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YOUNG STAND THINNING & DIVERSITY MONITORING PROJECT

WILDLIFE PRETREATMENT REPORT

Pre-treatment Analysis of Wildlife - Habitat Relationships in Young Managed Stands in the Oregon Cascade Range

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Introduction

Harvest of timber over the past 50 years in western Oregon has led to a proportional increase in the area of managed forest ≤50 years old relative to area occupied by old-growth or natural young stands. Young stands that regenerate following clearcut harvesting may differ considerably in structural composition from naturally regenerated young stands, and certainly differ from old-growth. Thus, a consequence of the predominance of young, managed stands on the landscape may be a deficit of habitat for wildlife that are associated either with late successional forest or special habitat components in naturally regenerated young stands (e.g., woody debris). Interest in the management of young Douglas-fir forests to provide future habitat for species associated with late successional forests has been increasing in recent years. Managers required to maintain populations of wildlife associated with late-successional forest characteristics are interested in exploring silvicultural practices that could decrease the amount of time required for young forests to become suitable habitat for species associated with features characteristic of natural young or old-growth forests.

The Cascade Center for Ecosystem Management initiated the Young Stand Thinning and Diversity Study on the Willamette National Forest to investigate the effects of several management regimes of young stands on vegetation and wildlife. The overall objective of the wildlife portion of the study is to evaluate the influence of various thinning regimes on abundance of wildlife. The objective of pre-treatment data collection was to provide baseline data on the abundance of diurnal birds and common forest-floor vertebrates and their habitat-relationships. We will use these data as a baseline to determine changes in abundance of wildlife populations following application of the silvicultural treatments, and to relate differences in abundance to changes in forest structure and vegetation patterns. Here we report on the composition of the vertebrate communities and the abundance of their component species prior to the application of the silvicultural treatments. In addition, we report on relationships between selected species and habitat features.

Study Sites

We collected data in 16 33- to 43-year old Douglas-fir stands in the McKenzie, Blue River, and Oakridge Ranger Districts of the Willamette National Forest. All sites are in the *Tsuga heterophylla* vegetation zone (Franklin and Dyrness 1988) on the western slope of the Cascade range in Oregon. Douglas-fir (*Pseudotsuga menziesii*) was the dominant overstory tree species; other tree species present included western hemlock (*Tsuga heterophylla*) , western redcedar (*Thuja plicata)*, bigleaf maple (*Acer macrophyllum*), and madrone (*Arbutus menziesii*). Common understory shrubs included vinemaple (*Acer circinatum*), Oregon grape (*Berberis nervosa*), salal (*Gaultheria shallon*), rhododendron (*Rhododendron macrophyllum*) , *Vaccinium* species, and sword fern (*Polystichum munitum*). Sites ranged in elevation from 439- to 905 m and were relatively flat (slope range, 0 - 24%).

Most of the study sites regenerated naturally following clearcut harvesting and burning, although the 4 stands in the Blue River district were planted following harvest and site preparation to supplement natural regeneration. The hot fires used in site preparation typically removed most slash and duff, except for the largest logs. As a result of the harvesting practices of the era, few large (>50 cm diameter) snags remain in these stands. However, suppression mortality resulting from high stem density (range, 417 - 825 stems/ha) has created numerous small (< 20 cm diameter) snags. The average stand diameter for live trees ranged from 24- to 34-cm diameter at breast height (dbh).

Study Design

We selected stands in 4 geographic blocks for the study (1 block each in McKenzie and Blue

River Ranger Districts, and 2 blocks in Oakridge Ranger District). Each District determined the stand boundaries and the assignment of treatments to the stands within their jurisdiction. Each of the 4 stands comprising a block was assigned a different treatment (Table 1).

Table 1. Treatments to be applied in young Stand Thinning and Diversity Study.

Treatment	Residual tree density	Gaps created	Underplanting
Control	existing density	none	none
Light Thin	100 - 120 TPA[1]	none	none
Light Thin with Gaps	100 -120 TPA	two ½ acre gaps per 10 acres	conifers in gaps
Heavy Thin	50 TPA	none	conifers throughout

[1] Trees per acre

Methods

Bird Surveys

We established 5 bird count stations in each stand. Stations were separated by ≥ 140 m, and were ≥ 50 m from stand edges. A single observer surveyed birds at the point count stations in each stand from 4 May to 25 June in 1992, and from 8 May to 30 June in 1993. The observer recorded the species of and distance to each bird detected during an 8 minute count period preceded by a 2 minute wait period at each station. Four visits were made to each stand at intervals of 8 to 12 days throughout the sample period. The observer conducted surveys between ½ hour before and 4 hours after sunrise on days without rain or strong wind.

Small mammal and herpetofauna trapping

We established one 5x5 grid for pitfall traps and one 10x10 grid for Sherman live-traps in each stand. Each grid had 20-m spacing between adjacent traps. We placed trapping grids in stands within the constraints of 1) a minimum of 50 m between any trap and a stand edge and 2) grids for pitfalls and live-traps did not overlap. Traps within a grid were placed next to a log or other natural runway near the grid point. Pitfalls were made from double-deep number 10 tin cans with holes punched in the bottom to allow drainage and the open end set flush with the surface of the ground. We baited all traps with pellets coated with peanut butter. We put batting in the traps for bedding, to reduce mortality of small mammals from hypothermia, and slipped the Sherman traps inside open, one-half gallon milk cartons, to provide additional insulation and protection for the traps. In pitfall traps, we placed batting inside one-half pint cartons.

We opened traps and checked them daily for 8 consecutive days between 22 October and 27 November, 1992 and 1993. Stands within a geographic block were trapped simultaneously, and blocks were trapped in the same chronological sequence each year. Animals were identified to species, weighed, aged, sexed, toe-clipped, and released. Animals that died in traps were stored in a freezer at OSU for later verification of species identification.

Habitat Data

We established 4 satellite points at a random distance 15- to 40-m from the center of each bird count point (N=20 plots/stand). At each satellite point we estimated percent canopy cover using a moosehorn and we measured litter depth (mm). We estimated volume (m^3) of vegetation by layer (herb, shrub, and tree), and of the most common tree and shrub species, in 10-m radius circular plots centered on each satellite point. To estimate volume, a single observer made ocular estimations of the percent of an imaginary cylinder containing live foliage in each the herb, shrub, and tree layers. This percentage was multiplied by the height of the layer and Πr^2 (where r=10 m) to derive volumes at the plot level. Volumes were averaged over the 20 satellite plots within each stand to derive mean volumes by vegetation layer and plant species at the stand level.

We used data describing understory vegetation cover, conifer regeneration, coarse woody debris, and overstory gaps collected by the crew documenting vegetation patterns and response (G.

Tucker, pers. comm.) They collected data in a continuous series of 20 x 20 m plots (i.e., belt transects), covering 5-8% of the stand area. They categorized vegetative cover on each plot into one of 6 classes (0-9, 10-20, 21-40, 41-60, 61-80, 81-100%) based on visual estimates for 4 strata of vegetation: moss, low shrubs, medium shrubs, and overstory. Herb and moss cover was estimated in a 3.7 x 20 m subplot centered in the full plot. The vegetation crew tallied conifer seedlings (< 1.4 m in height) and saplings (> 1.4 m in height, < 12.7 cm dbh) by species on subplots. They estimated percent cover by class of coarse woody debris (≥ 30.5 cm in diameter and ≥ 3 m in length) and tallied snags (≥ 25.4 cm dbh, ≥ 6.1 m in height) on the full plot. They estimated percent cover class of canopy gaps that spanned an area greater than or equal to the space occupied by two overstory crowns.

We derived variables describing lengths of logs by size and decay classes from data collected during stand examinations. Stand exam plots were 0.02 ha in size, and the number of plots/stand ranged from 5 to 23. We summed log lengths by size (< 20.3 cm, 20.4 - 60.9 cm, and > 60.9 cm diameter) and decay classes (decay 1-3 and decay 4-5, Maser et al. 1979) for each plot, and averaged among plots to derive a stand-level mean.

Data Analysis

We selected bird species that were observed at least two times in at least three of the four geographic blocks and at least one time in 10 of the 16 stands for analysis of treatment and year effects. We determined an effective detection distance for species meeting these criteria by sorting observations into 10-m distance bands; a 50% decrease in number of observations from one distance band to the next determined the detection distance cut-off (Reynolds et al. 1980) .We used the outer distance of the band including 75% of the observations as the effective distance if 75% of observations were made before they decreased by 50% between distance bands.

