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AVIAN ABUNDANCE IN RIPARIAN ZONES OF THREE FOREST TYPES IN THE CASCADE MOUNTAINS, OREGON

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ABSTRACT.—We surveyed bird populations along headwater streams of old-growth, mature, and young coniferous forests of the Oregon Cascade Mountains during summer and winter. Brown Creepers (*Certhia americana*), Chestnut-backed Chickadees (*Parus rufescens*), Golden-crowned Kinglets (*Regulus satrapa*), Evening Grosbeaks (*Hesperiphona vespertinus*), and Winter Wrens (*Troglodytes troglodytes*) were common in all stand types. During the summer, abundances of Brown Creepers, Hammond's Flycatchers (*Empidonax hammondii*), Hermit/Townsend's warblers (*Dendroica occidentalis*), and Chestnut-backed Chickadees were significantly higher in old-growth and mature forests compared to young forests. Species richness and densities generally were not significantly different among the stand types during winter. However, numbers of Chestnut-backed Chickadees, Evening Grosbeaks, Golden-crowned Kinglets, Hairy Woodpeckers (*Picoides villosus*), and Winter Wrens were much higher in the winter than in summer. Swainson's Thrushes (*Catharus ustulatus*) and Rufous Hummingbirds (*Selasphorus rufus*) were more abundant in riparian areas in this study compared to other studies in upland forests and may be riparian associates along these headwater streams. *Received 4 Oct 1994, accepted 20 Oct. 1995.*

Complexity of streamside vegetation associated with the aquatic and terrestrial interface creates unique habitats which are generally high in wildlife diversity and abundance (Thomas et al. 1979, Bull and Skovlin 1982). This is especially true in arid land environments or along large streams and rivers where riparian vegetation is markedly different from upland vegetation (Johnson and Jones 1977). However, vegetative communities along small mountain streams within western coniferous forests are less distinct from upland areas because conifers dominate and suppress the deciduous components of the riparian community (Swanson et al. 1982). The importance of these mountain streams as habitat for birds has been largely overlooked to date, especially in the dense forest lands of the western Cascade Mountains.

The rapid liquidation of old-growth forests and their recognition as unique wildlife habitat has made old-growth management a major forestry-wildlife issue in the Pacific Northwest (Meslow et al. 1981). Initially, the old-growth issue focused on the Northern Spotted Owl (*Strix*

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occidentalis), but other studies have indicated that many more species of wildlife may find optimum habitat in old-growth forests (Meslow 1978; Thomas 1979; Verner and Boss 1980; Anthony et al. 1982; Mannan 1980, 1982; Manuwal 1991).

In this study, we compared abundance of birds in small riparian zones among old-growth, mature, and young-aged forests. Specifically, species richness and density of the avian communities were compared among stand types and between summer and winter seasons.

STUDY AREAS AND METHODS

The study was conducted in the western hemlock (*Tsuga heterophylla*) zone of the Oregon Cascade Range on the Blue River and McKenzie River Ranger Districts of Willamette National Forest, Lane County, Oregon. Study areas were located along riparian zones of second and third-order streams within old-growth (400–450 yrs), mature (130–200 yrs), and young (25–35 yrs) forest stands. Five study areas were selected in both old-growth and mature stands and two in young stands. Old-growth stands were natural, unharvested forests, and mature stands were relatively even-aged and originated from an extensive wildfire during the 1850s. Young stands originated from clear-cut forest practices. Study areas ranged in mean elevation from 490–975 m and varied in slope and aspect. Annual rainfall is approximately 180 cm.

Douglas-fir (*Pseudotsuga menziesii*) dominated the forest community in all successional stages. Western hemlock and western red cedar (*Thuja plicata*) contributed to the old-growth canopy. Western red alder (*Alnus rubra*) was a conspicuous component of the young stands and was co-dominant with big-leaf maple (*Acer macrophyllum*) and willow (*Salix* spp.). The shrub layer included salmonberry (*Rubus spectabilis*), red huckleberry (*Vaccinium parvifolium*), vine maple (*Acer circinatum*), salal (*Gaultheria shallon*), Pacific rhododendron (*Rhododendron macrophyllum*), dwarf Oregon grape (*Berberis nervosa*), western swordfern (*Polystichum munitum*), and common bracken fern (*Pteridium aquilinum*). The young-aged stands had the lowest shrub cover because of the dense overstory of young Douglas-fir and western red cedar; however, early seral plants such as willow and snowbrush ceanothus (*Ceanothus velutinus*) were common.

