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## Small Mammal and Amphibian Abundance in Streamside and Upslope Habitats of Mature Douglas-fir Stands, Western Oregon

### Abstract

Capture rates of small mammals and amphibians were compared between streamside and upslope habitats along 700-m transects in each of six mature Douglas-fir stands, 1988. Equitability and diversity of small mammal communities were higher along streamside than upslope transects. There was no difference in small mammal or amphibian species richness per transect between streamside and upslope transects. Community similarity between streamside and upslope habitats was <55 percent for both amphibians and mammals. Capture rates of marsh shrews (*Sorex bendirii*), Pacific jumping mice (*Zapus trinotatus*), long-tailed voles (*Microtus longicaudus*), white-footed voles (*Phenacomys albipes*), and Dunn's salamanders (*Plethodon dunni*) were higher along streamside than upslope transects. Capture rates of western red-backed voles (*Clethrionomys californicus*), creeping voles (*M. oregoni*), Townsend's chipmunks (*Tamias townsendii*), Trowbridge's shrews (*S. trowbridgii*), and *Ensatina* salamanders (*Ensatina eschscholtzi*) were higher along upslope than streamside transects. Capture rates of marsh shrews, Pacific jumping mice, deer mice (*Peromyscus maniculatus*), shrew-moles (*Neurotrichus gibbsii*), and Pacific shrews (*S. pacificus*) decreased with distance from the stream along transriparian gradients. Capture rates of western red-backed voles increased with distance from the stream.

### Introduction

The importance of streamside habitat to maintaining small mammal diversity and abundance has been documented in the Midwest (Geier and Best 1980), southwest Oregon (Cross 1985), and the Oregon Cascades (Anthony *et al.* 1987, Doyle 1990). Few studies have been conducted on either small mammals or amphibians in streamside areas of the Oregon Coast Range, despite the need for this information to meet guidelines established by the National Forest Management Act (NFMA) and the Oregon Forest Practices Act (OFPA). The OFPA protects riparian vegetation for anadromous fish along fish-bearing streams and reduces non-point source pollution (Brazier and Brown 1973). The effects of OFPA regulations on terrestrial vertebrates are unknown.

Johnson and Lowe (1985) considered the transriparian gradient to be a major factor influencing the biological diversity and structural complexity of riparian zones in the southwestern United States. The influence of the transriparian gradient on small mammal or amphibian communities in western coniferous forests is largely unknown.

Our objectives were to: 1) compare small mammal and amphibian community structure and relative abundance between streamside and upslope habitats in mature Douglas-fir stands, 2) describe patterns of small mammal and amphibian abun-

dances along 400-m transriparian gradients in these stands, and 3) describe habitat associations of small mammals and amphibians.

### Study Area and Methods

The study was conducted in the Drift Creek drainage, Lincoln County, Oregon (123°60' long., 44°45' lat.). The drainage is 179 km<sup>2</sup>, almost completely forested, and has a bimodal age distribution of forest stands. About 50 percent of the drainage contains 0- to 30-year-old forest stands that regenerated following timber harvest. The remainder is dominated by mature forests (120-140 years old) that regenerated after a series of fires in the mid-1800's. We sampled within six mature stands that were >80 ha each, and contained a second- or third-order stream (Brown 1985:201). Streams averaged 2.8 m wide (SE = 0.4, range 2-5) and drained an average of 197 ha (SE = 345, range 82-330) of land. These stands were dominated by Douglas-fir (*Pseudotsuga menziesii*) and red alder (*Alnus rubra*); other tree species included western hemlock (*Tsuga heterophylla*), western redcedar (*Thuja plicata*) and bigleaf maple (*Acer macrophyllum*). Understory vegetation was dominated by salmonberry (*Rubus spectabilis*), salal (*Gaultheria shallon*), vine maple (*A. circinatum*), huckleberries (*Vaccinium* spp.), Oregon-grapes (*Berberis* spp.), stinking currant (*Ribes bracteosum*),

sword fern (*Polystichum munitum*), and devil's-club (*Oplopanax horridum*). Average weekly precipitation measured at a NOAA weather station in Tide-water, Oregon, 4-12 km south of the study sites was 3.6 cm (range = 0-9) during April-July (wet season) and 0.07 cm (range = 0-0.1) during August-October (dry season).