We calculated an index of bird abundance as the number of observations of each species (within the appropriate detection distance) summed over 5 count points and averaged over 4 visits/year in each stand (N=16). We calculated species richness as the total number of species detected in each stand, not including fly-overs and species observed fewer than two times. We used an effective detection distance of 100 m for species richness and 80 m for total abundance (all species combined). We did not use repeat counts of individual birds in any of the analyses.

We used number of individuals captured per 100 trap nights, excluding recaptures, as an index of abundance for forest floor vertebrates. This index was calculated by dividing the total number of individuals captured of each species in each stand by the number of undisturbed trap nights, then multiplying by 100. We designated traps as disturbed when we found them closed but empty. We selected forest-floor vertebrate species that were captured at least once in $\geq$ 14 of the 16 stands for analysis of treatment and year effects. We examined scatter plots of date vs. captures to determine if a temporal effect related to season influenced capture rate. For species apparently influenced by season, we used only data from those stands trapped during the animal's active period in the habitat relationships models.

We tested for differences in abundance among treatment assignments even though the data was collected prior to application of treatments in order to document any random bias in the assignment of treatments. While it is important to note these biases, the comparison of pre- to post-treatment means will account for treatment effects. We used a split plot ANOVA (Proc Mixed, SAS 1985) to test for differences in mean abundance (birds and forest floor vertebrates) among treatment assignments, between years, and between years within treatment assignments (year by treatment interactions) for those species exhibiting normal distributions and constant variance. For those species for which a treatment assignment effect was indicated, a least-squares means test was used to compare means (lsmeans, SAS 1985). Similarily, when an interactive effect of year and treatment was indicated, we used least-squares means to compare treatment means within a year. For species which deviated from assumptions of normal distribution and/or constant variance that transformations could not correct, we tested for pre-treatment biases among treatment groups separately for each year using a Friedman's test, and tested for a year effect using single-factor ANOVA.

We developed regression models describing habitat-relationships for bird and forest floor vertebrate species present in >12 stands (2 years combined). We did not develop models for species whose abundance varied inconsistently among treatment assignments between the 2 sampling seasons (Swainson's thrush; see Appendix A. for scientific names of birds).

Results and Discussion

Birds

A total of 44 species and 4739 individual observations of birds were recorded within 100 m of bird sample points in both years of surveying combined (not including fly-overs or repeat observations of a given individual at the same count station on the same day; including species with only a single observation). Forty-two species and 2307 individuals were recorded in 1992, and 33 species and 2432 individuals were recorded in 1993. The 7 most frequently observed species comprised > 75% of all the observations in the two years combined (Figure 1).

Total abundance and the abundance of five species differed between years ($P < 0.10$; Table 1). Golden-crowned kinglets were the only species more abundant (1.3 times) in 1992 than 1993. The abundance of hermit warblers, Pacific-slope flycatchers, Swainson's thrushes, hermit thrushes, and total abundance were all greater (1.2 - 1.5 times) in 1993 than 1992. The abundance of only one bird species seemed to be affected by a pre-treatment bias in the assignment of treatments: hermit thrushes were more abundant (average of 1.5 times) in the stands which are to receive the heavy thinning than in the control stands and those that will receive light thinning (Table 2). An interaction of year and treatment group effects was indicated for one bird species. Swainson's thrushes were less abundant (0.42 - 0.49 times) in stands that will receive light thinning with gaps than in any of the other treatment assignments in 1993 (when their overall abundance was greater), but their abundance did not differ among pre-treatment groups in 1992 (Table 3).

We developed multiple regression models of bird abundance as a function of habitat variables in order to qualitatively predict changes in abundance in response to silvicultural treatments. Nine bird species, total abundance, and bird species richness met the criteria for regression analysis.

The range in variability of most habitat variables related to conifers was very narrow, which may explain why they were generally poor predictors of bird abundance. For example, hermit warblers nest and forage almost exclusively in canopies of conifers, but no habitat variables were selected by the stepwise regression procedure to explain variation in their abundance among stands. However, variation in conifer-related variables was associated with variation in the abundance of three species (Table 4). The abundance of hermit thrushes and red-breasted nuthatches was positively associated with basal area of conifers. The abundance of winter wrens was negatively associated with stem densities of conifers. It is difficult to predict changes in the abundance of birds following silvicultural manipulations of the density of conifer stems based on these results because the stands we sampled represent only a small slice of the full range of densities expected under natural conditions. Relationships between bird abundance and conifer basal area, for example, are likely not linear throughout the full range of natural conditions.

Variables related to the density or cover of hardwood trees were positively associated with the abundance of black-throated gray warblers, Hutton's vireos, and Pacific-slope flycatchers, and negatively associated with the abundance of chestnut-backed chickadees. Hardwood stem density also was positively associated with species richness and total abundance (Table 4). Because the silvicultural prescriptions called for retaining hardwoods wherever possible during thinning operations, species positively associated with hardwoods, bird species richness, and total bird abundance are expected to show a positive response to thinning. The response may be confounded if some of these species respond strongly to other variables in addition to hardwoods (e.g. Hutton's vireos also were associated with medium shrub cover (see below)).

The abundance of three species and total abundance of birds were associated with characteristics of the understory vegetation (Table 4). The abundance of Hutton's vireos was negatively associated with percent cover of medium shrubs, whereas the abundance of hermit thrushes was positively associated with cover of vine maple. Because the cover of medium shrubs, including vine maple may be expected to increase in the thinned stands in the first few years following treatment, we expect that the abundance of Hutton's vireos may decrease while that of hermit thrushes may increase. However, the silvicultural prescription for a heavily thinned stand and a stand with gaps on one of the replicates calls for suppression of vine maple. Where vine maple is artificially suppressed, we expect to see a decrease or no change in the abundance of hermit thrushes. The abundance of dark-eyed juncos and total abundance was negatively associated with cover of low shrubs and volume of ferns. Based on these relationships, we might expect abundance of juncos to decrease in thinned stands where shrubs and ferns may respond positively to increased light levels. However, other studies have noted increases in abundance of juncos following removal of trees because increased production of herbs may have provided a source of food for this seed-eating species (Hagar et al. 1996, Artman 1990).

Coarse woody debris was associated with the abundance of three bird species; none of them were cavity-nesting and/or bark-foraging species as might have been expected. Cover of logs was positively associated with the abundance of dark-eyed juncos and hermit thrushes. Snags were selected in only one model; black-throated gray warblers were negatively associated with hard snags. Black-throated gray warblers may have been avoiding very dense conifer stands where small-diameter, hard snags were most abundant as a result of suppression mortality.

In addition to changes in the abundances of birds that were common in the stands prior to silvicultural treatment, we also will look for changes in the abundances of rare species, and in the composition of the avian assemblages after treatments are applied. For example, woodpeckers were rare in our pre-treament stands. The three species of woodpeckers recorded (northern flicker, pileated woodpecker, and hairy woodpecker) were each observed in fewer than 5 stands in both years of surveys combined. Brown creepers also were relatively uncommon in our study areas, occurring in fewer than half of the stands in one or both of the survey years. Gilbert and Allwine (1991) considered hairy woodpeckers and brown creepers to be old-growth associates, so it is not surprising that they were rare in the young stands we examined. Recent research in the Oregon Coast Range has indicated that some bark-foraging, cavity-nesting bird species (e.g., hairy woodpecker, red-breasted nuthatch) may increase in abundance in response to thinning (Hagar et al. 1996, Adam et al. 1996). Therefore, we hypothesize that the abundance of cavity-nesting species will increase in thinned stands, although the magnitude of this response will likely vary with species and is probably not linear. We hope to better define these relationships by quantifying the post-treatment response.

Rufous hummingbirds and varied thrushes, also considered old-growth associates (Gilbert and Allwine 1991), were uncommon in the young stands we surveyed. Both of these species were absent from at least half of the stands in one or both of the survey years. Hummingbirds may be associated with canopy gaps that are a feature of old-growth forests, and may have been rare in the stands we surveyed because the dense, continuous overstory did not allow for the development of flowering plants that attract hummingbirds. Post-treatment bird surveys will indicate whether rufous hummingbirds respond to the decrease in canopy cover in the thinned and gapped treatments. In a study on bird response to thinning in the northern Oregon Coast Range, varied thrush abundance decreased after harvest (Adam et al. 1996). Varied thrushes may not begin to increase in abundance until stands develop some of the characteristics of old-growth. We expect that thinned stands will develop old-growth structure sooner than untreated stands, so while varied thrush abundance may decrease in the short term in thinned stands, long-term response may be positive.

