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Effects of Silvicultural Treatments on Wintering Bird Communities in the Oregon Coast Range

Abstract

Changes in forest management policies in the Pacific Northwest have resulted in a broad array of management alternatives to clearcutting on state and federal forest lands. These management alternatives should be monitored for their effects on animal use, particularly during critical periods for survival. We compared abundance of resident birds among three alternative silvicultural treatments (modified clearcut, two-story, small-patch group-selection) and unharvested controls during winter. Total bird abundance was highest in small-patch stands and lowest in modified clearcuts during winter. Species richness was highest in small-patch stands and lowest in control and clearcut stands. Two species (Steller's jays [*Cyanocitta stelleri*] and golden-crowned kinglets [*Regulus satrapa*]) were most abundant in control stands and small-patch stands. Spotted towhees (*Pipilo erythrophthalmus*) were more abundant in two-story stands; dark-eyed juncos (*Junco hyemalis*) were more abundant in harvested stands than control stands. The small-patch group-selection treatment retained structural and compositional complexity of vegetation and provided habitat for more individuals than two-story or modified clearcut treatments. However, two-story and modified clearcut treatments with components of mature and old-growth forests (snags, logs, large trees) provided habitat for several bird species during winter. Silvicultural treatments that retain structural and compositional vegetation complexity or develop late-successional characteristics more quickly than stands regenerating following traditional clearcutting practices may be used by more bird species and should be considered when developing stand management guidelines.

Introduction

The availability of winter habitat may influence successful breeding and population persistence of resident bird species (Huff et al. 1991, DellaSala et al. 1996). Winter may be a more critical period for survival because of limitations or changes in seasonal food and cover resources. In fact, some species of birds exhibit morphological adaptations or behavioral characteristics that seem better adapted to survival in winter than during the breeding season (e.g., some finch species are insectivores during the breeding season but granivores during the winter and have beaks better adapted for handling seeds) (Salomonson and Balda 1977, Cody 1985).

Because bird use of habitat may vary among seasons (Cody 1985, Manuwal and Huff 1987, Hagar 1993), it is important for land managers to understand habitat needs of birds during spring breeding and winter seasons to insure adequate habitat is available (Morrison et al. 1985). Cover and food resources in late-successional forests may provide better winter habitat than early or mid-seral stages, particularly during inclement weather (DellaSala et al. 1996). Species richness and/or total abundance of diurnal birds was higher during winter in old-growth forest stands (250- to 600-year-old) than in young (42- to 75-year-old), mid-seral (65- to 140-year-old), or mature (105- to 165-year-old) stands in the Pacific Northwest (Manuwal and Huff 1987, Huff et al. 1991). In mixed-conifer forests of the Sierra Nevada, birds used areas with denser upper and mid-canopy cover in winter than during summer (Morrison et al. 1986).

The task of identifying appropriate winter and breeding habitat is complicated by changes in forest composition and structure caused by human-induced disturbances. A variety of forest management techniques (e.g., controlled burning, thinning, even-aged and uneven-aged regeneration systems) may produce very different effects on vertical and horizontal vegetation layers. Vegetation

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structure may have an important influence on bird community structure (MacArthur and MacArthur 1961, Roth 1976), so managers should understand the potential effects of disturbances on structure and resulting community composition.

Changes in forest management policies in the Pacific Northwest have resulted in consideration of a broad array of management alternatives to clearcutting on state and federal forest lands (Oregon Forest Practices Act, Forest Ecosystem Management Assessment Team 1993). Even-aged, two-aged, and uneven-aged silvicultural treatments that retain some features of old-growth forests (e.g., snags, logs, large diameter trees) but still allow some timber extraction may create stand structures that maintain habitat for birds. In a comparison of response of breeding birds to three silvicultural treatments (small-patch group-selection, two-story, and modified clearcut) and control (unharvested) stands, some bird species were most abundant in clearcut and two-story stands (e.g., white-crowned sparrow [*Zonotrichia leucophrys*], spotted towhee), while others were most abundant in uncut control or small-patch group-selection stands (e.g., brown creeper [*Certhia americana*], winter wren [*Troglodytes troglodytes*]) (Chambers 1996). Use of these stands may shift during the winter, however. If birds favor areas with greater structural and compositional complexity during the winter, they might be expected to be most abundant in control or small-patch group-selection stands, which retain all (control stands) or most (small-patch group-selection stands) of the trees and shrubs originally present in the stand (Chambers 1996). Based on this hypothesis, the objective of this study was to determine whether there were differences among resident bird use of three silvicultural treatments and control stands during winter. We used a subset of the same study sites used by Chambers (1996) so we could compare winter and breeding season habitat use by birds.

