Table 14—Total bird-observation effort (number of stations times number of visits) in the southern Oregon Coast Range, 1985

Stand number	Number of stations	Number of visits	Total effort
701	7	11	77
702	12	7	84
703	11	6	66
704	12	7	84
705	12	7	84
706	12	7	84
717	12	7	84
718	12	7	84
719	12	7	84
721	12	7	84
726	12	7	84
728	12	6	72
732	10	8	80
733	12	7	84
737	12	8	96
740	12	6	72
741	12	7	84
742	12	7	84
750	12	7	84
755	12	7	84
760	12	7	84
761	12	7	84
764	12	7	84
765	12	7	84
806	12	8	96
810	12	8	96
812	12	8	96
815	12	8	96
817	12	6	72
818	12	9	108
819	12	6	72
821	11	6	66
835	12	6	72
837	12	6	72
838	12	8	96
839	12	6	72
840	12	8	96
845	12	8	96
847	12	8	96
848	12	8	96
860	11	9	99
861	12	6	72
862	12	8	96
865	12	6	72
870	12	8	96

Table 15—Total bird-observation effort (number of stations times number of visits) in the southern Oregon Coast Range, 1986

Stand number	Number of stations	Number of visits	Total effort
702	12	7	84
704	12	7	84
705	12	7	84
718	12	6	72
719	12	7	84
720	12	7	84
722	12	7	84
726	12	7	84
733	12	7	84
737	12	7	84
742	12	7	84
750	12	7	84
755	12	7	84
761	12	7	84
764	12	7	84
765	12	6	72
806	12	7	84
810	12	7	84
812	12	7	84
815	12	7	84
818	12	7	84
819	12	7	84
835	12	7	84
838	12	7	84
839	12	7	84
840	12	7	84
845	12	7	84
847	12	7	84
848	12	7	84
860	11	7	77
861	12	7	84
862	12	7	84
870	12	7	84

Table 16—Standard deviations (and percent coefficients of variation) for age-class means of densities of birds associated with old-growth forests in the southern Oregon Coast Range, 1985

Species	Age-class					
	Young		Mature		Old-growth	
Brown creeper	7.2	(51)	12.4	(48)	18.2	(56)
Chestnut-backed chickadee	22.7	(29)	36.1	(41)	54.5	(41)
Hairy woodpecker	1.3	(118)	1.0	(111)	1.1	(79)
Olive-sided flycatcher	.0	—	.2	(317)	1.2	(200)
Pileated woodpecker	.1	(300)	.5	(121)	.5	(134)
Red-breasted nuthatch	1.5	(58)	6.0	(93)	3.5	(49)
Red-breasted sapsucker	.2	(283)	1.1	(233)	1.0	(137)
Varied thrush	7.2	(129)	10.5	(77)	10.3	(75)
Western flycatcher	10.9	(23)	16.6	(45)	16.3	(26)

Table 17—Standard deviations (and percent coefficients of variation) for age-class means of densities of birds associated with old-growth forests in the southern Oregon Coast Range, 1986

Species	Age-class					
	Young		Mature		Old-growth	
Brown creeper	6.3	(39)	14.4	(45)	10.8	(30)
Chestnut-backed chickadee	9.3	(36)	18.6	(53)	22.8	(32)
Hairy woodpecker	.5	(125)	1.0	(81)	1.6	(72)
Olive-sided flycatcher	.3	(254)	.0	—	.4	(145)
Pileated woodpecker	.0	—	.2	(200)	.5	(107)
Red-breasted nuthatch	2.7	(75)	6.3	(97)	7.0	(60)
Red-breasted sapsucker	.3	(150)	2.8	(212)	1.9	(146)
Varied thrush	5.0	(122)	9.2	(52)	9.3	(60)
Western flycatcher	15.4	(38)	12.8	(40)	15.3	(26)

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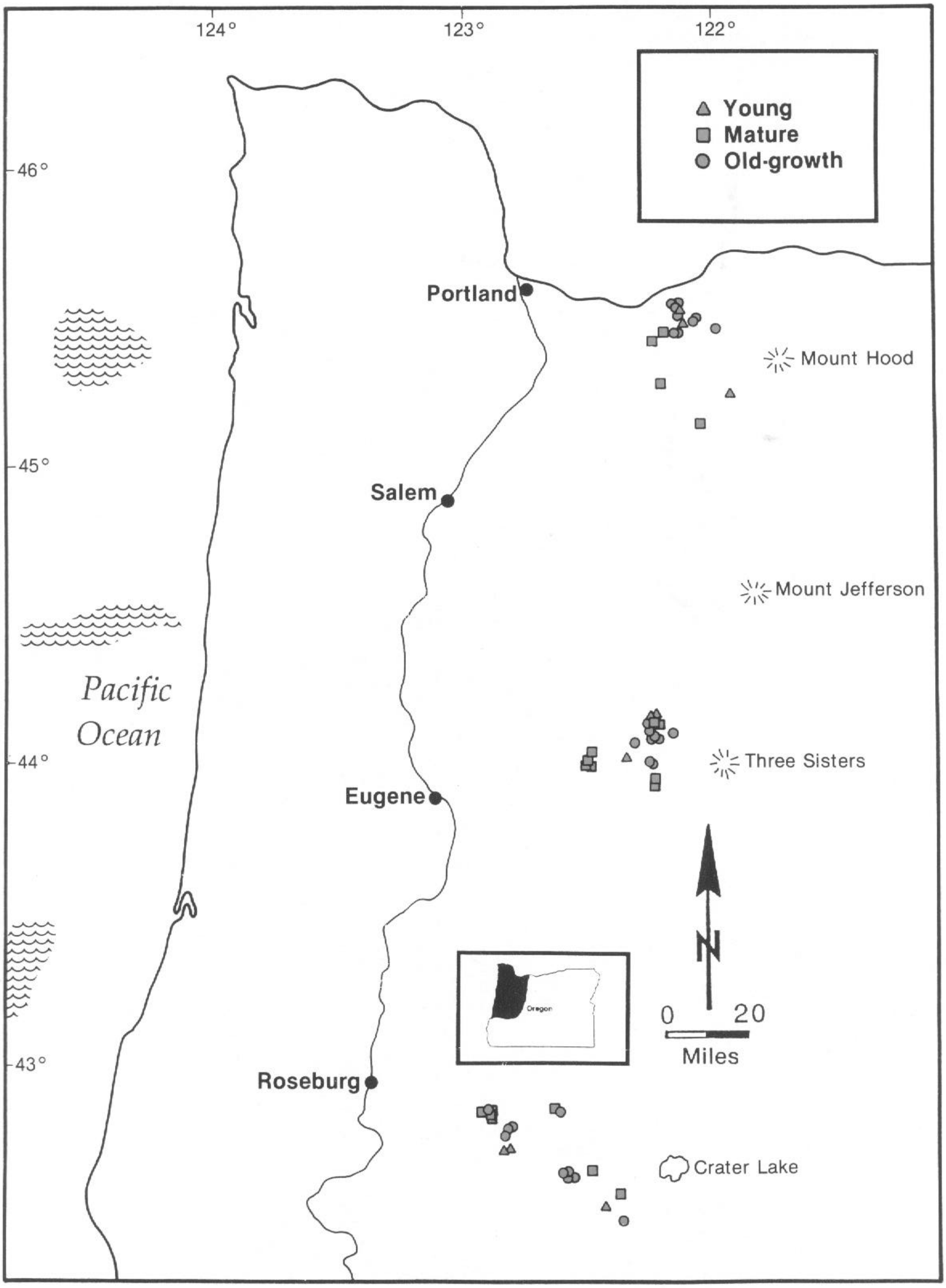

Location of study sites.

Spring Bird Communities in the Oregon Cascade Range

Frederick F. Gilbert and Rochelle Allwine

Authors

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Abstract

Spring bird communities in the western Oregon Cascade Range were examined in 1984 and 1985 using point counts. Three locations in the northern (Mt. Hood), central (H.J. Andrews), and southern (Rogue River-Umpqua) portions of this physiographic region were studied in 1984; in 1985, only the central location was studied.

A total of 70 species was detected in 1984 in 56 Douglas-fir stands ranging in age from 30 to 450 years. Species richness values were similar for all locations in 1984 but increased slightly between years at H.J. Andrews to 62 species (from 56) in 1985. Numbers of bird species did not differ across the chronosequence (old, mature, young) or moisture gradient (dry, mesic, wet) in either year. The hermit warbler was the most common species encountered in 1984, and the winter wren the most common species at H.J. Andrews in both 1984 and 1985.