Forest floor vertebrates

Seven species of amphibians and 16 species of mammals were captured during the combined trapping seasons (1991 and 1992). *E. eschscholtzi* was the only amphibian species captured frequently enough (>75% of total amphibian captures, 43 out of 57 individuals) to provide useful data for analysis. Five mammal species (*Peromyscus maniculatus, Clethrionomys californicus, Sorex trowbridgii, Glaucomys sabrinus* , and *Tamias townsendii*) plus a shrew complex (*Sorex* species) were captured with sufficient frequency to perform statistical analyses.

Variability in the capture rates of forest floor vertebrates between years and among treatment assignments ranged from 15 - 93%. The capture rate of *E. eschscholtzi* was 2.4 times greater in 1991 than 1992, but that of *C. californicus* was 2.2 times greater in 1992 than 1991 (Table 5). Species richness (average number of species captured/stand) of forest floor vertebrates was marginally (1.2 times) greater in 1992 than 1991 ($P = 0.10$). Total capture rate was 0.62 times lower ($P = 0.07$) in the control group than in any of the groups that will receive silvicultural treatments (Table 6). The capture rate of *G. sabrinus* averaged at least 13.6 times greater in the stands that will receive the light thinning than in stands designated for no treatment or heavy thinning (Table 7). Capture rates of 4 small mammal species did not differ between years or among treatment groups.

Most amphibian species in Pacific Northwest forests are aquatic for part or all of their life cycle and are therefore most abundant in or near riparian areas. *E. eschscholtzi* are an exception because they are more abundant in drier upslope habitats than in wet areas in western Oregon forests. Most of our study areas were upslope sites, so it is not surprising that *E. eschscholtzi* was the only amphibian species captured regularly. *E. eschscholtzi* was positively associated with conifer basal area and small diameter logs in our study stands (Table 8). Conifer basal area will decrease in thinned stands in the short term, so the capture rate of *E. eschscholtzi* also is expected to decrease.

Aneides ferreus also sometimes occur in upslope habitats if the large logs with which they are associated are available. We had only two captures of *A. ferreus* in both years of sampling combined. We hypothesize that amphibians as a group will be negatively impacted by thinning in the short term. However, over the long term thinned stands may provide better amphibian habitat because they are expected to produce large (>50 cm) diameter woody material sooner than untreated stands.

Peromyscus maniculatus and *Sorex trowbridgii* were the 2 most abundant small mammals in our study stands, accounting for more than 70% of all mammal captures. Regression models for mammals explained 48 - 85% of variability in capture rates among stands, and most variables selected characteristics of forest floor, such as herb, shrub, seedling cover (Table 8).

We hypothesize that small mammal species that respond favorably to open conditions and understory vegetation, such as *P. maniculatus* and *T. townsendii*, will increase in abundance following thinning. We predict that *C. californicus* and *Sorex* species will not be impacted by light thinning, and may increase if thinning results in increases in quantities of coarse woody debris on the forest floor.

Timeline for Post-treatment Data Collection

1997 - We will conduct the first post-treatment bird survey in the blocks in which harvesting has been completed. We will re-establish trapping grids for small vertebrates during the summer, and conduct the first post-treatment trapping session in all blocks where harvesting has been completed in the fall.

1998 - The second post-treatment sampling sessions for birds and small vertebrates will be conducted. We will report on the results from the first post-treatment sampling.

1999 - The third post-treatment sampling sessions for birds and small vertebrates will be conducted. Reports on post-treatment data will be compiled.

2000 - The fourth post-treatment sampling sessions for birds and small vertebrates will be conducted. Study on wildlife use of created snags will be initiated.

2001 - .... Sampling of bird and small vertebrates will continue every 1-5 years.

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Figure 1. Breeding bird community composition (% of total observations within 100 m of observer) in young (30- to 50-year old), managed Douglas-fir stands, Oregon Cascades, 1992 and 1993.

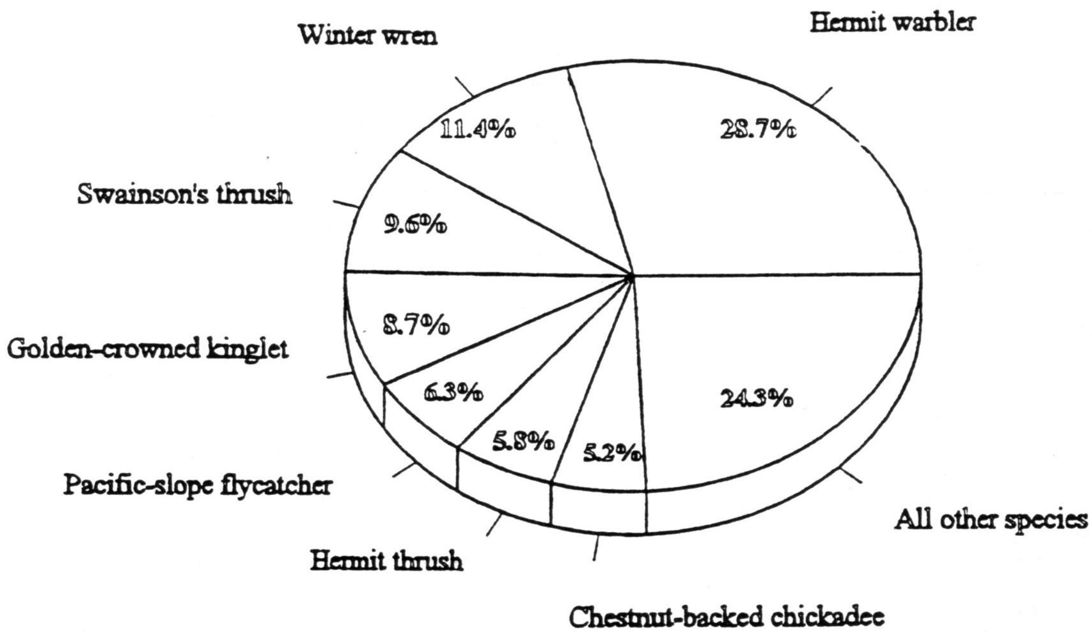

Table 1. Bird abundance indices (observations/visit/stand) by year (4 visits/year) for 16 Douglas-fir stands prior to silvicultural treatment, Oregon Cascades, May-June, 1992 and 1993.

	1992		1993		
Species	$\bar{x}$	SE	$\bar{x}$	SE	P[1]
Pacific-slope flycatcher	1.75	0.24	2.30	0.32	0.09
Stellar's jay	0.41	0.11	0.61	0.13	0.16
Chestnut-backed chickadee	1.45	0.23	1.44	0.22	0.96
Winter wren	3.70	0.29	3.52	0.37	0.70
Golden-crowned kinglet	3.19	0.36	2.44	0.29	0.06
Swainson's thrush	2.56	0.28	3.28	0.33	0.04
Hermit thrush	1.75	0.29	2.55	0.34	0.01
Hutton's vireo	0.91	0.11	0.73	0.14	0.16
Black-throated gray warbler[2]	1.27	0.35	1.53	0.47	0.73
Hermit warbler	7.16	0.56	9.78	0.55	<0.01
Dark-eyed junco	1.12	0.28	1.05	0.21	0.74
Total abundance	27.86	1.30	32.86	1.37	<0.01
Species richness (# species/4 visits/year)	16.62	0.44	16.87	0.58	0.66

[1] Probability associated with the null hypothesis that means do not differ, split plot ANOVA.
[2] Analysis performed on log-transformed data for black-throated gray warbler; means reported are untransformed.

Table 2. Abundance indices (observations/ visit; 4 visits/year) for bird species observed in >12 young Douglas-fir stands (N=16) prior to silvicultural treatment, Oregon Cascades, May-June 1992 and 1993. P is the probability associated with the null hypothesis that means do not differ, split plot ANOVA. Where P< 0.10, different letters indicate significantly different means, least squares means test.

