Influence of Alternative Silviculture on Small Mammals

Background

Small mammals are an important component of forest ecosystems in the Pacific Northwest and are the primary prey for many species of predators, such as the northern spotted owl and marten. In addition, small mammals play key roles in the dispersal of fungal spores and influence population dynamics of herbaceous and woody plants.

A variety of silvicultural methods (e.g., thinning, green-tree retention) can be used as alternatives to traditional clearcut systems to promote structural diversity within forest stands and to provide commodity production. However, our understanding of the responses of wildlife in general, and small mammals in particular, to these methods is poorly developed.

In recent years, there has been increased interest in retaining dead wood on the forest floor to promote biodiversity and other ecological values. Downed wood provides numerous benefits to small mammals, such as favorable microhabitat for dens and cover from predators. Research on how small mammals respond to downed wood in stands harvested with alternative silvicultural systems is lacking and would enable managers to better manage forest stands to meet multiple objectives, including timber and wildlife.

A recent study by CFER scientists Dave Waldien and John Hayes examined small mammal response to alternative silvicultural systems 8–12 years following harvest and in the first two years following addition of downed wood to the same stands. Specifically, their study objectives were to determine:

1. how populations of small mammals respond to alternative silvicultural treatments 8–12 years after harvest,
2. how downed wood influences small mammals for two years after the addition of wood, and
3. if path selection by Townsend's chipmunk is influenced by downed wood.

This study was located in the McDonald-Dunn Research Forest in the Oregon Coast Range (Figure 1). The Douglas-fir-dominated stands in this study were 30–90 years old and were part of a long-term research project with uncut control stands and replicates of three alternative silvicultural treatments implemented from 1989 to 1991. From least to most intense, the three treatments were small group-selection (where 33% of the stand volume is removed in patches), two-story (75% of the volume is uniformly removed), and clearcut. For their first objective, Waldien and Hayes sampled the small mammal population in two replicates of each stand

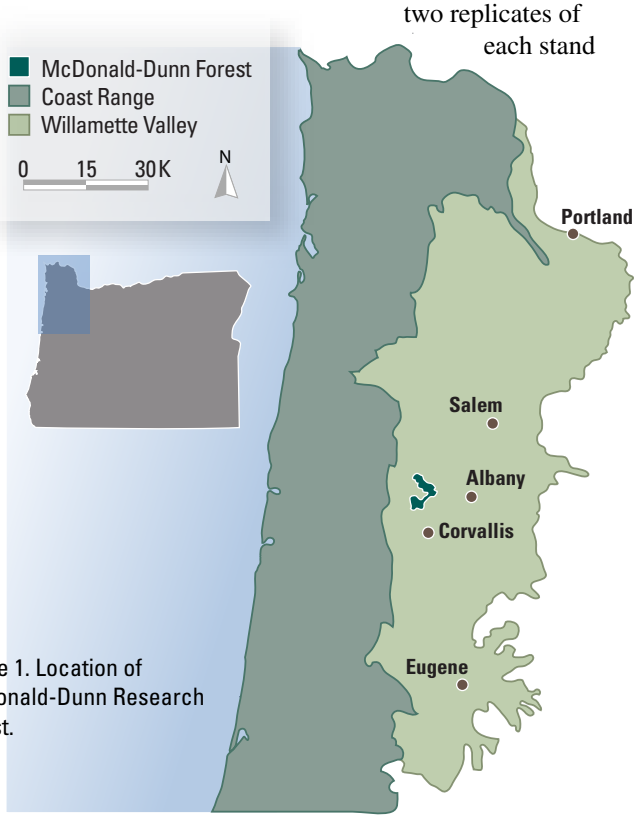

Figure 1. Location of McDonald-Dunn Research Forest.

type in three geographic blocks (24 stands total). Trapping sessions were conducted each year (1999 and 2000) during spring, summer, and fall. For the second objective, downed wood was added to a randomly selected group-selection stand from each replicate pair by felling five mature Douglas-fir trees within a trapping grid. Similarly, one clearcut was randomly selected from each replicate pair, and 11 mature Douglas-fir logs were placed by helicopter in a trapping grid (Figure 2). Trapping sessions were conducted each year (1999–2002) during spring, summer, and fall.

Figure 2. Tree being felled in group-selection stand (upper) and Douglas-fir logs ready for placement in clearcut stand (lower).

For the third objective, Townsend's chipmunks were trapped from July to September of 2001. Using the spool-and-line technique, thread was attached to each animal as it was released. At least four hours later, the researchers returned to the study area and followed the thread to measure the habitat along the chipmunk's path (Figure 3). Habitat use was classified as arboreal (in trees or shrubs), subterranean (below ground), or surficial (on the ground surface). Use of downed wood was evaluated by comparing presence of wood at points along the path to presence of wood at random points next to the path. Three models were developed to evaluate how wood availability, wood diameter, and whether the wood was elevated or not influenced path selection. These models were refined by examining influence of gender, season, or quantity of wood.