Locational differences were found for particular species, and the birds segregated out on the basis of elevation, latitude, and longitude and-where they shared the same environments-on the basis of resource utilization, Species associated with older stands, based on significant correlations with stand age or old-growth stands in the chronosequence, were the brown creeper, chestnut-backed chickadee, hairy woodpecker, rufous hummingbird, varied thrush, and winter wren. Two other species that were, with small sample sizes, significantly associated with old growth in 1984 were Vaux's swift and the olive-sided flycatcher; the red-breasted sapsucker was found only in old growth. In 1985, the evening grosbeak and western flycatcher were significantly associated with stand age, and Cooper's hawk, blue grouse, Hutton's vireo, red crossbill, and Vaux's swift were found only in old-growth stands.

In all, 17 species over the 2 years of study were significantly associated with either the dry or wet portion of the moisture gradient. Hutton's vireo and Swainson's thrush were found only in wet stands in 1985. At Andrews, however, 14 species changed their use of the moisture gradient from dry to mesic or wet between 1984 and 1985.

The variability found among locations and between years in bird detections suggested considerable flux in the way avian species selected habitats and that environmental factors and interspecific competition were important in modifying the relations of avian species to habitat but not necessarily to vegetative structure.

A few (5-6) species dominated the avifauna (>60 percent of all detections), and most were common in all age-classes. The only important old-growth associates may be some of the rarer species, such as Vaux's swift; spotted owl management prescriptions may accommodate the needs of these and other species.

The vegetative structure in the young stands studied, which were all fire-derived, had similar characteristics to that of the old-growth stands. Thus, our findings are probably not representative of the avifauna that might be found in managed stands of similar ages.

Introduction

The avifauna is the most visible component of the vertebrate community. As such, it frequently is used to define and thus indicate the total faunal support capacity of any given environment (see Graber and Graber 1976). Spring bird communities are the most stable and thus predictive because they normally are composed primarily of breeders. Breeding forest birds select and use habitat based on its structure (for example, Anderson and Shugart 1974; Crawford and others 1981; De Graaf and Chadwick 1987; Karr and Roth 1971; MacArthur and others 1962, 1966; Smith 1977). Although this relation to structure is generally accepted, some researchers disagree (for example, Tomoff 1974, Willson 1974). Old-growth Douglas-fir forests have structural characteristics that distinguish them from younger and managed forests (Franklin and others 1981; Franklin and Spies 1984; Spies and others, unpubl. manuscript). Theoretically, determining the structural components responsible for any given bird species' presence and abundance in old growth should be possible. Management prescriptions to ensure its continued existence could be developed or appropriate areas set aside, as is being attempted for the spotted owl (U.S. Department of Agriculture 1988a). Conceivably, these structural components, if known, could be provided in younger stands.

The objectives of this study were to document the spring bird communities in the Oregon Cascade Range and to relate particular species and associations of species to the age and structural characteristics of unmanaged Douglas-fir forests.

Materials and Methods

The study was conducted at three locations on the west side of the Oregon Cascade Range during 1984 (Mt. Hood, H.J. Andrews (Andrews), and Rogue River-Umpqua (Rogue-Umpqua)) and Andrews in 1985. In 1984,56 stands extending along a chronosequence of 35 to 500 years (appendix table 15) and dominated by a Douglas-fir overstory were sampled (see frontispiece). Although mesic stands dominated the young (30-80 years) and mature (80-200 years) categories, a moisture gradient (wet, mesic, and dry) was determined for the old-growth stands. Of the 56 stands, 46 were used for chronosequence analysis and 28 for the old-growth moisture-gradient analysis.

Birds were sampled using simple point counts (Vemer 1985). Twelve stations separated by 150 m and at least 75 m from the edge of the stand were established within each stand. Six surveys were run for each stand in 1984 with the direction being reversed for each survey (that is, 1 to 12, 12 to 1, 1 to 12 and so on) and observers were randomly assigned to minimize observer bias. Different crews were used at the three locations, so despite common training procedures, observer bias among locations was possible. Detections were summed among stations and reported as counts of species per stand. Only birds detected within 75 m of the station and species detected on at least two sample days in a stand and in more than one stand per location were included in the data analyses. This strategy reduced the number of species from 70 to 38, suggesting that 46 percent of the species detected were migrants, transients, or rare breeders at the three locations. For the purpose of analysis, *Empidonax* flycatchers denote dusky and Hammond's flycatchers. Seven surveys were done in 1985 in each of 15 stands at Andrews.

Vegetational data were collected for the forest floor, shrubs, and trees, and physical characteristics of the 56 stands were measured (appendix table 16). Each station was individually described using a nested plot design with 500-m^2 (13-m radius) and 2000-m^2 (25-m radius) sampling areas.

We used nonparametric analysis of variance (ANOVA) to test the hypotheses that abundance of birds and species richness did not differ among age- or moisture-classes or locations. We used detrended correspondence analysis (DCA) (Hill 1979a) to explore the relation between bird abundances and habitat-classes or environmental variables. Detrended correspondence analysis is an ordination technique that arranges a matrix of species' abundances (communities) by samples (stands) in low-dimensional space so that the communities occurring in each stand are represented in space along several axes. Thus, many components are reduced to a few important ones and variability is reduced. Communities with similar species composition and relative abundances occupy positions near each other within the space described by the first and second DCA axes. To determine whether stands grouped themselves with respect to age, moisture, or location categories, a plot of the DCA axis scores was examined to detect clustering of stands that might be caused by these factors.

To classify sites into community phases, two-way indicator species analysis (TWINSPAN) (Hill 1979b) was used. The analysis, based on a multilevel, two-way partitioning of the correspondence analysis axis scores, was used to classify avian species into categories related to location and to the stand age- and moisture-classes.

Bird species found to be associated with old-growth forests from the TWINSPAN analysis were correlated with the vegetational and environmental variables to examine the relation between individual bird species and individual environmental features.

Old-growth-associated species based on significant, positive Spearman rank correlations with stand age were examined in relation to the vegetative structure of the old-growth stands to identify which vegetational characteristics may have been important elements in effecting the observed association. Avian guilds were assembled (Manuwal and others 1987) to examine intraguild habitat use.

In 1985, only the Andrews location was studied. The procedures followed were identical to the previous year, but as noted earlier only 15 stands were sampled (appendix table 15). Data from 1984 were compared to those from 1985 in the same 15 stands. Because of differences in species richness and relative abundances between the 2 years, these data could not be combined for analysis. Chi-square analyses (Zar 1974) were used to examine differences between years. Statistical significance is reported at $P < 0.05$; means are presented with standard errors.

Results

1984

A total of 38 different bird species were considered in 1984, although the total data set consisted of over 18,000 detections of 70 different species. Using the restructured data set, an average of 15.8 species were detected per stand (range 10-23). ANOVA indicated that neither abundance of birds detected (57.8 per stand in old-growth, 55.9 in mature, and 52.4 in young) nor the species richness values were related to age or moisture (table 1). The mean numbers of species in old-growth, mature, and young stands were 16.4 $\pm$ 0.6, 16.5 $\pm$ 0.7 and 15.2 $\pm$ 0.6. Species numbers detected at the three locations were not different (Rogue-Umpqua, 18.2 $\pm$ 0.9; Andrews, 15.0 f$\pm$ 0.7; Mt. Hood, 14.3 $\pm$ 0.7). The most frequently detected species for all three sites combined was the hermit warbler, although the winter wren was the most frequently detected species at Andrews.

Nineteen species exhibited significant location effects by being predominantly found at only one or two of the three locations (table 2). More birds were detected at Rogue-Umpqua than at Andrews (average 62.5 $\pm$ 2.7 vs 52.7 $\pm$ 3.9 birds per stand per visit) ($P < 0.05$).

Table l-Analysis of variance for bird abundance and species richness values compared to age and moisture conditions, Oregon Cascades, 1984

Factors	DF	F- value	*Prob>F*
Species richness x age	2	0.01	0.9876
Species richness x moisture	2	0.26	0.7728
Bird abundance **x** age	2	0.67	0.5163
Bird abundance x moisture	2	0.33	0.7191

Seven species were positively associated ($P < 0.05$) with stand age and three negatively associated (table 3), based on Spear-man rank correlations. ANOVA showed the chestnut-backed chickadee to be significantly associated with old-growth compared to young stands, and Steller's jay and the western flycatcher detections approached significance ($P < 0.06$ and < 0.07, respectively). Two species with small sample sizes significantly associated with old growth were Vaux's swift and the olive-sided flycatcher.