	Control N=4	Light Thin N=4	Heavy Thin N=4	Thin with Gaps N=4		
Species	$\bar{x}$ (SE)	$\bar{x}$ (SE)	$\bar{x}$ (SE)	$\bar{x}$ (SE)	P_{trt} [1]	P_{intx} [2]
Pacific-slope flycatcher	2.28 (0.33)	2.75 (0.43)	1.44 (0.33)	1.62 (0.41)	0.19	0.84
Stellar's jay	0.56 (0.15)	0.56 (0.24)	0.44 (0.14)	0.47 (0.17)	0.88	0.16
Chestnut-backed chickadee	1.28 (0.22)	1.00 (0.19)	1.87 (0.44)	1.62 (0.30)	0.26	0.72
Winter wren	3.5 (0.37)	3.47 (0.37)	3.16 (0.52)	4.31 (0.55)	0.38	0.80
Golden-crowned kinglet	2.94 (0.64)	2.56 (0.59)	2.84 (0.39)	2.91 (0.24)	0.89	0.68
Swainson's thrush	3.28 (0.48)	3.03 (0.39)	3.09 (0.49)	2.28 (0.40)	0.17	0.03
Hermit thrush	1.94 (0.51) **B**	2.22 (0.52) **AB**	2.75 (0.39) **A**	1.69 (0.43) **B**	0.08	0.25
Hutton's vireo	0.62 (0.18)	0.97 (0.16)	0.72 (0.14)	0.97 (0.22)	0.59	0.12
Black-throated gray warbler[3]	0.91 (0.43)	2.62 (0.66)	0.81 (0.35)	1.25 (0.66)	0.16	0.27
Hermit warbler	7.44 (0.66)	8.75 (1.06)	9.09 (0.98)	8.59 (0.93)	0.69	0.64
Dark-eyed junco	1.03 (0.28)	1.22 (0.39)	1.22 (0.37)	0.87 (0.41)	0.72	0.73
Total abundance	28.75 (1.73)	32.91 (1.98)	29.91 (2.42)	29.50 (2.09)	0.21	0.27
Species richness (# species/4 visits/year)	17.12 (0.55)	16.87 (0.72)	16.37 (0.80)	16.62 (0.88)	0.81	0.27

[1] Probability that means do not differ among treatments, split plot ANOVA
[2] Probability that there is no interaction between treatment and year, split plot ANOVA
[3] ANOVA performed on log-transformed data; means reported are untransformed.

Table 3. Abundance indices (observations/4 visits/stand; 4 stands/treatment) for bird species observed in ≥8 but <12 young Douglas-fir stands (N=16) (Friedman's test), or species (i.e. Swainson's thrush) with year*treatment interaction from split plot ANOVA. Data are from surveys conducted prior to silvicultural treatment, Oregon Cascades, May-June 1992 and 1993. Where P< 0.10, different letters indicate significantly different means (least squares means test).

		Control	Light Thin	Heavy Thin	Thin with Gaps	
Species	**Year**	**x̄ (SE)**	**x̄ (SE)**	**x̄ (SE)**	**x̄ (SE)**	**P**
Hammond's flycatcher	1992	0.12 (0.12)	0.06 (0.06)	0.00 (0.00)	0.12 (0.12)	0.76
	1993	0.44 (0.36)	0.94 (0.71)	0.00 (0.00)	0.12 (0.07)	0.17
Gray jay	1992	0.37 (0.16)	0.06 (0.06)	0.12 (0.07)	0.19 (0.12)	0.35
	1993	0.56 (0.36)	0.37 (0.24)	0.25 (0.18)	0.19 (0.19)	0.80
Red-breasted nuthatch	1992	0.25 (0.25)	0.50 (0.50)	0.44 (0.36)	0.31 (0.19)	0.82
	1993	0.44 (0.16)	0.44 (0.16)	0.25	0.25 (0.10)	0.68
Swainson's thrush	1992	2.37 (0.37)	2.43 (0.56)	2.62 (0.83)	2.81 (0.64)	0.51
	1993	4.19 (0.62) **A**	3.62 (0.41) **A**	3.56 (0.54) **A**	1.75 (0.39) **B**	0.01
Varied thrush	1992	0.12 (0.12)	0.31 (0.19)	0.44 (0.29)	0.37 (0.22)	0.44
	1993	0.87 (0.56)	0.12 (0.12)	0.19 (0.12	0.87 (0.63)	0.28
Warbling vireo	1992	0.00 (0.00) **B**	0.94 (0.77) **A**	0.06 (0.06) **AB**	0.06 (0.06) **AB**	0.08
	1993	0.06 (0.06)	1.06 (0.82)	0.12 (0.07	0.25 (0.25)	0.54
MacGillivray's warbler	1992	0.12 (0.07)	0.06 (0.06)	0.12 (0.07)	0.62 (0.30)	0.19
	1993	0.19 (0.12)	0.00 (0.00)	0.25 (0.14	0.12 (0.12)	0.21
Western tanager	1992	0.19 (0.12)	0.81 (0.50)	0.31 (0.19)	0.06 (0.06)	0.42
	1993	0.31 (0.16)	0.75 (0.35)	0.94 (0.47	0.19 (0.12)	0.61
Black-headed grosbeak	1992	0.31 (0.12)	0.44 (0.21)	0.25 (0.10)	0.62 (0.54)	0.93
	1993	0.75 (0.67)	0.37 (0.22)	0.88 (0.72	0.44 (0.28)	0.81
Purple finch	1992	0.19 (0.12)	0.31 (0.24)	0.00 (0.00)	0.25 (0.18)	0.35
	1993	0.31 (0.19)	0.56 (0.28)	0.25 (0.18)	0.19 (0.12)	0.70

Table 4. Stand-level multiple regression results for bird species observed in >12 of 16 Douglas-fir stands prior to silvicultural treatment, Oregon Cascades, 1992 and 1993.

Species	Variable	Parameter Estimate	P-value	Cumulative R^2 / Adjusted R^2
Pacific-slope flycatcher	Constant	+1.45	<0.01	
	hardwood trees (>5" dbh)/ ha	+0.01	0.03	0.28 / 0.23
Chestnut-backed chickadee	Constant	+1.82	<0.01	
	hardwood trees (>5" dbh) / ha	-0.008	0.02	0.34 / 0.29
Red-breasted nuthatch	Constant	-0.88	0.50	
	mean stand conifer basal area	+0.03	<0.01	0.64/0.62
Winter wren	Constant	+5.48	<0.01	
	conifer trees (>5" dbh)/ ha	-0.004	0.03	0.27
	canopy gap cover	+11.26	0.04	0.48 / 0.40
Golden-crowned kinglet	Constant	-4.25	0.08	
	canopy gap cover (%)	+13.64	0.01	0.35
	mean stand conifer diameter	+0.22	0.02	0.59 / 0.53
Hermit thrush	Constant	-1.97	0.01	
	conifer basal area (m^2/ha)	+0.07	<0.01	0.58
	vine maple cover (%)	+4.65	0.01	0.75
	coarse woody debris cover (%)	+6.64	0.04	0.83 / 0.79
Hutton's vireo	Constant	+1.15	<0.01	
	hardwood overstory cover (%)	+3.58	0.03	0.31
	medium shrub cover (%) (log-trans.)	-2.53	0.05	0.49 / 0.41
Black-throated gray warbler	Constant	+2.11	0.01	
	hardwood overstory cover (%)	+12.54	0.02	0.50
	hard snag density (log-trans.)	-0.92	0.03	0.65 / 0.60

Table 4, continued.

Species	**Variable**	**Parameter Estimate**	**P-value**	**Cumulative R^2 /Adjusted R^2**
Hermit warbler	no model			
Dark-eyed junco	Constant	+2.55	0.01	
	coarse woody debris cover (%)	+10.92	<0.01	0.62
	low shrub cover (%) (log-transformed)	-4.45	0.01	0.77
	fern volume (cm^3) (log-transformed)	-0.44	0.01	0.87 / 0.83
Species richness	Constant	+6.38	0.04	
	ave. tree height (m)	+0.36	<0.01	0.57
	hardwood trees (>5" dbh)/ ha	+0.01	0.08	0.66/ 0.61
Total abundance (all species)	Constant	+41.95	<0.01	
	hardwood trees (>5" dbh)/ ha	+0.05	<0.01	0.65
	low shrub cover (%, log-transformed)	-21.09	0.01	0.75
	fern volume (%, log-transformed)	-2.09	0.01	0.85 / 0.82

Table 5. Average number of individual animals captured/ 100 trap nights and species richness of forest floor vertebrates in 16 Douglas-fir stands in the Cascade Range, Oregon, in the 2 years prior to silvicultural treatment.