We established five plots at 200-m intervals along the riparian zone in each of the 12 study areas. Inclusion of more than five plots was not possible because of difficulty of locating homogeneous habitats that were more than 1 km long. Stream noise was minimal, because the streams were small (1–3 m wide). Birds were surveyed using the variable circular plot method (Reynolds et al. 1980). Each plot was sampled once per week for 10 min during the period of dawn to 10:00 h. Each bird seen or heard during the sample period was identified, and the distance from their location to the plot center was estimated and verified with range finders. Surveys were repeated five to seven times during summer (May–June) and six times during winter (Jan–Feb). The third and fourth authors conducted the surveys and alternated visits to a stand to minimize observer bias.

Estimates of bird density were determined by the method first described by Emlen (1971), and later modified by Ramsey and Scott (1981), to distance sampling of birds. At least 15 detections per species over all stands were required for the algorithm to estimate detection distances and generate density estimates. Densities were not estimated for species with <15 detections.

Differences in densities between seral stages were tested using analysis of variance with Duncan's multiple range test for mean separation (Steel and Torrie 1980:187). All statistical

TABLE 1
COMMON NAMES, SCIENTIFIC NAMES, AND ABBREVIATIONS FOR BIRD SPECIES OBSERVED DURING THE STUDY

Common name	Scientific name	Abbreviation
Black-capped Chickadee	*Parus atricapillus*	BCCH
Brown Creeper	*Certhia americana*	BRCR
Chestnut-backed Chickadee	*P. rufescens*	CBCH
Common Raven	*Corvus corax*	CORA
Dark-eyed Junco	*Junco hyemalis*	DEJU
Evening Grosbeak	*Hesperiphona vespertinus*	EVGR
Golden-crowned Kinglet	*Regulus satrapa*	GCKI
Gray Jay	*Perisoreus canadensis*	GRJA
Hammond's Flycatcher	*Empidonax hammondii*	HAFL
Hairy Woodpecker	*Picoides villosus*	HAWO
Hermit Warbler	*Dendroica occidentalis*	HEWA
MacGillivray's Warbler	*Oporornis tolmiei*	MGWA
Olive-sided Flycatcher	*Contopus borealis*	OSFL
Pine Siskin	*Corduelis pinus*	PISI
Pileated Woodpecker	*Dryocopus pileatus*	PIWO
Red-breasted Nuthatch	*Sitta canadensis*	RBNU
Rufous Hummingbird	*Selasphorus rufus*	RUHU
Steller's Jay	*Cyanocitta stelleri*	STJA
Swainson's Thrush	*Catharus ustulatus*	SWTH
Vaux's Swift	*Chaetura vauxi*	VASW
Varied Thrush	*Ixoreus naevius*	VATH
Warbling Vireo	*Vireo gilvus*	WAVI
Pacific Slope Flycatcher	*Empidonax difficilis*	WEFL
Western Tanager	*Piranga ludovicianus*	WETA
Wilson's Warbler	*Wilsonia pusilla*	WIWA
Winter Wren	*Troglodytes troglodytes*	WIWR

tests were performed at the 0.05 level of significance. A key to bird species codes, common names, and scientific names is provided in Table 1.

