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Forest Ecology and Management 164 (2002) 57–66

Forest Ecology and Management

www.elsevier.com/locate/foreco

Response of white-footed mice (*Peromyscus leucopus*) to coarse woody debris and microsite use in southern Appalachian treefall gaps

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Received 11 December 2000; accepted 3 May 2001

Abstract

The influence of treefall gaps and coarse woody debris (CWD) on white-footed mouse (*Peromyscus leucopus*) abundance was tested experimentally during 1996-1999 in a southern Appalachian hardwood forest. I compared the relative abundance and body size of *P. leucopus* among unsalvaged gaps that were created by wind disturbance and retained high CWD levels, salvage logged gaps where fallen and damaged tree boles had been removed, and closed-canopy controls. I also tested the relative use by mice of four microsite types: CWD, pits, woody brush, and open ground. One-hundred and forty-one *P. leucopus* were captured 310 times during the study. There were no differences in capture success, body size, or sex ratio among treatments before or after salvage logging, but abundance varied among years. Capture success was higher at traps set adjacent to CWD ($P < 0.05$) and in pits ($P < 0.10$) than at traps set under brush or on open ground. In the southern Appalachians, windthrow-created canopy gaps and associated microsites do not affect habitat use by *P. leucopus* at a landscape level (as measured by relative abundance among treatments), but CWD influences the microdistribution of *P. leucopus* where it is present. Published by Elsevier Science B.V.

Keywords: *Peromyscus leucopus*; White-footed mouse; Microsite use; Coarse woody debris: Treefall gaps; Southern Appalachians; Natural disturbance

1. Introduction

Both timber harvest and intense natural disturbance such as windthrow affect forest structure and composition at macro- and microhabitat scales. Changes in macro- or microhabitat type and availability due to intense disturbance have the potential to affect rodent populations and community composition. Microsites such as coarse woody debris (CWD), pit and mound topography, brushpiles, and structurally complex vegetation provide cover and nest sites. Coarse woody debris also harbors fungi and invertebrate food sources for some rodents (Loeb, 1996). Flushes of plant growth, seed production, and higher densities of invertebrates provide food resources in recently disturbed sites (Blake and Hoppes, 1986). Because rodents differ in their use of microhabitats and in the kind of microhabitats they require (e.g. Dueser and Shugart, 1978, 1979; McComb and Rumsey, 1982; Seagle, 1985a,b) they may be differentially affected by disturbance. Disturbed areas could function as rodent population sources or sinks by affecting

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0378-1127/02/$ see front matter. Published by Elsevier Science B.V.
PII: S0378-1127(01)00588-6

reproductive rates, predation intensity, and survival (Sullivan, 1979; Loeb, 1999).

Peromyscus spp. are one of the most common rodents in eastern deciduous forest (Godin, 1977). In suitable habitat, densities of *Peromyscus leucopus* vary among years and habitats, ranging from 3.7 to 93.4 ha (Brooks et al., 1998). As such, they likely play a primary role as seed dispersers and as prey for carnivorous mammals, birds and snakes (Sullivan, 1990). Their far-reaching influence on forest dynamics is illustrated by their link to gypsy moth (*Lymantria dispar*) populations (Elkinton et al., 1996) and even the prevalence of Lyme disease (Jones et al., 1998).

Several studies clearly illustrate that CWD, including standing snags, stumps and fallen logs is heavily used by *P. leucopus* and several other species of rodents (Dueser and Shugart, 1978, 1979; Seagle, 1985a; Barnum et al., 1992; Planz and Kirkland, 1992; McCay, 2000). Fallen logs appear to be non-randomly selected as travel routes (Olszewski, 1968; Graves et al., 1988; Barnum et al., 1992; Planz and Kirkland, 1992), orientation aids (Barry and Francq, 1980), cover (Olszewski, 1968), foraging, and nest sites (Wolff and Hurlbutt, 1982; Frank and Layne, 1992; Loeb, 1996). Log characteristics such as state of decay, diameter and size of overhang may influence site use by l? *leucopus* and other rodent species (Hayes and Cross, 1987; Barnum et al., 1992; Bowman et al., 2000; McCay, 2000). However, preferential use of CWD does not necessarily imply that it is a critical habitat component for rodents, or that it enhances their populations.