	1991		1992		
Species	$\bar{x}$	(SE)	$\bar{x}$	(SE)	P
Ensatina eschscholtzi	0.97	(0.23)	0.41	(0.13)	0.05[1]
Peromyscus maniculatus	3.26	(0.57)	3.07	(0.53)	0.77[2]
Clethrionomys californicus	0.55	(0.15)	1.22	(0.33)	0.03[2]
Sorex trowbridgii	1.80	(0.26)	1.70	(0.34)	0.59[2]
Tamias townsendii	0.93	(0.46)	1.31	(0.34)	0.73[1]
Glaucomys sabrinus	0.26	(0.13)	0.21	(0.10)	0.75[1]
Sorex spp.	0.38	(0.08)	0.50	(0.10)	0.34[2]
Total individuals (mammal species only)	7.01	(0.77)	7.59	(0.75)	0.54[2]
Species richness (number of species/stand)	5.81	(0.40)	6.87	(0.42)	0.10[2]

1 P is the probability associated with the null hypothesis that means do not differ between years, single factor ANOVA.

2 P is the probability associated with the null hypothesis that means do not differ between years, split plot ANOVA.

Table 6. Mean number of individuals/100 trap nights and species richness (number of species/stand) for forest floor vertebrates in pre-treatment Douglas-fir stands in the Cascade Range, Oregon, 1991 and 1992 (4 stands/treatment). Capture rates based on undisturbed trap nights. Different letters indicate significantly different means ($P < 0.05$, least squares means test).

	Control	Light Thin	Heavy Thin	Light Thin with Gaps		
Species	$\bar{x}$ (SE)	$\bar{x}$ (SE)	$\bar{x}$ (SE)	$\bar{x}$ (SE)	P[1]	P_{intx}[2]
Peromyscus maniculatus	1.80 (0.62)	3.57 (0.50)	3.76 (0.96)	3.54 (0.85)	0.14	0.90
Clethrionomys californicus[3]	0.62 (0.23)	0.89 (0.37)	0.97 (0.30)	1.05 (0.56)	0.79	0.76
Sorex trowbridgii[3]	1.49 (0.38)	1.93 (0.39)	2.08 (0.49)	1.49 (0.44)	0.58	0.99
Other Sorex spp.	0.54 (0.11)	0.52 (0.16)	0.31 (0.14)	0.39 (0.11)	0.48	0.94
Total individuals (mammal species only)	5.01 (1.05) A	7.96 (0.69) B	8.29 (1.19) B	7.94 (1.02) B	0.07	0.99
Species richness	6.37 (0.56)	6.25 (0.59)	6.37 (0.60)	6.37 (0.75)	1.00	0.67

[1] Probability that treatment means do not differ, split plot ANOVA.
[2] Probability that treatment and year effects do not interact, split plot ANOVA.
[3] Tests performed on log-transformed data; means reported are untransformed.

Table 7. Mean number of individuals/100 trap nights and species richness (number of species/stand) for forest floor vertebrates in pre-treatment Douglas-fir stands in the Cascade Range, Oregon, 1991 (4 stands/ treatment). Capture rates based on undisturbed trap nights. P is the probability that means do not differ among treatment assignments, Friedman's test. Different letters indicate significantly different means (P < 0.05, least squares means test).

	Control	**Light Thin**	**Heavy Thin**	**Light Thin with Gaps**	
Species	$\bar{x}$ (SE)	$\bar{x}$ (SE)	$\bar{x}$ (SE)	$\bar{x}$ (SE)	**P**
Ensatina eschscholzi (1991)	1.02 (0.35)	1.68 (0.72)	0.78 (0.33)	0.40 (0.24)	0.25
Ensatina eschscholzi (1992)	0.65 (0.26)	0.12 (0.12)	0.51 (0.36)	0.37 (0.24)	0.22
Glaucomys sabrinus (1991)	0.00 (0.00) A	0.68 (0.45) B	0.05 (0.05) A	0.31 (0.26) AB	0.04
Glaucomys sabrinus (1992)	0.10 (0.10)	0.31 (0.31)	0.22 (0.18)	0.19 (0.19)	0.82
Tamias townsendii* (1991)	0.00 (0.00)	0.49 (0.49)	1.54 (1.24)	1.69 (1.39)	0.13
Tamias townsendii* (1992)	0.74 (0.40)	1.02 (0.68)	0.90 (0.48)	1.87 (1.12)	0.57

* Only 12 stands included in analyses because capture rate varied temporally (with date).

Table 8. Regression models describing habitat relationships for forest floor vertebrates in 16 young Douglas-fir stands in the Oregon Cascades prior to silvicultural treatment. Dependent variable is captures/100 undisturbed trap nights, averaged over 2 years.

Species (individuals/100 TN)	Parameter	Estimate	P	Cumulative / Adjusted R^2
Ensatina eschscholtzi	Constant	-0.640	0.168	
	conifer basal area (m^2/ha)	+0.029	0.047	0.39
	length (m) of decay 1-3, <12" diameter logs/ 1/20 acre	+0.025	0.087	0.52 / 0.45
Peromyscus maniculatus	Constant	-4.395	0.043	
	log of herb volume (m^3/10m r plot)	+1.684	0.007	0.30
	deciduous shrub cover (%)	+9.715	0.010	0.59 / 0.52
Clethrionomys californicus (log transformed)	Constant	-0.594	0.004	
	length (m) of decay 4-5, >24" diameter logs/ 1/20 acre	+0.032	0.002	0.41
	log of rhododendron foliage volume (m^3/10m r plot)	+0.150	<0.001	0.69
	moss cover (%)	+1.309	0.009	0.83 / 0.78
Sorex trowbridgii	Constant	-0.359	0.706	
	log of conifer seedling density (stems/ha)	+1.172	0.008	0.35
	log of hard snag density (snags/ha)	-1.067	0.035	0.55 / 0.48
Sorex spp.	Constant	+0.312	0.006	
	length (m) of decay 1-3, >24" diam. logs/ 1/20 acre	+0.022	<0.001	0.58
	grass volume (m^3/10m r plot)	-0.108	0.048	0.69/ 0.65

Table 8, continued.

Species (individuals/100 TN)	Parameter	Estimate	P	Cumulative / Adjusted R^2
Tamias townsendii (includes only 12 stands)	Constant	-4.197	0.018	
	evergreen shrub cover (%)	+9.642	<0.001	0.54
	log of hard snag density (snags/ha)	-1.774	0.005	0.81
	log of western hemlock foliage volume (m^3/10m r plot)	+0.653	0.038	0.89 / 0.85
Total individuals (all mammal species combined)	Constant	+3.511	0.065	
	litter depth (mm)	+0.123	0.007	0.42
	herbaceous cover (%)	-43.887	0.010	0.66 / 0.60
Species Richness	Constant	+0.921	0.560	
	log of deciduous tree foliage volume (m^3/10m r plot)	+0.505	0.008	0.27
	log of conifer seedling density (stems/ha)	+1.439	0.020	0.52 / 0.45

Appendix A. Counts of birds within effective detection distance for each species in 16 stands of young managed Douglas-fir in the Oregon Cascades prior to silvicultural treatment, 1992 and 1993. Counts are sum of observations from 4 visits/year and do not include repeat observations of individuals during a visit or fly-overs (except where noted).

		Species *latin name* (detection distance cut-off (m))															
Block	Treatment assignment	Cooper's hawk *Accipiter cooperii* (100)		Ruffed Grouse *Bonasa umbellus* (100)		Band-tailed pigeon *Columba fasciata* (100)		Common nighthawk[1] *Chordeiles minor* (100)		Rufous hummingbird *Selasphorus rufus* (60)		Northern flicker *Colaptes auratus* (100)		Pileated woodpecker *Dryocopus pileatus* (100)		Hairy woodpecker *Picoides villosus* (100)	
Christy Flats		1992	1993	1992	1993	1992	1993	1992	1993	1992	1993	1992	1993	1992	1993	1992	1993
	Control	1	0	0	2	0	0	0	1	0	0	0	0	0	0	0	1
	Light	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
	Heavy	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0
	Thin with Gaps	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Cougar Reservoir	Control	0	0	1	1	0	0	0	1	1	0	0	0	1	0	0	0
	Light	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Heavy	0	0	0	0	1	0	0	0	1	0	0	0	0	0	1	0
	Thin with Gaps	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0
Mill Creek	Control	0	0	0	0	2	0	0	0	1		3	0	2	0	0	1
	Light	1	0	1	1	0	0	0	0	0	2	0	0	0	0	0	0
	Heavy	0	0	0	0	1	0	0	0	1	2	0	0	0	0	0	0
	Thin with Gaps	0	0	0	0	0	0	0	0	3	0	1	0	1	0	0	0
Sidewalk Creek	Control	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0
	Light	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
	Heavy	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Thin with Gaps	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0