RESULTS

Species composition.—Forty-six species were detected during the study. The Brown Creeper, Chestnut-backed Chickadee, Golden-crowned Kinglet, Evening Grosbeak, and Winter Wren were common in all stands during both seasons (Table 2). In addition, Hammond's Flycatcher, Hermit/Townsend's warbler, Swainson's Thrush, and Western Flycatcher were found in all stands during the summer. Because the study was conducted in the zone of hybridization between Hermit and Townsend's warblers, we could not distinguish the two species by song. Vaux's Swift (4 observations) and Black-capped Chickadee (8 observations) were observed

TABLE 2

AVIAN POPULATION DENSITIES (#/40 HA) IN OLD-GROWTH, MATURE, AND YOUNG SERAL STAGES IN THE WESTERN CASCADE MOUNTAINS, OREGON, DURING SUMMER AND WINTER 1984

	Old-growth (N = 5)		Mature (N = 5)		Young (N = 2)	
Species[a]	$\bar{x}$	± 2 SE	$\bar{x}$	± 2 SE	$\bar{x}$	± 2 SE
			Summer			
BRCR	24.10	6.50	9.50	4.50	1.00	1.8**
CBCH	42.00	17.20	33.40	19.20	22.40	11.3*
CORA	0.70	1.20	0.00	0.00	0.70	0.80
DEJU	9.00	9.70	1.60	1.50	26.30	36.90
EVGR	0.10	0.10	0.60	0.30	0.20	0.3*
GCKI	14.30	6.70	12.10	8.00	11.90	14.10
HAFL	30.90	10.60	30.70	10.90	7.40	0.0*
HAWO	0.50	0.50	0.50	0.30	0.50	1.00
HETH	0.90	1.00	0.30	0.20	1.80	2.40
HEWA	5.90	4.70	4.70	2.30	1.70	2.00
MGWA	1.60	3.20	0.00	0.00	8.80	17.70
ROBI	0.10	0.10	0.80	0.80	0.50	0.60
RUHU	66.70	29.80	29.50	31.40	40.00	80.00
STJA	0.80	0.70	1.20	0.90	3.50	2.1**
SWTH	6.50	3.90	14.30	9.70	25.50	3.0*
VATH	3.60	2.00	1.20	1.30	0.00	0.00
WAVI	0.00	0.00	0.00	0.00	11.70	23.30
WEFL	11.70	4.80	12.50	11.30	14.60	0.00
WETA	1.40	1.20	2.20	1.40	5.40	10.70
WIWA	1.90	2.00	3.90	3.50	3.00	0.30
WIWR	39.30	5.00	47.00	13.20	18.80	27.40
Total	261.70	58.50	205.70	43.80	205.30	169.30
			Winter			
BRCR	6.20	2.90	7.50	2.20	3.60	7.10
CBCH	103.20	30.00	91.70	32.20	97.70	77.60
DEJU	3.90	4.50	1.30	2.50	6.00	4.90
EVGR	5.00	4.80	10.90	6.70	92.90	144.0*
GCKI	55.80	11.00	57.40	31.90	72.10	13.60
HAWO	5.40	4.50	2.60	3.30	1.80	3.70
WIWR	171.10	24.00	218.90	88.70	148.30	70.00
Total	350.50	36.90	390.20	81.00	422.30	139.70

[a] Table 1.
* $P < 0.05$, analysis of variance.
** $P < 0.01$, analysis of variance.

only in old-growth stands, and Olive-sided Flycatcher (10 observations) were observed in two old-growth and one mature stand during the summer. Varied Thrush was recorded only in old-growth and mature stands and during summer. Pileated Woodpecker was detected predominately in old-growth and mature forests. Similarly, the Hairy Woodpecker was re-

corded mostly in old-growth and mature forests during winter, but some were observed in one young-aged stand. Twenty-one observations of Warbling Vireos occurred in a single young-aged stand during summer.