A positive relationship between abundance of some rodent species, including l? *leucopus*, and CWD has been established for some species in some geographical regions (Miller and Getz, 1977; Goodwin and Hungerford, 1979; Seagle, 1985a; Planz and Kirkland, 1992; Loeb, 1999), but not others (Loeb, 1999; Menzel et al., 1999; Bowman et al., 2000). However, only a few studies (Planz and Kirkland, 1992; Loeb, 1999) have used controlled experimental designs to examine the influence of CWD on small mammal abundance. Inconsistent results among studies, even within species or regions, suggest that CWD may not be a requirement for most species, or that large additions or removals of CWD may be required to elicit any response at a population level.

Associations between rodents and specific microsite types are most commonly documented by correlating microhabitat features to capture success (Dueser and Shugart, 1978; Seagle, 1985a; Carey and Johnson, 199.5; Menzel et al., 1999; Bowman et al., 2000). Other researchers have used fluorescent powder (Barnum et al., 1992; Planz and Kirkland, 1992; McMillan and Kaufman, 199.5’; McCay, 2000) or radiotelemetry (Tallmon and Mills, 1994; McCay, 2000) to track rodent movement and microsite preferences. Olszewski (1968) compared rodent capture success on, below, and away from uprooted trees to determine their preferential travel routes in relation to CWD. However, experimental studies that compare rodent capture success among different microsite types are rare.

On 5 October 1995 the remnants of Hurricane Opal passed approximately 240 km west of Asheville, NC. Downbursts of wind created at least 30 gaps >0.1 ha within the Bent Creek Experimental Forest, primarily by uprooting large trees. Gaps were irregularly shaped, and retained partial canopy cover. Within a sample of five gaps, tree density decreased by 19-39%, and basal area (BA) by 30–53% (Greenberg and McNab, 1998). Several gaps were salvage logged during 1996-1997; others were left unsalvaged (fallen trees remaining). This allowed me to test the hypothesis that relative abundance and body size of *P. leucopus* in unsalvaged windthrow gaps with high amounts of CWD would be greater than in salvage logged gaps and mature closed-canopy forest with less CWD. I also hypothesized that *P. leucopus* capture success would be higher near cover (adjacent to CWD, in pits created by uprooted trees, and beneath woody brush) than on open ground.

2. Study area

The Bent Creek Experimental Forest encompasses a 2500 ha watershed in western North Carolina. Annual precipitation averages 800 mm and is evenly distributed year round. Winters are short and mild, summers are long and warm. Elevation ranges from 700 to 1070 m. Common tree species on xeric sites include scarlet oak (*Quercus coccinea*), chestnut oak (*Q. prinus*), black oak (Q. *velutina*), blackgum (*Nyssa sylvatica*), sourwood (*Oxydendrum arboreum*), and shortleaf pine (*Pinus echinata*). Tulip poplar (*Liriodendron tulipifera*), and northern red oak (Q. *rubra*) dominate moist slopes and coves. Red maple (*Acer rubrum*), hickory (*Carya* spp.), dogwood (*Cornus florida*), and white oak (Q. *alba*) are present on all sites (McNab, 1996).

3. Methods

Treatments were (1) windthrow gaps with fallen trees remaining on the ground, and (2) windthrow gaps that were subsequently salvage logged. Control areas were unbounded, mature (SO-loo-year-old) closed-canopy forest located adjacent to gaps but >25 m from gap edges. All study gaps and control areas were on relatively xeric sites with similar vegetation and elevations. Salvage logging during fall 1996 through 1997 removed standing and fallen trees that were or heavily damaged by Hurricane Opal. Trapping was conducted at the same 11 sites during 1996-1999. Trapping in summer 1996 was conducted prior to salvage logging, and was considered a pre-treatment year (comparing four replicate unsalvaged gaps, three replicate pre-treatment salvaged gaps, and four replicate controls). Because salvage logging occurred over a 2-year-period I considered pre-salvaged sites as replicates for the unsalvaged treatment. In 1997 only two of three gaps that were intended for salvage logging had been salvage logged, hence two salvage logged gaps were sampled, and the third was included in the unsalvaged treatment ($n = 5$). Salvage logging was completed by 1998, so three salvage logged and four unsalvaged gaps were trapped. In 1999 the three salvage logged gaps but only three of the unsalvaged gaps were trapped. The same four control sites were trapped in each year. Average (±S.E.) gap size was 0.59 ± 0.14 ha (range 0.1.5-l .5 ha).