Appendix A Continued

Block	Treatment assignment	Species *latin name* (detection distance cut-off (m)) Western wood-pewee *Contopus sordidulus* (100)		Pacific-slope flycatcher *empidonax difficilis* (80)		Hammond's flycatcher *Empidonax hammondii* (80)		Gray Jay *Perisoreus canadensis* (100)		Stellar's jay *Cyanocitta stelleri* (100)		Common Raven *Corvus corax* (100)		Black-capped chickadee *Parus atricapillus* (90)		Chestnut-backed chickadee *Parus rufescens* (60)	
Christy Flats		1992	1993	1992	1993	1992	1993	1992	1993	1992	1993	1992	1993	1992	1993	1992	1993
	Control	0	0	8	12	0	0	2	3	0	1	1	0	0	0	7	3
	Light	0	0	12	9	1	0	0	4	0	0	0	0	0	0	4	2
	Heavy	0	0	9	12	0	0	1	0	2	1	0	0	0	0	12	3
	Thin with Gaps	0	0	9	16	2	0	2	3	0	0	0	0	0	0	6	1
Cougar Reservoir	Control	0	0	3	6	0	0	3	0	2	2	0	0	0	0	8	7
	Light	0	0	12	9	0	0	0	0	0	7	0	0	0	0	7	5
	Heavy	0	0	2	1	0	0	0	0	4	2	0	0	0	0	11	9
	Thin with Gaps	0	0	6	6	0	0	1	0	1	5	0	0	0	0	11	3
Mill Creek	Control	0	0	9	8	0	1	0	6	2	2	0	0	0	0	4	7
	Light	0	0	9	20	0	12	0	0	1	0	0	0	0	0	3	3
	Heavy	0	0	6	6	0	0	0	1	1	0	0	0	0	0	2	6
	Thin with Gaps	0	0	1	2	0	1	0	0	0	4	0	3	1	0	9	9
Sidewalk Creek	Control	0	0	14	13	2	6	1	0	6	3	1	0	0	0	1	4
	Light	0	0	3	14	0	3	1	2	4	5	0	1	1	0	2	7
	Heavy	0	1	3	7	0	0	1	3	1	4	0	0	0	0	5	15
	Thin with Gaps	0	0	6	6	0	1	0	0	2	3	0	0	0	0	1	8

Appendix A. Continued

Block	Treatment assignment	Red-breasted nuthatch *Sitta canadensis* (80)		Brown creeper *Certhia americana* (100)		Winter wren *Troglodytes troglodytes* (80)		Golden-crowned kinglet *Regulus satrapa* (80)		American robin *Turdus migratorius* (100)		Varied thrush *Ixoreus naevius* (100)		Swainson's thrush *Catharus ustulatus* (80)		Hermit thrush *Catharus guttatus* (100)	
Christy Flats		1992	1993	1992	1993	1992	1993	1992	1993	1992	1993	1992	1993	1992	1993	1992	1993
	Control	4	2	1	6	15	12	19	15	0	0	2	10	8	10	10	20
	Light	8	2	2	2	15	10	21	9	0	0	3	0	6	14	17	16
	Heavy	6	1	0	1	8	2	16	10	0	0	2	2	4	12	11	17
	Thin with Gaps	3	2	1	1	18	19	15	10	0	0	3	11	4	5	13	12
Cougar Reservoir	Control	0	2	0	0	15	20	20	6	0	0	0	3	8	16	6	8
	Light	0	3	0	0	12	15	12	12	0	2	2	0	7	11	4	11
	Heavy	1	1	0	0	13	15	12	18	0	0	5	2	18	10	7	11
	Thin with Gaps	2	0	0	0	16	26	16	10	0	2	3	1	13	8	4	12
Mill Creek	Control	0	3	1	1	7	17	12	17	0	0	0	1	14	21	5	5
	Light	0	0	0	4	23	11	17	2	0	1	0	0	16	19	12	6
	Heavy	0	1	0	0	12	22	12	12	0	0	0	0	14	15	8	18
	Thin with Gaps	0	1	1	0	25	11	13	10	0	0	0	0	16	4	6	2
Sidewalk Creek	Control	0	0	0	0	16	10	3	2	0	0	0	0	8	20	0	8
	Light	0	2	0	0	11	14	2	7	0	0	0	0	10	14	2	3
	Heavy	0	1	0	1	16	13	6	5	1	1	0	1	6	20	6	10
	Thin with Gaps	0	1	0	0	15	8	8	11	0	0	0	2	12	11	1	4

Species / *latin name* / (detection distance cut-off (m))

Appendix A. Continued

Block	Treatment assignment	Species *latin name* (detection distance cut-off (m))															
		Cedar waxwing *Bombycilla cedrorum* (100)		Hutton's vireo *Vireo huttoni* (90)		Solitary vireo *Vireo solitarius* (100)		Warbling vireo *Vireo gilvus* (80)		Orange-crowned warbler *Vermivora celata* (100)		Yellow-rumped warbler *Dendroica coronata* (100)		Black-throated gray warbler *Dendroica nigrescens* (90)		Hermit warbler *Dendroica occidentalis* (80)	
Christy Flats		1992	1993	1992	1993	1992	1993	1992	1993	1992	1993	1992	1993	1992	1993	1992	1993
	Control	0	0	1	0	0	1	0	0	0	0	0	0	2	0	30	34
	Light	0	0	2	4	0	0	1	2	0	0	0	0	0	0	37	42
	Heavy	0	0	5	5	1	0	0	1	0	0	1	0	0	1	40	52
	Thin with Gaps	0	0	6	3	0	0	0	4	0	0	0	0	2	1	42	52
Cougar Reservoir	Control	0	0	3	5	0	0	0	0	0	0	1	0	0	0	22	29
	Light	0	0	3	6	0	0	1	0	0	0	0	0	7	19	35	49
	Heavy	0	0	1	3	0	0	1	0	0	0	0	0	0	0	30	28
	Thin with Gaps	0	0	5	1	0	0	0	0	0	0	0	0	1	0	16	31
Mill Creek	Control	0	0	5	4	0	0	0	0	0	1	0	0	4	7	31	43
	Light	0	0	6	5	0	0	13	14	0	0	0	0	16	17	10	29
	Heavy	1	0	2	1	0	0	0	0	0	0	0	0	8	9	25	43
	Thin with Gaps	0	0	7	6	1	0	1	0	0	0	0	1	12	21	35	39
Sidewalk Creek	Control	2	0	2	0	0	0	0	1	0	0	0	0	14	2	18	31
	Light	0	0	4	1	0	0	0	1	0	0	0	0	12	13	33	45
	Heavy	0	0	3	3	0	0	0	1	0	0	0	0	1	7	24	49
	Thin with Gaps	0	1	3	0	0	0	0	0	0	0	0	0	2	1	30	30

Appendix A. Continued

Block	Treatment assignment	Ovenbird *Seiurus aurocapillus* (100)		MacGillivray's warbler *Oporonis tomiei* (100)		Wilson's warbler *Wilsonia pusilla* (100)		Western tanager *Piranga ludoviciana* (100)		Black-headed grosbeak *Pheuticus melanocephalus* (80)		Lazuli bunting Passerina amoena (100)		Rufous-sided towhee *Pipilo erythrophalmus* (100)		Chipping sparrow *Spizella passerina* (100)	
Christy Flats		1992	1993	1992	1993	1992	1993	1992	1993	1992	1993	1992	1993	1992	1993	1992	1993
	Control	0	0	0	0	1	0	0	0	1	11	0	0	0	0	0	0
	Light	0	0	0	0	1	0	9	7	4	3	0	0	0	0	0	0
	Heavy	0	0	0	0	0	0	3	9	1	12	0	0	0	0	0	0
	Thin with Gaps	0	0	0	0	0	0	0	0	9	5	0	0	0	0	0	0
Cougar Reservoir	Control	0	0	1	0	4	0	1	1	0	1	0	0	0	0	0	0
	Light	0	0	0	0	0	0	3	1	0	0	0	0	0	0	0	0
	Heavy	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
	Thin with Gaps	0	0	1	0	0	0	0	2	0	1	0	0	0	0	0	0
Mill Creek	Control	0	0	0	1	0	0	2	3	2	0	1	0	0	0	0	0
	Light	1	0	0	0	0	0	1	3	1	0	0	0	0	0	0	0
	Heavy	0	0	1	2	0	0	2	3	2	2	0	0	0	0	1	0
	Thin with Gaps	0	0	4	0	0	0	1	1	1	1	0	0	2	0	0	0
Sidewalk Creek	Control	0	0	1	2	4	4	0	1	2	0	0	0	0	0	0	0
	Light	0	0	1	0	2	2	0	1	2	3	0	0	0	0	0	0
	Heavy	0	0	0	2	2	2	0	3	1	0	0	0	0	0	0	0
	Thin with Gaps	0	0	5	2	1	2	0	0	0	0	0	0	0	0	0	0