### Animal and Habitat Sampling

Within each stand we established a 700-m streamside transect < 10 m from the stream, a 700-m upslope transect (400 m upslope) parallel to the streamside transect, and two 400-m transriparian transects that connected the ends of the streamside and upslope transects. All sampling occurred > 100 m from the periphery of each stand. Pitfall trap stations were established every 100 m along the streamside and upslope transects and every 50 m along the transriparian transects ( $n = 180$  total stations). We subjectively placed two pitfall traps (double-deep No. 10 tin can) within 5 m of the station. Snap trap (Museum Special) stations were placed every 20 m along the streamside and upslope transects and every 10 m along the transriparian transects ( $n = 960$  total stations) such that one out of five snap trap stations coincided with a pitfall station. Two traps were set at each snap trap station in the wet season (see below).

We sampled stands in random order between 3 May and 28 June (wet season) and between 8 September and 15 October (dry season), 1988. Sampling was conducted during periods when the influence of the stream on use of riparian habitat by vertebrates may have been high (dry season) or low (wet season). Sampling was initiated in a new stand every seven days during the wet season and every day during the dry season. Within each stand, we set and checked Museum Specials daily during the first five sampling days (9,600 trap nights [TN]); the pitfalls were opened and checked weekly for 30 consecutive days (10,800 TN/season). All animals were removed from the sites. Specimens of shrews were deposited in the National Museum, Washington, D.C.; all other taxa were stored as frozen specimens in the Department of Forest Science, Oregon State University. Snap trapping was abandoned in the dry season because pitfalls sampled all but two of the common species captured during the wet season (McComb *et al.* 1991). Patterns of capture rates were similar between the wet and dry seasons, so capture rates

were averaged between seasons and averages were used in subsequent statistical analyses.

We either directly measured or derived 39 habitat variables that described floristics and vegetation structure at 20-m radius plots centered on pitfall stations (Table 1). Field measurements were conducted from May-September, 1988. Captures of mammals in snap traps within 20 m of a pitfall station were assigned to that pitfall station for habitat analyses because habitat characteristics were only measured at pitfall stations.

### Statistical Analyses

The total number of captures of each species at each trap station was determined and converted to capture rates (captures/1,000 TN). We tallied captures by species along streamside and upslope transects and calculated Shannon-Weaver species diversity ( $H' = -\sum p_i \log p_i$ ), equitability ( $E = H'_{observed}/H'_{max}$ ), and richness (number of species) for small mammal and amphibian communities (Brower and Zar 1984:157-160). We also calculated proportional community similarity (PS) between streamside and upslope transects (Brower and Zar 1984:161-164).

Analyses were conducted in three steps for each species: (1) comparison of capture rates and community structure between upslope and streamside transects, (2) association of capture rates with distance from water along the transriparian transects, and (3) identification of habitat variables that best separated capture sites from non-capture sites.

First, we tested the null hypothesis that capture rates did not differ ( $P < 0.05$ ) between streamside ( $n = 6$ ) and upslope transects ( $n = 6$ ) with a Wilcoxon rank-sum test because data were not normally distributed.

Second, Pearson correlation coefficients of capture rates with linear and log-linear distances from the stream were used to assess transriparian patterns of relative abundance for species with  $n \geq 20$  captures. Captures were pooled for each of the two sample points within each stand at each distance from the stream ( $n = 54$ ).

Third, for species with  $\geq 20$  capture sites and  $\geq 20$  non-capture sites (10 species), we used stepwise discriminant function analysis (DFA) to select no more than six independent ( $r < 0.80$ ) habitat characteristics that best separated capture sites from non-capture sites (Williams *et al.* 1990). Results are only reported for models with  $> 80$

TABLE 1. Habitat variables ( $\bar{x}$ , SE) along streamside ( $n^a = 6$ ) and upslope ( $n = 6$ ) transects in six mature Douglas-fir stands, 1988, Lincoln County, Oregon.