Summer densities and species richness.—No major differences in species richness were observed between the three forest types with 26, 29, and 32 species recorded in mature, old-growth, and young stands, respectively. Thirty-nine species of birds were detected in the 12 stands during the summer, of which 21 were observed >15 times to estimate density. Brown Creepers, Chestnut-backed Chickadees, Hermit/Townsend's warblers, Rufous Hummingbirds, and Varied Thrushes had highest densities in old-growth stands (Table 2). Abundances of Brown Creepers and Chestnut-backed Chickadees were significantly ($P < 0.05$) higher in the old-growth and mature forests than in young forests. Abundances of Hammond's Flycatchers ($P < 0.05$), Hermit/Townsend's warblers, and Winter Wrens were similar in old-growth and mature forests and greater than densities in young stands. Common Ravens were equally abundant in old-growth and young stages, but densities were very low, and there was no significant difference among all three seral stages. Numbers of Evening Grosbeaks, Wilson's warblers, and Winter Wrens were highest in the mature stands; but only densities of the Evening Grosbeak were significantly ($P < 0.05$) higher. Species with highest abundance in the young successional stages were Dark-eyed Junco, MacGillivray's warbler, Stellar's Jay, Swainson's Thrush, Warbling Vireo, and Western Tanager. The Warbling Vireo was found only in one young stand and at low numbers. Abundances of Hairy Woodpecker, Golden-crowned Kinglet, and Pacific Slope Flycatcher were similar across all forest types. Abundances of Brown Creeper, Varied Thrush, Chestnut-backed Chickadee, and Hermit warbler were greater with increasing age of forest stands, while numbers of Steller's Jays, Swainson's Thrushes, and Western Tanagers were less with increasing age of forest stands.

Winter densities.—Species richness during winter differed little among the three forest types, with 12, 15 and 15 species recorded in old-growth, mature, and young stands, respectively. Twenty species were recorded in all 12 stands during the winter survey period, and densities could be estimated for seven of these. Except for Evening Grosbeaks, only minor differences in abundance were noted among the three forest types (Table 2). Evening Grosbeak densities were 10–20 times greater ($P < 0.05$) in the young stands as in mature and old-growth forests. Highest numbers were found in the old-growth forests for Chestnut-backed Chickadees and Hairy Woodpeckers, although neither were significantly different among forest types. Abundances of Chestnut-backed Chickadees were high and similar throughout all forest types. Brown Creepers and Winter Wrens

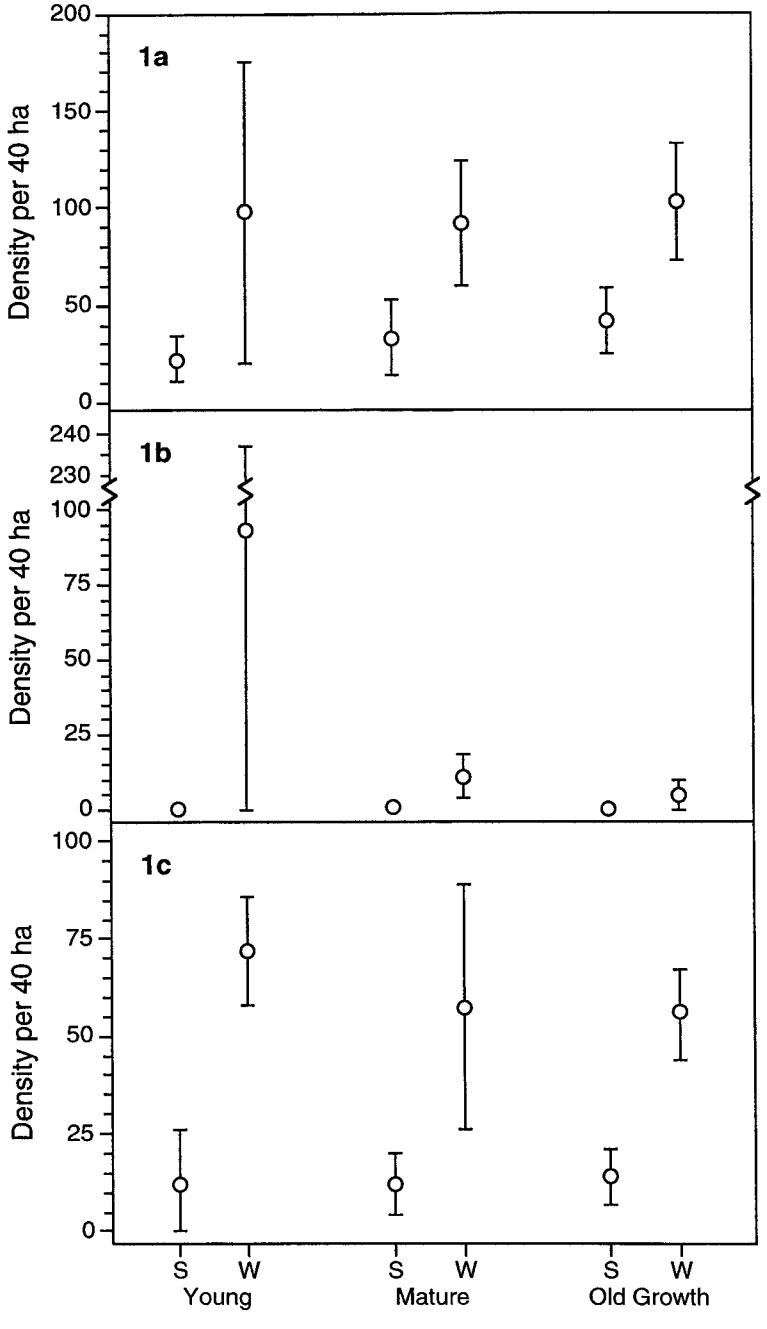
had their highest numbers in the mature forests. Abundances of the Dark-eyed Junco, Evening Grosbeak, and Golden-crowned Kinglet were highest in young forests. Hairy Woodpecker numbers were greater with increased stand age; Evening Grosbeak numbers were less with stand age.