Species *latin name* (detection distance cut-off (m))

Appendix A. Continued

		Species *latin name* (detection distance cut-off (m))													
Block	Treatment assignment	Song sparrow *Melospiza melodia* (100)		Dark-eyed junco *Junco hyemalis* (80)		Brown-headed cowbird *Molothrus ater* (100)		Purple finch *Carpodacus purpureus* (100)		Pine siskin[1] *Carduelis pinus* (100)		Total (sum of individuals of all species) (80)		Richness (number of species) (100)	
Christy Flats		1992	1993	1992	1993	1992	1993	1992	1993	1992	1993	1992	1993	1992	1993
	Control	0	0	11	3	0	0	0	0	1	4	121	141	19	19
	Light	0	0	13	7	0	0	0	0	5	1	154	128	19	18
	Heavy	0	0	10	11	0	0	0	0	1	2	125	148	20	17
	Thin with Gaps	0	0	12	9	0	0	1	1	3	1	143	155	19	19
Cougar Reservoir	Control	0	0	2	3	0	0	0	3	1	0	98	104	19	17
	Light	0	0	7	2	0	0	0	1	0	1	111	146	15	16
	Heavy	0	0	1	1	0	0	0	1	1	1	109	99	19	14
	Thin with Gaps	0	0	0	0	0	0	0	0	0	0	93	104	16	14
Mill Creek	Control	0	0	3	6	0	0	2	0	0	1	107	147	21	22
	Light	0	0	0	0	1	0	4	5	1	3	124	153	20	20
	Heavy	0	0	2	2	0	0	0	3	0	4	97	147	19	18
	Thin with Gaps	0	0	0	1	0	0	3	2	2	6	134	120	22	19
Sidewalk Creek	Control	0	0	1	4	0	0	1	2	0	0	93	110	20	16
	Light	2	0	3	7	0	0	1	3	0	0	91	146	19	21
	Heavy	0	0	4	8	0	0	0	0	2	0	80	152	16	22
	Thin with Gaps	5	1	3	3	0	0	0	0	0	2	99	96	16	20

[1] May include birds flying over the canopy.

Appendix B. Amphibians - number of individuals, captures, and capture rates in young Douglas-fir stands (N=16) on the west slope of the Cascades, Oregon. Capture rates based on undisturbed trap nights.

	Species # Individuals (#/100 TN) # Captures (#/ 100 TN)													
Block Treatment assignment[1]	Ambystoma gracile		Hyla regilla		Plethodon dunni		Ensatina eschscholtzi		Aneides ferreus		Dicamptodon ensatus		Taricha granulosa	
	1991	1992	1991	1992	1991	1992	1991	1992	1991	1992	1991	1992	1991	1992
Christy Flats Control	1 (0.50) 1 (0.50)	0	0	1 (0.50) 1 (0.50)	0	0	4 (2.00) 4 (2.00)	1 (0.50) 1 (0.50)	0	0	0	0	0	0
Light	0	0	0	0	0	0	7 (3.57) 7 (3.57)	0	0	0	0	0	0	0
Heavy	0	2 (1.00) 2 (1.00)	0	0	0	0	3 (1.50) 3 (1.50)	0	2 (1.00) 3 (1.50)	0	0	0	0	0
Thin with Gaps	0	0	0	0	0	0	2 (1.00) 2 (1.00)	0	0	0	0	0	0	0
Cougar Reservoir Control	0	0	0	0	0	0	1 (0.51) 1 (0.51)	2 (1.12) 2 (1.12)	0	0	0	0	0	0
Light	0	0	0	0	0	0	4 (2.03) 4 (2.03)	0	0	0	0	0	0	0
Heavy	0	0	0	0	0	0	2 (1.10) 2 (1.10)	3 (1.53) 3 (1.53)	0	0	0	0	0	0
Thin with Gaps	0	0	0	0	0	1 (0.50)	0	1 (0.50) 1 (0.50)	0	0	0	0	0	0
Mill Creek Control	0	0	0	0	0	0	2 (1.06) 2 (1.06)	2 (1.00) 2 (1.00)	0	0	0	0	0	3 (1.50) 3 (1.50)
Light	0	0	0	0	0	0	1 (0.50) 1 (0.50)	1 (0.50) 1 (0.50)	0	0	0	0	1 (0.50) 1 (0.50)	0
Heavy	0	1 (0.50) 1 (0.50)	0	0	0	0	1 (0.50) 1 (0.50)	1 (0.50) 1 (0.50)	0	0	0	0	0	0
Thin with Gaps	0	0	0	0	0	0	1 (0.60) 1 (0.60)	2 (1.00) 2 (1.00)	0	0	0	0	0	0

Appendix B. Continued

	Species # Individuals (#/100 TN) # Captures (#/ 100 TN)													
Block Treatment assignment[1]	Ambystoma gracile		Hyla regilla		Plethodon dunni		Ensatina eschscholtzi		Aneides ferreus		Dicamptodon ensatus		Taricha granulosa	
	1991	1992	1991	1992	1991	1992	1991	1992	1991	1992	1991	1992	1991	1992
Sidewalk Creek Control	0	0	0	0	0	0	1 (0.50) 1 (0.50)	0	0	0	0	0	0	0
Light	0	0	0	1 (0.50) 1 (0.50)	0	0	1 (0.63) 1 (0.63)	0	0	0	1 (0.55) 1 (0.55)	0	0	0
Heavy	0	0	0	0	0	0	0		0	0	0	0	0	0
Thin with Gaps	0	0	0	0	0	0	0		0	0	0	0	0	0

[1] Assigned treatments, not applied at time of trapping: C= Control; L= light thin; H=heavy thin; G= thin with gaps.

Appendix C. Number of individuals, captures, and capture rates of small mammals in young Douglas-fir stands (N=16) on.the west slope of the Cascades, Oregon. Capture rates based on undisturbed trap nights.

	Species # Individuals (#/100 TN) # Captures (#/ 100 TN)											
Block Treatment assignment[1]	Clethrionomys californicus		Glaucomys sabrinus		Microtus longicaudus		Microtus oregoni		Microtus richardsoni		Mustela erminea	
	1991	1992	1991	1992	1991	1992	1991	1992	1991	1992	1991	1992
Christy Flats Control	3 (0.32) 3 (0.32)	8 (0.81) 8 (0.81)	0	0	0	0	0	0	0	0	0	0
Light	4 (0.45) 7 (0.79)	18 (1.86) 24 (2.48)	0	0	0	0	0	0	0	0	0	0
Heavy	0	20 (2.03) 21 (2.13)	0	0	0	0	0	0	0	0	0	0
Thin with Gaps	1 (0.11) 1 (0.11)	6 (0.62) 6 (0.62)	0	0	0	0	0	0	0	0	0	0
Cougar Reservoir Control	10 (1.40) 14 (1.97)	2 (0.22) 5 (0.56)	0	0	0	0	0	0	0	0	0	1 (0.11) 1 (0.11)
Light	0	5 (0.51) 5 (0.51)	2 (0.51) 2 (0.51)	0	1 (0.15) 1 (0.15)	0	0	0	0	0	0	0
Heavy	10 (1.51) 10 (1.51)	3 (0.31) 6 (0.63)	1 (0.21) 1 (0.21)	0	0	0	0	0	1 (0.15) 1 (0.15)	0	0	0
Thin with Gaps	3 (0.44) 3 (0.44)	2 (0.22) 3 (0.33)	0	0	0	0	0	0	0	0	0	1 (0.11) 1 (0.11)
Mill Creek Control	0	1 (0.10) 1 (0.10)	0	0	0	0	0	0	0	0	0	0
Light	0	1 (0.10) 1 (0.10)	12 (1.98) 16 (2.64)	10 (1.25) 14 (1.75)	0	0	0	0	0	0	1 (0.12)	0
Heavy	2 (0.23) 2 (0.23)	3 (0.30) 4 (0.40)	0	6 (0.76) 7 (0.89)	0	0	0	0	0	0	0	0
Thin with Gaps	1 (0.12) 1 (0.12)	8 (0.80) 12 (1.20)	7 (1.07) 13 (2.00)	6 (0.75) 10 (1.25)	0	0	0	1 (0.10) 1 (0.10)	0	0	0	0
Sidewalk Creek Control	3 (0.32) 3 (0.32)	17 (1.80) 21 (2.23)	0	3 (0.40) 3 (0.40)	0	0	0	0	0	0	0	0
Light	8 (1.35) 11 (1.85)	27 (2.88) 33 (3.53)	1 (0.23) 1 (0.23)	0	0	0	0	0	0	0	0	0
Heavy	12 (1.33) 15 (1.66)	20 (2.05) 35 (3.59)	0	1 (0.13) 1 (0.13)	0	0	0	0	0	0	0	0
Thin with Gaps	10 (1.18) 15 (1.78)	48 (4.89) 64 (6.52)	1 (0.15) 1 (0.15)	0	0	0	0	0	0	0	0	0

Appendix C. Continued.