Study Area

We selected 12 stands in Oregon State University's McDonald-Dunn Forest located on the eastern edge of the Coast Range, ≤ 24 km north and northwest of Corvallis. Replicates were located near (1) Lewisburg Saddle: Township 11S, Range 5W, Willamette Baseline and Meridian (W. M.), Sections 4, 8, 9, 16, 17; (2) Peavy: Township 10S, Range 5W, W. M., Sections 25, 35, 36; and (3) Dunn: Township 10S, Range 5W, W. M., Sections 14, 22, 23, 27. Stands were 80- to 120-years old and ranged from 5 to 18 ha in size. Elevation ranged from 120 to 400 m. Douglas-fir comprised ≥ 64% basal area prior to harvest; grand fir (*Abies grandis*), bigleaf maple (*Acer macrophyllum*), Oregon white oak (*Quercus garryana*), Pacific madrone (*Arbutus menziesii*), Pacific dogwood (*Cornus nuttallii*), red alder (*Alnus rubra*), Oregon ash (*Fraxinus latifolia*), and bitter cherry (*Prunus emarginata*) comprised the remaining basal area.

Winter climate is typically wet and mild. Annual precipitation averages 100 cm; 95% occurs between October and June in the form of rain. Average annual snowfall is < 2 cm. Temperatures during January average 4.0 C (Franklin and Dyrness 1973:110-111).

The 12 stands included three replicates of four treatments: control (uncut), small-patch group-selection (1/3 volume removed in 0.2-ha circular patches), two-story (3/4 volume removed with remaining green trees [20 to 30/ha] scattered uniformly throughout the stand), and modified clearcut (1.2 green trees/ha retained). Harvesting began in fall and was completed by early spring. Lewisburg Saddle replicate was cut in 1989, Peavy replicate in 1990, and Dunn replicate in 1991. Statistical analyses were based on sample sizes of three stands per treatment.

Methods

Bird Data Collection

We sampled birds from December 1994 through March 1995, using the modified variable circular plot (VCP) method (Reynolds et al. 1980). Three VCPs were established in each stand with each VCP center at least 100 m from the stand edge and other VCP centers. We visited each VCP three times between 0900 and 1600. We alternated order of visitation among stands to account for daily variation in activity of birds. We did not conduct counts in rain or winds > 15 km/h.

Counts began two minutes after arrival at the VCP station to allow for resumption of normal bird activity. Each count lasted 15 minutes, during which time birds observed in the stand were identified to species and their approximate location mapped. We recorded distances to the nearest meter for birds ≤ 10 m from VCP station, to the nearest 5 m for birds >10 m but ≤ 50 m, and to the nearest 10 m for birds > 50 m but ≤ 100 m. The same observer conducted all sampling.

Statistical Analyses

We compared average detection distance (m) for each species of adequate sample size (in ≥ 8 stands, ≥ 3 treatments, $n \geq 20$ observations). We used analysis of variance (SAS Institute Inc. 1989) to determine if there were differences in detection distances among treatments. Distances were transformed using a log transformation [$\log_{10}$(distance)] to meet assumptions of normal distribution and equal variance (Sabin and Stafford 1990). If detection distance did not differ among treatments, we used all observations ≤ 75 m in analyses. If we did detect differences in detection distances among treatments, we calculated 95% confidence intervals for treatment means. If the 95% confidence interval placed individuals at detection distances > 75 m, we eliminated these species from analyses.

All individuals ≤ 75 m from the VCP center were included in analyses except repeat observations of the same individual and records of birds observed flying over stands. Abundances for individual bird species were transformed using a log transformation [$\log_{10}$(bird abundance + 1)] to meet assumptions of normal distribution and equal variance (Sabin and Stafford 1990). Total abundance of all bird species and species richness were not transformed for analyses.

The experimental design was a randomized block design. We used analysis of variance (SAS Institute Inc. 1989) to determine if there were differences in average detection distances, total abundance of birds (average number of observations/stand), species richness, and individual species abundances (average number of observations/stand for species that were detected in ≥ 8 stands, ≥ 3 treatments, and with ≥ 20 total observations) among treatments. If treatment effects were significant ($P < 0.10$), we made multiple means comparisons using Scheffe's test with $\alpha = 0.10$ (SAS Institute Inc. 1989).

Results

We observed a total of 594 birds representing 30 species. Most abundant species were golden-crowned kinglet (25% of total observations), winter wren (13%), dark-eyed junco (13%), song sparrow (*Melaspiza melodia*) (7%), Hutton's vireo (*Vireo huttoni*) (6%), Steller's jay (4%), and spotted towhee (4%) (Table 1).