Results

Twenty-two species of small mammals were captured 35,138 times during 91,200 trap nights (one trap night = one trap set). The deer mouse was the most abundant species, with Townsend's chipmunk and Trowbridge's shrew the next most abundant (Table 1).

Response to silvicultural treatment depended on the species. The deer mouse, dusky-footed woodrat, Oregon vole, Pacific jumping mouse, Townsend's chipmunk, and vagrant shrew tended to be more abundant in stands 8–12 years after harvest than in controls (Figure 4). This likely reflects a relationship with the increasing understory vegetation following overstory removal. Although data were limited for analysis of northern flying squirrels and western red-backed voles, these two species were captured more often in control or group-selection stands where some forest canopy was retained, and less often or not at all in two-story and clearcut stands (Figure 5).

There were no clear responses by small mammals to the addition of downed wood. All measures for all species varied by season except for densities of Pacific and vagrant shrews. Lack of a clear response by small mammal populations to the addition of downed wood may be due to the newness of the wood used; the benefits of downed wood to small mammals may be related to how much the wood is decayed.

Forty-one chipmunks were tracked using the spool-and-line technique for a total of 5,093 m. The mean trail averaged 85% surficial, 15% arboreal, and <1% subterranean. Just over half of surficial trail use was associated with downed wood, and a

Figure 3. Line of thread marking chipmunk's path on the forest floor.

Table 1. Number of individual small mammals captured for the silvicultural treatment and downed wood treatment objectives. NW=no wood added. W=wood added.

	First Objective: Silvicultural Treatment					Second Objective: Wood Treatment				
						Group-Selection		Clearcut		
SPECIES	Control	Group-Selection	Two-Story	Clearcut	Total	NW	W	NW	W	Total
Virginia opossum	0	0	0	0	0	0	0	1	0	1
Pacific jumping mouse	1	4	26	10	41	8	5	26	30	69
Brush rabbit[1]	0	0	1	0	1	3	2	1	0	6
Western red-backed vole	16	22	4	0	42	25	35	2	1	63
Oregon vole	29	83	74	137	323	64	109	79	209	461
Townsend's vole	0	0	0	0	0	0	0	2	0	2
House mouse	1	0	0	0	1	0	1	0	0	1
Bushy-tailed woodrat	1	0	0	0	1	0	1	0	0	1
Dusky-footed woodrat	2	15	35	52	104	29	25	127	53	234
Deer mouse	910	1074	1293	1158	4435	1047	1045	1261	1012	4365
Ermine	4	8	8	11	31	8	5	9	11	33
Northern flying squirrel	27	18	0	0	45	21	36	0	0	57
California ground squirrel[1]	0	0	7	12	19	1	1	9	21	32
Townsend's chipmunk	98	261	336	208	903	350	336	300	310	1296
Douglas squirrel[1]	0	1	0	0	1	13	1	0	0	14
Baird's shrew	12	24	14	8	58	24	15	4	8	51
Pacific shrew	33	74	43	18	168	87	87	7	29	210
Fog shrew	17	37	23	18	95	24	30	10	13	77
Trowbridge's shrew	195	182	145	111	633	281	251	174	242	948
Vagrant shrew	5	18	34	80	137	16	25	57	108	206
Shrew-mole	4	0	0	0	4	4	1	1	1	7
Coast mole[1]	0	1	0	0	1	2	1	0	2	5
TOTAL[2]	1355	1822	2029	1799	7005	1967	2002	2049	2005	8023

[1]Represents number of captures because individuals were not marked.
[2]Does not include captures of California ground squirrels for the silviculture treatment or captures of brush rabbits, California ground squirrels, Douglas squirrels, and coast moles for the wood treatment because the number of individuals of these species were not tracked.

majority of this use was on top of logs. In all but one case, chipmunks disproportionately selected paths with downed wood relative to its availability (Figure 6). Size and quantity of wood also influenced path selection.

Management Implications

Forest managers often strive to balance timber revenues and forest biodiversity. Studies that investigate wildlife responses to alternative silvicultural practices help managers make informed decisions on how best to achieve this balance. This study suggests that group-selection and two-story harvesting are viable alternatives to clearcutting. These alternative silvicultural practices leave behind overstory that is important to some small mammal species, while creating gaps that allow early-successional species to increase in abundance. Of the three harvest systems examined, group selection is the method

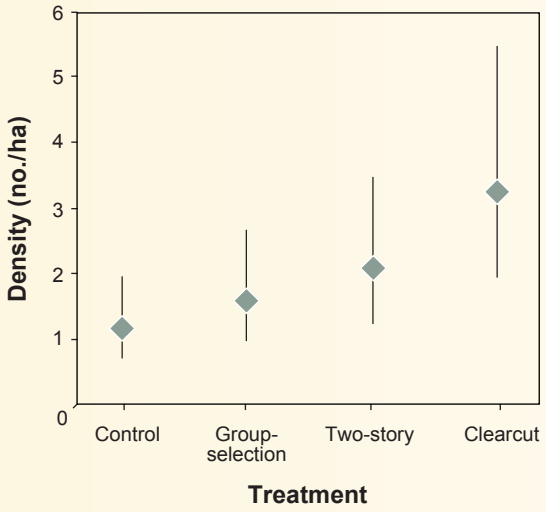

Figure 4. Density of vagrant shrews by silvicultural treatment.