3. I. Habitat measurements

Habitat features including percent cover of woody brush (brushpiles or fallen, dead tree crowns), shrubs, herbaceous vegetation, leaf litter, open ground and CWD (≥ 12.5 cm diameter at contact point with line transect) were measured in summer 1998 using five randomly located, non-overlapping 15 m line transects in each study site. I measured the length and diameter (at contact point with line transect) of each piece of CWD encountered along transects. The bark condition of CWD was categorized as follows: (1) recently dead with 100% bark attached; (2) 70% bark attached; (3) 40–69% bark attached; (4) I 0–39% bark attached; (5) 10% bark attached. Wood decay was categorized as follows: (1) no visible decay; (2) slight decay; (3) moderate decay; (4) slight fragmentation evident; (5) heavy fragmentation; (6) completely disintegrated but still distinguishable as CWD. Percent cover of pits was estimated from the measurements of all pit lengths and widths within five unsalvaged gaps, including the four unsalvaged gaps used in this study (Greenberg and McNab, 1998). Virtually no recent pits were present on control sites, and occasional older pits were detectable only by slight indentations on the soil surface. I assumed that the average percent cover of pits was similar in salvaged and unsalvaged gaps, and that conditions in control areas were representative of pre-hurricane conditions in gaps.

3.2, Rodent trapping

Trapping arrays consisted of 28–48 Sherman live traps (7.7 cm x 9.0 cm x 23.3 cm) baited with rolled oats and spaced approximately 10 m apart in an irregularly shaped "grid" configured to the shape and size of each gap. The number of traps within each unsalvaged gap (limited by size or shape constraints) was matched at a salvage logged gap and control site, such that each treatment received a similar number of trapnights each year.

Traps in unsalvaged and salvage logged gaps were placed in approximately equal proportion at one of four recorded microsites as encountered: (1) in pits created by uprooted trees; (2) adjacent to CWD ≥ 10 cm diameter at trap location and ≥ 1 m long; (3) beneath woody brush (e.g. fallen tree crowns or brush piles); or (4) on open ground (≥ 1 m from any cover). On control sites, where pits and brush were uncommon, only CWD and open ground microsites were used.

Traps were open at each site for four consecutive nights during June-August. Each trapping session included l-2 sites per treatment (or pre-treatment in 1996) to reduce the potential for temporal biases in capture success among treatments. Traps were checked each morning, and captured rodents were identified, sexed, measured (head-body and total length), weighed, and examined for pregnancy, lactation or enlarged testes. In 1996, rodents were marked by notching the right ear. In subsequent years animals were marked using size 1 Monel eartags (National Band and Tag Co., Newport, KY). Animals were released within 1 m of capture site. Trap number, and microsite location was recorded.

3.3. Microsite use

In 1997 three unsalvaged gaps were trapped in addition to those included in the above-described study design. These data supplemented data on relative capture success among the four microsite types; they were used only in analyses of microsite use and not in comparing unsalvaged gaps, salvage logged gaps and closed-canopy controls.

3.4. Statistical analysis

I used one-way analysis of variance (ANOVA) to test for treatment differences in all habitat features. Percentage data were square-root arcsine transformed for ANOVA. I used one-way ANOVA to test for pre-treatment (1996) differences in the relative abundance (captures per trapnight) of *P. leucopus* among unsalvaged gaps, pre-treatment salvage-logged (still unsalvaged), and closed-canopy controls. Repeated measures two-way ANOVA to test for post-treatment (1997-1999) differences in relative abundance of *P. leucopus* among treatments and years. Using gap area as the independent variable and percent trap success (each year tested separately) as the dependent variable, I used simple linear regression to determine whether gap size affected relative abundance of *P. leucopus*. I also tested for among treatment and year differences in head-body length and body mass among treatments using two-way ANOVA. I used Chi-square tests to determine whether pre- and post-treatment sex ratios differed significantly from I: 1 within treatment or control areas. Student's t-tests were used to test for male and female differences in head-body length and body mass. Males and females were combined for all statistical analyses except those comparing the sexes.

