

TABLE 2
BREEDING DENSITIES (prs/40 ha) OF SPECIES AND FORAGING AND NESTING GUILDS IN 1973

	Study plots ^a				
	C. cut	S. Thn.	Strip	Cntrl.	Silv. (PT)
Species (guilds)					
Mountain Chickadee (PG,CD)	—	1.5	—	—	—
Pygmy Nuthatch (PG,CD)	—	—	—	13.5	7.5
House Wren (PG,CD)	—	—	2.3	—	2.3
Solitary Vireo (PG,FN)	—	3.8	6.0	1.5	—
Yellow-rumped Warbler (PG,FN)	—	—	3.0	—	—
Grace's Warbler (PG,FN)	—	3.8	7.5	7.5	11.2
Red-faced Warbler (PG,GN)	—	—	—	2.3	3.0
Western Tanager (PG,FN)	—	1.5	3.0	—	3.0
Rock Wren (GF,GN)	5.0	5.2	3.8	—	—
Robin (GF,FN)	—	6.8	5.2	—	—
Hermit Thrush (GF,GN)	—	—	—	0.8	—
Gray-headed junco (GF,GN)	2.0	9.8	6.0	9.0	12.7
Rufous-sided Towhee (GF,FN)	5.5	—	—	—	—
Chipping Sparrow (GF,FN)	—	6.0	4.5	—	3.0
Common Flicker (HT,CD)	—	3.0	2.3	3.0	3.0
Hairy Woodpecker (HT,CD)	—	2.3	2.3	3.0	3.0
Steller's Jay (HT,FN)	—	—	3.0	—	3.0
White-br. Nuthatch (HT,CD)	—	5.2	4.5	3.0	3.0
Black-headed Grosbeak (HT,FN)	—	—	—	—	1.5
Broad-td. Hummingbird (AF,FN)	—	—	3.0	—	—
Western Flycatcher (AF,CD)	—	—	—	6.0	3.0
Western Wood Pewee (AF,FN)	—	3.0	8.2	—	2.3
Violet-green Swallow (AF,CD)	—	—	—	9.0	6.0
Western Bluebird (AF,CD)	—	6.0	6.7	4.5	5.2
Foraging guilds					
Pickers and gleaners (PG)	—	10.5	20.8	24.8	27.0
Ground feeders (GF)	12.5	27.8	19.5	9.8	15.8
Hammerers and tearers (HT)	—	10.5	12.0	9.0	13.5
Aerial feeders (AF)	—	9.0	18.0	19.5	16.5
Nesting guilds					
Cavity and depression (CD)	—	18.0	18.0	42.0	33.0
Foliage nesters (FN)	5.5	24.8	43.5	9.0	24.0
Ground nesters (GN)	7.0	15.0	9.8	12.0	15.8
Totals	12.5	57.8	71.3	63.0	72.8

^a C. cut = clear cut plot; S. Thn. = severely thinned plot; Strip = strip cut plot; Cntrl. = control plot; Silv. (PT) = silviculturally cut plot (pre-treatment).

during the months of May and June amounted to 3.1 cm in 1973, 0.0 cm in 1974, and 0.8 cm in 1975. Precipitation during the breeding season (May–July) was 7.3 cm in 1973 and 1974, 8.2 cm in 1975.

RESULTS

BREEDING SEASON CENSUSES

Densities.—There was a tremendous amount of variability in breeding bird densities between study plots (Tables 2–4). The densities in pairs per 40 ha varied from 12.5 to 72.8 in 1973 with the lowest densities on the clear cut plot and the

TABLE 3
BREEDING DENSITIES (prs/40 ha) OF SPECIES AND FORAGING AND NESTING GUILDS IN 1974

	Study plots ^a				
	C. cut	S. Thn.	Strip	Silv.	Cntrl.
Species (guilds)					
Mountain Chickadee (PG,CD)	—	—	9.0	6.0	7.5
Pygmy Nuthatch (PG,CD)	—	2.3	3.0	15.0	15.0
Solitary Vireo (PG,FN)	—	6.0	12.0	6.0	3.0
Yellow-rumped Warbler (PG,FN)	—	—	3.0	15.0	3.0
Grace's Warbler (PG,FN)	—	6.0	18.7	18.7	12.0
Red-faced Warbler (PG,GN)	—	—	—	—	4.5
Western Tanager (PG,FN)	—	—	3.0	6.7	—
Hepatic Tanager (PG,FN)	—	—	3.0	—	—
Mourning Dove (GF,FN)	—	6.0	—	—	3.0
Rock Wren (GF,GN)	5.5	3.0	8.3	—	—
Robin (GF,FN)	—	4.5	7.5	3.0	—
Hermit Thrush (GF,GN)	—	—	—	0.8	1.5
Gray-headed Junco (GF,GN)	2.0	6.7	10.5	22.5	18.0
Rufous-sided Towhee (GF,FN)	6.5	—	—	—	—
Chipping Sparrow (GF,FN)	—	6.0	12.0	7.5	1.5
Common Flicker (HT,CD)	—	3.0	3.8	3.0	3.0
Hairy Woodpecker (HT,CD)	—	3.0	6.0	3.0	3.0
Steller's Jay (HT,FN)	—	7.5	7.5	6.0	9.0
White-br. Nuthatch (HT,CD)	—	9.0	9.0	7.5	10.5
Black-headed Grosbeak (HT,FN)	—	—	1.5	3.0	4.5
Common Nighthawk (AF,GN)	—	3.0	3.0	—	3.0
Broad-td. Hummingbird (AF,FN)	—	10.5	15.0	5.2	9.0
Say's Phoebe (AF,FN)	—	—	3.0	—	—
Western Flycatcher (AF,CD)	—	—	—	5.3	6.8
Western Wood Pewee (AF,FN)	—	3.0	9.0	3.0	—
Violet-green Swallow (AF,CD)	—	—	3.0	9.0	9.0
Mountain Bluebird (AF,CD)	1.0	—	—	—	—
Western Bluebird (AF,CD)	—	8.3	12.0	8.3	6.0
Foraging guilds					
Pickers and gleaners (PG)	—	14.3	51.7	67.5	45.0
Ground feeders (GF)	14.0	26.2	38.3	33.8	24.0
Hammerers and tearers (HT)	—	22.5	27.8	22.5	30.0
Aerial feeders (AF)	1.0	24.8	45.0	30.7	33.8
Nesting Guilds					
Cavity and depression (CD)	1.0	22.5	45.8	57.0	60.8
Foliage nesters (FN)	6.5	49.5	95.2	74.2	45.0
Ground nesters (GN)	7.5	12.8	21.8	23.3	27.0
Totals	15.0	87.8	162.8	154.5	132.8

^a See footnote Table 2.

highest densities on the silviculturally cut plot. In 1974 the lowest and highest densities were on the clear cut and strip cut plots with bird densities on the forested watersheds nearly double that of their 1973 values. In 1975 densities decreased on all forested watersheds while on the clear cut plot bird densities remained stable. The decreases varied from 10% on the silviculturally cut plot to 34% on the control plot.

The density data were subdivided into foraging and nesting guilds after Root

TABLE 4
BREEDING DENSITIES (prs/40 ha) OF SPECIES AND FORAGING AND NESTING GUILDS IN 1975

	Study plots*				
	C. cut	S. Thn.	Strip	Silv.	Cntrl.
Species (guilds)					
Mountain Chickadee (PG,CD)	—	1.5	—	4.5	3.0
Pygmy Nuthatch (PG,CD)	—	1.5	9.0	18.0	13.5
House Wren (PG,CD)	—	—	3.0	—	—
Solitary Vireo (PG,FN)	—	6.0	6.0	6.0	3.0
Yellow-rumped Warbler (PG,FN)	—	3.0	3.0	9.0	—
Grace's Warbler (PG,FN)	—	7.5	9.8	19.5	6.0
Red-faced Warbler (PG,GN)	—	—	—	—	1.5
Western Tanager (PG,FN)	—	—	3.0	4.5	3.0
Mourning Dove (GF,FN)	—	4.5	—	3.0	3.0
Rock Wren (GF,GN)	4.5	6.0	6.0	—	—
Robin (GF,FN)	1.0	3.0	3.0	3.0	—
Hermit Thrush (GF,GN)	—	—	—	—	2.3
Gray-headed Junco (GF,GN)	1.5	6.0	12.0	15.0	12.0
Rufous-sided Towhee (GF,FN)	7.3	—	—	—	—
Chipping Sparrow (GF,FN)	—	3.0	6.0	4.5	3.0
Common Flicker (HT,CD)	1.5	3.0	3.0	3.0	3.0
Acorn Woodpecker (HT,CD)	—	3.0	—	—	—
Hairy Woodpecker (HT,CD)	—	1.5	3.0	3.0	3.0
Steller's Jay (HT,CD)	—	3.0	3.0	3.0	6.0
White-br. Nuthatch (HT,CD)	—	6.0	12.0	15.0	3.0
Black-headed Grosbeak (HT,FN)	—	—	1.5	3.0	3.0
Common Nighthawk (AF,GN)	—	3.0	3.0	3.0	3.0
Broad-td. Hummingbird (AF,FN)	—	9.0	9.0	3.0	3.0
Western Flycatcher (AF,CD)	—	—	—	3.0	3.0
Western Wood Pewee (AF,FN)	—	3.0	9.0	1.5	—
Violet-green Swallow (AF,CD)	—	—	3.0	7.5	7.5
Western Bluebird (AF,CD)	—	3.0	15.0	7.5	3.0
Foraging guilds					
Pickers and gleaners (PG)	—	19.5	33.8	61.5	30.0
Ground feeders (GF)	14.3	22.5	27.0	25.5	20.3
Hammerers and tearers (HT)	1.5	16.5	22.5	27.0	18.0
Aerial feeders (AF)	—	18.0	39.0	25.5	19.5
Nesting guilds					
Cavity and depression (CD)	1.5	19.5	48.0	61.5	39.0
Foliage nesters (FN)	8.3	42.0	53.3	60.0	30.0
Ground nesters (GN)	6.0	15.0	21.0	18.0	18.8
Totals	15.8	76.5	122.3	139.5	87.8

* See footnote Table 2.

(1967). In 1973 the pickers and gleaners exhibited a positive correlation with increasing foliage volume across the different watersheds ($r = 0.91$). However, in 1974 and 1975 they reached their highest densities on the silviculturally cut plot and declined in density on the control plot. The densities of the other foraging guilds fluctuated in response to foliage volume throughout the study (Tables 2–4). Nesting guild densities fluctuated with foliage volume with no real trends present except in 1974, when ground nester densities were positively correlated

with increasing foliage volume ($r = 0.89$) and cavity and depression nester densities ($r = 0.90$) with increasing foliage volume.

Individual species also showed varying patterns with increasing foliage volume. Six species (Common Flicker, *Colaptes auratus*; Hairy Woodpecker, *Picoides villosus*; White-breasted Nuthatch, *Sitta carolinensis*; Grace's Warbler, *Dendroica graciae*; Gray-headed Junco; Western Bluebird, *Sialia maxicana*) were present on all forested areas throughout the study. The Common Flicker and Hairy Woodpecker had stable densities with increasing foliage volume in all years. In 1973 the Grace's Warbler ($r = 0.87$) and Gray-headed Junco ($r = 0.70$) increased in density with increasing foliage volume, whereas the White-breasted Nuthatch showed a negative correlation ($r = -0.98$) between density and foliage volume. The Western Bluebird fluctuated in density. In addition, five species (Pygmy Nuthatch, *Sitta pygmaea*; Steller's Jay, *Cyanocitta stelleri*; Chipping Sparrow, *Spizella passerina*; Broad-tailed Hummingbird, *Selasphorus platycercus*; Solitary Vireo, *Vireo solitarius*) were present on all the forested study plots in 1974 and 1975. In 1975 one other species, the Common Nighthawk (*Chordeiles minor*) was present on all the forested study areas. Three species (Robin, *Turdus migratorius*; Rock Wren, *Salpinctes obsoletus*; Rufous-sided Towhee, *Pipilo erythrophthalmus*) failed to occur in areas of denser foliage. In contrast, three species (Violet-green Swallow, *Tachycineta thalassina*; Red-faced Warbler, *Cardellina rubrifrons*; Western Flycatcher, *Empidonax difficilis*) were not present below a certain threshold of foliage volume.

The breeding bird communities on all the forested areas experienced similar patterns of density change during the study. They were most dense in 1974, had their lowest densities in 1973, and had intermediate densities in 1975 (Tables 2-4). However, the magnitude of density change varied between study plots. Similarly, most individual species followed this same pattern of density fluctuations. Coefficients of variation indicated that the variability in densities was very similar on the control, silviculturally cut and strip cut plots (37, 36, and 39% respectively) but that it was much lower on the severely thinned plot (21%) during the three-year study period. Coefficients of variation for the two-year period (1974 and 1975) showed that there was much less density variability on the silviculturally cut (7%) and severely thinned plots (10%) than on the strip cut (21%) and control (29%) plots.