TWINSPAN analysis distinguished two groups of birds (table 4), as indicator species. The first group was somewhat associated with stands that were old and mature, and the second with stands that were young and mature. Correlations of individual environmental components with DCA axis scores showed 10 significant physical variables correlated with DCAl (table 5). Foremost were elevation, latitude, and the two fern-height categories. More (20) physical variables were significantly correlated with DCA2, but only slope, large-diameter, and medium-height snags of decay-class 4, berry-producing and deciduous shrubs, and needle-leaved evergreen trees in the lower to midstory had r values $\geq$ 0.50 (table 6). Plots of DCAl versus DCA2 showed that age and moisture stands did not cluster, although location did (figs. l-3).

The most commonly detected species were represented similarly in the different-aged stands (table 7).

Species with old-growth associations differed considerably in relation to vegetative and physical factors of the environment. Spearman rank correlations showed that the varied thrush occurred significantly more than expected at locations with little exposed soil or fine organic litter, few tree pits but good ground cover by logs of decay-class 3 ($R = 0.42$; $P = 0.01$). This species was found predominantly in western hemlock ($R = 0.52$-0.67; $P < 0.001$) and, to a lesser extent, in stands of very large western redcedars ($R = 0.39$; $P < 0.03$) and Douglas-firs ($R = 0.32$; P c 0.02). The associations with deciduous tree species were generally negative although small alders ($R = 0.28$; $P = 0.03$) and maples ($R = 0.34$; $P = 0.01$) were used preferentially.

Table 2—Bird species showing significant (*P* c 0.05) association with location (based on ANOVA), Oregon Cascades, 1984

Species	F-value	*P*	Location influence[a]	
Brown creeper	3.73	0.03 1	RRU>HJA	
Black-headed grosbeak	5.42	0.007	RRU>MTH	
Chestnut-backed chickadee	13.59	0.0001	RRU>MTH	HJA>MTH
Red-breasted nuthatch	41.62	0.0001	RRU>MTH	RRU>HJA
Hermit thrush	11.80	0.0001	RRU>MTH	RRU>HJA
Townsend's solitaire	5.93	0.005	RRU>MTH	RRU>HJA
Nashville warbler	8.53	0.0006	RRU>MTH	RRU>HJA
Yellow-rumped warbler	5.41	0.007	RRU>MTH	RRU>HJA
Western tanager	6.71	0.003	RRU>MTH	RRU>HJA
Pine siskin	11.05	0.0001	RRU>MTH	RRU>HJA
Dark-eyed junco	9.17	0.0004	RRU>MTH	RRU>HJA
Hermit warbler	3.46	0.039	HJA>MTH	
Winter wren	14.26	0.0001	HJA>RRU	MTH>RRU
Band-tailed pigeon	4.41	0.017	Only at MTH	
Empidonax flycatchers	18.35	0.0001	MTH>HJA	RRU>HJA
Western flycatcher	20.48	0.0001	MTH>HJA	MTH>RRU
Varied thrush	19.67	0.0001	MTH>HJA	MTH>RRU
Golden-crowned kinglet	21.16	0.0001	MTH>H JA	RRU>HJA
Wilson's w arbler	13.52	0.0001	MTH>HJA	MTH>RRU
Swainson's thrush	4.06	0.023	MTH>RRU	

[a] RRU = Rogue River-Umpqua National Forest; HJA = H.J. Andrews Experimental Forest; MTH = Mount Hood National Forest.

Table 3—Significant associations of bird species with stand age, Spearman rank correlations, Oregon Cascades, 1984

Species	Correlation coefficient	Probability
Hairy woodpecker	0.439	0.0009
Varied thrush	0.410	0.0021
Western flycatcher	0.384	0.0041
Rufous hummingbird	0.356	0.0082
Steller's jay	0.304	0.0255
Brown creeper	0.297	0.0293
Winter wren	0.276	0.0430
American robin	-0.449	0.0007
Evening grosbeak	-0.323	0.0170
Hermit warbler	-0.266	0.0520

The western flycatcher was detected primarily in areas with down logs of decay-classes 3 and 4 (R = 0.34-0.41; P < 0.01), substantial fern cover (R = 0.43; P = O.OOl), deciduous shrubs in the understory (R = 0.32-0.57), and with an overstory dominated by western hemlocks (R = 0.30-0.40; P < 0.02) and very large western rcdcedar (R = 0.27; P < 0.05).

The hairy woodpecker was detected at sites with very large Douglas-firs (R = 0.43; P = 0.001), large and very large western redcedars (R = 0.30-0.32; P < 0.02), large and very large western hemlocks (R = 0.30-0.32; P = 0.02), and large Pacific madrones (R = 0.31; P = 0.02). The winter wren was associated with western hemlocks of all size-classes (R = 0.44-0.54; P < 0.006) and very large western redcedars (R = 0.30; P = 0.02). The rufous hummingbird was found at sites with large and very large western hemlocks (R = 0.07-0.32; P < 0.04).

Table 4—Bird species sorting out by stand age, TWINSPAN analysis, Oregon Cascades, 1984

Species generally associated with older stands:
- Northern flicker
- Pileated woodpecker
- Hairy woodpecker
- Common raven
- Brown creeper
- Varied thrush
- Pine siskin

Species generally associated with younger stands:
- Blue grouse
- American robin
- Swainson's thrush
- Nashville warbler
- Black-throated gray warbler
- Townsend's warbler
- Wilson's warbler
- Western tanager
- Black-headed grosbeak

Table 5—Physical and vegetative variables significantly associated with DCA1 (DECORANA) bird species, Oregon Cascades, 1984 (Spearman rank correlations)

Factor	*R* value	*P*
Elevation	0.57	<0.0001
Latitude	–0.73	<0.0001
Short snags, decay-class 3	0.30	0.024
Medium-tall snags, decay-class 5	–0.39	0.003
Fern (0-0.5-m tall)	–0.51	<0.0001
Evergreen shrub (0-0.5-m tall)	0.29	0.032
Fern (0.5-2-m tall)	–0.54	<0.001
Needle-leaved evergreen trees (super canopy)	0.44	0.0008
Logs, decay-class 2	–0.32	0.018
Logs, decay-class 3	–0.37	0.005

Table 6—Physical and vegetative variables significantly associated with DCA2 (DECORANA) bird species, Oregon Cascades, 1984 (Spearman rank correlations)

Factor	*R* value	*P*
Stand age	0.33	0.015
Latitude	0.27	0.045
Slope	–0.50	<0.0001
Number of very large trees (0-0.5 m)	0.38	0.004
Number of very large trees (0.5-2 m)	0.29	0.038
Number of very large trees (2 m-midstory)	–0.39	0.003
Medium-diameter, medium-tall[a] snags, decay-class 5	0.27	0.041
Medium-diameter, tall snags, decay-class 4	0.34	0.009
Medium-diameter, tall snags, decay-class 5	0.30	0.023
Large-diameter, medium-tall snags, decay-class 3	0.45	0.0005
Large-diameter, medium-tall snags, decay-class 4	0.50	<0.0001
Large-diameter, medium-tall snags, decay-class 5	0.30	0.024
Berry-producing shrubs (0-0.5 m)	0.62	<0.0001
Evergreen shrubs (0-0.5 m)	–0.37	0.005
Deciduous shrubs (0-0.5 m)	0.67	<0.0001
Needle-leaved evergreen trees (2 m-midstory)	0.52	<0.0001
Deciduous shrubs (all height-classes combined)	0.58	<0.0001
Logs, decay-class 3	0.35	0.008
Logs, decay-class 4	0.42	0.001
Logs, decay-class 5	0.35	0.008

[a] Medium tall means 5-15 in height.