I used two-way ANOVA to test whether microsite use by I? *leucopus* differed among unsalvaged gaps, salvage logged gaps and closed-canopy controls during 1996-1999 (data from 1998 were omitted from this analysis because of low captures). For several reasons, replication for microsite analyses differed among treatments and from the overall study design. In 1996, gaps assigned to the salvage logged treatment had not yet been harvested, and were thus considered unsalvaged. In 1997, I trapped three unsalvaged gaps (in addition to those used each year in the overall experimental design) to gather additional microsite data, and I used these only in microsite analyses. I considered sites and years to be independent because only first-captures were used in data analyses. Hence, for microsite analyses only, the same sites trapped in different years were considered replicates (hence, $n = 15$ site-years for unsalvaged gaps, $n = 5$ site-years for salvage logged gaps and $n = 11$ site-years for controls).

Two-way ANOVA suggested that relative capture success differed among microsites ($F = 2.12$, d.f. = 3, $P = 0.10$), but there were no differences among treatments ($F = 1.41$, d.f. = 2, $P = 0.25$), or treatment by microsite interaction ($F = 0.45$, d.f. = 4, $P = 0.77$). Therefore, I combined data from unsalvaged gaps, salvage logged gaps and closed-canopy controls, and used one-way ANOVA to test whether capture success differed among the four microsite locations. Capture data were converted to percent capture success ((number of captures/number of trapnights) x 100) and square-root arcsine transformed for ANOVA's. Differences among means were compared using least squares means tests.

4. Results

4.1. Habitat characteristics

Live-tree density and BA were significantly higher in closed-canopy controls than in unsalvaged or salvage logged gaps. Snag density did not differ among treatments. but snag BA was lower in salvage logged gaps (Table 1). Percent cover of CWD was higher in unsalvaged gaps than in salvage logged gaps or controls (Table 1). Logs were longer, and diameter was marginally greater ($P = 0.09$) in unsalvaged gaps than salvage logged gaps or controls, Coarse woody debris within control sites had less bark (<10%, on average) than in unsalvaged or salvage logged gaps.

Table 1
Percentage cover (±S.E.) of select microhabitat features in unsalvaged (n = 4) and salvage-logged (I = 3) gaps created in 1995 by hurricane Opal, and relatively undisturbed mature forest (controls) (n = 4') in a southern Appalachian hardwood forest"

Microsite feature	Treatment (Mean ± S.E.)			*F*	*P*
	Unsalvaged	Salvage-logged	Control		
Coarse woody debris (%)[b] (>12.5 cm diameter)	2.5 ± 0.4 a	0.7 ± 0.4 b	0.4 ± 0.1 b	9.X8	0.0070
Length (m)	15.1 ± 1.2 a	4.5 ± 0.5 b	6.8 ± 1.2 b	27.4X	0.0005
Diameter (cm)	27.4 ± 3.8	16.8 ± 1.1	19.9 ± 2.2	3.56	0.0859
Bark class (l-5)	2.2 ± 0.3 a	2.7 ± 0.7 a	5.0 t 0.0 b	12.81	0.0046
Wood class (I-6)	1.3 ± 0.3 a	3.5 ± 0.5 b	5.3 ± 0.3 c	37.32	0.0002
Woody brush cover (%)	8.4 ± 1.3 a	20.2 ± 4.7 b	0.0 ± 0.0 c	52.X7	<0.0001
Open ground (%)	43.3 ± 6.X	SO.6 ± 1x.4	72.5 ± 6.9	2.17	0.1760
Live tree density (ha)	205.0 ± 29.0 a	153.3 ± 21.9 a	401.3 ± 19.6 b	8.66	0.0002
Live tree BA (m^2/ha)	9.8 ± 1.6 a	9.0 ± 1.0 a	27.X ± 1.9 b	41.55	0.0001
Snag density (ha)	40.0 ± 4.1	10.0 ± 5.8	37.5 ± 13.1	2.93	0.1107
Snag BA (m^2/ha)	3.2 ± 0.3 a	0.6 ± 0.5 b	2.6 ± 0.8 a	4.82	0.0423

[a] Percentages are presented as actual means, hut data were square-root arcsine transformed for ANOVA. Different letters within rows denote significant differences among treatments.
[b] Because coarse woody debris was present within transects of only three of the four control sites measured, characteristics are based on n = 3 sites (percent cover is based on all four replicates).