Habitat characteristic	Streamside	Upslope	$P^b$	Transformation <sup>c</sup>
<b>TOPOGRAPHY AND STRUCTURE</b>				
Distance to intermittent stream (m)	2 (0.2)	114 (13)	0.0001	Log
Distance to permanent stream (m)	2 (0.2)	245 (20)	0.0001	Log
Elevation (m)	288 (15)	421 (21)	0.0001	Log
Slope (%) <sup>d</sup>	47.6 (2.9)	44.6 (3.1)	0.6624	None
Litter depth (mm) <sup>e</sup>	2.1 (0.1)	5.0 (0.2)	0.0001	None
Vegetative cover (%) <sup>f</sup>				
Herb layer	49.1 (2.7)	67.1 (4.7)	0.1351	Logit
Shrubs < 1.3 m	22.3 (1.4)	73.4 (2.7)	0.0016	Logit
Shrubs 1.3-4 m	74.7 (2.1)	24.7 (3.4)	0.0021	Logit
Midstory (4 m to lower canopy)	21.9 (1.6)	11.5 (1.4)	0.0362	Logit
Overstory	43.6 (2.5)	69.6 (1.2)	0.0039	Logit
Basal area (m <sup>2</sup> /ha) <sup>g</sup>				
Conifers	17.5 (1.9)	54.5 (3.5)	0.0089	None
Hardwood	8.1 (1.3)	9.2 (2.0)	0.9762	None
Snags	6.0 (0.9)	18.2 (1.6)	0.0146	None
Total	31.7 (2.2)	81.7 (3.7)	0.0034	None
Log lengths (m/ha)				
10-19 cm dia.	233 (31)	227 (31)	0.8170	Log
20-49 cm dia.	354 (40)	348 (44)	0.5735	Log
> 50 cm dia.	865 (111)	414 (42)	0.1834	Log
Total	1452 (134)	990 (61)	0.0953	Log
Stumps <sup>h</sup> /ha	57 (7.2)	150 (13)	0.0188	Log
<b>COMPOSITION (% cover)<sup>f</sup></b>				
Forbs	35.6 (2.4)	10.3 (2.0)	0.0025	Logit
Grasses and sedges	4.2 (0.5)	4.6 (0.8)	0.9650	Logit
Ferns (primarily sword fern)	9.3 (1.3)	52.1 (3.3)	0.0019	Logit
Salal	0.0 (0.0)	17.6 (4.0)	0.0323	Logit
Oregon-grapes	0.0 (0.0)	8.8 (2.0)	0.0149	Logit
Salmonberry	56.4 (3.4)	9.6 (3.2)	0.0030	Logit
Stinking currant	14.4 (2.5)	0.1 (0.1)	0.0400	Logit
Huckleberries	2.1 (0.1)	5.6 (0.7)	0.0124	Logit
Devil's-club	4.0 (1.0)	0.4 (0.4)	0.0002	Logit
Vine maple	17.9 (2.2)	7.0 (1.9)	0.0205	Logit
Elderberries	1.3 (0.6)	0.0 (0.0)	0.0678	Logit
Hazels	1.6 (0.7)	0.0 (0.0)	0.2546	Logit
Plums ( <i>Prunus</i> spp.)	0.3 (0.1)	0.0 (0.0)	0.2070	Logit
Ocean-spray ( <i>Holodiscus discolor</i> )	0.1 (0.1)	0.3 (0.1)	0.2604	Logit
Rhododendrons ( <i>Rhododendron</i> spp.)	0.0 (0.0)	0.6 (0.5)	0.2729	Logit
Red alder	40.4 (3.9)	23.3 (4.0)	0.0842	Logit
Bigleaf maple	3.7 (1.1)	0.1 (0.1)	0.2051	Logit
Douglas-fir	14.4 (2.4)	58.7 (3.5)	0.0047	Logit
Western hemlock	10.5 (1.8)	9.9 (2.7)	0.8267	Logit
Western redcedar	7.1 (1.7)	0.3 (0.2)	0.0392	Logit

<sup>a</sup> $n$  = number of transects; each transect had 8 sample points 100 m apart.

<sup>b</sup>Two-way analysis of variance with stand as the block and the stand by transect interaction used as the error term to test transect effects.

<sup>c</sup>Log =  $\log_{10}(\text{value} + 1)$ ; Logit =  $\log(\text{proportion of value}/(1 - \text{proportion of value}))$ .

<sup>d</sup>Measured with a clinometer 20 m upslope and downslope from plot center.

<sup>e</sup>Average of 9 systematically arranged points 10 m apart/station.

<sup>f</sup>Ocular estimates of cover.

<sup>g</sup>Wedge prism tally for basal area.