Seasonal changes.—Abundances of Chestnut-backed Chickadees, Evening Grosbeaks, Golden-crowned Kinglets, Hairy Woodpeckers, and Winter Wrens were much higher in winter as compared to summer (Figs. 1, 2). These species are the most common winter residents, and some form large winter flocks. In contrast, numbers of Dark-eyed Junco were generally lower in the winter than in summer (Fig. 2c). All the warblers, flycatchers, and thrushes were not present on the study area during winter because they migrated out of the area.

DISCUSSION

Overall, population densities were highest in old-growth stands during summer and young stands during winter. These results are different from those of Manuwal and Huff (1987) for the Washington Cascades where species richness and abundance were greater in old-growth versus young forests during winter. Birds present in the summer period were, for the most part, breeders, and the greater structural diversity of vegetation in the old-growth forests likely provided more nesting and foraging habitat, resulting in greater abundance. Total overall bird numbers for the three successional stages were approximately twice as high during the winter as compared to the summer. This was likely a result of "flocking" of migrants from higher elevations and latitudes, and there could be more seed- and fruit-bearing vegetation in young stands.

Brown Creepers were relatively more abundant in old-growth stands than in young and mature stands during summer; they were more abundant with increasing age of stands. This is consistent with other studies (e.g., Thomas 1979, Verner 1980, Mannan 1982). Fidelity to old-growth was not as great during winter, as Brown Creeper numbers were similar in both old-growth and mature stands. We found highest numbers of Varied Thrushes in old-growth stands during summer, and they were totally absent from the young stands. Varied Thrushes appear to reach their highest breeding densities in older coniferous forests (Ramsden et al. 1979, Mannan 1982). We observed greater abundances of Chestnut-backed Chickadees and Golden-crowned Kinglets in old-growth forests. These results compare well with findings by Hagar (1960), Buckner et al. (1975), and Manuwal (1991) who found both species to prefer the late-successional forests. We found Hammond's Flycatchers equally abundant in the old-growth and mature forests and four times greater than in the young stands during the summer, which is consistent with the reports of


1a
1b
1c
Density per 40 ha
200
150
100
50
0
240
230
100
75
50
25
0
100
75
50
25
0
S
W
S
W
S
W
Young
Mature
Old Growth

Hagar (1960), Verner (1980), McMillan and Walter (1981), and Manuwal (1991) for Douglas-fir forests. However, Mannan (1982) found Hammond's Flycatcher densities to be equal for both 85 and >200-year-old stands in mixed-conifer forests in northeastern Oregon. Evening Grosbeaks were found at consistently low numbers (<1/40 ha) during summer but were significantly more abundant in mature stands. They were about 100-fold more abundant during winter with highest densities found in young stands. Our results are consistent with those of Thomas (1979) and McMillan and Walter (1981) who found that Evening Grosbeaks breed in dense stands of older conifer forests and move to younger forests during winter. Winter Wrens were most abundant in three mature stands during both seasons, and all of these sites were at low elevations and contained much shrub cover. Hagar (1960) also found Winter Wren densities to be highest in mature stands, while Peterson and Peterson (1983) stated that slash and brush cover positively influenced Winter Wren densities, not age class.