Wood decay was lower in unsalvaged gaps than in salvage logged gaps, and highest in controls (Table 1). Percent cover of woody brush was highest on salvage logged sites and lowest in controls (Table I). The percentage of ground surface area recently disturbed by treefall-caused pits ranged from 1.6 to 4.3 (mean ± S.E., 2.6 ± 0.5) among five unsalvaged gaps (Greenberg and McNab, 1998). This estimate likely applies also to salvage logged gaps, whereas recent pits were virtually non-existent in controls.

4.2. Trapping results

One-hundred and forty-one I? *leucopus* were captured 3 10 times during 6424 trapnights. Across all years, 37–54% of marked individuals were recaptured at least once, and by the last day of any trapping period 50–100% (79.0 ± 3.3%) of all captures were recaptures. Four rodent species were captured in addition to *P. leucopus*,including one pine vole (*Microtus pinetorum*), three golden mice (*Ochrotomys nuttalli*), one deer mouse (*P. maniculatus*), and one eastern chipmunk (*Tamias striatus*).

Prior to salvage logging (1996) there was no difference in capture success of *P. leucopus* among unsalvaged gaps, pre-treatment salvage logged (still unsalvaged) gaps, or controls (F = 1.45, d.f. = 2, P = 0.29). Following salvage logging (1997-1999) there was also no difference in *P. leucopus* capture success among treatments (F = 0.93, d.f. = 2, P = 0.42). However, capture success was significantly lower in 1998 than in other post-treatment years (F = 7.71, d.f. = 2, P < 0.01) (Fig. 1). There were no site by treatment or year by treatment interaction effects ($P \geq 0.75$). There was no relationship between gap size and the relative abundance of l? *leucopus* in any year ($P \geq 0.10$).

Only 10 of 14 1 individuals captured during 1996-1999 were subadult (12-14.5 g), and subadult captures did not appear to be related to treatment. Before salvage logging (1996), sex ratios did not significantly differ from 1: 1 in pre-treatment salvage logged gaps (still unsalvaged) (9 females, 11 males; χ^2 = 0.2000, d.f. = I, P > 0.50), unsalvaged gap treatment (15 females, 14 males; χ^2 = 0.034, d.f. = 1, P > 0.75), or controls (7 females, 14 males; χ^2 = 2.333, d.f. = 1, P > 0.10). After treatment implementation (1997-1999), sex ratios also did not differ from 1: 1 in the salvage logged treatment (7 females, 12 males; χ^2 = 1.316, d.f. = 1, P > 0.25), unsalvaged gap treatment (7 females, 15 males; χ^2 = 2.909, d.f. = 1, P > 0.05), or controls (10 females, 12 males; χ^2 = 0.182, d.f. =