<sup>h</sup>Stumps = dead standing stems > 10 cm diameter and < 2 m tall.

percent correct classification rates to minimize the probability of reporting spurious relationships (Rexstad *et al.* 1988). Interpretation of the results was based on linear correlations between the selected variables and the discriminant scores. For species with <20 non-capture sites, we used step-wise multiple regression to identify the set of habitat variables that best predicted capture rates/station. Only results with multiple  $R^2 > 50$  percent are reported. These analyses should be considered descriptive and exploratory because sample points along transects were distributed among six stands, so points within a stand were likely more dependent on one another than points among stands; hence there is the potential for patterns to be confounded by stand effects. We tried to minimize this effect by analyzing data only for species that occurred in all six stands.

We compared habitat characteristics between streamside and upslope transects with a two-way ANOVA. The stand-by-transect interaction was used to test the transect effect, when appropriate. In instances where residuals were not normally distributed or where variances were heterogeneous, analyses were conducted on transformed (logit, log, or rank) data to more closely meet the assumptions of ANOVA. Where transformations were unsuccessful, a Wilcoxon rank-sum test was used.

## Results and Discussion

### Habitat Comparisons

In addition to several major physiographic features (elevation and distance to permanent and intermittent streams), nine structural and 12 floristic habitat variables differed between streamside and upslope transects (Table 1). Streamside areas were characterized by having shallower litter depth, greater shrub cover in the 1.3- to 4-m layer, greater midstory cover, less shrub cover in the <1.3-m layer, less overstory cover, less basal area of snags and live conifers, and fewer stumps than upslope areas. These differences largely result from differences in floristics between streamside and upslope areas. Streamside transects had greater coverage by forbs, salmonberry, vine maple, red alder, stinking currant, elderberries (*Sambucus* spp.), western redcedar, and devil's-club, whereas upslope transects had greater coverage by ferns, salal, Oregon-grapes, huckleberries, and Douglas-fir.

### Streamside-Upslope Comparisons and Transiparian Analyses

In 31,200 TN, we caught 2,562 small mammals and 288 amphibians representing 18 of 22 small mammal species and 9 of 13 amphibian species known to occur in the central Oregon Coast Range (Brown 1985: appendix 8).

*Small mammals.*—Small mammal species diversity was higher on streamside than on upslope transects in the wet season, largely because equitability was higher on streamside than upslope transects (Table 2). Low upslope equitability was caused by the dominance of Trowbridge's shrews and western red-backed voles. The capture rate for all small mammals combined was negatively correlated with the log-linear distance from the stream (Table 3). Community similarity averaged <55 percent between streamside and upslope transects.

Capture rates of marsh shrews, Pacific jumping mice, long-tailed voles, and white-footed voles were higher along streamside than upslope transects (Table 2). Capture rates of Pacific shrews, marsh shrews, shrew-moles, Pacific Jumping mice, and deer mice were inversely related to distance from stream (Table 3) and dropped sharply from 50-100 m from the stream (Figure 1).

Capture rates for western red-backed voles, creeping voles, Trowbridge's shrews, and Townsend's chipmunks were higher along upslope than streamside transects (Table 2). Captures of western red-backed voles were positively associated with distance from the stream (Table 3) and rose abruptly beyond 200 m from the stream (Figure 1).

Neither streamside nor upslope habitats alone seemed to provide adequate habitat for all of the small mammal species that we sampled. These findings differ somewhat from those in the Oregon Cascades and the southern Coast Range. In the western Cascades, small mammal species richness was higher in riparian zones than in habitat 20-30 m upslope from the stream (Anthony *et al.* 1987). In the same area, Doyle (1990) found higher abundance and species richness of small mammals in fourth- and fifth-order streamside zones than in upland forest and higher equitability in upslope than streamside habitats, but these differences were not consistent over years. Five of 10 small mammal species trapped had higher relative abundance in streamside than upland habitat, including species

TABLE 2. Captures/1000 TN of small mammals and amphibians along streamside ( $n = 6$ ) and upslope ( $n = 6$ ) transects in six stands, Lincoln County, Oregon, 1988.