The foraging guilds exhibited a large amount of variation in their yearly density fluctuations. The pickers and gleaners on the severely thinned (31%) and control (32%) plots exhibited less variation than the same guild on the strip cut (41%) and silviculturally cut (42%) plots. The ground feeders on the severely thinned plot (11%) showed much less variation than the ground feeders on the strip cut (35%), silviculturally cut (36%), and control (41%) plots. Density variations in the hammerers and tearers were much lower on the severely thinned (36%) and control (33%) plots than on the strip cut (48%) and silviculturally improved (56%) plots. The aerial feeders had their greatest variability in densities on the severely thinned (46%) and strip cut (42%) plots and their least variability on the silviculturally cut (30%) and control (34%) plots.

The nesting guilds showed differing amounts of variability in their yearly densities. The cavity and depression nesters exhibited their least variation on the severely thinned plot (12%) and their greatest variation on the strip cut plot (45%). This guild exhibited similar variations on the silviculturally cut (30%) and control

TABLE 5
SPECIES RICHNESS, DIVERSITY, AND EVENNESS FOR THE BIRD COMMUNITIES ON ALL STUDY PLOTS

Plots	Number of species			Diversity (H')			Evenness (E)		
	1973	1974	1975	1973	1974	1975	1973	1974	1975
Clear cut	3	4	5	1.02	1.18	1.34	0.93	0.85	0.83
Severely thinned	13	16	19	2.44	2.67	2.82	0.95	0.96	0.96
Strip cut	16	22	20	2.68	2.89	2.83	0.97	0.94	0.95
Silviculturally cut	—	20	21	—	2.76	2.77	—	0.92	0.91
Control	12	20	20	2.23	2.78	2.81	0.90	0.93	0.94
Silviculturally cut (pre-treat.)	16	—	—	2.57	—	—	0.93	—	—

(25%) plots. The foliage nesters varied from a low of 33% on the severely thinned plot to a high of 65% on the control plot. On the strip cut and silviculturally cut plots, the foliage nesters exhibited variations of 44 and 49% respectively. The ground nesters on the severely thinned plot showed very little variation (9%). Ground nester variation was much greater on the strip cut (38%), silviculturally cut (20%), and control (39%) plots than on the severely thinned plot.

Species richness.—The study plot with the highest number of breeding species changed during the three years (Table 5). In 1973 the highest number of breeding species (16) was found on the silviculturally cut and strip cut plots. In 1974 the number of species on the strip cut plot (22) was greater than the 20 species on the silviculturally cut and control plots. Twenty-one species were found on the silviculturally cut plot whereas 20 species were found on the strip cut and control plots in 1975.

Species number and composition changed on all areas between years. The number of species on the clear cut plot increased by one each year from three in 1973 to five in 1975 (Table 5). In 1974 the additional species was the Mountain Bluebird, while in 1975 it did not breed on the area and the Robin and Common Flicker became breeding species.

The avian community on the severely thinned plot added three species each year to a high of 19 species in 1975. In 1974 there were five additions (Common Nighthawk, Pygmy Nuthatch, Steller's Jay, Mourning Dove (*Zenaida macroura*), Broad-tailed Hummingbird) as well as two subtractions (Western Tanager, *Piranga ludoviciana*; Mountain Chickadee, *Parus gambelii*). In 1975 the Mountain Chickadee again bred on the area and the Yellow-rumped Warbler (*Dendroica coronata*) and Acorn Woodpecker (*Melanerpes formicivorus*) were breeding species on the severely thinned plot for the first time.

Changes in species number and composition in the breeding bird community on the strip cut plot consisted of an increase of six species from 1973 to 1974. In 1973 there was a total of 16 species, whereas in 1974 there were 22 species present on the study site. Twenty species were found on the plot in 1975. The House Wren (*Troglodytes aedon*) was a breeding species on the study area in 1973 and 1975 but not in 1974. Seven new species (Pygmy Nuthatch; Say's Phoebe, *Sayornis saya*; Hepatic Tanager, *Piranga flava*; Black-headed Grosbeak, *Pheucticus melanocephalus*; Common Nighthawk; Mountain Chickadee; and Violet-green

TABLE 6
BEHAVIORAL RESPONSES TO HABITAT ALTERATION

Guilts and Species	No. changes	Activity pattern	Foraging method	Tree species	Tree position	Perch	Stance	Mean height
Pickers and gleaners								
Mountain Chickadee	5	A ^a	—	A	A	A	—	A
Pgymy Nuthatch	5	—	—	A	A	A	A	A
Solitary Vireo	6	A	—	A	A	A	A	A
Yellow-rd. Warbler	5	A	A	A	—	A	—	A
Grace's Warbler	5	—	—	A	A	A	A	A
Ground feeders								
Rock Wren	3	A	—	A	—	A	—	—
Gray-headed Junco	6	A	A	A	A	A	—	A
Chipping Sparrow	5	A	—	A	A	A	—	A
Aerial feeders								
Broad-td. Hummingbird	3	—	—	A	A	A	—	—
Western Wood Pewee	5	A	—	A	A	A	—	A
Violet-gr. Swallow	3	A	—	—	—	A	—	A
Western Bluebird	6	A	A	A	A	A	—	A
Hammerers and tearers								
Common Flicker	7	A	A	A	A	A	A	A
Hairy Woodpecker	5	A	—	—	A	A	A	A
White-br. Nuthatch	7	A	A	A	A	A	A	A
Total		13	5	13	12	15	6	13

^a Behavioral response associated with treatment by *G*-test, $P \leq 0.05$.

Swallow) bred on the strip cut plot in 1974. In 1975 Say's Phoebe, Hepatic Tanager, and Mountain Chickadee were again missing from the breeding bird community.

The breeding bird community on the control plot showed a large increase in species from 12 in 1973 to 20 in 1974 and 1975. There were eight additional species (Common Nighthawk, Broad-tailed Hummingbird, Steller's Jay, Yellow-rumped Warbler, Chipping Sparrow, Black-headed Grosbeak, Mourning Dove, Western Flycatcher) breeding in 1974. However, in 1975, even though species numbers remained the same, the Yellow-rumped Warbler left the area and the Western Tanager became a breeding species for the first time.

The difference between the breeding bird community on the control plot in 1973 and on the silviculturally cut plot in 1974 was an increase of four species. Six additional species (Yellow-rumped Warbler; Solitary Vireo; Mountain Chickadee; Broad-tailed Hummingbird; Hermit Thrush, *Catharus guttatus*; Robin) were present in the breeding community while two species (Red-faced Warbler, House Wren) did not utilize the area.

Diversities.—Bird species diversities varied on the study sites with the changing densities and species numbers (Table 5). Breeding bird diversity increased each year on the clear cut plot from 1.02 to 1.34 in 1975. Similarly, diversity increased each year on the severely thinned plot from 2.44 in 1973 to 2.82 in 1975. The breeding bird community on the strip cut plot had its highest diversity in 1974 whereas the avian communities on the silviculturally cut and control plots had their highest diversities in 1975. The breeding bird community on the strip cut had the highest diversity each year of the study.

TABLE 7
ACTIVITY PATTERN ALTERATIONS BY FOUR SELECTED BIRD SPECIES

Species	Plot	n	% total observations		
			Singing-calling	Foraging	Resting-preening
Solitary Vireo ^a	S. Thn.	245	69.8	29.4	0.8
	Strip	260	66.2	33.5	0.3
	Silv.	149	47.2	48.9	3.4
	Cntrl.	222	70.3	23.8	5.9
Gray-headed Junco ^a	S. Thn.	139	33.8	38.1	28.1
	Strip	125	37.6	48.8	13.6
	Silv.	178	69.1	20.2	10.7
	Cntrl.	199	60.3	33.2	6.5
Western Wood Pewee ^a	S. Thn.	68	30.9	47.1	22.0
	Strip	308	34.1	47.4	18.5
	Silv.	72	51.4	40.3	8.3
Common Flicker ^a	S. Thn.	64	17.2	34.4	48.4
	Strip	88	22.7	35.2	42.1
	Silv.	24	29.2	45.8	25.0
	Cntrl.	35	17.1	20.0	62.9

^a Activity pattern associated with treatment by *G*-test, $P \leq 0.05$.

BEHAVIOR

Activity patterns.—The observations in a particular activity by foraging guilds were divided into three categories: 1) singing and calling, 2) foraging, and 3) resting and preening. A composite community activity pattern was calculated by summing all the observations regardless of species. The composite community activity pattern was associated with treatment (*G*-test, $P \leq 0.05$) as were the activity patterns for 12 out of the 15 species (Table 6).

The activity patterns of four species which altered their behavior in response to treatment are illustrated in Table 7. The Solitary Vireo did more resting on the control and silviculturally cut plots than on either of the heavily treated areas. Moreover, that species foraged more on the silviculturally cut plot than any of the other study sites. The Gray-headed Junco spent more time foraging on the severely thinned and strip cut plots than it did on the silviculturally cut and control plots. The amount of time the junco spent resting and preening was inversely correlated with foliage volume ($r = 0.91$). The Western Wood Pewee (*Contopus sordidulus*) was the only aerial feeder to do a substantial amount of calling. In fact, the proportion of the pewee's time spent calling was directly correlated with foliage volume ($r = 0.99$) while the amount of time it spent resting and preening was inversely correlated with foliage volume ($r = -1.00$). The Common Flicker did much more resting than any of the other hammerers and tearers.

A cluster analysis of the activity patterns was performed on the coefficient matrix of Euclidean distances. The species on all study plots clustered into groups representing similarities in activity patterns. For example, on the severely thinned plot the species clustered into two main groups: 1) Yellow-rumped Warbler, Western Wood Pewee, Gray-headed Junco, Western Bluebird, Common Flicker, Grace's Warbler, Chipping Sparrow, Solitary Vireo, and Rock Wren, and 2) Violet-green Swallow, Hairy Woodpecker, Mountain Chickadee, White-breasted

TABLE 8
FORAGING METHOD ALTERATIONS BY FOUR SELECTED BIRD SPECIES

Species	Plot	n	% total observations			
			Picking-gleaning	Aerial feeding	Hammering-tearing	Probing-walking
Yellow-rumped Warbler ^a	S. Thn.	34	55.9	11.7	0.0	32.4
	Strip	32	68.8	25.0	0.0	6.2
	Silv.	110	95.5	0.9	0.0	3.6
Gray-headed Junco ^a	S. Thn.	53	15.1	0.0	0.0	84.9
	Strip	61	27.9	0.0	0.0	72.1
	Silv.	36	0.0	0.0	0.0	100.0
	Cntrl.	84	10.7	0.0	0.0	89.3
Western Bluebird ^a	S. Thn.	69	0.0	0.0	81.2	18.8
	Strip	84	6.0	0.0	69.0	25.0
	Silv.	46	0.0	0.0	91.3	8.7
	Cntrl.	36	0.0	0.0	97.2	2.8
White-breasted Nuthatch ^a	S. Thn.	81	1.2	0.0	98.8	0.0
	Strip	177	2.8	0.0	93.2	4.0
	Silv.	103	15.5	0.0	84.5	0.0
	Cntrl.	72	9.7	0.0	90.3	0.0

^a Foraging method associated with treatment by *G*-test, $P \leq 0.05$.

Nuthatch, and Broad-tailed Hummingbird. The first group consists of those species that spent 9–47% of their time foraging whereas the second group spent over 94% of their time foraging. On the other study sites the species split into two basic groups: 1) those species that spent less than 60% of their time foraging, and 2) those species that spent more than 60% of their time foraging. The most consistent members of group 2 were the Hairy Woodpecker, Broad-tailed Hummingbird, Mountain Chickadee, White-breasted Nuthatch, and Pygmy Nuthatch.

Foraging methods.—Observations of foraging methods were divided into four categories: 1) picking and gleaning, 2) aerial feeding, 3) hammering and tearing, and 4) probing and walking. Foraging methods of the community composite were independent of treatment ($P \leq 0.05$).

The foraging methods of only five species (Yellow-rumped Warbler, Gray-headed Junco, Western Bluebird, Common Flicker, White-breasted Nuthatch) were associated with treatment ($P \leq 0.05$) (Tables 6 and 8). The amount of time the Yellow-rumped Warbler spent picking and gleaning was positively correlated with foliage volume ($r = 0.99$) (Table 8). The Western Bluebird spent a larger part of its time on the ground on the heavily treated study plots. The Common Flicker spent 39–64% of its time probing on the heavily treated plots but spent no time probing on the silviculturally cut and control plots. The White-breasted Nuthatch was the only species in the hammerer and tearer guild that picked and gleaned, which it did in greater proportion on the natural and silviculturally cut areas than on the heavily treated areas.