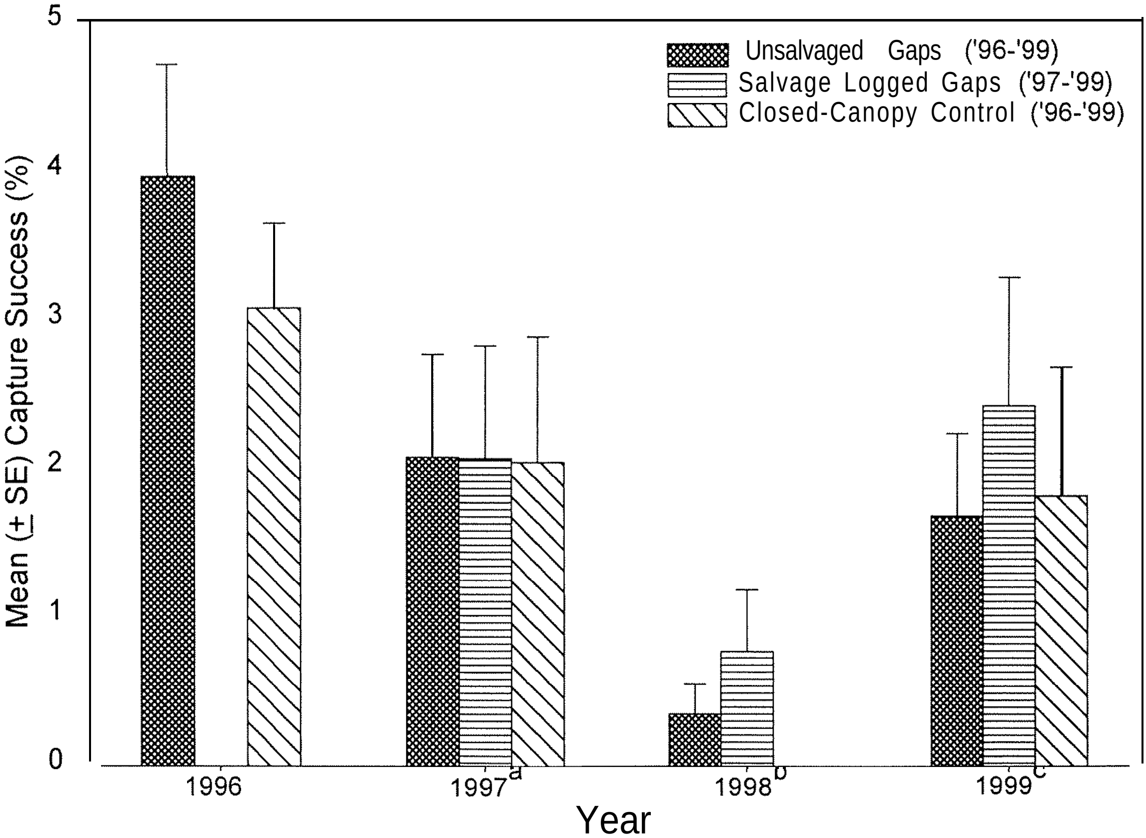

Fig. 1. Mean (±S.E.) capture success (%) of *P. leucopus* in unsalvaged gaps, salvage logged gaps, and closed-canopy controls in a southern Appalachian hardwood forest during 1996 (prior to salvage logging; pretreatment) and 1997-1999 (post-treatment). Data are presented as actual means but were arcsine square-root transformed for statistical analyses. Different letters denote significant differences among years (1997-1999 only). No differences among treatments were detected within or among years.

1, $P > 0.75$). Movement between study sites (detectable in all but the first year when ears were notched) was detected only in one case, when an adult female moved <100 m from an unsalvaged gap into an adjacent control site.

There was no difference between adult ($\geq$ 15 g) (Wolff, 1985a) male ($n = 76$ measured) and female ($n = 48$ measured) *P. leucopus* in head-body length (83.6 ± 0.7 versus 84.5 ± 1.6 mm; $t = 0.65$, $P = 0.52$) or body mass (19.8 ± 0.3 versus 19.X ± 0.6 g; $t = 0.08$, $P = 0.9326$). Head-body length did not differ among unsalvaged gaps (84.0 ± 0.9 mm), salvage logged gaps (SO.8 ± 1.1 mm), and controls (85.5 ± 1.1 mm) ($F = 2.09$, d.f. = 2, $P = 0.13$) or among years ($F = 0.36$, d.f. = 3, $P = 0.78$), and there was no treatment x year interaction ($F = 0.63$; d.f. = 4; $P = 0.64$). Body mass also was similar among treatments (19.4 ± 0.4 g unsalvaged; 19.6 ± 0.8 salvage logged; 20.6 ± 0.5 controls) ($F = 0.75$, d.f. = 3, $P = 0.65$), among years ($F = 0.55$, d.f. = 3, $P = 0.6489$), and there was no treatment x year interaction ($F = 0.24$, d.f. = 4, $P = 0.91$).

4.3. Microsite use

Capture success was higher at traps placed adjacent to CWD than with traps placed under brush or in the open (pit capture success differed from brush and open microsites at $P < 0.10$) ($F = 3.17$, $d.f. = 3$, $P = 0.03$) (Fig. 2).