TABLE 1. Birds[1] observed during winter counts (December 1994 - March 1995) representing 594 observations, McDonald-Dunn Research Forest, Benton County. Silvicultural treatments are unharvested control (CN), small patch (SP), two-story (TS), and modified clearcut (CC). Species are listed in descending order of abundance.

	TREATMENT				
Common Name	CN	SP	TS	CC	TOTAL
Golden-crowned kinglet[2]	87	60	4	0	151
Winter wren[2]	26	24	15	13	78
Dark-eyed junco[2]	0	17	34	27	78
Song sparrow[2]	2	5	17	15	39
Hutton's vireo[2]	20	7	10	1	38
Steller's jay[2]	11	10	4	1	26
Spotted towhee[2]	0	4	12	8	24
Bushtit	0	20	0	0	20
American robin	1	5	5	6	17
Pine siskin	0	10	0	6	16
Evening grosbeak	0	15	0	0	15
Black-capped chickadee	7	4	2	1	14
Northern flicker	2	3	6	1	12
Red-breasted nuthatch	5	3	1	0	9
Chestnut-backed chickadee	5	2	0	0	7
European starling	0	0	0	7	7
Gray jay	3	3	0	0	6
Red-breasted sapsucker	0	2	1	3	6
Red-tailed hawk	1	1	0	4	6
American crow	0	1	4	0	5
House wren	0	0	4	1	5
Varied thrush	2	1	0	1	4
Brown creeper[2]	2	0	0	0	2
Hairy woodpecker	0	1	1	0	2
Pileated woodpecker	2	0	0	0	2
Downy woodpecker	0	0	0	1	1
Great-horned owl	0	0	0	1	1
Sharp-shinned hawk	0	0	1	0	1
White-crowned sparrow[2]	0	1	0	0	1

[1] Scientific names for species are: bushtit (*Psaltriparus minimus*); American robin (*Turdus migratorius*); pine siskin (*Carduelis pinus*); evening grosbeak (*Coccothraustes vespertinus*); black-capped chickadee (*Parus atricapillus*); northern flicker (*Colaptes auratus*); red-breasted nuthatch (*Sitta canadensis*); chestnut-backed chickadee (*Parus rufescens*); European starling (*Sturnus vulgaris*); gray jay (*Perisoreus canadensis*); red-breasted sapsucker (*Sphyrapicus ruber*); red-tailed hawk (*Buteo jamaicensis*); American crow (*Corvus brachyrhynchos*); house wren (*Troglodytes aedon*); varied thrush (*Ixoreus naevi*); hairy woodpecker (*Picoides villosus*); pileated woodpecker (*Dryocopus pileatus*); downy woodpecker (*Picoides pubescens*); great-horned owl (*Bubo virginianus*); northern pygmy-owl (*Glaucidium gnoma*); sharp-shinned hawk (*Accipiter striatus*).

[2] Scientific names are listed in the text.

Six species were observed frequently enough for statistical analyses. We did not detect a difference ($P > 0.1$) in detection distances among treatments for five of these species: golden-crowned kinglet (average distance and standard error [in brackets and indicated by '.' if sample size was too small to calculate standard error]: control [CN] 42 m [2]; small-patch group-selection [SP] 44 m [1]; two-story [TS] 60 m [.]; clearcut [CC] no observations), winter wren (CN = 31 m [7], SP = 28 [4], TS = 22 [5], CC = 24 [3]), dark-eyed junco (CN = no observations, SP = 38 [4], TS = 33 [8], CC = 20 [6]), Steller's jay (CN = 59 m [11], SP = 36 [3], TS = 55 [15], CC = 80 [.]), or spotted towhee (CN = no observations, SP = 43 [15], TS = 30 [2], CC = 25 [3]).

Song sparrow detection distance differed among treatments ($P = 0.05$). Song sparrows were recorded at closer distances in clearcuts and two-story stands. Average detection distance was 16 m (2) in clearcuts, 26 m (1) in two-story stands, 49 m (6) in small patch stands, and 60 m (.) in control stands. Differences in detection distances among treatments were likely the result of actual differences in bird use of the stands. Song sparrows usually foraged or moved among dense shrubs. Shrub patches were more evenly distributed and denser in clearcuts and two-story stands than in small patch and control stands (Chambers 1996). Probably because shrubs were too sparse (e.g., control stands) and/or patchily distributed (e.g., small patch stands), we observed only two song sparrows in control stands, and observations in small patch stands were associated with shrubs in openings. However, all song sparrow observations occurred within 75 m of the VCP center in all treatments, so we assumed that we were able to adequately detect song sparrows in all treatments.