A clustering of the foraging methods on the four study plots indicates that the species cluster on the basis of foraging guilds. The four clusters on all areas were: 1) pickers and gleaners (Yellow-rumped Warbler, Grace's Warbler, Solitary Vireo, Mountain Chickadee, Pygmy Nuthatch), 2) ground feeders (Rock Wren, Chip-

TABLE 9
ALTERATIONS IN TREE SPECIES SELECTION BY FIVE BIRD SPECIES

Species	Plot	n	% total observations	
			Ponderosa pine	Gambel oak
Yellow-rumped Warbler ^a	S. Thn.	34	35.3	61.7
	Strip	64	73.4	26.6
	Silv.	186	87.1	12.9
Grace's Warbler ^a	S. Thn.	165	72.7	27.3
	Strip	185	83.8	16.2
	Silv.	253	97.2	2.7
	Cntrl.	200	88.5	11.5
Gray-headed Junco ^a	S. Thn.	55	92.7	7.3
	Strip	59	62.7	37.3
	Silv.	131	96.9	3.1
	Cntrl.	123	97.6	3.4
Western Bluebird ^a	S. Thn.	79	86.1	13.9
	Strip	120	86.7	13.3
	Silv.	46	100.0	0.0
	Cntrl.	45	97.8	2.2
White-breasted Nuthatch ^a	S. Thn.	82	67.1	32.9
	Strip	164	80.5	19.5
	Silv.	94	79.8	20.2
	Cntrl.	74	85.1	14.9
% foliage	S. Thn.	—	85.0	15.0
	Strip	—	67.2	32.5
	Silv.	—	83.2	16.8
	Cntrl.	—	84.9	10.4

^a Tree species selection associated with treatment by G-test, $P \leq 0.05$.

ping Sparrow, Gray-headed Junco), 3) aerial feeders (Violet-green Swallow, Western Wood Pewee, Broad-tailed Hummingbird, Western Bluebird), and 4) hammerers and tearers (Hairy Woodpecker and White-breasted Nuthatch). The only species which switched from one foraging cluster to another was the Common Flicker.

Tree species selection.—The selection of tree species by the birds was divided into three categories: 1) ponderosa pine, 2) gambel oak, and 3) alligator juniper (*Juniperus deppeana*). However, as no birds were observed in the juniper, it was not considered in the following analysis. Tree species selection by the community composite was associated with treatment ($P \leq 0.05$). Moreover, the tree species selections of 13 of the 15 species were influenced by treatment (Table 6).

The amount of available foliage volume varied from watershed to watershed but was lowest on the severely thinned plot (3968 m³/ha) and highest on the control plot (19,370 m³/ha). Yet, because of selective cutting practices, the proportion of gambel oak on the treated areas (15.0% on the severely thinned plot, 16.8% on the silviculturally cut plot and 32.5% on the strip cut plot) was greater than on the control plot (10.4%). Gambel oak foliage was not used in proportion to its availability by any of the 15 species examined but in general was used in greater proportion on the more open sites (the severely thinned and strip cut plots) than on the denser areas (silviculturally cut and control plots). For example,

the Gray-headed Junco, Western Bluebird, Yellow-rumped Warbler, and Grace's Warbler spent more time in gambel oak on the severely thinned and strip cut plots than on the denser areas (Table 9). The White-breasted Nuthatch, however, overused gambel oak on all plots except the strip cut plot where it used oak 20% of the time compared with its 33% availability.

Cluster analyses of tree species selection indicate that the bird species segregated on the basis of the proportion of their time spent in ponderosa pine. For example, on the severely thinned plot the bird species clustered into three groups: 1) Yellow-rumped Warbler, Western Wood Pewee, and Broad-tailed Hummingbird (13–54%), 2) Grace's Warbler, Solitary Vireo, White-breasted Nuthatch, Rock Wren, and Chipping Sparrow (67–82%), and 3) Western Bluebird, Common Flicker, Gray-headed Junco, Hairy Woodpecker, and Mountain Chickadee (86–100%). On the strip cut plot the clusters were 1) Rock Wren, Gray-headed Junco, Western Wood Pewee, and Chipping Sparrow (44–67%), 2) Yellow-rumped Warbler, Pygmy Nuthatch, Grace's Warbler, Western Bluebird, Solitary Vireo, and White-breasted Nuthatch (73–87%), and 3) Violet-green Swallow, Mountain Chickadee, Common Flicker, and Hairy Woodpecker (93–100%). On the silviculturally cut and control areas there were two main clusters, with those spending less than 97% of their time in ponderosa pine in the first cluster and those spending more than 97% of their time in ponderosa pine in the second. The latter group consisted of the Violet-green Swallow, Chipping Sparrow, Common Flicker, Hairy Woodpecker, Western Bluebird, Pygmy Nuthatch, and Gray-headed Junco. Grace's Warbler was in the second group only on the silviculturally cut area.

Horizontal tree position.—Observations on the position from the trunk were divided into two categories: 1) trunks and inner branches, and 2) outer foliage. The horizontal tree positions of the entire breeding bird community were associated with treatment ($P \leq 0.05$). Moreover, the trunk positions of 11 species were affected by treatment ($P \leq 0.05$) (Table 6).

There was a general dichotomy in tree position selection between the four guilds. The pickers and gleaners and the ground feeders spent most of their time in the outer foliage whereas the hammerers and tearers and the aerial feeders spent most of their time on the trunks and inner branches. For example, the Solitary Vireo used the inner branch space the heaviest on the strip cut plot (36%) where it was the least available (5.6%) (Table 10). In contrast, the Gray-headed Junco made greater use of the inner branch space on the silviculturally cut plot than on the other study plots. The Western Wood Pewee which spent 66% of its time in the outer foliage on the severely thinned plot, by dramatic contrast spent none of its time in the outer foliage on the silviculturally cut plot. The White-breasted Nuthatch spent at least 82% of its time on the trunks and inner branches on all areas (Table 10).

The bird communities on all four study plots separate into two clusters: 1) those species mainly using the foliage, and 2) those species mainly using the trunks and inner branches. For example, the clusters on the severely thinned area were: 1) Yellow-rumped Warbler, Grace's Warbler, Mountain Chickadee, Rock Wren, Chipping Sparrow, Gray-headed Junco, Western Wood Pewee, Solitary Vireo, and Broad-tailed Hummingbird (65–100% outer foliage use), and 2) White-breasted Nuthatch, Western Bluebird, Common Flicker, and Hairy Woodpecker (68–100% trunk and inner branch use). The pine use clusters on the other three

TABLE 10
ALTERATIONS IN HORIZONTAL TREE POSITIONS BY FOUR BIRD SPECIES

Species	Plot	n	% total observations	
			Outer foliage	Trunks-branches
Solitary Vireo ^a	S. Thn.	245	86.9	13.1
	Strip	260	64.2	35.8
	Silv.	149	71.1	28.9
	Cntrl.	222	86.9	13.1
Gray-headed Junco ^a	S. Thn.	55	92.7	7.3
	Strip	59	78.0	22.0
	Silv.	131	49.6	50.4
	Cntrl.	123	74.0	26.0
Western Wood Pewee ^a	S. Thn.	35	65.7	34.3
	Strip	157	45.2	54.8
	Silv.	36	0.0	100.0
White-breasted Nuthatch ^a	S. Thn.	82	18.3	81.7
	Strip	164	3.7	96.3
	Silv.	94	4.3	95.7
	Cntrl.	74	8.1	91.7
% foliage	S. Thn.	—	85.9	14.1
	Strip	—	94.4	5.6
	Silv.	—	87.7	12.3
	Cntrl.	—	81.7	18.3

^a Horizontal tree position associated with treatment by *G*-test, $P \leq 0.05$.

plots were the same as above except that the Pygmy Nuthatch was in the first cluster and the Violet-green Swallow and Western Wood Pewee were in the second cluster.

Perch selection.—Observations on perch selection were divided into six categories: 1) trunk, 2) branches, 3) twigs, 4) foliage (needles and leaves), 5) ground, and 6) air. The composite bird community perch selection was associated with treatment ($P \leq 0.05$), as was that of each of the 15 individual species ($P \leq 0.05$) (Table 6).

Members of a foraging guild exhibited similar preferences for a particular foraging substrate. The pickers and gleaners were found primarily on twigs. For example, the Pygmy Nuthatch and Grace's Warbler spent more than 60% of their time on twigs (Table 11). The ground feeders foraged primarily on the ground but utilized the twigs and branches as song posts. The aerial feeders obviously foraged in the air more than any other guild but primarily used branches as both song and foraging posts. The Western Bluebird was the only member of this guild to use the ground as a foraging substrate (Table 11). The hammerers and tearers spent most of their time on the trunks and branches except for the Common Flicker which spent much of its time on the ground on the severely thinned and strip cut plots but little or no time on the ground on the silviculturally cut and control plots (Table 11).

The perch selection of individual species cluster into foraging guilds or combinations of foraging guilds. For example, on the severely thinned plot the clusters were: 1) Yellow-rumped Warbler, Chipping Sparrow, Grace's Warbler, Solitary

TABLE 11
PERCH SELECTION ALTERATIONS BY FIVE SELECTED BIRD SPECIES

Species	Plot	n	% total observations					
			Trunk	Branch	Twig	Foliage	Ground	Air
Pygmy Nuthatch ^a	Strip	48	2.1	0.0	83.3	14.6	0.0	0.0
	Silv.	144	9.0	5.6	59.7	20.1	5.6	0.0
	Cntrl.	358	3.4	8.7	60.9	22.9	3.6	0.5
Grace's Warbler ^a	S. Thn.	165	0.0	3.6	88.5	6.7	0.0	1.2
	Strip	187	0.0	1.1	90.4	5.3	0.5	2.7
	Silv.	253	0.0	1.6	89.3	5.9	2.0	1.2
	Cntrl.	209	0.0	6.2	84.8	3.8	3.8	1.4
Gray-headed Junco ^a	S. Thn.	139	0.0	38.8	23.0	0.7	37.5	0.0
	Strip	125	0.0	3.2	36.8	4.0	56.0	0.0
	Silv.	178	0.0	43.3	25.3	0.0	31.4	0.0
	Cntrl.	199	0.0	23.1	36.7	2.5	37.7	0.0
Western Bluebird ^a	S. Thn.	152	0.0	38.2	13.7	0.0	9.9	38.2
	Strip	206	2.4	47.6	6.8	0.0	10.7	32.5
	Silv.	95	0.0	50.5	0.0	0.0	6.3	43.2
	Cntrl.	81	0.0	53.1	2.5	0.0	3.7	40.7
Common Flicker ^a	S. Thn.	64	14.1	54.6	0.0	0.0	31.3	0.0
	Strip	88	27.3	37.5	0.0	0.0	35.2	0.0
	Silv.	24	45.8	45.8	0.0	0.0	8.3	0.0
	Cntrl.	35	45.7	54.3	0.0	0.0	0.0	0.0

^a Perch selection associated with treatment by G-test, $P \leq 0.05$.

Vireo, and Mountain Chickadee (58–89% twigs), 2) Rock Wren, Common Flicker, and Gray-headed Junco (31–85% ground), 3) Violet-green Swallow, Broad-tailed Hummingbird, Western Bluebird, and Western Wood Pewee (38–88% air), and 4) Hairy Woodpecker and White-breasted Nuthatch (71–100% trunk). The Chipping Sparrow was the only species that did not cluster according to foraging guild on the severely thinned plot. The clustering was the same on the strip cut plot except for the addition of the Pygmy Nuthatch into the first cluster. On the silviculturally cut plot the pickers and gleaners and the hammerers and tearers cluster into separate groups whereas the ground feeders and aerial feeders cluster together

TABLE 12
CHANGES IN STANCE BY THE PYGMY NUTHATCH AND WHITE-BREASTED NUTHATCH

Species	Plot	n	% total observations			
			Standing upright	Hanging	Head up	Head down
Pygmy Nuthatch ^a	Strip	48	85.4	12.5	2.1	0.0
	Silv.	144	71.5	20.2	8.3	0.0
	Cntrl.	356	72.5	23.3	2.2	2.0
White-breasted Nuthatch ^a	S. Thn.	82	9.8	12.2	42.7	35.3
	Strip	196	32.1	14.3	30.6	23.0
	Silv.	94	0.0	2.1	53.2	44.7
	Cntrl.	74	17.6	9.5	40.5	32.4

^a Stance associated with treatment by G-test, $P \leq 0.05$.