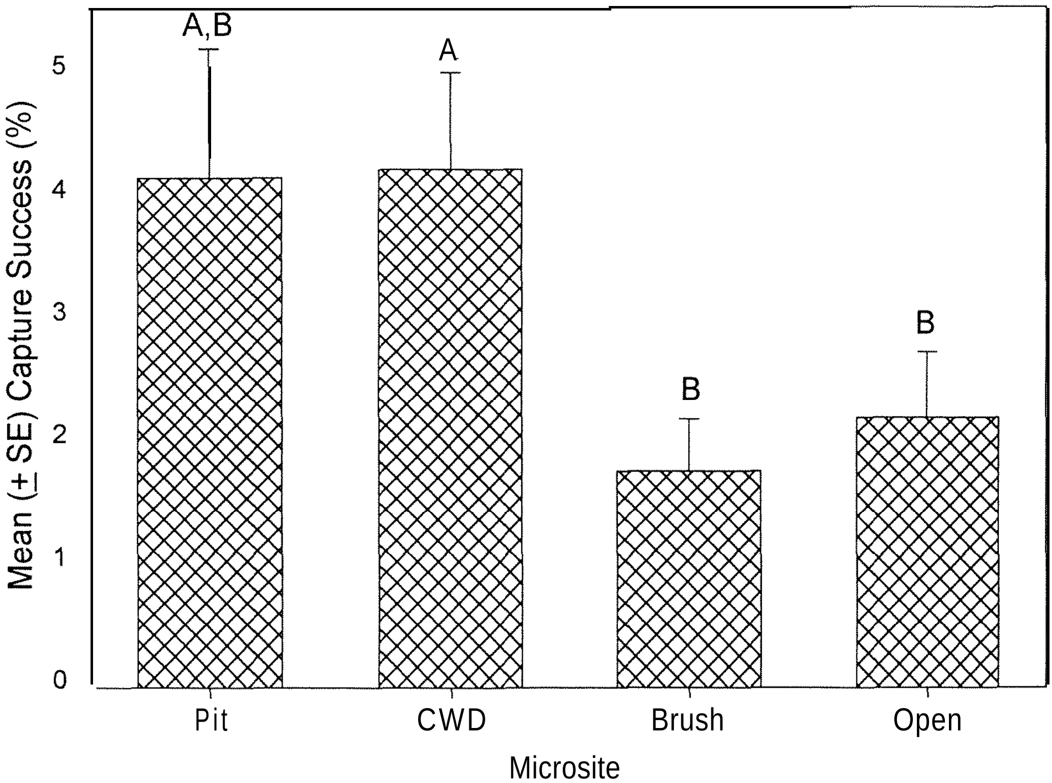

Fig. 2. Relative capture success (%) (±S.E.) of white-footed mice at traps placed in pits; adjacent to CWD: under woody brush; or on open ground in unsalvaged gaps, salvage logged gaps, and closed-canopy controls (only CWD and open microsites were tested in controls) in a southern Appalachian hardwood forest. Data are presented as actual means but were arcsine square-root transformed for statistical analyses. Different letters denote significant differences among treatments.

5. Discussion

Two lines of evidence suggest that CWD is an important habitat component for many rodent species. First, tracking techniques and correlations of capture success with the presence of CWD indicate that some species, including *P. leucopus*, heavily use CWD for travel, orientation, foraging, nesting, and refuge sites (Kirkland, 1990; Tallmon and Mills, 1994; McCay, 2000). Second, there is a positive relationship between the density of some rodent species and quantity of CWD (e.g. Miller and Getz, 1977; Seagle, 1985a; Planz and Kirkland, 1992; Loeb, 1999; Menzel et al., 1999). *Peromyscus leucopus* home-ranges could exceed (Wolff et al., 1983; Wolff, 1985a,b) or only partially encompass study gaps. Therefore, while I was unable to determine a population response per se to windthrow-created canopy gaps and associated microsites (CWD. pit and mound topography and woody brush), I could determine whether relative abundance (hence habitat use) differed among treatments that differed in the amount of CWD and other tested microsites (unsalvaged gaps, salvage logged gaps, or closed-canopy controls). It is possible that I did not use sufficiently high thresholds of CWD levels to determine its potential influence. However, the number of fallen trees within unsalvaged gaps was substantial, and representative of a relatively common type of natural disturbance in the southern Appalachians (Greenberg and McNab, 199X). Results of this study indicate that in the southern Appalachians canopy gaps and associated microsites do not affect habitat use or body size of *P. leucopus* at a landscape level.