Species	Frequency of occurrence in stands (out of 6)	Captures/1000 TN						$P^b$
		Stream			Upslope			
		$\bar{x}$	(SE)	( $n^a$ )	$\bar{x}$	(SE)	( $n^a$ )	
<b>MAMMALS<sup>c</sup></b>								
Wandering shrew ( <i>Sorex vagrans</i> )	4	0.4	(0.2)	(3)	0.4	(0.2)	(3)	0.7842
Pacific shrew	6	11.4	(1.5)	(126)	7.2	(1.1)	(64)	0.1495
Marsh shrew	6	9.4	(1.0)	(105)	0.6	(0.3)	(5)	0.0030
Trowbridge's shrew	6	22.3	(2.0)	(273)	32.8	(2.6)	(372)	0.0247
Shrew-mole	6	2.5	(0.6)	(20)	1.3	(0.4)	(11)	0.2198
Coast mole ( <i>S. orarius</i> )	5	1.1	(0.4)	(9)	0.5	(0.2)	(4)	0.3359
Townsend's mole ( <i>Scapanus townsendii</i> )	2	0.3	(0.3)	(2)	0.1	(0.1)	(1)	0.9020
Mountain beaver ( <i>Aplodontia rufa</i> )	6	0.7	(0.4)	(6)	0.5	(0.2)	(4)	0.4844
Townsend's chipmunk	6	2.5	(0.6)	(6)	11.7	(2.2)	(28)	0.0235
Mazama pocket gopher ( <i>Thomomys mazama</i> )	2	0.1	(0.1)	(1)	0.3	(0.2)	(2)	0.5233
Deer mouse	6	10.0	(1.8)	(87)	4.2	(0.9)	(35)	0.2223
Dusky-footed woodrat ( <i>Neotoma fuscipes</i> )	1	0.1	(0.1)	(1)	0	(0)	(0)	0.3173
Western red-backed vole	6	1.1	(0.5)	(8)	17.1	(2.9)	(129)	0.0121
White-footed vole	6	1.2	(0.5)	(10)	0.1	(0.1)	(1)	0.0051
Red tree vole ( <i>P. longicaudus</i> )	2	0.1	(0.1)	(1)	0.1	(0.1)	(1)	1.0000
Long-tailed vole	4	0.6	(0.3)	(5)	0	(0)	(0)	0.0209
Creeping vole	6	0.5	(0.2)	(4)	2.1	(0.5)	(21)	0.0303
Pacific jumping mouse	6	11.4	(1.8)	(93)	1.3	(0.5)	(12)	0.0076
Total captures		53.0	(3.4)	(765)	48.7	(3.3)	(695)	0.8726
Species richness		7.8	(1.5)		7.4	(1.1)		0.6681
Species diversity ( $H'$ )		0.70	(0.09)		0.56	(0.07)		0.0211
Equitability		0.80	(0.05)		0.70	(0.06)		0.0062
Community similarity (%)				53.5	(3.5)			
<b>AMPHIBIANS<sup>c</sup></b>								
Pacific giant salamander	6	1.6	(0.5)	(9)	1.0	(0.4)	(6)	0.4029
Olympic salamander ( <i>Rhyacotriton olympicus</i> )	1	0.2	(0.2)	(1)	0	(0)	(0)	0.3173
Roughskin newt ( <i>Taricha granulosa</i> )	5	1.7	(0.6)	(10)	1.4	(0.5)	(8)	0.7350
Dunn's salamander	5	1.7	(0.5)	(13)	0.4	(0.2)	(2)	0.0855
Western redback salamander	5	3.0	(0.8)	(21)	2.6	(0.7)	(16)	0.7435
Ensatina salamander	5	0.2	(0.2)	(1)	1.9	(0.6)	(12)	0.0233
Clouded salamander ( <i>Aneides ferreus</i> )	2	0.2	(0.2)	(1)	0.2	(0.2)	(1)	1.0000
Tailed frog	6	4.3	(0.8)	(28)	3.2	(0.7)	(22)	0.3289
Red-legged frog ( <i>Rana aurora</i> )	1	0	(0)	(0)	0.2	(0.2)	(1)	0.3173
Total captures		10.9	(1.2)	(86)	8.9	(0.9)	(68)	0.2971
Species richness		3.3	(0.8)		3.1	(0.6)		0.4049
Species diversity ( $H'$ )		0.45	(0.10)		0.39	(0.10)		0.3379
Equitability		0.90	(0.05)		0.89	(0.05)		0.8381
Community similarity (%)				39.6	(5.3)			

<sup>a</sup>Number of captures.