TABLE 13
MEAN HEIGHTS AND USE RANGES FOR SEVEN SELECTED BIRD SPECIES

Species	Plot	<i>n</i>	Mean	SD	Range
Pygmy Nuthatch ^a	Strip	48	9.5	3.7	2-14
	Silv.	134	13.3	6.7	0-26
	Cntrl.	340	17.0	6.1	0-28
Solitary Vireo ^a	S. Thn.	245	13.1	5.1	2-22
	Strip	260	7.7	3.0	0-14
	Silv.	149	8.8	4.3	2-20
	Cntrl.	222	3.9	2.8	0-14
Gray-headed Junco ^a	S. Thn.	55	12.7	6.9	0-20
	Strip	59	7.0	4.2	0-14
	Silv.	131	8.2	5.4	0-20
	Cntrl.	123	6.2	5.0	0-18
Chipping Sparrow ^a	S. Thn.	54	7.1	3.5	2-14
	Strip	79	6.4	3.7	0-14
	Silv.	60	8.8	2.1	2-12
	Cntrl.	18	8.4	2.8	4-12
Western Wood Pewee ^a	Strip	35	7.5	3.5	0-14
	Silv.	157	6.1	3.1	0-12
	Cntrl.	36	5.3	2.9	2-12
Violet-green Swallow ^a	Strip	51	7.3	2.1	6-12
	Silv.	57	14.1	3.9	12-18
	Cntrl.	83	17.4	4.4	14-20
White-breasted Nuthatch ^a	S. Thn.	82	6.4	2.8	0-14
	Strip	164	7.6	3.2	0-20
	Silv.	94	7.8	5.0	0-16
	Cntrl.	74	8.2	4.4	0-18

^a Difference in mean height between study plots significant ($P \leq 0.05$) by *F*-test.

because of their heavy branch use. On the control area the ground feeders clustered with the pickers and gleaners plus the Broad-tailed Hummingbird.

Stance.—Observations on stance were divided into four categories: 1) standing upright, 2) hanging, 3) head up, and 4) head down. The stance selection of only six of the species were associated ($P \leq 0.05$) with treatment (Table 6).

All pickers and gleaners, ground feeders, and aerial feeders spent the majority of their time standing upright (72–100%). In addition, the Common Flicker spent much of its time standing upright on all study areas. The other hammerers and tearers, the Hairy Woodpecker and White-breasted Nuthatch primarily used the trunks and therefore were positioned with their heads up or down. However, the White-breasted Nuthatch was the only species consistently to move vertically down the trunk whereas the Pygmy Nuthatch was the only non-hammerer and tearer to utilize the head-up posture (Table 12).

A clustering of the species on the basis of stance shows that most species on all study plots stood upright. The only exceptions were the Hairy Woodpecker and White-breasted Nuthatch which spent the majority of their time in a vertical position. The only switch that occurred was by the Common Flicker on silviculturally cut plot where it switched from standing upright 88–99% of the time to standing upright only 54% of the time. Furthermore, while the flicker spent less

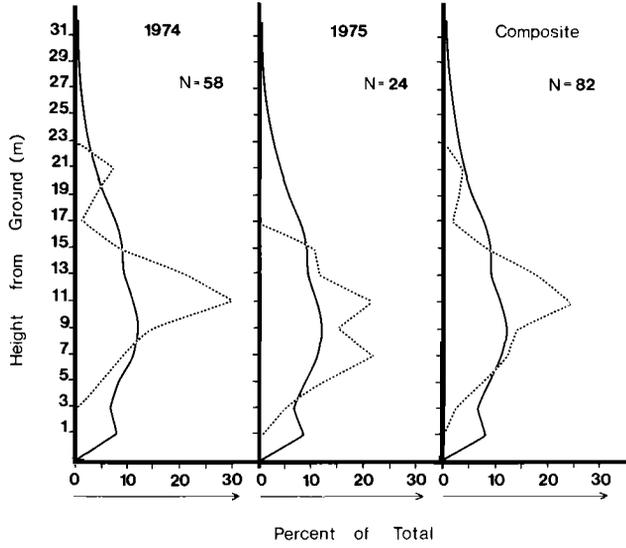


FIGURE 7. Mountain Chickadee use (dotted line) of the available foliage volume (solid line) by height on the silviculturally cut plot. The composite combines all observations for 1974 and 1975.

than 13% of its time vertically upward on the severely thinned, strip cut, and control plots, it was vertically upward 46% of the time in the silviculturally cut plot.

FOLIAGE UTILIZATION

Foliage use both on an individual and community basis was examined over the three-year study period. Observations were classed into 2-m height intervals. Foliage use was examined on a species basis as sexes were not separated.

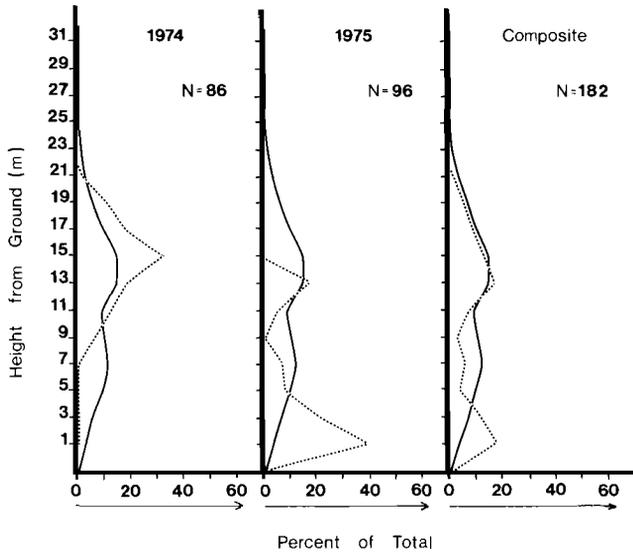


FIGURE 8. Mountain Chickadee use (dotted line) of the available foliage volume (solid line) by height on the control plot. The composite combines all observations for 1974 and 1975.

Mean height and use range.—Differences in use range and mean height in the tree were examined in order to determine the effects of treatment. Only the Rock Wren and Broad-tailed Hummingbird were not influenced by increasing foliage volume (Table 6). There were basically three trends exhibited by the other 13 species: 1) negative correlation, or 2) positive correlation with increasing foliage volume, or 3) change in foliage height selection with no obvious pattern. Of the pickers and gleaners, for example, the Pygmy Nuthatch's mean height in the trees was positively correlated with increasing foliage volume ($r = 0.94$), while that of the Solitary Vireo suggested a negative trend (Table 13). Amongst the ground feeders, the Gray-headed Junco exhibited a negative correlation ($r = 0.70$) between mean height and foliage volume. The Chipping Sparrow fluctuated in height but was consistently higher in the trees on the denser areas. The Western Wood Pewee, an aerial feeder, showed a negative correlation ($r = 0.88$) whereas another aerial feeder, the Violet-green Swallow showed a positive correlation ($r = 0.99$) between mean height and foliage. The White-breasted Nuthatch, a hammerer and tearer, exhibited a positive correlation ($r = 0.81$) between mean height and increasing foliage volume.

Foliage profiles.—Differences in foliage use profiles were examined in order to determine yearly fluctuations and the impact of treatment. The Mountain Chickadee exhibited differing use profile trends on the silviculturally cut and control plots. On the silviculturally cut plot, the chickadee shifted downward from the spire into the bulge (the bulge specifically is that region of the foliage profile which includes approximately 70% of the foliage) from 1974 to 1975 (Fig. 7). Overall, the Mountain Chickadee overused the 7- to 13-m range. Similarly, the Mountain Chickadee shifted down from the spire on the control plot in 1975 and overused the 1- to 4-m region (Fig. 8). The composite profile of the Mountain Chickadee approximated the foliage profile except for the overuse of the 1- to 3-m region and an underuse of the 5- to 11-m region.

Even though the White-breasted Nuthatch moved higher into the trees on all study plots in 1974, its use profiles markedly differed between plots and years. The White-breasted Nuthatch had a statistically significant drop in mean height in 1975 ($P \leq 0.05$) on the severely thinned plot (Fig. 9). The composite profile of the White-breasted Nuthatch showed an underuse of the 11-m and up region and an overuse of the 3- to 7-m region. In contrast, on the strip cut plot the White-breasted Nuthatch expanded its use range by 14 m in 1974 over what it used in 1973 while increasing its mean height by 7 m ($P \leq 0.05$) (Fig. 10). The tremendous overuse of the 3-m height class by the White-breasted Nuthatch in 1973 was dramatically reduced in 1974 with a corresponding overuse of the 17- to 19-m region. In 1975 the White-breasted Nuthatch contracted its use range by 10 m with a marked overuse at 1-m. The White-breasted Nuthatch's composite profile approximated the foliage profile. On the silviculturally cut plot, the White-breasted Nuthatch overused the 5- to 9-m range in 1973 (Fig. 11). In 1974 and 1975, after treatment, the use profile of the White-breasted Nuthatch closely approximated the foliage profile. The use profiles of the White-breasted Nuthatch on the control plot showed over-utilization at different height classes each year (Fig. 12). The nuthatch's composite profile showed a slight overuse of 13-m and below and an underuse above 13-m.

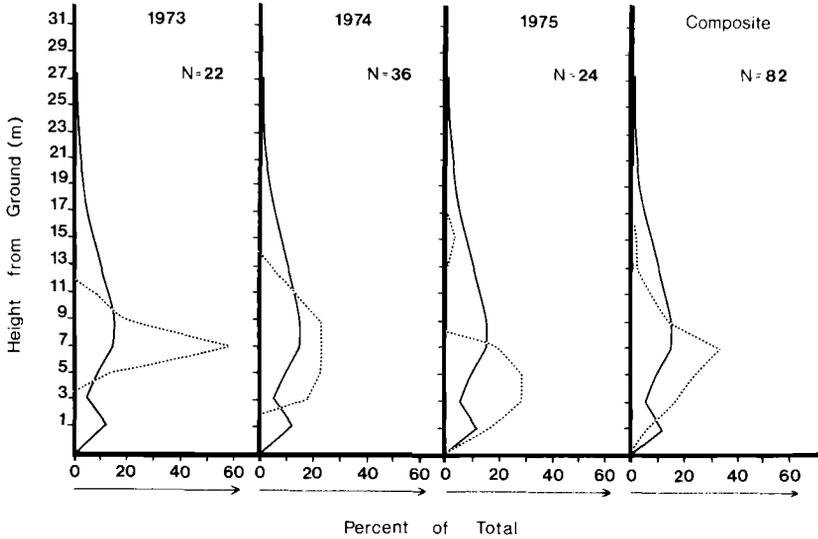


FIGURE 9. White-breasted Nuthatch use (dotted line) of the available foliage volume (solid line) by height on the severely thinned plot. The composite combines all observations for the study.

The Pygmy Nuthatch exhibited similar foliage use profiles on the silviculturally cut and control plots (Figs. 13, 14). On both plots the Pygmy Nuthatch overused the upper portions of the trees in 1974 and then shifted downward from the spire into the bulge region in 1975. Differences emerged in the Pygmy Nuthatch's composite profiles, with an overuse of the 21- to 29-m region on the control plot

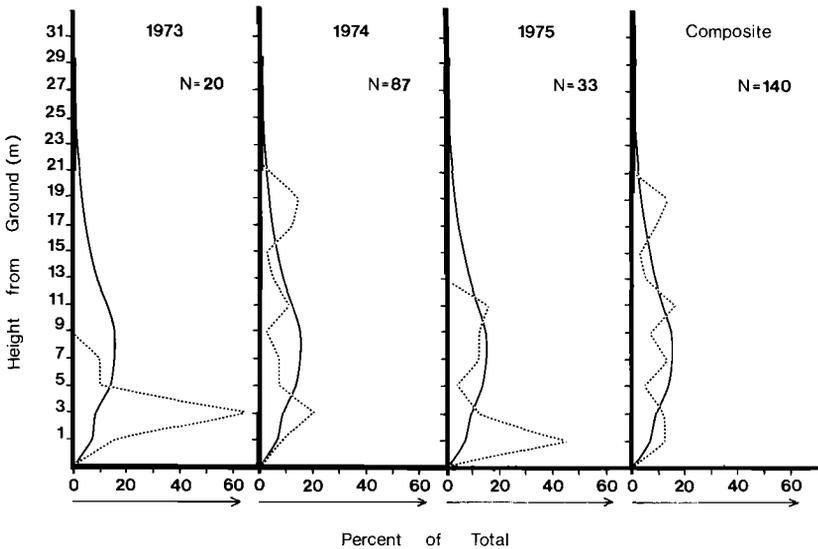


FIGURE 10. White-breasted Nuthatch use (dotted line) of the available foliage volume (solid line) by height on the strip cut plot. The composite combines all observations for the study.