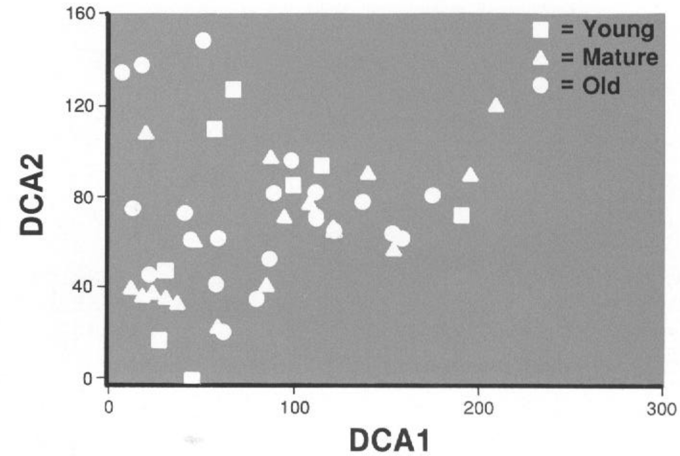

Figure 1—Plot of detrended correspondence analysis axis scores for 1984 Oregon Cascades bird data with stand age (old, mature, and young Douglas-fir stands).

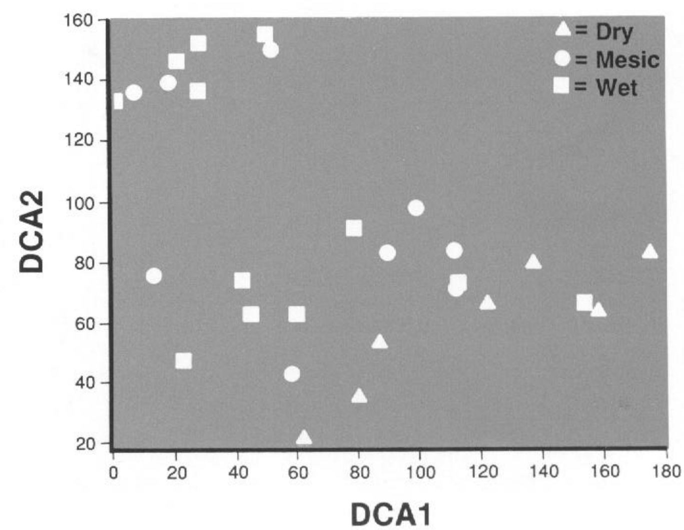

Figure 2—Plot of detrended correspondence analysis axis scores for 1984 Oregon Cascades bird data with stand moisture condition (wet, mesic, and dry old-growth Douglas-fir stands).

Clear segregations of habitat associations occurred within two guilds, the aerial insectivores (western and *Empidonax* flycatchers) and tree-seed eaters (evening grosbeak and pine siskin). Pine siskins were positively associated with sites with grand fir trees, and evening grosbeaks were negatively associated (table 8). *Empidonax* flycatchers were detected at sites with deciduous trees and medium-large Douglas-firs, tree types either avoided or having no significant association with the western flycatcher based on Spearman rank correlations (table 9).

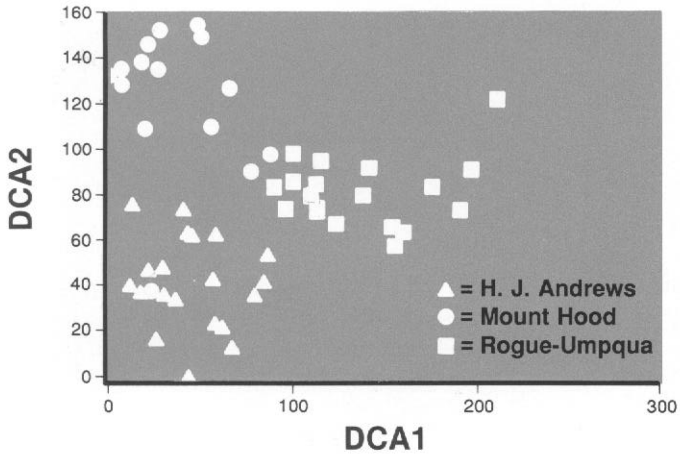

Figure 3—Plot of detrended correspondence analysis axis scores for 1984 Oregon Cascades bird data with location (MTH = Mt. Hood National Forest, HJA = H.J. Andrews Experimental Forest, RRU = Rogue River-Umpqua National Forest).

Table 7—The 6 most frequently detected bird species (combining Hammond's and dusky flycatchers as *Empidonax* flycatchers) by stand age, Oregon Cascades, 1984

Rank	Old-growth	Mature	Young
1.	Winter wren	Hermit warbler	Hermit warbler
2.	Hermit warbler	Winter wren	Winter wren
3.	Chestnut-backed chickadee	*Empidonax* flycatchers	Chestnut-backed chickadee
4.	*Empidonax* flycatchers	Chestnut-backed chickadee	*Empidonax* flycatchers
5.	Western flycatcher	Red-breasted nuthatch	Western flycatcher
6.	Varied thrush	Western flycatcher	Red-breasted nuthatch

Other guilds—for example, understory-ground insectivores and bark insectivores—were separately related to tree species and size-class. The only overlap in significant Spearman rank correlations for bark insectivores was for small sugar pine with the red-breasted nuthatch and the red-breasted sapsucker (table 10). The large understory-ground insectivore guild showed more overlap, but clear separations of habitat association were evident between the hermit thrush and Swainson's and varied thrushes, and between Wilson's warbler and the winter wren and three other smaller members of the guild (tables 11-12).

Table 8—The tree-seed-eater guild and the significant Spearman rank correlations for tree species and size-classes, Oregon Cascades, 1984 (correlation coefficient with probability in brackets)

Tree species and size	Evening grosbeak	Pine siskin
Medium Douglas-fir	+0.37 (0.004)	–0.10 (0.48)
Small grand fir	–0.36 (0.007)	+0.59 (0.0001)
Medium grand fir	–0.37 (0.006)	+0.60 (0.0001)
Large grand fir	–0.31 (0.02)	+0.53 (0.0001)
Very large grand fir	–0.10 (0.48)	+0.44 (0.0007)
Small golden chinkapin	–0.08 (0.55)	+0.26 (0.05)
Medium golden chinkapin	+0.05 (0.73)	+0.34 (0.01)
Small incense-cedar	–0.29 (0.03)	+0.50 (0.0001)
Medium incense-cedar	–0.29 (0.03)	+0.47 (0.0002)
Large incense-cedar	–0.27 (0.04)	+0.47 (0.0003)
Very large incense-cedar	–0.19 (0.16)	+0.44 (0.0007)
Large western white pine	–0.10 (0.48)	+0.36 (0.007)
Small sugar pine	–0.18 (0.19)	+0.29 (0.03)
Medium sugar pine	–0.24 (0.07)	+0.35 (0.008)
Large sugar pine	–0.28 (0.03)	+0.50 (0.0001)
Very large sugar pine	–0.23 (0.09)	+0.47 (0.0002)
Small California red fir	–0.05 (0.69)	+0.27 (0.05)
Small hazel	–0.13 (0.35)	+0.46 (0.0004)
Small red alder	+0.42 (0.001)	–0.22 (0.10)

Table 9—Significant Spearman rank correlations of the aerial insectivore guild with tree species and size-classes, Oregon Cascades, 1984 (correlation coefficient with probability in brackets)

Tree species and size	Western flycatcher	*Empidonax* flycatchers
Medium Douglas-fir	–0.28 (0.04)	+0.27 (0.05)
Large Douglas-fir	–0.37 (0.005)	+0.28 (0.04)
Very large redcedar	+0.27 (0.05)	–0.07 (0.60)
Small western hemlock	+0.30 (0.02)	–0.23 (0.09)
Medium western hemlock	+0.32 (0.02)	–0.33 (0.01)
Large western hemlock	+0.40 (0.002)	–0.28 (0.03)
Very large western hemlock	+0.40 (0.002)	–0.46 (0.0004)
Small bigleaf maple	–0.04 (0.75)	+0.28 (0.04)
Medium bigleaf maple	+0.04 (0.79)	+0.30 (0.03)
Small golden chinkapin	–0.15 (0.26)	+0.35 (0.01)
Medium golden chinkapin	–0.21 (0.13)	+0.31 (0.02)
Medium red alder	–0.05 (0.70)	+0.27 (0.05)
Small Pacific dogwood	–0.21 (0.13)	+0.54 (0.0001)
Medium Pacific dogwood	–0.18 (0.19)	+0.46 (0.0004)

Table 10—Significant Spearman rank correlations with tree species and sizes for members of the bark insectivore guild, Oregon Cascades, 1984