Abundance of birds differed among treatments ($P = 0.03$) and was highest in small patch stands and lowest in modified clearcut stands (Table 2). Species richness was highest in small patch stands and lowest in control and clearcut stands ($P = 0.02$) (Table 2).

Abundance of four bird species differed among treatments ($P \leq 0.04$): Steller's jay, golden-crowned kinglet, spotted towhee, and dark-eyed junco. We did not detect differences among treatments for winter wrens and song sparrows ($P \geq 0.12$) (Table 2).

Observations of golden-crowned kinglets were most frequent in control and small patch stands compared with two-story and clearcut stands ($P = 0.0001$). Steller's jays were more abundant in control and small-patch stands and low in abundance or absent from two-story and clearcut stands ($P = 0.04$). Observations of dark-eyed juncos were higher in harvested treatments than in control stands ($P = 0.0009$). Spotted towhees were more abundant in two-story and clearcut stands, lower in abundance in small patch stands, and absent in control stands ($P = 0.002$).

TABLE 2. Abundance (observations/stand) of birds ≤ 75 m from VCP centers in 3 silvicultural treatments (small-patch group-selection, two-story, modified clearcut) and unharvested control stands averaged over 3 counts conducted between December 1994 and March 1995, McDonald-Dunn Research Forest, Oregon. Means and standard errors (SE) for total bird abundance, species richness, and individual bird species are reported as untransformed. Data for bird species were transformed using $\log_{10}$(abundance + 1) for analyses. Total bird abundance and species richness were untransformed for analyses. P is the probability of Type I error associated with the rejection of the null hypothesis that there is no difference among means using ANOVA (degrees of freedom = 2, 3). Means that differed significantly ($P < 0.1$) using Scheffe means separation tests are designated with different letters.

	CONTROL		SMALL PATCH		TWO-STORY		CLEARCUT		
SPECIES	Mean	SE	Mean	SE	Mean	SE	Mean	SE	P
Bird abundance	53.0^{AB}	5.7	65.3^{A}	6.8	38.7^{AB}	6.6	27.7^{B}	4.7	0.03
Species richness	7.7^{B}	0.3	12.3^{A}	1.4	9.0^{AB}	1.5	7.0^{B}	1.5	0.02
Steller's jay	3^{A}	1	3^{A}	1	1^{AB}	1	0^{B}	0	0.04
Winter wren	8	1	8	2	5	1	4	3	0.3
Golden-crowned kinglet	26^{A}	2	20^{A}	3	1^{B}	1	0^{B}	0	0.0001
Spotted towhee	0^{C}	0	1^{BC}	0	4^{A}	1	3^{AB}	1	0.002
Song sparrow	0.3	0.3	2	1	6	2	5	3	0.12
Dark-eyed junco	0^{B}	0	6^{A}	1	11^{A}	4	9^{A}	3	0.0009

Discussion

Many species of birds alter their use of habitat between seasons because of changes in habitat structural features that affect availability of cover and roost sites (Morrison et al. 1986, Huff et al. 1991). Quantity and quality of food resources also may vary seasonally, and birds may alter foraging locations or patterns to obtain food (Martin et al. 1951, Conner 1980, Hutto 1981, Lewke 1982, Morrison et al. 1985).

Following harvest, abundance of breeding birds was higher in control (uncut) and small-patch group-selection stands than in two-story and clearcut stands (Chambers 1996). Bird communities in control and small-patch stands were dominated by migratory bird species whereas resident bird species were more abundant in two-story and clearcut stands (Chambers 1996). During the winter season, resident birds were more abundant in stands with higher canopy cover and least abundant in clearcut stands, although differences among control and two-story treatments were not statistically different from small-patch and clearcut stands.

Two species associated with forests (golden-crowned kinglet and Steller's jay) were low in abundance or absent from clearcut stands. Steller's jays were more abundant in control and small patch stands, lower in two-story stands and almost absent in clearcut stands; these patterns were the same as those observed during the breeding season (Chambers 1996) so it seemed that Steller's jays did not alter use of habitat seasonally.