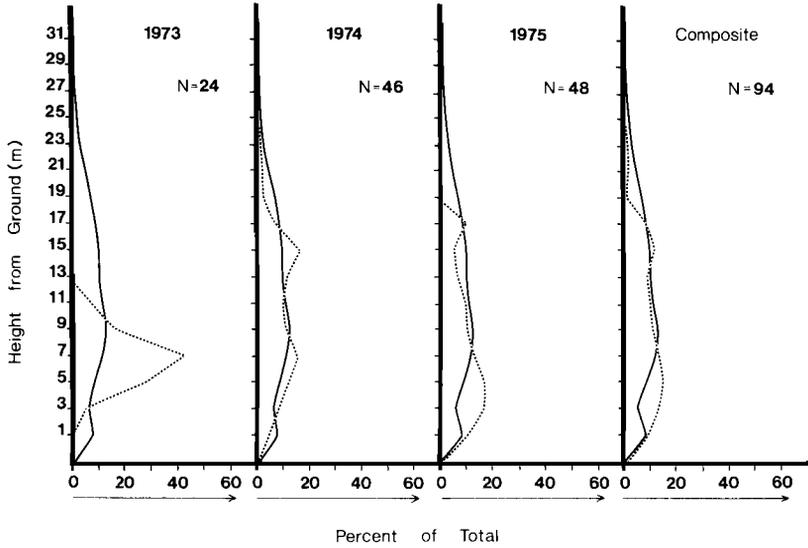


FIGURE 11. White-breasted Nuthatch use (dotted line) of the available foliage volume (solid line) by height on the silviculturally cut plot. The composite combines all observations for 1974 and 1975.

and a close similarity of the use profile and foliage profile on the silviculturally cut plot.

The Western Bluebird overused the lower height classes on all study plots. On the severely thinned plot the Western Bluebird exhibited a dichotomous use profile in 1975 (Fig. 15). Similarly, on the strip cut plot the Western Bluebird exhib-

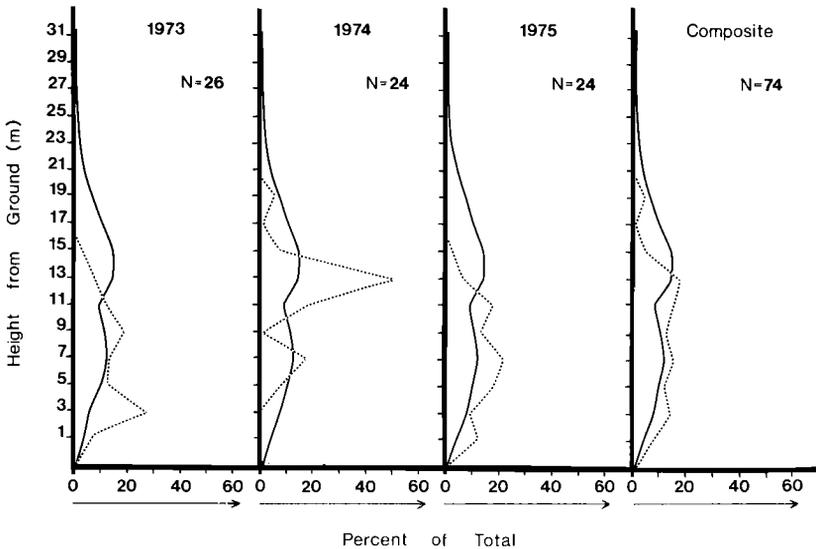


FIGURE 12. White-breasted Nuthatch use (dotted line) of the available foliage volume (solid line) by height on the control plot. The composite combines all observations for the study.

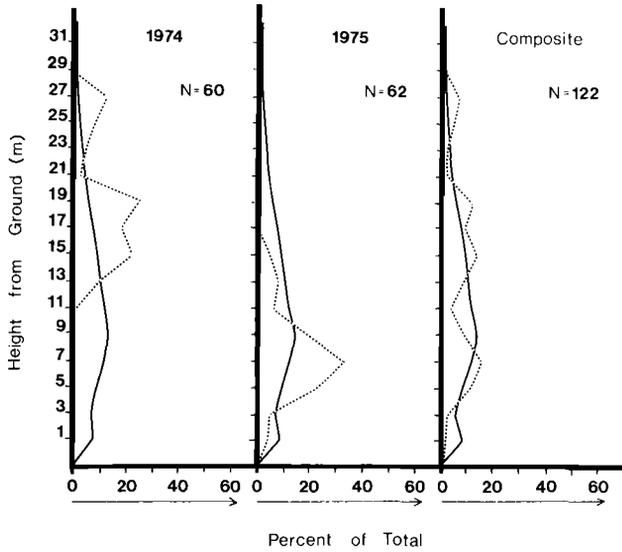


FIGURE 13. Pygmy Nuthatch use (dotted line) of the available foliage volume (solid line) by height on the silviculturally cut plot. The composite combines all observations for 1974 and 1975.

ited a tendency towards a dichotomous use profile in 1974 and 1975 (Fig. 16). In 1973 on the silviculturally cut plot (before treatment) the Western Bluebird had a dichotomous use profile which was not observed on the silviculturally cut plot in 1974 and 1975 (Fig. 17).

The use profiles of the Solitary Vireo on the four study plots showed marked variations. In 1975 the Solitary Vireo on the severely thinned plot contracted its

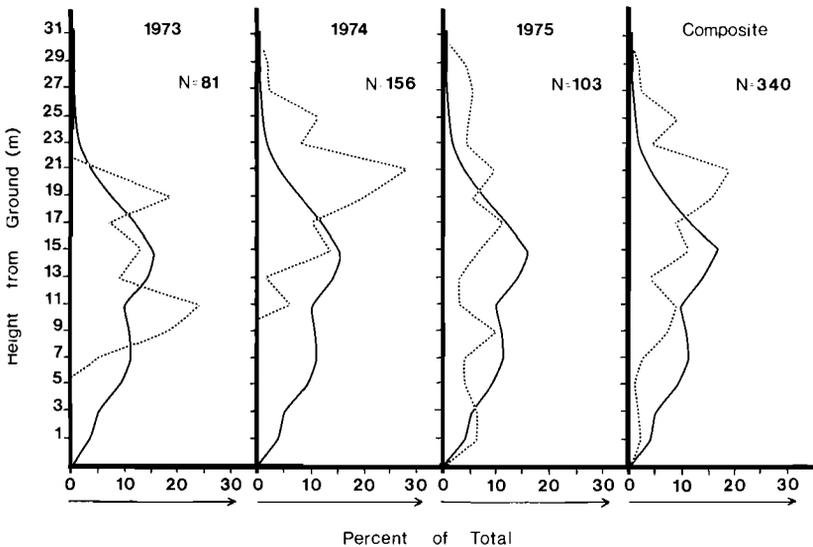


FIGURE 14. Pygmy Nuthatch use (dotted line) of the available foliage volume (solid line) by height on the control plot. The composite combines all observations for the study.

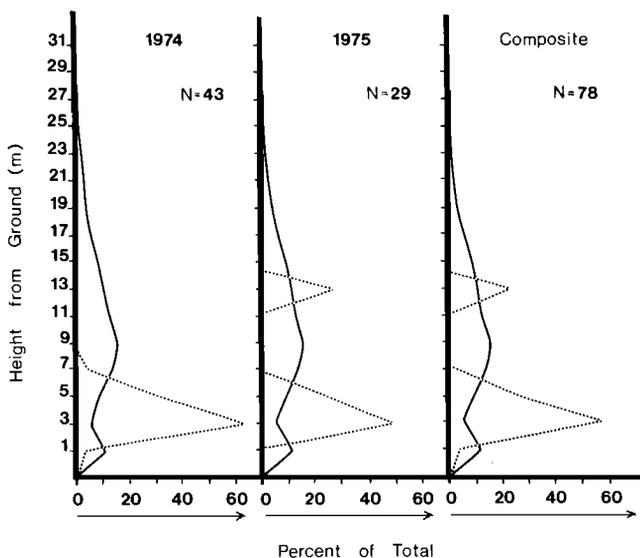


FIGURE 15. Western Bluebird use (dotted line) of the available foliage volume (solid line) by height on the severely thinned plot. The composite combines all observations for 1974 and 1975.

use range and overutilized the 11- to 15-m area which the previous year was grossly underused (Fig. 18). In contrast, in 1974 the Solitary Vireo overutilized the 17- to 23-m area. The Solitary Vireo's overall use profile indicated an overuse of the upper spire. On the strip cut plot the Solitary Vireo remained between 0 to 16 m but overutilized a different height class each year (Fig. 19). On the silviculturally cut plot the vireo heavily used the bulge region in 1974 whereas in

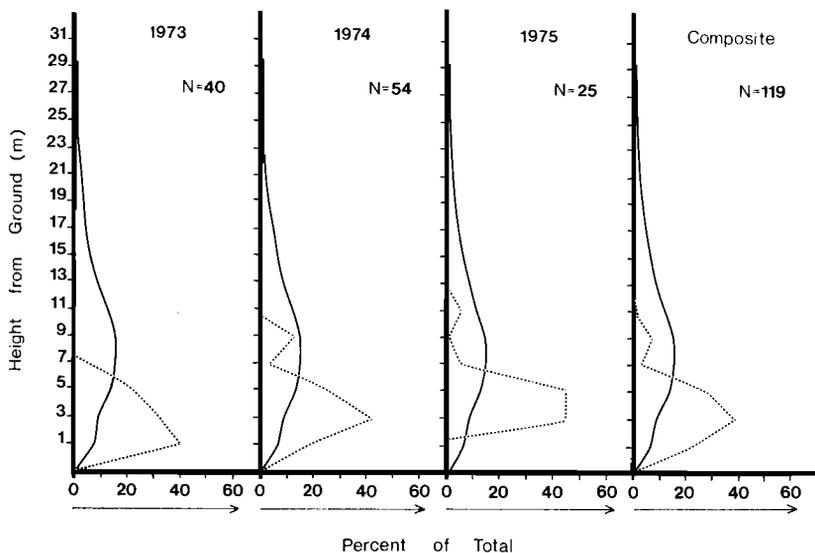


FIGURE 16. Western Bluebird use (dotted line) of the available foliage volume (solid line) by height on the strip cut plot. The composite combines all observations for the study.

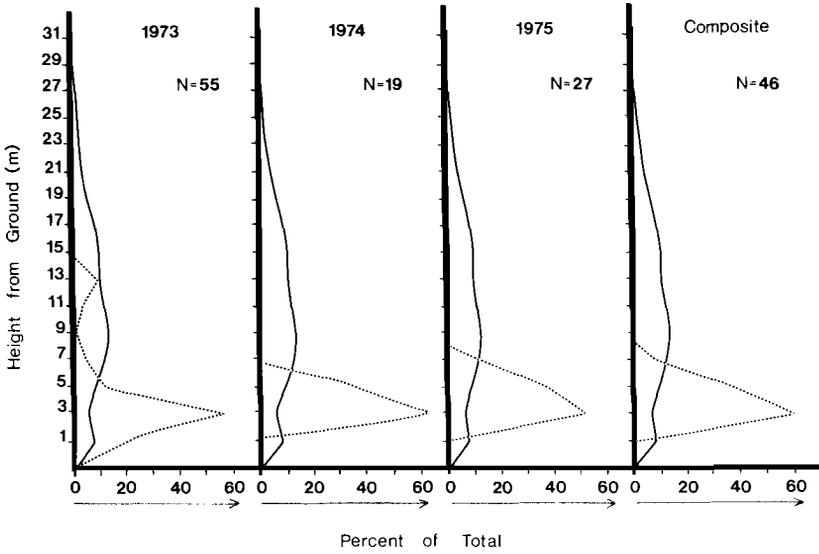


FIGURE 17. Western Bluebird use (dotted line) of the available foliage volume (solid line) by height on the silviculturally cut plot. The composite combines all observations for 1974 and 1975.

1975 it expanded its use range upward and downward with no use of the 13- to 15-m region (Fig. 20). The Solitary Vireo on the control plot remained close to the ground with no difference in mean height between years (Fig. 21). The Solitary Vireo's mean heights showed an inverse relationship with increasing foliage volume ($r = 0.71$).

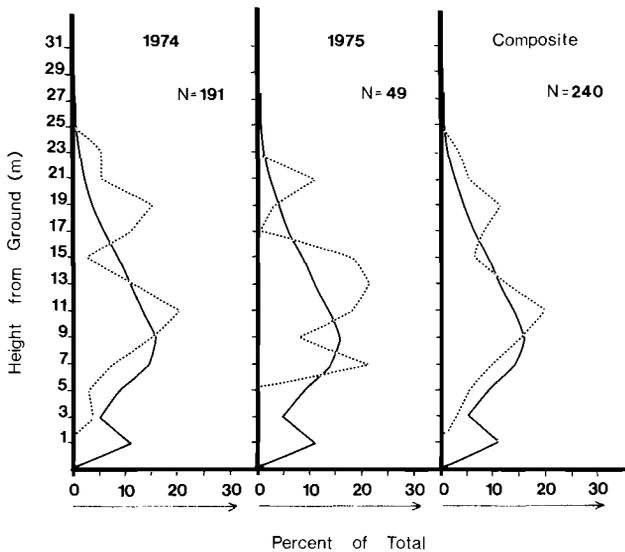


FIGURE 18. Solitary Vireo use (dotted line) of the available foliage volume (solid line) by height on the severely thinned plot. The composite combines all observations for 1974 and 1975.

