 3 and 5 over the same period. Damage levels rebounded 76% in 1991 in previously trapped Area 1. However, in previously trapped Areas 2 and 4, damage levels fell 17% and 24%, respectively, similar to the trend in the untreated Areas, which averaged 25% lower in 1991 than in 1990. The estimated savings due to trapping ranged from $38.63 to $279.51/ha (Table 3).

Trap Types

A total of 86 fox squirrels and 20 nontarget animals were captured in the combined 5500 TD of the project. Nontarget catches were significantly ($P=0.008$) different among trap types. Fox squirrel catches were only weakly ($P=0.059$) different among trap types. Cage traps were the most efficient type, significantly more than foot-hold or padded foot-hold traps (Table 4). There were no significant differences in efficiency of padded versus unpadded or baited versus unbaited foot-hold traps. Cage and baited foot-hold traps caught more nontargets than the other three types. Baited foot-hold and padded foot-hold traps had the lowest and highest relative cost per trapped squirrel, respectively.

DISCUSSION

The high number of squirrels removed from the study Areas in 1989 (23.8 squirrels/ha) apparently was a result of substantial immigration of immature (subadult and juvenile) squirrels from surrounding habitat into the relatively small, trapped Areas. Adult to immature ratios of trapped squirrels increased from 1:2.7 in August to 1:6.2 in September, and then dropped to 1:5 in October and 1:1.7 in November. Nixon et al. (1974) observed a similar influx of immature fox squirrels into heavily hunted woodlots in Ohio from early September through early November. This dispersal period was apparently much reduced in 1990, as the trapping ratio never increased above 1:3.

The damage levels and savings due to trapping are applicable to the perimeter portions of native pecan groves only. These edge habitats adjacent to woodland can be considered a fox squirrel "damage zone" extending into the grove approximately 90 m (Huggins 1995). Since native groves occur predominantly along riparian corridors, they generally have a large edge component.

In this study, trapping was limited to the pecan grove only, which limited the effectiveness of trapping prior to the initiation of damage. The effectiveness of trapping the adjacent woodland during other seasons should be evaluated.

Humaneness is one aspect of trap choice, though not specifically addressed in this study, which should be considered. Due to the large number of squirrels which must be dealt with in pecan management situations, translocation is not a practical option. Therefore, trapped squirrels will be killed. Under these conditions, killing traps are the most humane, for the squirrel is not held under stress, sometimes sustaining injury, prior to being killed by the trapper. Other factors which influence trap type choice include legality and ease of use.

Table 1. Estimated kilograms and dollar value per hectare of pecans damaged by fox squirrels from August to December in Love County, Oklahoma, native pecan groves.

	kg/ha					$/ha[a]				
Year	1[b]	2	3	4	5	1	2	3	4	5
1988	110.3	425.5	40.3	--	--	104.54	403.33	38.24	--	--
1989	42.8	80.4	41.8	56.9	16.9	65.91	123.82	64.37	87.63	26.03
1990	12.1	52.6	67.3	17.3	22.3	30.73	133.60	170.94	43.94	56.64
1991	20.5	40.8	54.5	10.1	13.3	42.44	84.46	112.82	20.91	27.53

[a]Based on price received of $0.94, $1.54, $2.54, and $2.07/kg for in-shell pecans in 1988-1991, respectively.

[b]Study Areas: Areas 1 and 2 were squirrel hunted and trapped in 1989; Areas 1, 2, and 4 were squirrel trapped in 1990.

Table 2. Mean number of fox squirrel damaged pecans found in 1-m^2 ground plots from August to December in Love County, Oklahoma, native pecan groves.

	Area[a]				
Year	1	2	3	4	5
1988	8.30A[b]	37.35A	3.25A	--	--
1989	2.58B	5.97B	3.62A	11.87A	7.47A
1990	0.75B	3.75B	5.92A	3.13B	10.28A
1991	1.32B	3.10B	4.38A	2.37B	6.20A

[a]Areas 1 and 2 were squirrel trapped and hunted in 1989; Areas 1, 2, and 4 were squirrel trapped in 1990.

[b]Means within a column followed by the same letter are not statistically different ($P>0.05$, Duncan's multiple range test.

Table 3. Value of pecans saved due to fox squirrel trapping in three native pecan grove study areas in Love County, Oklahoma, 1989 to 1990.

	Area 1		Area 2		Area 4	
Year	$/ha	CI[a]	$/ha	CI	$/ha	CI
1989	38.63	12.55- 64.71	279.51	150.38-408.64	--	--
1990	73.81	38.68-108.94	269.73	154.02-385.44	43.69	18.04-69.34

[a]Confidence intervals (95%) extrapolated as the same percentage of the mean as confidence intervals developed from 1-m^2 plot samples of fox squirrel nut damage.

Table 4. Mean number of fox squirrels and non-target wildlife and relative cost per squirrel caught in 44 trap days per set in various trap sets in native pecan groves in Carter County, Oklahoma, 1990.

Trap Type	Fox squirrels[a]	Nontargets	Relative cost[b]
Baited cage	0.92A	0.36A	16.39
No. 1 baited foot-hold	0.72AB	0.36A	4.17
No. 110 baited body	0.44AB	0.00B	4.55
No. 1 foot-hold	0.32B	0.08B	9.38
No. 1 padded foot-hold	0.20B	0.00B	18.20

[a]Means followed by the same letter within a column are not significantly different at $\underline{P} = 0.05$, Duncan's multiple range test.

[b]Total cost of 25 traps/total squirrels caught in that type. Based on costs/trap of $2.00 for body, $3.00 for foot-hold, $3.64 for padded foot-hold, and $15.08 for cage traps.

Cage traps were highly efficient, but were not selective for fox squirrels and had a high relative cost. They also present the problem of dealing with a live, enclosed squirrel. Foot-hold traps were relatively inefficient, but selective. Baiting foot-hold traps did not significantly increase their efficiency, but significantly reduced their selectivity. Padding foot-hold traps did not eliminate leg injury to squirrels, and had minimal effect on efficiency and selectivity. Body traps had moderate efficiency, low relative cost, high selectivity, and were humane. Therefore, where legal, they appear to be the best type of trap of those tested. The tunnel trap, a kill trap not tested in this study, should be evaluated versus the number 110 body trap.

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