In summary, the results of this study provide information on species that attain their highest densities in small riparian areas of late-successional forests (>120 yrs old) or are found predominately in old-growth forests. During summer, Brown Creepers, Varied Thrushes, Hermit/Townsend's warblers, and Chestnut-backed Chickadees were more abundant with increasing age of stands. Hammond's Flycatchers were more abundant in old-growth and mature forests and much less common in young forests, Evening Grosbeaks were most abundant in mature forest stands. Vaux's Swifts, Black-capped Chickadees, Olive-sided Flycatchers, and Pileated Woodpeckers were not abundant enough to estimate densities, but most observations of these species were in old-growth stands. Likewise, numbers of Hairy Woodpeckers were greater with age of forest stands during winter.

Of the above list of species, the Brown Creeper, Chestnut-backed Chickadee, Black-capped Chickadee, Evening Grosbeak, Varied Thrush, and Hairy Woodpecker are common and widely distributed species, so any dependencies on late-successional forests are unlikely. However, the group contains a number of cavity-nesting species (Chestnut backed Chickadee, Black-capped Chickadee, Brown Creeper, Vaux's Swift, and Pileated Woodpecker) that may be responding to higher densities of snags

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FIG. 1. Densities of Chestnut-backed Chickadee (1a), Evening Grosbeak (1b), and Golden-crowned Kinglet (1c) in three forest types during summer (S) and winter (W), western Oregon. Circles and bars represent mean ± 2 SE; where only circles are present, error bars are too small to graph.

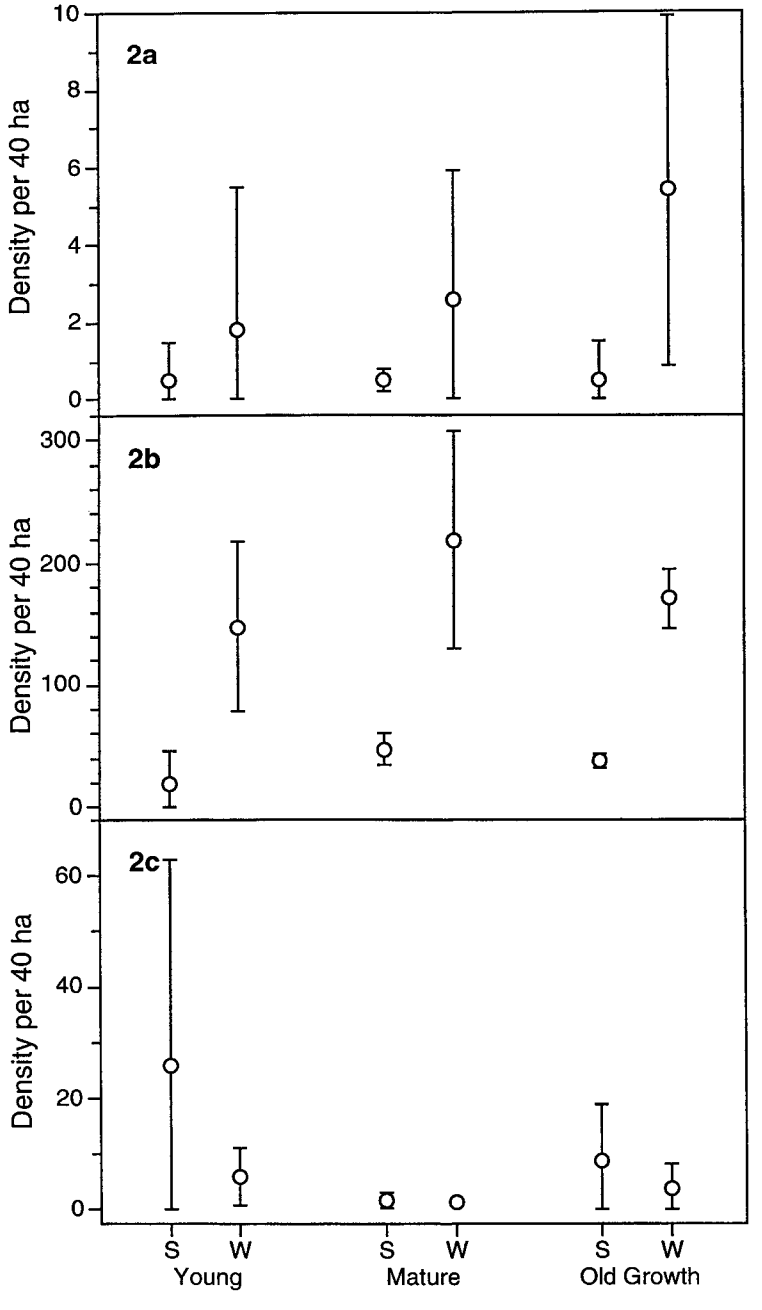
2a
Density per 40 ha
10
8
6
4
2
0
2b
Density per 40 ha
300
200
100
0
2c
Density per 40 ha
60
40
20
0
S
W
Young
S
W
Mature
S
W
Old Growth