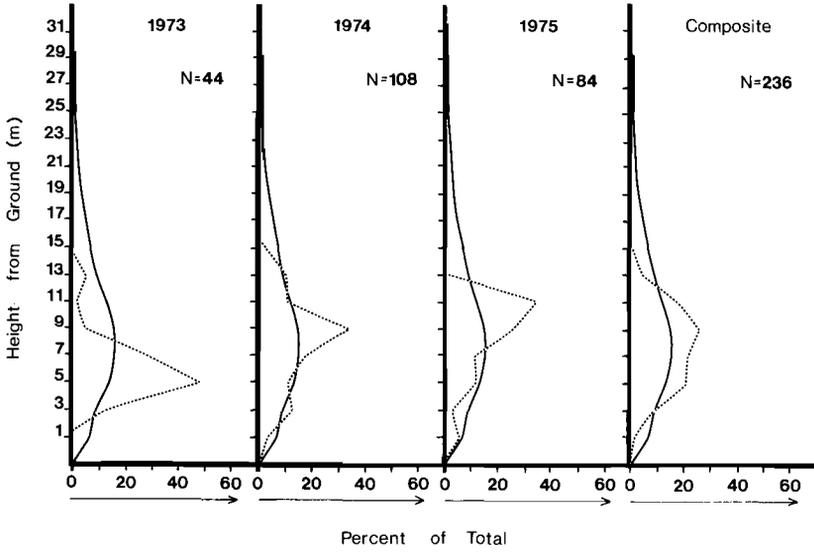


FIGURE 19. Solitary Vireo use (dotted line) of the available foliage volume (solid line) by height on the strip cut plot. The composite combines all observations for the study.

The use profiles of the Yellow-rumped Warbler indicated an overuse of the lower reaches and lower bulge on the silviculturally cut plot (Fig. 22). In 1974 the Yellow-rumped Warbler greatly overused the foliage at 5-m but was not observed at this height in 1975. The Yellow-rumped Warbler's composite profile showed an overuse of the lower reaches and no use of the spire.

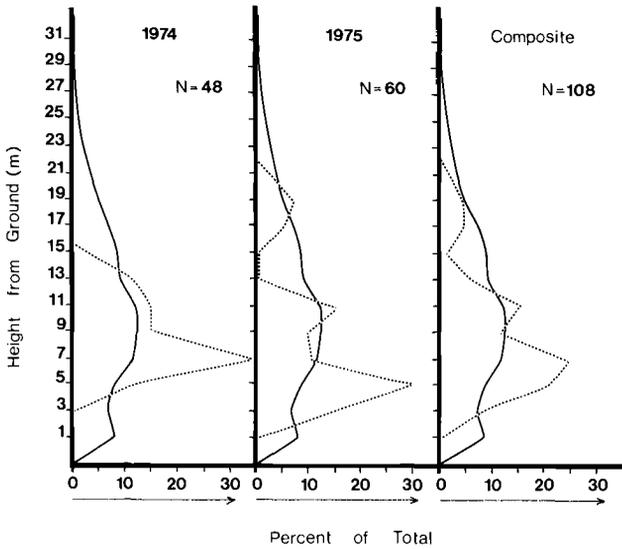


FIGURE 20. Solitary Vireo use (dotted line) of the available foliage volume (solid line) by height on the silviculturally cut plot. The composite combines all observations for 1974 and 1975.

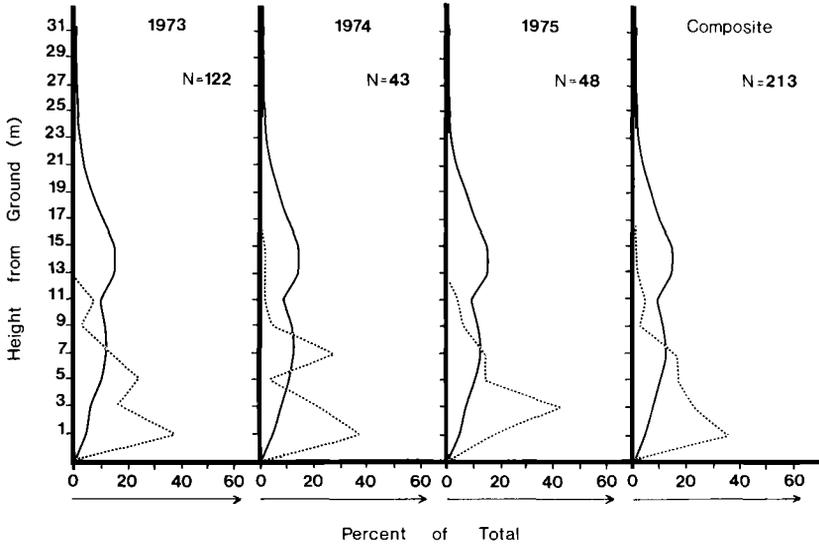


FIGURE 21. Solitary Vireo use (dotted line) of the available foliage volume (solid line) by height on the control plot. The composite combines all observations for the study.

The use profiles of the Grace's Warbler varied considerably between years and study plots. In 1975 the Grace's Warbler moved 4 m higher in the trees on the severely thinned plot ($P \leq 0.05$) (Fig. 23). The Grace's Warbler's composite profile showed an overuse of the 7- to 13-m range and the 19-m height class. In addition, the Grace's Warbler was not observed in the 0- to 4-m region close to the ground. On the strip cut plot the warbler increased its mean height by 7 m in

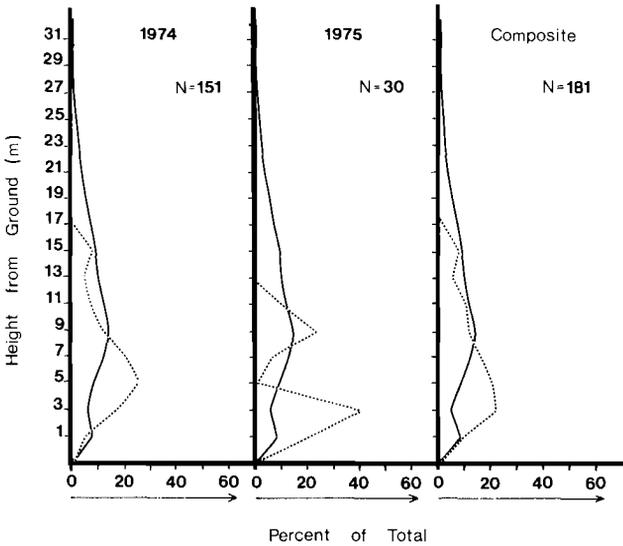


FIGURE 22. Yellow-rumped Warbler use (dotted line) of the available foliage volume (solid line) by height on the silviculturally cut plot. The composite combines all observations for 1974 and 1975.

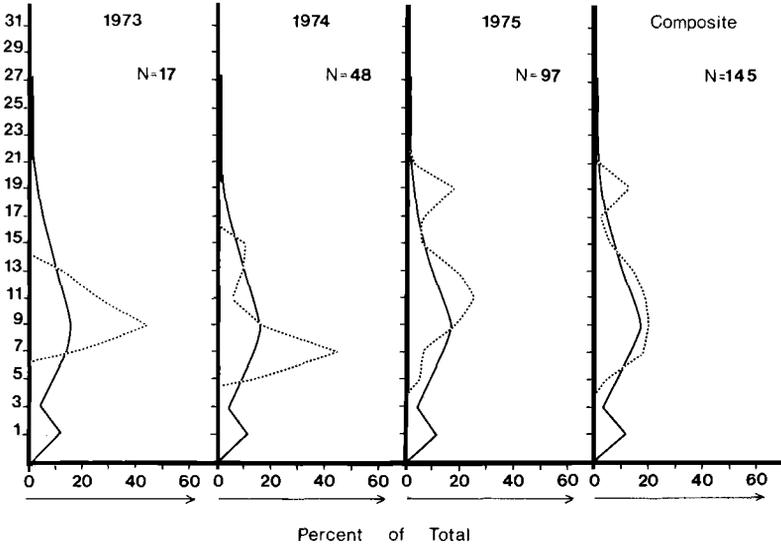


FIGURE 23. Grace's Warbler use (dotted line) of the available foliage volume (solid line) by height on the severely thinned plot. The composite combines all observations for the study.

1974 as compared to 1973 (Fig. 24). The 5- to 7-m range so heavily overused by the Grace's Warbler in 1973 was not used by the warbler in 1974. In 1975 the Grace's Warbler expanded its use range downward, making greater use of the bulge. On the silviculturally cut plot, the Grace's Warbler expanded its use range both higher and lower in the trees while underusing the area that was overused the year before (Fig. 25). In 1975 the Grace's Warbler exhibited a dichotomous

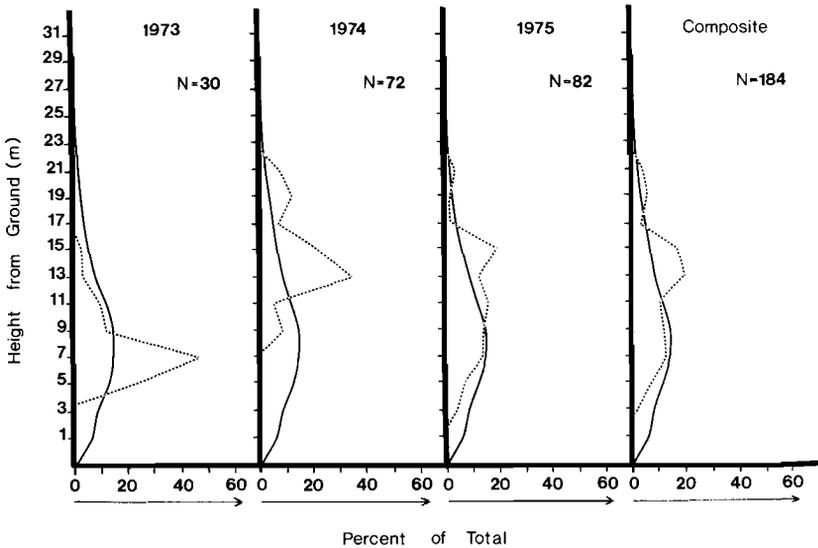


FIGURE 24. Grace's Warbler use (dotted line) of the available foliage volume (solid line) by height on the strip cut plot. The composite combines all observations for the study.

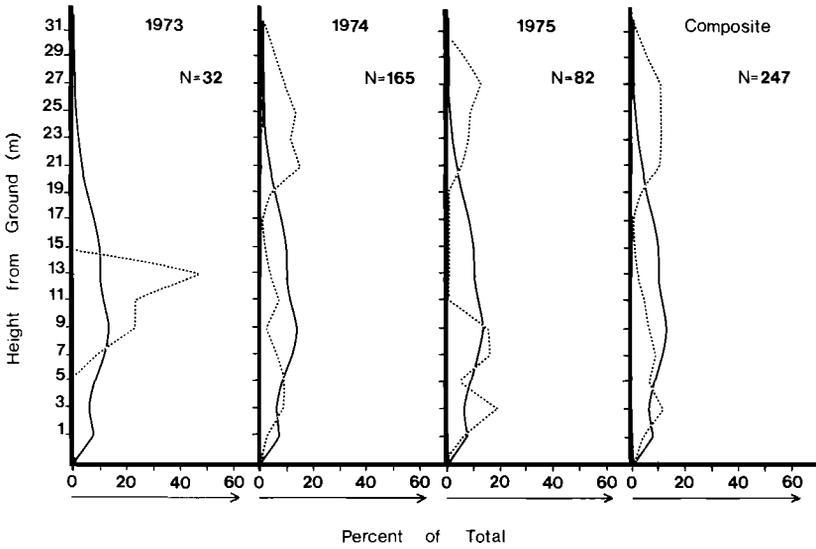


FIGURE 25. Grace's Warbler use (dotted line) of the available foliage volume (solid line) by height on the silviculturally cut plot. The composite combines all observations for 1974 and 1975.

use profile by not using the 11- to 19-m area. The composite bird profile showed that this warbler overused the 21- to 31-m region and underused the 5- to 29-m region. The Grace's Warbler on the control plot shifted its use range upward by 10 m and showed a statistically significant difference in mean height of 6.5 m ($P \leq 0.05$) in 1974 when compared to its profile in 1973 (Fig. 26). In 1975 the Grace's

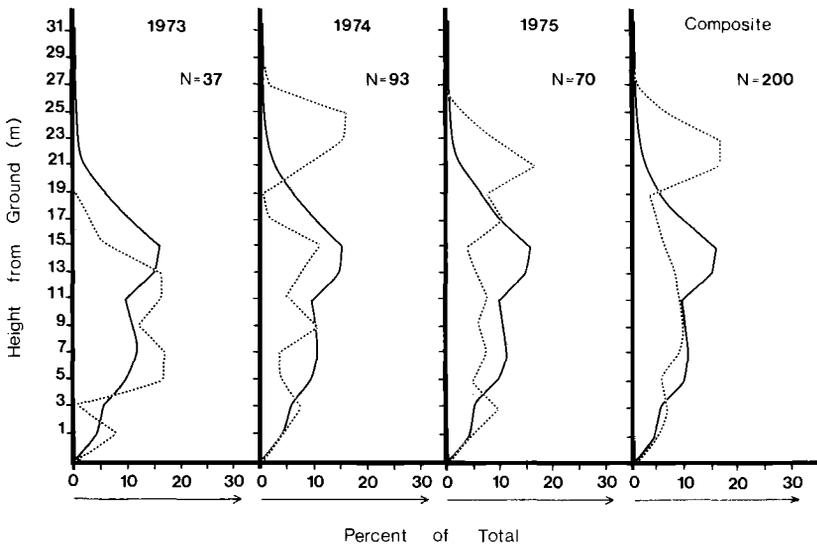


FIGURE 26. Grace's Warbler use (dotted line) of the available foliage volume (solid line) height on the control plot. The composite combines all observations for the study.