<sup>b</sup>Wilcoxon rank-sum test.

<sup>c</sup>Mammal capture rates are based on pitfall and Museum special traps, except Townsend's chipmunks and dusky-footed woodrat rates are based on Museum Specials only and mountain beaver rates are based on pitfalls only. Amphibian capture rates based on pitfall sampling.

found on our study sites: Trowbridge's shrew, deer mouse, Pacific jumping mouse, creeping vole, and ermine (*Mustela erminea*). Doyle (1990) also reported western red-backed voles and Townsend's chipmunks to be more abundant in upslope than riparian habitats. Although most of Doyle's (1990)

findings are similar to ours, deer mice and Trowbridge's shrews seemed to have a stronger affinity for riparian habitat in the central Cascades than in the Coast Range. Cross (1985) reported higher abundances of deer mice, Pacific shrews, shrew-moles, and jumping mice in streamside zones

TABLE 3. Correlations between distance along transriparian transects and capture rates of small mammals and amphibians with  $\geq 20$  captures\* in six mature Douglas-fir stands, Lincoln County, Oregon, 1988 ( $n = 54$ ).

Species	Number of captures	Linear		Log-linear	
		<i>r</i>	<i>P</i>	<i>r</i>	<i>P</i>
<b>MAMMALS</b>					
Pacific shrew	138	-0.22	0.1116	-0.33	0.0164
Marsh shrew	33	-0.41	0.0019	-0.46	0.0005
Trowbridge's shrew	723	-0.04	0.7543	-0.09	0.5118
Shrew-mole	36	-0.32	0.0180	-0.30	0.0273
Townsend's chipmunk	29	+0.16	0.2566	+0.09	0.5287
Deer mouse	130	-0.53	0.0001	-0.53	0.0001
Western red-backed vole	200	+0.29	0.0340	+0.30	0.0280
Creeping vole	21	+0.18	0.1833	+0.20	0.1444
Pacific jumping mouse	52	-0.57	0.0001	-0.63	0.0001
Total mammals	1414	-0.29	0.0354	-0.33	0.0159
<b>AMPHIBIANS</b>					
Pacific giant salamander	23	-0.10	0.4808	-0.13	0.3590
Western redback salamander	39	+0.06	0.6636	+0.05	0.7000
Ensatina salamander	20	+0.07	0.5921	+0.10	0.4852
Tailed frog	63	-0.21	0.1186	-0.22	0.1100
Total amphibians	177	-0.20	0.1437	-0.24	0.0826

\*Other species captured along the transriparian transects include: clouded salamander (1), wandering shrew (8), coast mole (13), Townsend's mole (1), mountain beaver (13), Mazama pocket gopher (2), white-footed vole (5), red tree vole (3), ermine (1), rough-skin newt (12), Dunn's salamander (9), red-legged frog (1), and Olympic salamander (1).

than in upland or transition zones in southwest Oregon.

*Amphibians.*—Amphibian species richness, equitability and diversity did not differ between streamside and upslope transects, even though community similarity was <40 percent between the 2 habitat types (Table 2). Total amphibian captures declined with increasing distance from the stream along the transriparian transect, but this relationship was weak ( $r = 0.24$ ,  $P = 0.08$ , Table 3). Although some amphibian species require streams or ponds for reproduction, total amphibian captures were not associated with streamside habitat (Table 3).

More Dunn's salamanders were caught along streamside than upslope transects, whereas more ensatinas were caught along upslope than streamside transects (Table 2). No amphibian species exhibited associations with distance from stream along the transriparian transects ( $r < 0.22$ ).

#### Habitat Associations

Discriminant functions with correct classification rates >80 percent were obtained for only three of 10 species with  $\geq 20$  capture sites and  $\geq 20$  non-capture sites. In all three models, distance to

either intermittent or permanent streams was useful for discriminating capture sites from non-capture sites. Correct classification rates were <80 percent for deer mice (74%), Townsend's chipmunk (70%), shrew-mole (55%), Pacific shrew (70%), tailed frog (59%), western redback salamander (*Plethodon vehiculum*) (75%), and Pacific giant salamander (*Dicamptodon tenebrosus*, 67%). A multiple regression model to predict Trowbridge's shrew captures at each trap station was also weak ( $R^2 = 16\%$ ).