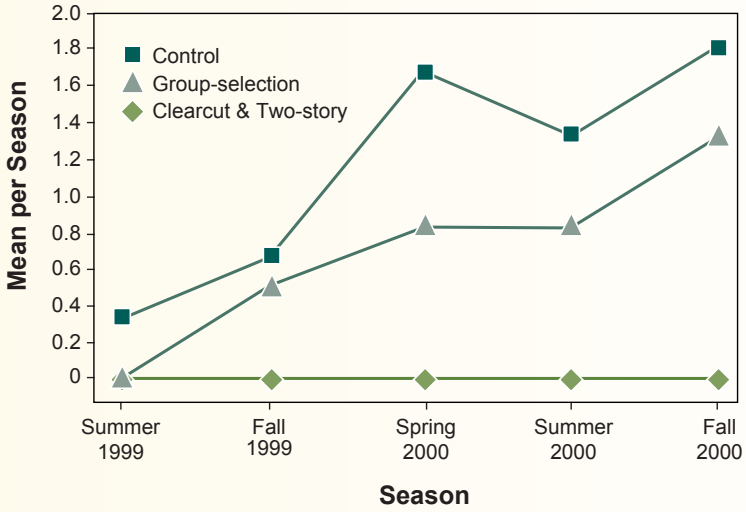

Figure 5. Mean captures per season of northern flying squirrels by silvicultural treatment.

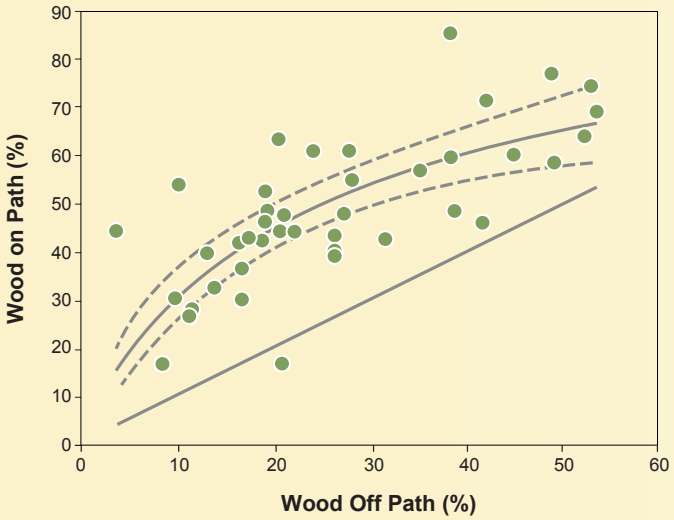

Figure 6. Percentage of wood on used paths vs. wood off of paths for Townsend's chipmunks. Values located above the line indicate a greater preference for paths with downed wood.

most likely to maintain populations of northern flying squirrels and western red-backed voles and allow some intermediate levels of timber harvest. This could potentially benefit northern spotted owls, which feed on these species.

The addition of downed wood to group-selection and clearcut stands may have been functionally redundant to the high levels of understory vegetation present in these stands, thus leading to no significant response by small mammals. However, Townsend's chipmunks disproportionately selected plots with downed wood. These seemingly contradictory findings may be explained in part by the high variability in chipmunk populations, making it difficult to measure the benefits of downed wood at the population level in field settings. Further studies are needed at individual and population levels to examine the importance of downed wood across multiple spatial scales.

Contributing Scientists

Dr. David L. Waldien received his doctoral degree from Oregon State University in February 2005. Currently he is a conservation scientist and co-director of programs for Bat Conservation International.

Dr. John P. Hayes is a wildlife ecologist for the CFER program. He also serves as the Associate Dean of International Programs for the College of Forestry and as a professor in the Department of Forest Science at Oregon State University.

Research Highlights

- Species associated with open forest canopies were similarly abundant in all three silvicultural treatments and control stands.
- Species associated with closed overstory forest canopies tended to be captured less often in harvested stands.
- Group-selection stands appear to provide habitat for northern flying squirrels and western red-backed voles while still allowing for timber harvest.
- Chipmunks disproportionately selected paths with downed wood–54% of the average path was within 50 cm of downed wood and only 29% of the nearby area not selected by chipmunks had downed wood.

For Further Reading

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