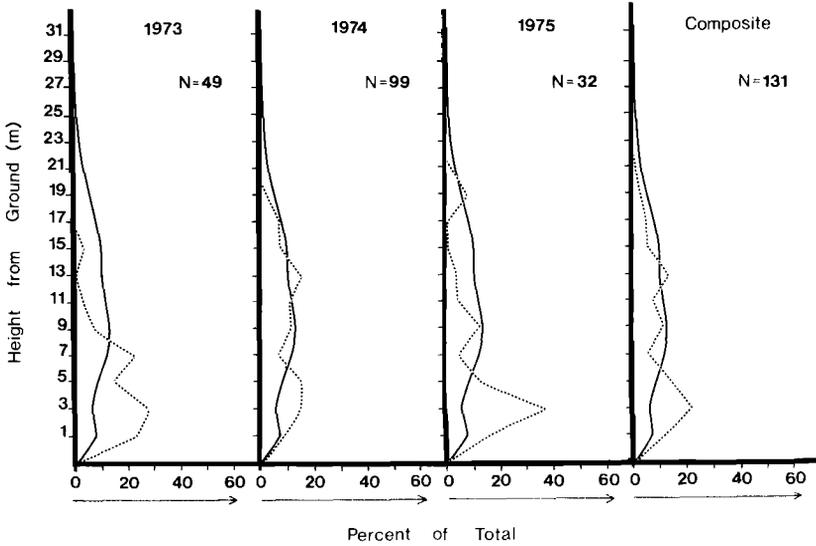


FIGURE 27. Gray-headed Junco use (dotted line) of the available foliage volume (solid line) by height on the silviculturally cut plot. The composite combines all observations for 1974 and 1975.

Warbler's use profile remained similar to its 1974 profile. The Grace's Warbler's three-year composite profile indicated an overuse of the 21- to 27-m region.

There were shifts in foliage use by the Gray-headed Junco between years on the silviculturally cut and control plots. The Gray-headed Junco moved higher in the trees all three years on the silviculturally cut plot (Fig. 27). The composite use pattern of the Gray-headed Junco for the two years after treatment showed

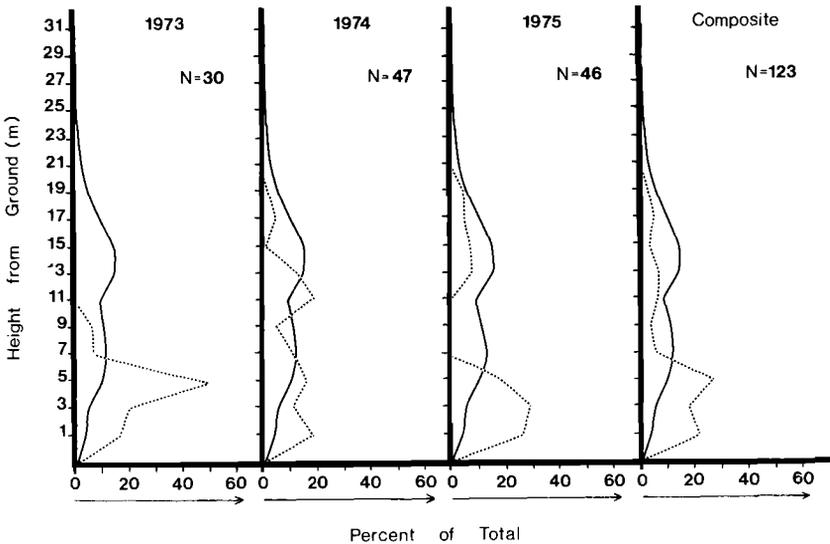


FIGURE 28. Gray-headed Junco use (dotted line) of the available foliage volume (solid line) by height on the control plot. The composite combines all observations for the study.

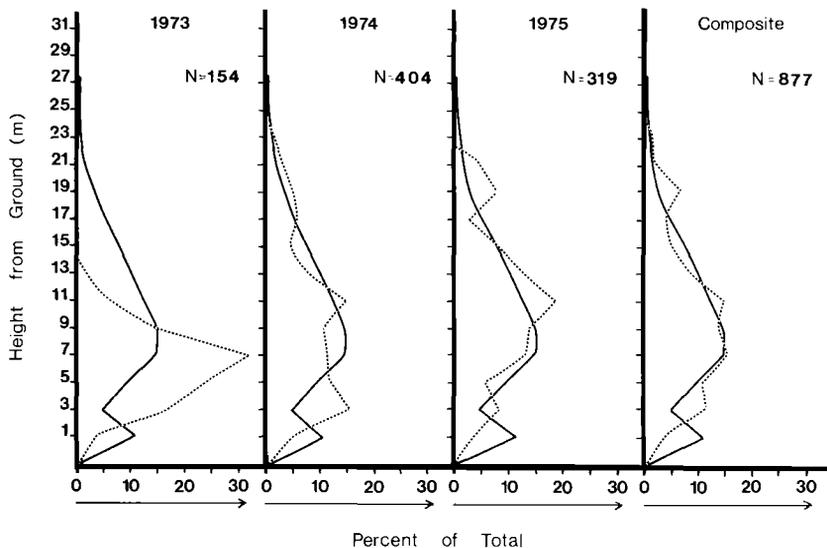


FIGURE 29. Total bird use (dotted line) of the available foliage volume (solid line) by height on the severely thinned plot. The composite combines all observations for the study.

that the Junco overused the 1- to 5-m height range. In 1974 on the control plot, the Gray-headed Junco moved higher in the trees whereas in 1975 it overused the 1- to 5-m region and made no use of the 7- to 11-m area (Fig. 28). The Gray-headed Junco consistently overused the 1- to 5-m region during the study.

The entire bird communities on the four study plots exhibited shifts in foliage utilization. During the study there were dramatic shifts in how the avian com-

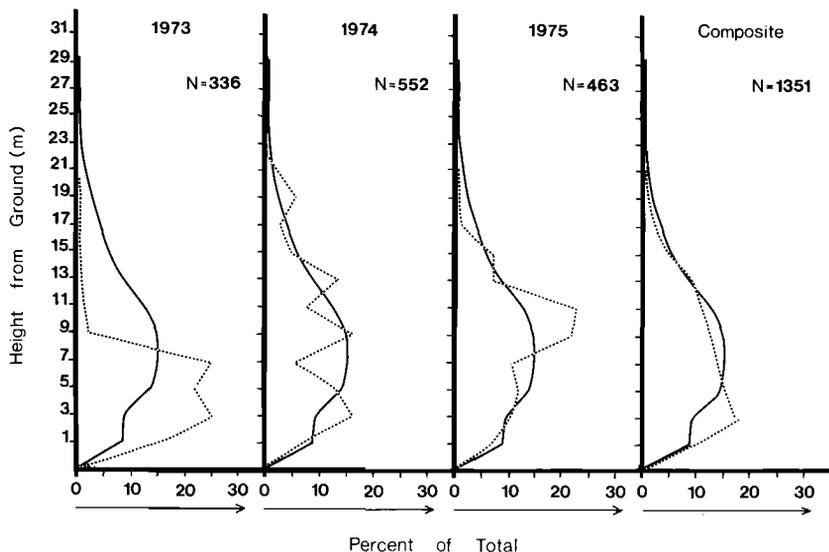


FIGURE 30. Total bird use (dotted line) of the available foliage volume (solid line) by height on the strip cut plot. The composite combines all observations for the study.

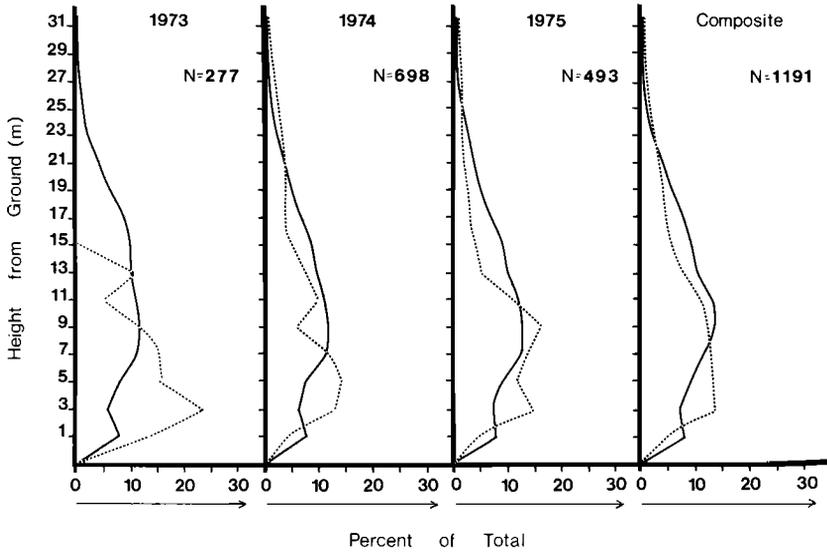


FIGURE 31. Total bird use (dotted line) of the available foliage volume (solid line) by height on the silviculturally cut plot. The composite combines all observations for 1974 and 1975.

munity utilized the foliage on the severely thinned and strip cut plots. These differences, however, averaged out the composite profiles (Figs. 29, 30). On the severely thinned plot, the bird community heavily overused the 3- to 7-m region whereas in 1974 the bird community shifted upward almost using the foliage in relation to its availability. In 1975 the avian community overused the 11- to 13- and 19- to 21-m height classes. The community profile on the strip cut plot showed

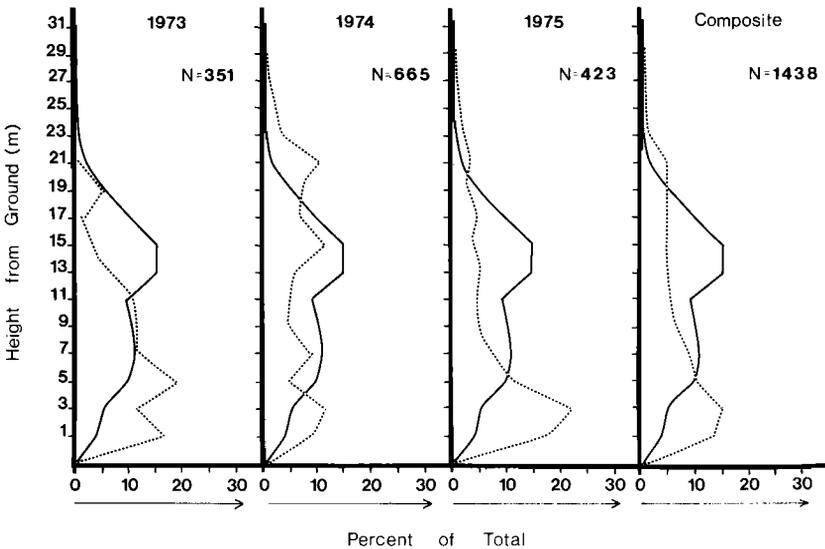


FIGURE 32. Total bird use (dotted line) of the available foliage volume (solid line) by height on the control plot. The composite combines all observations for the study.