Golden-crowned kinglets were most abundant in control and small-patch stands. This pattern was similar to the pattern observed during the breeding season (Chambers 1996). Morrison et al. (1986) also found no difference between habitat use of golden-crowned kinglets during winter and summer in a mixed-conifer forest in Sierra Nevada, California. Marcot (1985) and Huff et al. (1991), however, did find a seasonal shift in habitat use by golden-crowned kinglets in Douglas-fir forests in the Pacific Northwest. Marcot (1985) found golden-crowned kinglets were more abundant in sawtimber stands during breeding season, but during the rest of the year their density was highest in shrub-sapling stages. Huff et al. (1991) found kinglets more abundant in mid- than late-seral stands during the winter. The two-story and clearcut stands we studied were recently harvested (within the previous five years) and were structurally simpler than control and small patch stands (Chambers 1996). Conditions in these stands may not have provided adequate cover or food for kinglets.

We did not detect a treatment response for winter wrens, a forest-associate that is sensitive to forest fragmentation (Rosenberg and Raphael 1986, Lehmkuhl and Ruggiero 1991, McGarigal 1993). However, winter wrens were more abundant in control and small-patch stands than in two-story and clearcut stands during the breeding season (Chambers 1996). This may indicate a seasonal shift in habitat use. It also may indicate that dispersing juveniles use poorer quality habitat in winter (e.g., clearcuts and two-story stands) because better sites are already occupied by adults (Van Horne 1983). In California, Barrows (1986) found winter wrens occurred almost exclusively in old-growth forests during the breeding season, but were more randomly distributed among stands of different seral stages in winter. Winter wrens may be more selective of habitat for breeding sites than for winter use.

Spotted towhee abundance was significantly higher in heavily disturbed areas (modified clearcut and two-story stands) than lightly disturbed (small-patch group-selection) or control stands during the breeding season (Chambers 1996). The pattern of habitat use in winter was similar. We observed spotted towhees most frequently in clearcuts and two-story stands. They were also present in small-patch stands but we did not observe them in control stands. Spotted towhees did not appear to alter their use of habitat during the year.

During the winter, dark-eyed juncos were more abundant in clearcut, two-story, and small patch stands than in control stands. However, Chambers (1996) found dark-eyed juncos abundant in all stand types (including control stands) during the breeding season. They seemed more selective of winter habitat, using areas with more disturbance.

No difference in song sparrow abundance was detected among treatments during the winter season. Chambers (1996) did not have an adequate sample size during the breeding season to test for treatment differences.

Cody (1985) suggested that in the winter, birds may occupy niches vacated by migratory or summer visitors. We did detect seasonal shifts for some species. During the winter, some species became more selective (e.g., dark-eyed junco), some maintained the same degree of selectiveness (e.g., golden-crowned kinglet, spotted towhee), others became less selective (e.g., winter wren). Species such as the winter wren may occupy niches vacated by migratory species. Change in habitat use also might be attributed to occupation by dispersing juveniles Juveniles may use poorer quality habitat (e.g., clearcuts) because better habitat is already occupied by adults. We did not find a change in seasonal use of habitat for most of the species in our study.

Manuwal and Huff (1987), Morrison et al. (1986), and Huff et al. (1991) have suggested that structural features of late-successional forests and forests with dense upper- and mid-story canopies offer better habitat to resident birds during winter. Although we did not find greater use of mature forest (control stands), total bird abundance was higher in small-patch stands. These stands retained significantly higher canopy cover in the overstory (sawtimber cover, > 20 m) than two-story or modified clearcut stands (Chambers 1996). Our data indicate a need for a variety of seral stages on a landscape to provide habitat for all winter resident bird species, but stands that are more similar to mature forest may provide habitat for higher numbers of individuals.

Total winter bird abundance was approximately 1.5 times higher in control, small patch, and two-story stands than in clearcut stands. In other Pacific Northwest studies, birds were more abundant in late-successional stands than in younger forest seral stages (Manuwal and Huff 1987, Huff et al. 1991). Retaining late-successional forest stands or structural features (e.g., large diameter green trees) may be particularly important in areas being managed under short (40 to 80 year) rotations and planted with a single tree species since structure and composition may be much simpler than late-successional forests. Habitat selected by some birds may never develop under these management conditions (Morrison et al. 1986). However, in this study, some bird species (spotted towhee and dark-eyed junco) were more abundant in clearcuts and two-story stands. We suggest maintaining a variety of seral stages or structural conditions to provide habitat for species associated with early seral stages.

Although stand conditions in two-story and clearcut treatments in our study did not provide mature forest structure, they retained or created some elements (snags, logs, large trees) of old-growth forests and added to stand-level structural complexity. For winter birds that use late-successional forests, these features may provide habitat earlier in stand development than traditional clearcuts. Treatments that develop late-successional characteristics more quickly or retain structural and compositional complexity may be used by more bird species and should be considered when developing stand prescriptions.

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