TABLE 3

RANKED ABUNDANCE OF BIRD SPECIES IN YOUNG, MATURE, AND OLD-GROWTH FORESTS OF THE OREGON AND WASHINGTON CASCADES

	Young			Mature			Old-growth		
Species[a]	This study	Gilbert and Allwine 1991	Manuwal 1991	This study	Gilbert and Allwine 1991	Manuwal 1991	This study	Gilbert and Allwine 1991	Manuwal 1991
RUHU	1			4			1		
CBCH	4	3	6	2	4	5	2	3	3
WIWR	5	2	2	1	2	1	3	1	1
HAFL	9	4		3	3		4	4	
BRCR	16		9	8		6	5		7
GCKI	7		3	7		2	6		2
WEFL	6	5	4	6	6	4	7	5	4
DEJU	2		5	10		8	8		8
SWTH	3			5			9		
HEWA		1	1		1	3		2	9
RBNU		6	8		5	9			6
VATH			7			7		6	5
PISI			10						
GRJA						10			
VASW									10

[a] See Table 1 for list of common and scientific names of birds.

or logs in late-successional forests. The importance of snags to these species in relation to their association with late-successional forests needs further clarification. Hairy Woodpeckers were the only species that displayed an association with old-growth forests during winter. Based on these findings and the common and widely distributed nature of Hairy Woodpeckers, winter bird surveys in riparian areas are probably not high priority to assess associations with late-successional forests.

Riparian associates—Similar studies on avian communities in upslope habitats have been conducted in young, mature, and old-growth forests in the Oregon Cascades (Gilbert and Allwine 1991), Oregon Coast Range (Carey et al. 1991), and Washington Cascades (Manuwal 1991). These studies provide estimates of relative bird abundance but only qualitative comparisons of ranked abundances can be made (Table 3), because the

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FIG. 2. Densities of Hairy Woodpecker (2a), Winter Wren (2b), and Dark-eyed Junco (2c) in three forest types during summer (S) and winter (W), western Oregon. Circles and bars represent mean ± 2 SE; where only circles are present error, bars are too small to graph.

previous studies did not estimate densities. All the species we detected in riparian areas were also found in upland areas in the above studies so we did not identify any riparian obligate species. However, Swainson's Thrushes and Rufous Hummingbirds were abundant along headwater streams in this study, but were detected infrequently in upland areas in the above studies. Further study may reveal some association with riparian areas for these two species. In contrast, Hermit/Townsend's warblers, Varied Thrushes, and Red-breasted Nuthatches were abundant in upland areas of the above three studies but were not among the top 10 most abundant species in riparian areas in this study. These species may be associated with upland habitats.

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