Tree species and size	Hairy woodpecker	Pileated woodpecker	Red-breasted nuthatch	Red-breasted sapsucker
Small Douglas-fir	—	—	+.40	—
Medium Douglas-fir	–.41	—	—	—
Large Douglas-fir	+.43	—	—	—
Small Pacific madrone	—	—	+.33	—
Medium Pacific madrone	—	—	+.36	—
Large Pacific madrone	+.31	—	—	—
Small grand fir	—	—	+.57	—
Medium grand fir	—	—	+.66	—
Large grand fir	—	—	+.60	—
Medium western redcedar	—	—	-.30	—
Large western redcedar	+.32	—	—	—
Very large western redcedar	+.30	—	—	—
Small western hemlock	—	—	–.52	—
Medium western hemlock	—	—	–.58	—
Large western hemlock	+.32	—	–.38	—
Very large western hemlock	+.30	—	–.36	—
Small Pacific yew	—	+.32	—	—
Medium Pacific yew	—	+.29	—	—
Small red alder	—	—	–.33	—
Medium red alder	–.34	—	—	—
Small sugar pine	—	—	+.35	+.36
Medium sugar pine	—	—	+.55	—
Large sugar pine	—	—	+.63	—
Very large sugar pine	—	—	+.63	—
Small golden chinkapin	—	—	+.51	—
Medium golden chinkapin	—	—	+.48	—
Small incense-cedar	—	—	+.69	—
Medium incense-cedar	—	—	+.65	—
Large incense-cedar	—	—	+.61	—
Very large incense-cedar	—	—	+.54	—
Large bigleaf maple	—	—	–.27	—
Small vine maple	—	—	–.37	—
Small hazel	—	—	+.39	—

1985

More than 6500 detections of 62 species were made. Although the most species (40) were found in old growth, the differences (30 in mature and 35 in young) were not significant. Only 40 species were used in the other analyses, and, for this data set, 21.0 ± 2.4 species were found in old-growth, 19.7 ± 4.4 in mature, and 21.0 ± 4.2 in young stands. Mean detections per stand did not differ between young, mature, and old-growth (24.0 ± 7.0, 27.0 ± 15.1, 33.2 ± 6.9).

Species associated with old growth based on significant positive Spearman rank correlations with stand age were the evening grosbeak ($R = 0.54$, $P < 0.04$) and the western flycatcher ($R = 0.55$, $P < 0.04$). Five other species, Cooper's hawk, blue grouse, Hutton's vireo, red crossbill, and Vaux's swift, were found only in old-growth stands. ANOVA indicated no significant associations with old growth. Similar analyses for these same stands in 1984 showed only that the brown creeper was associated with old-growth stands though not significantly (ANOVA, $P < 0.08$). No significant differences were found based on the moisture gradient in either abundance or species richness values in 1985.

We found 21.5 ± 4.7 species in wet stands, 20.5 ± 4.5 in mesic stands, and 20.7 ± 4.7 in dry stands; 37.3 ± 11.8 individuals were detected per stand in wet stands, 31.6 ± 21.3 in mesic, and 28.7 ± 10.8 in dry. Blue grouse, ruffed grouse, and rufous hummingbirds were found only in the dry portion of the moisture gradient, and Hutton's vireo and Swainson's thrush were found only in the wet portion. None of these species was significantly (ANOVA) associated with the moisture gradient, however. Based on Spearman rank correlations, five species were significantly associated with older stands at Andrews in 1984: the brown creeper ($R = 0.77$; $P = 0.0001$), hairy woodpecker ($R = 0.60$; $P = 0.006$), pileated woodpecker ($R = 0.52$; $P = 0.02$), western flycatcher ($R = 0.46$; $P = 0.04$) and Steller's jay ($R = 0.49$; $P = 0.03$).

The hairy woodpecker selected both mesic and wet stands, the hermit thrush and pileated woodpecker selected mesic stands, and the winter wren selected dry stands (ANOVA).

The five most abundant species in 1985 represented 65.9 percent of the detections. When the *Empidonax* flycatchers were added, 72.2 percent of the detections were accounted for, which compared with 76.1 percent for these same species in 1984 in the same stands (table 13).

The hairy woodpecker and hermit thrush were the only species that showed any differences in their use of vegetative structure and physical environment between years—that is, changed from three or more positive or negative relationships to the opposite (Spearman rank correlations).

Fourteen species had significant (chi-square) differences in relation to the moisture gradient in 1985 when compared to 1984. The hairy woodpecker and winter wren shifted from the wet to dry portion of the gradient, and the numbers of the northern flicker, pileated woodpecker, and western tanager increased in either dry and wet stands when they had been most common in mesic stands in 1984. Nine other species shifted from dry to wetter stands in 1985 compared to 1984 (table 14). The majority of the species showed consistent patterns of chronosequence and moisture-gradient use. The *Empidonax* flycatchers were a good illustration of this consistency (figs. 4-7).

Table 11—Significant conifer associations for larger members of the low understory-ground insectivore guild, based on Spearman rank correlations, Oregon Cascades, 1984

Tree species and size	American robin	Hermit thrush	Northern flicker	Swainson's thrush	Varied thrush
Small Douglas-fir	—	+.31	—	—	–.30
Medium Douglas-fir	+.50	—	—	—	–.34
Very large Douglas-fir	–.34	—	—	—	+.32
Small grand fir	—	+.46	—	–.46	–.38
Medium grand fir	—	+.49	—	–.40	–.46
Large grand fir	—	+.47	+.27	–.32	–.54
Small western hemlock	—	—	—	+.29	+.52
Medium western hemlock	—	—	—	+.38	+.57
Large western hemlock	–.34	–.29	—	—	+.67
Very large western hemlock	–.42	–.33	—	+.31	+.66
Small western redcedar	–.29	—	—	—	—
Medium western redcedar	–.27	—	—	—	—
Large western redcedar	–.28	—	—	—	—
Very large western redcedar	—	—	—	—	+.39
Small sugar pine	—	—	—	–.27	–.30
Medium sugar pine	—	+.32	—	–.32	–.46
Large sugar pine	—	+.42	—	–.47	–.49
Very large sugar pine	—	+.42	—	–.36	–.43
Small Pacific yew	–.39	—	—	—	—
Medium Pacific yew	–.35	—	+.27	—	—
Small incense-cedar	—	+.55	—	–.49	–.55
Medium incense-cedar	—	+.48	—	–.49	–.54
Large incense-cedar	—	+.46	—	–.46	–.51
Very large incense-cedar	—	+.44	+.26	–.35	–.35

Table 12—Significant conifer associations for smaller members of the low understory-ground insectivore guild, based on Spearman rank correlations, Oregon Cascades, 1984

Tree species and size	Dark-eyed junco	MacGillivray's warbler	Townsend's solitaire	Wilson's warbler	Winter wren
Small Douglas-fir	+.53	—	—	–.30	–.49
Large Douglas-fir	+.28	—	—	—	—
Small grand fir	+.43	+.32	+.41	–.42	–.54
Medium grand fir	+.43	—	+.51	–.35	–.50
Large grand fir	+.39	—	+.35	—	+.45
Very large grand fir	—	—	+.46	—	—
Small western hemlock	–.41	—	–.36	—	+.51
Medium western hemlock	–.49	–.27	–.43	—	+.54
Large western hemlock	–.35	—	–.26	—	+.44
Very large western hemlock	–.28	—	—	+.37	+.51
Small western redcedar	—	—	–.36	—	—
Medium western redcedar	—	—	–.27	—	—
Large western redcedar	—	—	–.31	—	—
Very large western redcedar	—	—	—	—	+.30
Small sugar pine	+.37	+.48	—	—	–.52
Medium sugar pine	+.27	+.28	—	–.32	–.47
Large sugar pine	+.32	+.28	—	–.38	–.55
Very large sugar pine	+.31	+.35	—	–.30	–.51
Small Pacific yew	—	—	—	–.38	—
Medium Pacific yew	—	—	—	–.30	—
Small incense-cedar	+.42	+.37	—	–.45	–.56
Medium incense-cedar	+.41	+.33	—	–.44	–.56
Large incense-cedar	+.44	+.35	—	–.42	–.60
Very large incense-cedar	+.31	+.42	—	–.36	–.44

Table 13—The 5 most common bird species plus the *Empidonax* flycatchers detected at Andrews in 1984 and 1985 by point counts, Oregon Cascades (values are percentages of total detections)

Species	1984	Rank	1985	Rank
Winter wren	18.9	2	18.4	1
Hermit warbler	23.7	1	17.2	2
Chestnut-backed chickadee	17.7	3	11.1	3
Golden-crowned kinglet	0.4	—	10.8	4
Red-breasted nuthatch	1.4	10	8.4	5
Empidonax flycatchers	14.0	4	6.3	6
Western flycatcher	5.6	5	—	—