Higher capture success near CWD than other microsites in this study indicates that *P. leucopus* uses CWD non-randomly in gaps and closed-canopy controls. Pits also were often used relative to brush and open ground ($P < 0.10$). Upon release I often observed mice going under root mass overhangs in pits, and into holes within pits as escape cover. Clearly, both CWD (fallen limbs and tree boles) and microsites created by fallen trees (pits and root masses) are used heavily by *P.* leucopus. Coarse woody debris was used significantly more than other microsites in all treatments despite differences in the amount of CWD between gaps (both treatments) and closed-canopy controls. Planz and Kirkland (1992) reported that significantly fewer *P.* leucopus were trapped after removal of woody litter >10 mm from small quadrats within a site, and fewer mice were trapped at litter-free quadrats than at quadrats with no litter removal. Their results suggest that areas with coarse woody debris are used more heavily than litter-free areas within a site. Results of this study indicate that in the southern Appalachians CWD does not influence macrohabitat use (unsalvaged gaps, salvage logged gaps, or closed-canopy controls) as determined by relative abundance, but clearly influences the microdistribution of *P.* leucopus within sites.

Disturbed areas could serve as rodent sources or sinks by affecting reproductive rates, predation intensity, and survival. Hence, comparing the relative abundance of rodents among sites does not alone adequately assess habitat quality (Van Horne, 1983). For example, Loeb (1999) reported that cotton mouse (*P. gossypinus*) density was higher, and females had higher survival rates and a higher likelihood of being in reproductive condition in South Carolina pine plantation plots with abundant CWD than in plots where CWD had been removed. 1 rarely observed evidence of reproductive activity, and captured few juveniles in any treatment. This may be because trapping was conducted in summer, when l? ***leucopus*** reproduction is often low (Wolff, 1985a). However, results of this study indicate that *P. leucopus* used unsalvaged gaps, salvage-logged gaps, and closed-canopy controls in similar numbers, and that gaps did not disproportionately attract any sex or age class.

Low capture success at all sites in 1998 suggests a response to a large-scale environmental influence other than local microsite availability. Wolff (1996) established a close, asynchronous correlation between production of acorns (an important food resource) and *P. leucopus* densities in the following year. A 1997 acorn crop failure within the study area (Greenberg, 2000) likely contributed to reduced numbers of ***P. leucopus*** in 1998.

Buckner and Shure (1985) reported higher densities of *P. leucopus* in small forest openings (especially in 0.8 ha openings, but also in openings up to 10 ha) than in controls. Other studies report higher, similar, or lower ***P. leucopus*** abundance (see Kirkland, 1990 for a review) in clearcuts than in forested sites. I found no differences in the relative abundance of ***l? leucopus*** in canopy gaps (unsalvaged or salvage logged) or closed-canopy controls, nor any evidence of a gap-size effect on local abundance over a 4-year period. Conflicting results among studies could be due to differences in forest types and geographic areas, differences in trapping periods, and conclusions based on single samples (Kirkland, 1990).

Several studies suggest that *P.* leucopus are habitat generalists (Miller and Getz, 1977; Dueser and Shugart, 1978; McComb and Rumsey, 1982; Seagle, 1985a,b). Kirkland (1990) suggests that many rodent species exploit recently disturbed sites, noting that they evolved in environments subject to intense, periodic natural disturbances. Animals also may use microhabitat differently in different habitat types (Seagle, 1985a). Results of this study also indicate that ***P. leucopus*** are tolerant of a wide range of habitat characteristics. Coarse woody debris is used opportunistically, but does not appear to be a critical habitat component for *P. leucopus* in the southern Appalachians.

Acknowledgements

This project was supported by the United States Department of Agriculture Southern Research Station and the Bent Creek Experimental Forest. I thank J. Odum, L.M. Smith, S. Freeman, V. Gibbs, J. Murphy, C. Perry, and T. Roof for assisting in trapping grid establishment. S.C. Loeb and J. Laerm provided valuable advice on trapping rodents. S.C. Loeb, W.M. Ford, and T.S. McCay and three anonymous reviewers provided input on earlier versions of this manuscript.

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