*Western red-backed vole.*—Capture sites were distinguished from non-capture sites by having less alder and forb coverage, greater coverage by Oregon-grapes and ferns, and by being farther from a stream (canonical  $R^2 = 45\%$ , Table 4). Upslope areas dominated by Douglas-fir and associated shrub and fern communities characterized habitat for western red-backed voles, consistent with the description of habitat given by Maser *et al.* (1981:196).

*Pacific jumping mouse.*—Capture sites were distinguished from non-capture sites by being closer to a permanent stream and having less coverage of shrubs <1.3 m tall (canonical  $R^2 = 49\%$ , Table 4). Early seral stage patches within the streamside

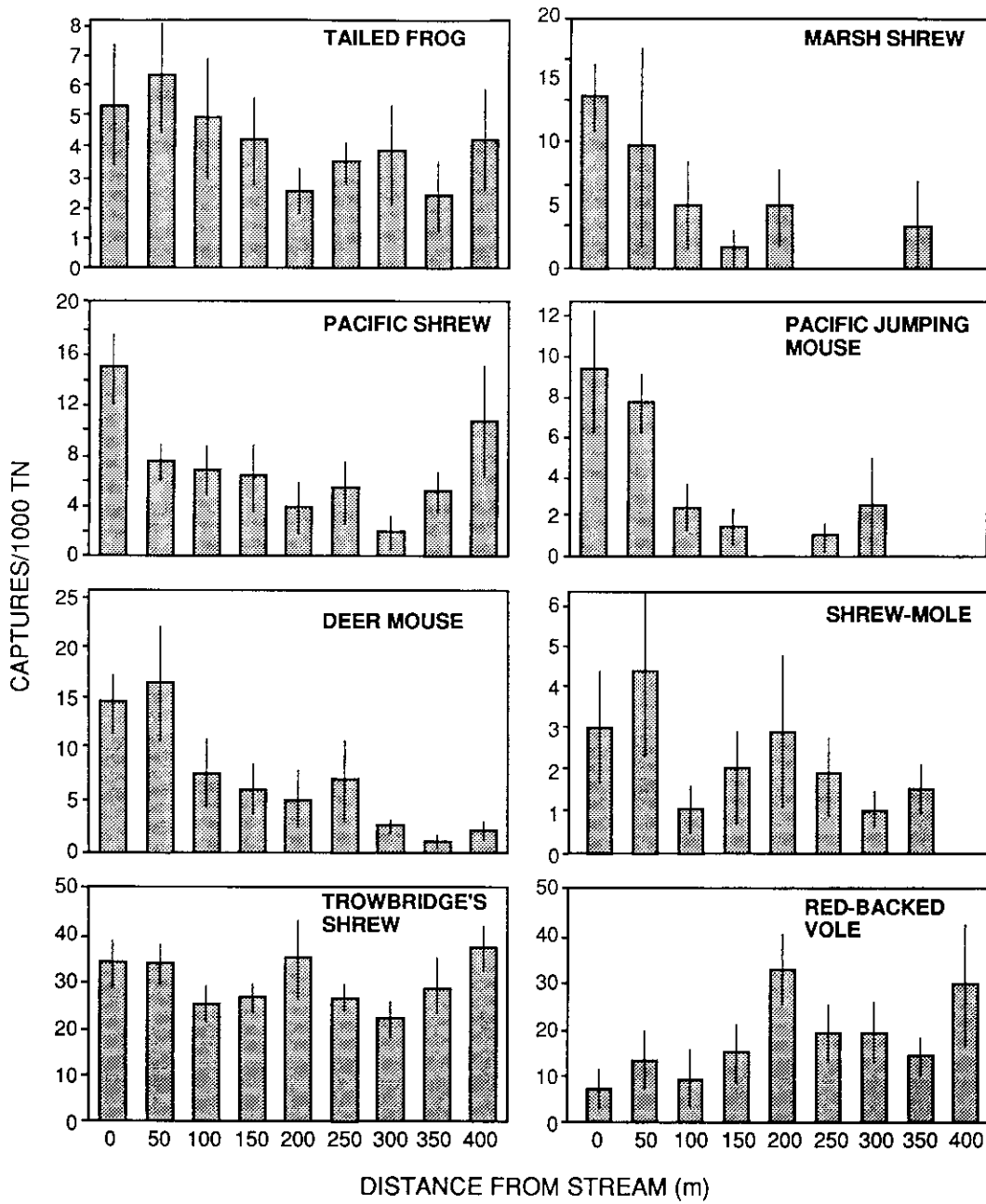


Figure 1. Average captures/1000 TN of 8 species along transriparian transects in six unmanaged, mature forest stands, Lincoln County, Oregon, 1988. Vertical bars indicate standard errors.