Table 14—Bird species that changed their use of the moisture gradient from dry to wet between 1984 and 1985, H.J. Andrews, Oregon Cascades

Species	Chi-square
Western flycatcher	($P < 0.002$)
Chestnut-backed chickadee	($P = 0.06$)
American robin	($P < 0.002$)
Hermit thrush	($P < 0.0001$)
Swainson's thrush	($P < 0.0001$)
Black-throated gray warbler	($P < 0.001$)
Townsend's warbler	($P < 0.0001$)
Hermit warbler	($P < 0.0001$)
Wilson's warbler	($P < 0.002$)

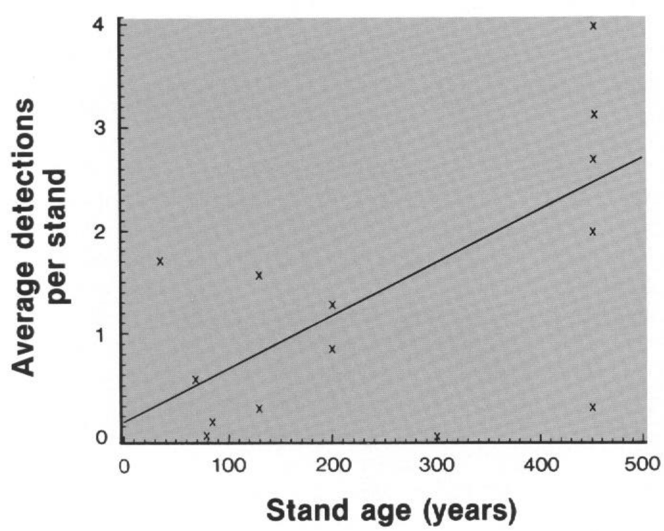

Figure 4—Average detections per stand of *Empidonax* flycatchers compared to the age of the stand, H.J. Andrews Experimental Forest, 1985.

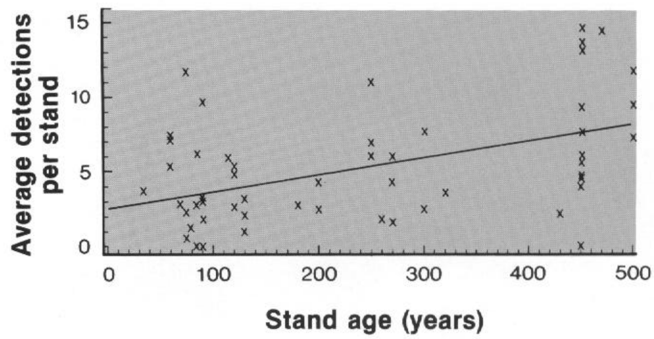

Figure 5—Average detections per stand of *Empidonax* flycatchers compared to the age of the stand, Oregon Cascades, 1984.

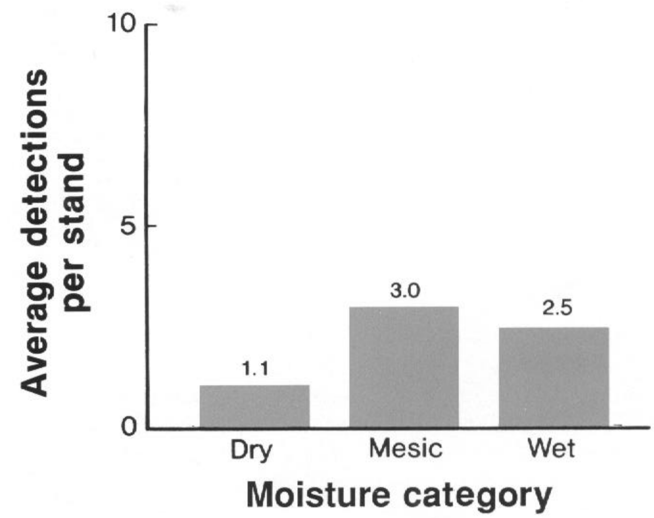

Figure 6—Average detections per stand of *Empidonax* flycatchers compared to the moisture condition of old-growth stands, H.J Andrews Experimental Forest, 1985.

Discussion

The similarity in species richness values and bird abundances along the chronosequence parallels findings in the Oregon Coast Range (Carey and others, this volume), northern California (Ralph and others, this volume; Raphael and Barrett 1984), and southern Washington (Manual, this volume; Manuwal and Huff 1987). The very similar stand physiognomies probably accounted for this. The young and mature stands had considerable coarse woody debris both standing (snags) and on the ground (logs) (see Spies and others 1988). Most of the stands studied were fire-derived rather than a result of logging. Therefore, our findings do not answer the concerns of Harris and others (1982) that long-term declines in species richness might be expected if truncation of seral development occurs at 80 to 100 years. Even in naturally regenerated stands, large-diameter snags would be gone after the harvest unless specific provision was made for them in the stand prescription, or uneven-aged

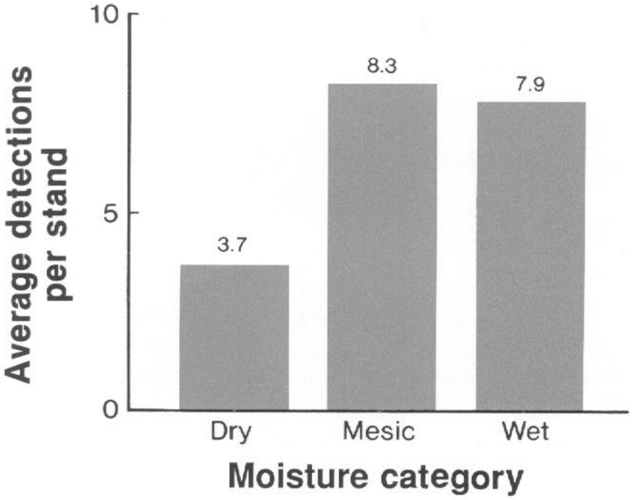

Figure 7—Average detections per stand of *Empidonax* flycatchers compared to the moisture condition of old-growth stands, Oregon Cascades, 1984.

management was used. Nyberg and others (1987) discuss the implications of such management activities to provide old-growth components in younger stands.

Many authors, including De Graaf and Chadwick (1987), Johnson and Landers (1982), Kessler and Kogut (1985), Manuwal and Huff (1987), and Wetmore and others (1985), have shown the changes in bird species and populations that can be expected from logging or changing the sizes of trees in a stand. But few long-term studies provide information on whether old-growth-associated species such as those in our study would persist 100 to 200 years from now in commercial forests without management intervention. The cavity nesters are the most vulnerable, but models are available that should ensure even their existence (Davis and others 1983, Thomas and others 1979).

Breeding bird communities in the Oregon Cascade Range were dominated by a few, relatively abundant species. Odum (1971) suggests that a more stable environment tends to have dominance shared among more species. Stand age appeared to have little effect on the dominance values, possibly because Douglas-fir forests in the western Oregon Cascades are a seral stage on the way to a western hemlock climax. Spies and others (1988) postulate that such forests may not reach an equilibrium state until they are 1000 years old. The implication is that many of the avian species present are generalists rather than specialists in the still-evolving landscape, and the species have not had the opportunity to segregate into niches of more equal size (see Orians and Willson 1964, Slobodkin and Sanders 1969). Huff and others (1985), however, found only four dominant species in a 515-year-old hemlock stand on the Olympic Peninsula of Washington State; they noted that more species reached their highest populations in this forest compared to younger stands.

Rufous hummingbird, brown creeper, chestnut-backed chickadee, hairy woodpecker, western flycatcher, varied thrush, and winter wren were associated with older stands and showed a positive selection for sites with very large trees. Western hemlock, western redcedar, and sugar pine were as important as Douglas-fir, however. The rufous hummingbird is normally associated with forest edges, and the numerous small openings in the older stands probably created suitable edge conditions. The counting stations were at least 150 m from edges in the young and mature forests, so fewer rufous hummingbirds were counted in these younger age-classes. The brown creeper, chestnut-backed chickadee, and the hairy woodpecker are foliage or bark insectivores and thus exploited the surfaces of the large trees for foraging. The western flycatcher, as an aerial-sallying insectivore, has a feeding behavior that requires open space beneath, or in the canopy, which is best met in the older stands. The varied thrush is an understory-gleaning insectivore, and the complex understory characteristics of old-growth stands probably favored this species. The particular patterns observed suggested that resource partitioning was occurring within guilds. More niche overlap was evident in the larger guilds, such as the low understory-ground insectivore guild, but species still separated out, with bird size an obvious factor.