Block Treatment assignment[1]	Species # Individuals (#/100 TN) # Captures (#/ 100 TN) Peromyscus maniculatus		Sorex spp.		Sorex trowbridgii		Sorex pacificus		Sorex vagrans		Sorex sonomae (?)	
	1991	1992	1991	1992	1991	1992	1991	1992	1991	1992	1991	1992
Christy Flats Control	4 (0.43) 4 (0.43)	15 (1.51) 26 (2.62)	5 (0.53) 5 (0.53)	11 (1.11) 12 (1.21)	5 (0.53) 5 (0.53)	11 (1.11) 11 (1.11)	0	1 (0.10) 1 (0.10)	0	0	0	2 (0.20) 2 (0.20)
Light	28 (3.16) 37 (4.18)	28 (2.89) 45 (4.65)	8 (0.90) 10 (1.13)	9 (0.93) 9 (0.93)	10 (1.13) 10 (1.13)	7 (0.72) 7 (0.72)	0	1 (0.10) 1 (0.10)	0	0	0	3 (0.31) 3 (0.31)
Heavy	25 (3.03) 53 (6.43)	12 (1.22) 31 (3.14)	2 (0.24) 2 (0.24)	11 (1.12) 11 (1.12)	18 (2.18) 18 (2.18)	12 (1.22) 12 (1.22)	0	0	0	0	0	0
Thin with Gaps	35 (4.00) 57 (6.51)	43 (4.42) 113 (11.64)	6 (0.69) 6 (0.69)	1 (0.10) 1 (0.10)	4 (0.46) 4 (0.46)	0	0	0	0	0	0	2 (0.21) 2 (0.21)
Cougar Reservoir Control	41 (5.76) 62 (8.71)	11 (1.24) 39 (4.39)	4 (0.56) 5 (0.70)	5 (0.56) 6 (0.68)	16 (2.25) 18 (2.53)	5 (0.56) 6 (0.68)	0	0	0	0	0	0
Light	32 (5.40) 46 (7.77)	23 (2.35) 44 (4.49)	0	2 (0.20) 2 (0.20)	20 (3.38) 20 (3.38)	15 (1.53) 17 (1.74)	0	0	0	0	0	0
Heavy	48 (7.27) 83 (12.56)	48 (5.01) 147 (15.34)	4 (0.61) 4 (0.61)	0	10 (1.51) 10 (1.51)	8 (0.83) 8 (0.83)	0	0	0	0	0	0
Thin with Gaps	50 (7.30) 85 (12.41)	50 (5.56) 120 (13.35)	1 (0.15) 1 (0.15)	2 (0.22) 2 (0.22)	14 (2.04) 14 (2.04)	12 (1.33) 12 (1.33)	0	0	0	0	0	1 (0.11) 1 (0.11)
Mill Creek Control	17 (1.78) 33 (3.46)	24 (2.40) 60 (6.00)	0	6 (0.60) 7 (0.70)	10 (1.05) 12 (1.26)	32 (3.20) 34 (3.40)	0	0	0	0	0	0
Light	20 (2.48) 44 (5.46)	59 (5.91) 94 (9.42)	1 (0.12) 1 (0.12)	1 (0.10) 2 (0.20)	8 (0.99) 8 (0.99)	37 (3.71) 37 (3.71)	0	2 (0.20) 2 (0.20)	0	0	0	0
Heavy	20 (2.29) 46 (5.26)	80 (8.09) 166 (16.78)	0	0	7 (0.80) 7 (0.80)	42 (4.25) 44 (4.45)	0	0	0	0	0	0
Thin with Gaps	30 (3.67) 48 (5.87)	27 (2.70) 50 (5.01)	0	7 (0.70) 8 (0.80)	15 (1.83) 15 (1.83)	41 (4.11) 45 (4.51)	0	0 1 (0.10)	0	0	0	0
Sidewalk Creek Control	2 (0.21) 4 (0.43)	10 (1.06) 30 (3.18)	6 (0.65) 7 (0.75)	3 (0.32) 3 (0.32)	25 (2.69) 26 (2.80)	5 (0.53) 5 (0.53)	0	0	0	0	0	0
Light	24 (4.04) 44 (7.41)	22 (2.35) 54 (5.77)	6 (1.01) 7 (1.18)	8 (0.85) 8 (0.85)	14 (2.36) 15 (2.52)	15 (1.60) 15 (1.60)	0	0	0	0	0	1 (0.11) 1 (0.11)
Heavy	10 (1.11) 23 (2.55)	20 (2.05) 46 (4.71)	2 (0.22) 2 (0.22)	3 (0.31) 3 (0.31)	38 (4.21) 38 (4.21)	16 (1.64) 16 (1.64)	0	0	0	1 (0.10) 1 (0.10)	0	0
Thin with Gaps	2 (0.24) 2 (0.24)	4 (0.41) 11 (1.12)	4 (0.47) 4 (0.47)	8 (0.18) 9 (0.92)	11 (1.30) 11 (1.30)	8 (0.81) 8 (0.81)	0	0	0	0	0	2 (0.20) 2 (0.20)

Appendix C. Continued.

Block Treatment assignment[1]	Species # Individuals (#/100 TN) # Captures (#/ 100 TN) Sorex bendirii		Tamias townsendii		Tamiasciurus douglasii		Neurotrichus gibbsii		Scapanus orarius		Spilogale gracilis	
	1991	1992	1991	1992	1991	1992	1991	1992	1991	1992	1991	1992
Christy Flats Control	0	0	0	0	0	0	0	0	0	0	0	0
Light	0	0	0	0	0	0	0	0	0	0	0	0
Heavy	0	0	0	0	0	0	0	1 (0.10) 1 (0.10)	0	0	0	0
Thin with Gaps	0	0	0	0	0	0	0	0	1 (0.11) 1 (0.11)	0	0	0
Cougar Reservoir Control	0	0	0	6 (0.85) 10 (1.41)	0	1 (0.14) 1 (0.14)	0	0	1 (0.14) 1 (0.14)	0	0	0
Light	0	0	0	18 (2.31) 36 (4.62)	0	0	0	0	0	0	0	1 (0.13) 1 (0.13)
Heavy	0	0	3 (0.62) 4 (0.83)	8 (1.05) 18 (2.36)	0	0	0	1 (0.10) 1 (0.10)	0	1 (0.10) 1 (0.10)	0	0
Thin with Gaps	0	0	3 (0.60) 5 (1.00)	12 (1.72) 13 (1.86)	0	0	0	0	0	0	0	0
Mill Creek Control	0	0	0	11 (1.37) 12 (1.50)	0	0	0	0	0	2 (0.20) 3 (0.30)	0	0
Light	0	0	9 (1.48) 18 (2.97)	6 (0.75) 7 (0.88)	0	0	0	2 (0.20) 2 (0.20)	0	0	0	0
Heavy	0	0	27 (3.99) 53 (7.83)	13 (1.65) 28 (3.55)	0	0	0	0	0	0	0	0
Thin with Gaps	0	1 (0.10) 1 (0.10)	29 (4.45) 51 (7.83)	31 (3.88) 68 (8.52)	0	0	0	0	0	0	0	0
Sidewalk Creek Control	0	0	0	0	0	0	1 (0.11) 1 (0.11)	1 (0.11) 1 (0.11)	0	0	0	1 (0.13) 1 (0.13)
Light	0	0	1 (0.23) 1 (0.23)	0	0	0	0	1 (0.11) 1 (0.11)	0	0	0	0
Heavy	0	0	0	2 (0.26) 2 (0.26)	0	0	0	0	0	2 (0.20) 2 (0.20)	0	0
Thin with Gaps	2 (0.24) 2 (0.24)	0	1 (0.15) 1 (0.15)	0	0	0	0	0	0	0	0	0