TABLE 4. Variables included in discriminant models for small mammals species in 6 mature Douglas-fir stands, Lincoln County, Oregon, 1988. Only correlation coefficients  $\geq 0.25$  with DFA scores are presented.

Species	<i>n</i> <sup>a</sup>	Habitat Feature	<i>r</i> with DFA
California red-backed vole	94/86	Alder cover	-0.76
		Oregon-grape cover	+0.65
		Dist. to intermittent stream	+0.63
		Forb cover	-0.61
Pacific jumping mouse	63/117	Fern cover	+0.56
		Dist. to permanent stream	-0.67
		Shrub cover <1.3 m tall	-0.58
		Stump density	-0.48
		Alder cover	+0.47
Marsh shrew	54/126	Elevation	-0.46
		Hazel cover	+0.29
		Dist. to permanent stream	-0.95
		Forb cover	+0.67
		Hazel cover	+0.39

<sup>a</sup>*n* = Number of capture sites/number of non-capture sites.

area characterized jumping mouse habitat in our stands, consistent with the description provided by Maser *et al.* (1981:232).

*Marsh shrew.*—Capture sites were distinguished from non-capture sites by being closer to a permanent stream and having greater coverage by forbs and hazel (canonical  $R^2 = 43\%$ , Table 4). They feed on aquatic insects and terrestrial invertebrates at the water's edge (Whitaker and Maser 1976), but little is known about the habitat needs of this species.

### Management Implications

Both streamside (24 species) and upslope (23 species) habitats contributed to the total species richness of 25. Some species occurred in lower numbers in one of these two habitats compared to the other, so small mammal and amphibian community structures differed between these streamside and upslope habitats.

Guidelines contained in the Oregon Forest Practices Act state that a riparian management area (RMA) with an average of three times the stream width (but not less than 7.6 m and not more than 30.3 m wide) shall be maintained on all fish-bearing streams. Within RMA's all logs on the ground prior to harvest, some live conifers, 50 percent of the preharvest shade level, and 75 percent of the shade over the aquatic zone must be retained following harvest. Federal land management agencies sometimes leave wider (30-50 m) RMA's to meet other needs, such as snag requirements. Tim-

ber harvest, which is usually in the form of clear-cutting, may occur outside of RMA's. If RMA's are >50 m on each side of the stream and managed to provide mature forest habitat for small mammals and amphibians, then most of the species that we sampled might find at least marginal habitat in RMA's prior to harvest of adjacent upslope areas. Marsh shrews, Pacific jumping mice, long-tailed voles, and white-footed voles might find optimal habitat in streamside areas. Harvesting adjacent upslope areas will have unknown effects on habitat quality within RMA's for the species that we sampled. For instance, if any of these species are adversely affected by induced edges (Brown 1985:119, *sensu* Temple 1986), then narrow RMA's may not even provide marginal habitat for such species.

Harris (1984:146-147) suggested that riparian areas could be used to link mature forest stands within landscapes. If streamside areas are intended to function as corridors, then consideration should be given to corridor width. Because of the dynamic nature of streamside systems [fluvial events and beaver (*Castor canadensis*) activity], they tend to be structurally and compositionally more complex than upslope areas. Narrow corridors (<50 m) with patchily distributed mature forest may not be sufficient as dispersal corridors for species strongly associated with one seral stage. Further study is needed to determine the level of forest disturbance that could occur in RMA's and still maintain optimal habitat for small mammals and amphibians.

Our data indicate that streamside corridors in mature forests may not be sufficient linkages for western red-backed voles. If land managers wish to promote linkages among upslope mature forest patches, then streamside corridors should be sufficiently wide to include optimal habitat used by western red-backed voles until additional data can be collected within streamside buffer strips to assess their value. Alternatively, intervening managed forest stands could be made more permeable to this species by retaining significant amounts of within-stand structure during harvest (green trees, snags, and logs), or by providing upslope corridors.

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