Noon and others (1980) found considerable consistency in habitat preferences of Eastern forest birds despite acknowledging that local population-genetic differences, changes in habitat availability, or changes in the competitive environment could theoretically result in selection of different habitats. Those species that shifted between dry stands in 1984 and wet stands in 1985 continued to use stands of similar structure. Thus, predictability of stand vegetative and physical characteristics was possible between years for these birds. The importance of weather cannot be overestimated. The winter of 1983-84 was long, with deep snow cover, especially in the southern portion of the Oregon Cascades. Spring was late and wet in 1984 and insect populations may have been low, resulting in fewer nesting pairs. This weather may have been responsible for the greater use of the dry portion of the moisture gradient in 1984 at Andrews.

Two species (hairy woodpecker and hermit thrush) at Andrews used very different habitats between the two years. At the same time, population size of other species apparently changed (an order of magnitude in a few cases), with 10 more species meeting the abundance criteria for analysis in 1985 than did so in 1984. Some changes in field personnel occurred between years, and although training techniques were equivalent, observer variability might have accounted for the major differences in detection rates (Verner and Milne 1989).

The cold, wet spring of 1984 may have depressed breeding activity by some species. The hairy woodpecker may have been influenced competitively in 1985 because other species in its guild (pileated woodpeckers, red-breasted nuthatches, red-breasted sapsuckers, and northern flickers), which compete either for foraging locations or nesting sites (Bull and others 1986a), were much more abundant or participated more in breeding in 1985.

What are the implications for Douglas-fir forest management other than the obvious ones already mentioned? The variety of vegetative structure in old-growth Douglas-fir stands favors a few rare species, such as the Vaux's swift, that comprise a small component of the total community. These species may never be common even in stands aged 1000 years or more. Instead of concentrating on old growth in unmanaged stands, perhaps we should examine much more closely such factors as moisture, where obvious relations, if not dependencies, exist. Old-growth trees are impressive to the human observer but most bird species apparently make little discrimination between trees 200 years old and trees 450 years old. The chronosequence can therefore end at the point where sufficient vegetative diversity and structural elements generate coarse woody debris and microhabitats for the rarer species. Large tracts of old growth may not be necessary for such mobile species as birds. Work is needed on minimum viable population sizes for these rarer species and the extent of habitat needed for their support. Intuitively, we suspect the minimum area sizes for most species will be less than those projected for the spotted owl (Anon. 1988), so that the spotted owl habitat conservation areas may accommodate the needs of these other birds. If that proves true, selection of the spotted owl as an indicator species may have been fortuitous, despite the current controversy.

Acknowledgments

The Oregon Cascades study was made possible by the contributions of many people, including U.S. Forest Service peronnel. Effective field supervision was given by Wynn Cudmore, and crew leaders Jim Reichel and Troy Cline at Rogue River-Umpqua, Kathleen Fulmer at H.J. Andrews, and Jeff Picton at Mount Hood in 1984. The 1985 crew leader was Tony Fuchs. John Teburg, Dick Gilbert, Rich Alldredge, and Betsy Piersone all assisted in data entry and analysis. The hard-working field crews, primarily made up of Washington State University wildlife students, were essential to successful completion of the work.

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Appendix

Table 15-Douglas-fir stands in the Oregon Cascade Range examined for vertebrate communities, Spring 1984 (age and moisture condition of stand given where appropriate)

Type[a]	Stand	Forest-Ranger District	Section	Township	Range	Elev	Lat	Long	Age	Moisture
Mt. Hood										
OG	5001	Mt. Hood-Columbia Gorge	8	T1S	R7E	610	45.490	121.980	470	Wet
OG	5005	Mt. Hood-Columbia Gorge	2	T1S	R6E	641	45.510	122.030	450	Wet
OG	5009	Mt. Hood-Columbia Gorge	4 & 9	T1S	R7E	907	45.490	121.980	450	Wet
OG	5017	Mt. Hood-Columbia Gorge	22	T1N	R6E	940	45.550	122.050	500	Mesic
OG	5019	Mt. Hood-Columbia Gorge	27	T1N	R6E	937	45.560	122.050	500	wet
OG	5020	Mt. Hood-Columbia Gorge	29 & 32	T1S	R6E	557	45.420	122.080	450	Mesic
OG	5031	Mt. Hood-Columbia Gorge	29	T1S	R6E	580	45.430	122.070	450	Mesic
OG	5033	Mt. Hood-Columbia Gorge	26	T1N	R6E	980	45.560	122.020	500	Wet
OG	5039	Mt. Hood-Columbia Gorge	19 & 30	T1S	R8E	1081	45.450	121.850	320	Wet
M	5041	Mt. Hood-Columbia Gorge	3	T2S	R5E	326	45.400	122.200	90	
M	5052	Mt. Hood-Columbia Gorge	29	T1S	R6E	—	45.300	122.070	—	
M	5048	Mt. Hood-Zig Zag	18	T3S	R6E	717	45.300	122.110	85	
Y	5050	Mt. Hood-Zig Zag	33	T3S	R8E	928	45.260	121.810	75	
M	5066	Mt. Hood-Zig Zag	3	T4S	R7E	677	45.260	121.930	85	
Y	5067	Mt. Hood-Columbia Gorge	34	T1N	R6E	871	45.520	122.030	60	
Y	5061	Mt. Hood-Columbia Gorge	14	T1S	R6E	552	45.480	122.020	75	
H.J. Andrews[b]										
OG	I L W	Willamette-Blue River	32	T16S	R5E	560	44.220	122.240	450	Mesic
OG		Willamette-Blue River	25	T15S	R5E	815	44.220	122.150	450	Wet
OG	E	Willamette-Blue River	30	T15S	R5E	975	44.220	122.150	450	Wet
OG	1015[c]	Willamette-Blue River	14 & 23	T15S	R5E	793	44.250	122.170	450	Wet
OG	1124[c]	Willamette-Blue River	25	T15S	R5E	862	44.220	122.160	450	Wet
OG	1019	Willamette-Blue River	15	T15S	R5E	902	44.250	122.180	450	Mesic
OG	1029	Willamette-McKenzie	25 & 26	T16S	R5E	700	44.150	122.150	200	Dry
OG	1083[c]	Willamette-McKenzie	25 & 26	T16S	R5E	950	44.130	122.150	300	Dry
OG	1133	Willamette-McKenzie	26	T16S	R6E	819	44.230	122.060	200	Dry
M	1035[c]	Willamette-Blue River	14 & 11	T16S	R5E	1000	44.260	122.170	130	
M	1111	Willamette-Blue River	3	T17S	R5E	610	44.100	122.290	130	
M	1037	Willamette-Blue River	15	T16S	R3E	490	44.160	122.430	90	
M	1038	Willamette-Blue River	24	T16S	R3E	535	44.160	122.420	90	
M	1036	Willamette-Blue River	13	T15S	R5E	—	44.260	122.150	130	
M	1065	Willamette-Blue River	15	T16S	R3E	708	44.170	12.430	90	
M	1066	Willamette-Blue River	14	T16S	R3E	—	44.165	122.435		
M	1093[c]	Willamette-Blue River	7	T17S	R6E	600	44.100	122.150	90	
Y	1086[c]	Willamette-Blue River	2	T15S	R5E	909	44.290	122.170	79	
Y	1048	Willamette-Blue River	2	T15S	R5E	1073	44.290	122.150	69	
Y	1089[c]	Willamette-Blue River	14	T16S	R4E	520	44.160	122.300	35	
Rogue River-Umpqua										
OG	6006	Umpqua-Tiller	23	T29S	R1W	437	43.030	122.810	300	Wet
OG	6001	Rogue River-Prospect	23	T32S	R4E	1199	42.770	122.310	260	Wet
OG	6003	Rogue River-Prospect	24 & 25	T30S	R2E	1284	42.940	122.510	270	Mesic
OG	6021	Umpqua-Tiller	13	T28S	R1W	566	43.050	122.780	250	Mesic
OG	6028	Umpqua-Tiller	31	T28S	R1W	920	43.090	122.850	450	Mesic
OG	6017	Rogue River-Prospect	25	T30S	R2E	1189	42.930	122.550	270	Dry
OG	6031	Rogue River-Prospect	31	T30S	R3E	1123	42.900	122.510	430	Dry
OG	6032	Rogue River-Prospect	36	T30S	R2E	1110	42.910	122.510	270	Dry
OG	6039	Umpqua-Tiller	12	T29S	R1W	642	43.060	122.760	250	Dry
OG	6046	Umpqua-Tiller	27	T28S	R2E	737	43.100	122.560	250	Mesic

See *footnotes* on next page.

Table E-continued

Type[a]	Stand	Forest-Ranger District	Section	Township	Range	Elev	Lat	Long	Age	Moisture
M	6052	Umpqua-Tiller	26	T28S	R1W	943	43.080	122.850	120	
M	6040	Rogue River-Prospect	26	T30S	R3E	1092	42.930	122.430	90	
M	6041	Umpqua-Tiller	32	T28S	R1W	840	43.090	122.830	115	
M	6044	Rogue River-Prospect	27	T31S	R4E	1478	42.850	122.330	90	
M	6047	Umpqua-Tiller	23	T28S	R2E	698	43.100	122.590	180	
M	6050	Umpqua-Tiller	25	T28S	R2W	1052	43.090	122.860	120	
M	6051	Umpqua-Tiller	5	T29S	R1W	831	43.080	122.840	120	
Y	6063	Umpqua-Tiller	1 & 12	T30S	R1W	924	42.980	122.760	60	
Y	6069	Umpqua-Tiller	5	T30S	R1W	1072	42.980	122.780	60	
Y	6099	Rogue River-Prospect		T32S	R4E	1428	42.820	122.350	75	

[a] OG = old-growth, M = mature, Y = young.
[b] Andrews stands studied in 1985 are underlined.
[c] Andrews stands sampled for small mammals and amphibians with new pitfall grids in 1985.

Table M-Vegetation and site measurements for stations used in the point count bird surveys

Measurements on a 500-m^2 area (13-m radius) centered at station).

Forest floor

1. Cover of logs by decay class (%) (>l0-cm diameter).
2. Cover of forest floor by various substrates: exposed bare rock, exposed bare mineral soil, fine organic litter (l0-cm diameter), coarse organic litter (>l0-cm diameter), moss, lichen (Total = l00%.)

Vegetation characteristics

3. Cover of foliage by height interval and life form
   a. Height intervals:
      1. 0-0.5 m (500-m^2 area)
      2. 0.5-2.0 m (500-m^2 area)
      3. 2.0 through midstory (trees and shrubs not entering main canopy) (measured on 2000-m^2 area)
      4. Canopy trees forming main canopy layer (2000-m^2 area)
      5. Super canopy trees (crowns extending well above main canopy layer) (2000-m^2 area)

   b. Life forms
      1. Herbs
      2. Graminoids
      3. Ferns
      4. Berry-producing ericaceous shrubs
      5. Evergreen shrubs (including those in no. 4)
      6. Deciduous shrubs (including those in no. 4)
      7. Deciduous trees
      8. Broad-leaved evergreen trees
      9. Needle-leaved evergreen trees

Stand characteristics

4. Number and species of small-diameter live trees (l-10 cm d.b.h.).
5. Number and species of medium-diameter live trees (l0-50 cm d.b.h.).
6. Number by decay class of short snags (any d.b.h., 1.5-5 m tall).
7. Number by decay class of medium-diameter, medium tall snags (l0-50 cm d.b.h., 5-15 m tall).
8. Numbers by decay class of large-diameter, medium tall snags (50 cm d.b.h. and 5-15 m tall).
9. Number of recent tree-fall mounds or pits with exposed tree roots or mineral soil.

Table H-continued

Measurements on a 2000-m^2 area (25-m radius centered at counting station)

A. Site characteristics

10. Surface water (presence/absence).
11. Type of water: I (intermittent stream); P (perennial stream); S (seep); 0 (pool/pond).
12. Rock outcrop (% of area) (presence/absence).
13. Exposed talus (% of area) (presence/absence).
14. Aspect
15. Slope (%)

B. Stand characteristics

16. Average height of dominant canopy trees.
17. Number and species of large, live trees (50-100 cm d.b.h.).
18. Number and species of very large, live trees (>lOO cm d.b.h.).
19. Number by decay-class of medium-diameter, tall snags (l0-50 cm d.b.h. and 15 m).
20. Number by decay-class of large-diameter, tall snags (>50 cm d.b.h. and 15 m tall).

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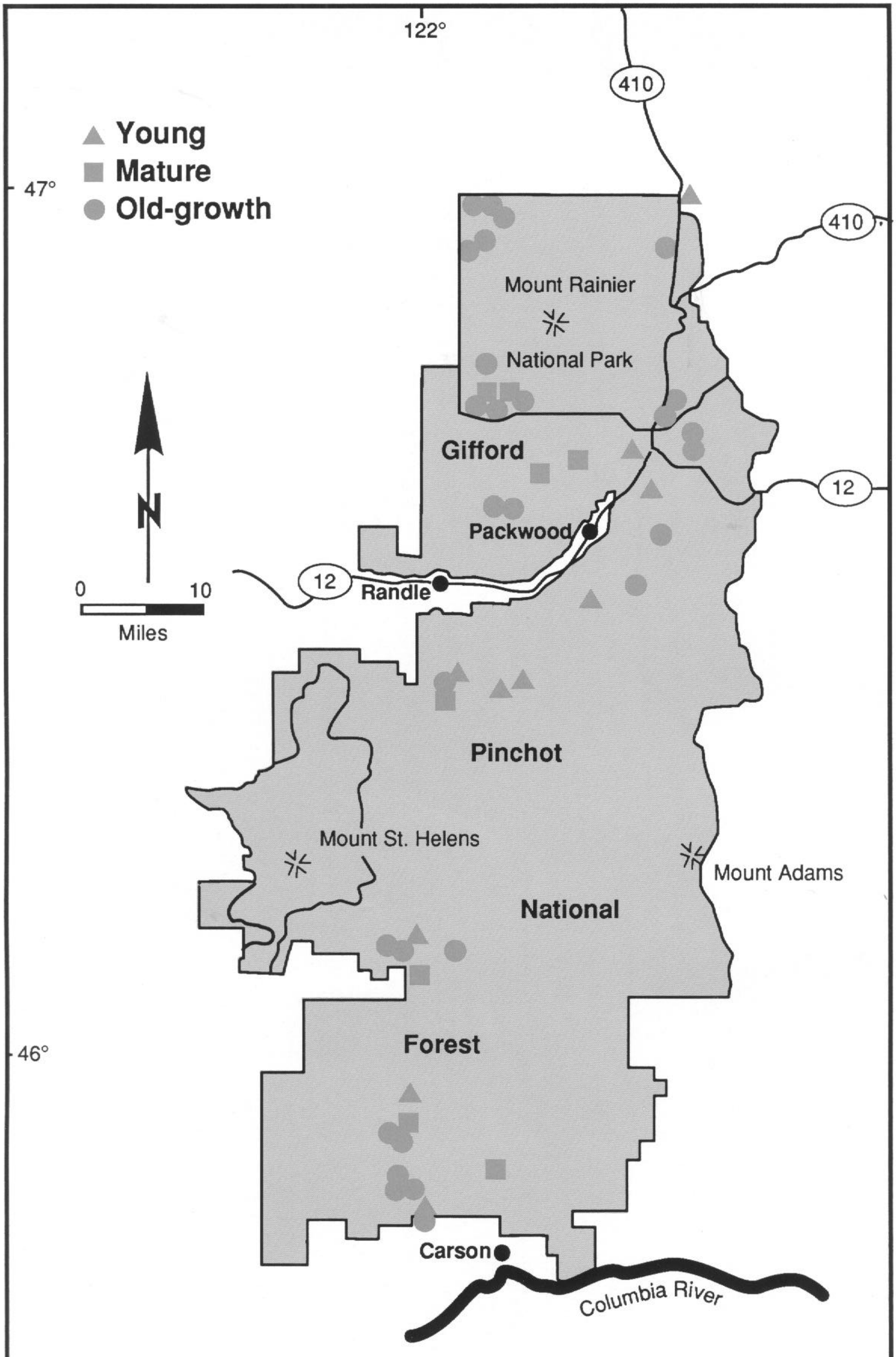

Location of study sites.