TABLE 14
FOLIAGE USE INDICES^a FOR NINE BIRD SPECIES

Bird species	Plot	1973	1974	1975
Western Wood Pewee	Strip	2.69	2.88	1.93
Mountain Chickadee	Silv.	—	1.15	1.45
	Cntrl.	—	1.65	2.84
White-breasted Nuthatch	S. Thn.	3.54	1.96	2.98
	Strip	4.16	1.54	2.79
	Silv.	2.58	5.44	9.67
	Cntrl.	1.88	2.59	1.54
Pygmy Nuthatch	Silv.	—	2.18	1.69
	Cntrl.	1.63	2.52	1.59
Western Bluebird	S. Thn.	—	4.98	4.11
	Strip	3.26	2.87	3.70
	Silv.	3.29	4.10	3.52
Solitary Vireo	S. Thn.	—	1.51	1.81
	Strip	2.79	1.40	1.81
	Silv.	—	1.96	1.68
	Cntrl.	2.90	3.03	2.97
Yellow-rumped Warbler	Silv.	—	1.52	2.52
Grace's Warbler	S. Thn.	2.64	2.54	1.95
	Strip	2.70	2.75	1.25
	Silv.	2.60	1.54	1.73
	Cntrl.	1.31	1.82	1.53
Gray-headed Junco	Silv.	3.27	9.54	2.22
	Cntrl.	2.19	1.72	2.52

^a All indices multiplied by 100.

that the birds underused the foliage above 7 m and grossly overused the foliage between 0 and 7 m in 1973. In 1974 the bird community shifted higher into the trees and underused the 7- and 11-m height classes. However, in 1975 the bird community on the strip cut plot greatly overused the 9- to 11-m interval. On the silviculturally cut plot, the bird community profile approximated the foliage profile in 1974 and 1975 (Fig. 31). The bird community on the control plot underused the foliage profile between 7- to 19-m (Fig. 32). The 13- to 17-m region was underused whereas the 0- to 3-m region was overused by the birds all three years of the study. An examination of the avian community profiles on the treated areas showed that although there were yearly fluctuations the composite bird use profiles reasonably approximated the foliage profiles. In contrast, the bird community on the control study plot underused the 7- to 19-m region on the composite profile.

Foliage profile cluster analyses.—The coefficient matrices for the 15 species on the four study plots were subjected to cluster analysis. The species on the study plots clustered according to the distributions of their foliage use profiles. The species on all areas divided into four to seven groups ranging from those that used the lower branches (e.g., Western Wood Pewee, Solitary Vireo) to those that primarily used the upper bulge area and tips of the trees (e.g., Grace's Warbler, Violet-green Swallow).

Foliage use index.—The foliage use index (*FUI*) was used mathematically to

TABLE 15
MEAN TERRITORY SIZES (ha) OF NINE BIRD SPECIES

Species	Plot	1973			1974			1975		
		<i>n</i>	Mean	SD	<i>n</i>	Mean	SD	<i>n</i>	Mean	SD
Western Wood Pewee	Strip	2	0.28	0.01	3	0.35	0.19	3	0.22	0.12
Mountain Chickadee	Silv. ^a	—	—	—	2	0.27	0.05	1	1.95	0.00
	Cntrl.	—	—	—	2	1.15	0.33	1	1.53	0.00
White-bd. Nuthatch	S. Thn. ^a	2	1.20	0.28	3	0.43	0.11	2	0.55	0.09
	Strip	1	1.38	0.00	4	0.82	0.30	4	1.40	0.48
	Silv.	1	0.43	0.00	3	0.78	0.24	5	1.05	0.36
	Cntrl.	1	0.37	0.00	3	0.56	0.11	1	0.53	0.00
Pygmy Nuthatch	Silv.	—	—	—	5	0.60	0.15	5	0.44	0.19
	Cntrl. ^a	3	0.61	0.11	5	0.84	0.08	4	0.45	0.06
Western Bluebird	S. Thn. ^a	—	—	—	3	0.72	0.05	1	0.57	0.00
	Strip	2	0.74	0.13	4	0.57	0.25	5	0.79	0.33
	Silv.	2	0.56	0.06	3	0.63	0.12	2	0.61	0.15
Solitary Vireo	S. Thn. ^a	—	—	—	2	0.68	0.26	2	1.30	0.09
	Strip	2	0.53	0.21	3	0.37	0.10	2	0.47	0.03
	Silv. ^a	—	—	—	2	0.71	0.17	2	0.33	0.07
	Cntrl.	1	0.48	0.00	2	0.53	0.04	2	0.47	0.02
Yellow-rd. Warbler	Silv.	—	—	—	6	0.39	0.18	3	0.43	0.13
Grace's Warbler	S. Thn.	2	0.75	0.07	2	0.60	0.06	3	0.55	0.10
	Strip	3	0.24	0.10	7	0.30	0.18	3	0.27	0.10
	Silv.	4	0.50	0.11	6	0.40	0.17	6	0.46	0.15
	Cntrl.	2	0.48	0.05	4	0.83	0.25	2	0.43	0.13
Gray-headed Junco	Silv.	3	0.41	0.17	6	0.62	0.20	5	0.53	0.14
	Cntrl.	3	0.65	0.22	6	0.57	0.24	4	0.68	0.11

^a Differences between years significant ($P \leq 0.05$) by *F*-test.

express how the bird species used the available foliage. It is the calculation of the Euclidean distance between the composite foliage configuration and the individual species profiles. As the species become specialists, the index number increases. In contrast, the index number decreases when the birds utilize the foliage in closer proportions to its availability. In other words, generalists will have a low index value.

The indices indicate that foliage utilization by the bird species in the ponderosa pine forest fluctuated between years (Table 14). Seven bird species on three different plots (Western Wood Pewee on the strip cut plot, White-breasted Nuthatch on the control plot, Pygmy Nuthatch on the control plot, Western Bluebird on the silviculturally cut plot, Solitary Vireo on the control plot, Grace's Warbler on the strip cut and control plots, and Gray-headed Junco on the silviculturally cut plot) were more selective of foliage height in 1974 than in 1973 and 1975. In contrast, five bird species on three different study plots (White-breasted Nuthatch on the severely thinned and strip cut plots, Western Bluebird and Solitary Vireo on the strip cut plot, Grace's Warbler and Gray-headed Junco on the silviculturally cut plot) were less selective of specific foliage heights in 1974 than they were in either 1973 or 1975. The White-breasted Nuthatch on the silviculturally cut plot was the only species to increase its *FUI* during the course of the study. The

TABLE 16
MEAN WEIGHT, CONSUMING BIOMASS, AND EXISTENCE ENERGY REQUIREMENTS PER INDIVIDUAL DURING THE BREEDING SEASON

Species	Mean wt. (g) (n = 5)	SD	Con. bio. (g)	Existence energy (kcal/day)		
				1973	1974	1975
Pickers and gleaners						
Grace's Warbler	7.8	0.4	3.7	7.9	7.7	8.1
Red-faced Warbler	9.9 ^a	0.8	4.3	8.9	8.7	9.1
House Wren	10.1	0.7	4.3	9.0	8.9	9.2
Pygmy Nuthatch	10.5	0.8	4.4	9.2	9.0	9.4
Mountain Chickadee	11.6	0.9	4.7	9.7	9.5	10.0
Yellow-rumped Warbler	14.1	1.0	5.3	10.8	10.6	11.1
Solitary Vireo	15.6	0.5	5.7	11.5	11.3	11.7
Western Tanager	30.4	1.7	8.7	16.7	16.4	17.0
Hepatic Tanager	37.8 ^a	1.2	10.0	18.9	18.6	19.2
Ground feeders						
Chipping Sparrow	12.6	0.3	5.0	10.2	10.0	10.4
Rock Wren	16.9	0.4	6.0	12.0	11.8	12.3
Gray-headed Junco	20.2	1.2	6.7	13.2	13.0	13.5
Hermit Thrush	28.5 ^a	2.3	8.3	16.1	15.8	16.4
Robin	81.8	2.3	16.3	29.3	29.0	29.8
Mourning Dove	122.7	11.1	21.0	37.1	36.7	37.7
Aerial feeders						
Broad-tailed Hummingbird	3.5	0.2	2.2	5.1	5.0	5.2
Western Flycatcher	11.8 ^a	1.5	4.8	9.8	9.7	10.1
Western Wood Pewee	14.2	1.5	5.4	10.9	10.7	11.1
Violet-green Swallow	14.2	1.0	5.4	10.9	10.7	11.1
Say's Phoebe	21.0 ^a	—	6.9	13.5	13.3	13.8
Western Bluebird	25.3	1.3	7.7	15.0	14.8	15.4
Common Nighthawk	51.2	2.8	12.1	22.4	22.1	22.8
Hammerers and tearers						
White-breasted Nuthatch	18.4	0.6	6.3	12.6	12.4	12.9
Black-headed Grosbeak	44.1 ^a	1.6	11.0	20.3	20.3	21.0
Hairy Woodpecker	61.8	2.0	13.6	24.6	24.6	25.4
Acorn Woodpecker	65.8 ^a	—	14.2	25.6	25.6	26.3
Steller's Jay	102.7	9.6	18.7	33.1	33.1	34.0
Common Flicker	112.8	11.4	19.9	34.9	34.9	35.9

^a Weights for these species were supplemented from the following sources: Poole (1938), Miller (1951), and Salt (1957).

Grace's Warbler on the severely thinned plot was the only species to decrease its *FUI* during the course of the study. The Mountain Chickadee on the silviculturally cut and control plots became a greater specialist in 1975 than in 1974. The Solitary Vireo increased its *FUI* on the severely thinned plot but decreased on the silviculturally cut plot between 1974 and 1975. The Western Bluebird on the severely thinned plot was more of a generalist in 1975 than in 1974, whereas the Yellow-rumped Warbler was more of a specialist in 1975 than in 1974.

Bulge use.—Concurrently with the changing use profiles, the use of the bulge also shifted. The amount of utilized foliage volume per territory increased with increased utilization of the bulge, all other factors remaining equal. The bulge specifically is that region of the foliage profile which encompasses 70% of the

TABLE 17
STANDING CROP BIOMASS AND CONSUMING BIOMASS OF THE BREEDING BIRDS OF THE STUDY AREAS

Plot	Year	Standing crop biomass (g/ha)	Consuming biomass (g/ha)
Clear cut	1973	17.2	5.0
	1974	21.1	6.1
	1975	32.3	7.9
Severely thinned	1973	91.6	23.9
	1974	171.7	39.8
	1975	131.9	31.9
Strip cut	1973	103.1	27.4
	1974	218.7	59.2
	1975	147.4	42.3
Silviculturally cut	1973	92.2	25.7
	1974	178.5	51.5
	1975	174.1	48.8
Control	1973	67.0	20.2
	1974	182.5	48.5
	1975	139.9	35.4

foliage. Therefore, as species shift upward into the bulge from the spire, the amount of foliage within territories increased. Conversely, foliage volume per territory decreased when the birds moved above or below the bulge. The amount of foliage per territory would decrease even with the increased bulge use either when territory size was greatly reduced or when there was a large contraction of the foliage use range.

TERRITORY SIZE

Territory size was examined for nine species (Table 15). Yearly differences in territory size were statistically significant (F -test, $P \leq 0.05$) in only six of the 23 cases. Territory size varied considerably between years, species, and study plots.

ENERGY REQUIREMENTS

Standing crop biomass and consuming biomass on each of the study sites were calculated using a mean weight (Table 16) and a density (Tables 13–15) for each species. Both standing crop and consuming biomass were the smallest on the clear cut plot (Table 17). In contrast, the largest standing crop and consuming biomass were found on the strip cut plot in 1973 (103.1 g/ha, 27.4 g/ha) and 1974 (218.7 g/ha, 59.2 g/ha) and on the silviculturally cut plot in 1975 (174.1 g/ha, 48.8 g/ha).

Existence energy requirements for individual species varied from a high of 37.7 kcal/day for the Mourning Dove to a low of 5.2 kcal/day for the Broad-tailed Hummingbird in 1973 (Table 16). These two species also had the largest and smallest existence energy requirements in both 1974 and 1975.

Total energy flow in 1973 was highest on the strip cut plot with a value of 52.7 kcal/ha-day and lowest on clear cut plot with a value of 9.6 kcal/ha-day (Table 18). In 1974 the largest energy flow was again on the strip cut (112.8 kcal/ha-day) and the smallest on the clear cut plot (11.6 kcal/ha-day) (Table 19). However, in

TABLE 18
PARTICIPATION OF INDIVIDUAL SPECIES IN ENERGY FLOW THROUGH THE BIRD COMMUNITY IN
TERMS OF EXISTENCE ENERGY (kcal/ha-day) IN 1973

	Study plots				
	C. cut	S. Thn.	Strip	Cntrl.	Silv. (PT)
Species (guilds)					
Mountain Chickadee (PG,CD)	—	0.7	—	—	—
Pygmy Nuthatch (PG,CD)	—	—	—	6.2	3.5
House Wren (PG,CD)	—	—	1.0	—	1.0
Solitary Vireo (PG,FN)	—	2.2	3.4	0.9	—
Yellow-rumped Warbler (PG,FN)	—	—	1.6	—	—
Grace's Warbler (PG,FN)	—	1.5	3.0	3.0	4.4
Red-faced Warbler (PG,GN)	—	—	—	1.0	1.3
Western Tanager (PG,FN)	—	1.3	2.5	—	2.5
Rock Wren (GF,GN)	3.0	3.2	2.3	—	—
Robin (GF,FN)	—	9.9	7.7	—	—
Hermit Thrush (GF,GN)	—	—	—	0.6	—
Gray-headed junco (GF,GN)	1.3	6.5	4.0	6.0	8.4
Rufous-sided Towhee (GF,FN)	5.3	—	—	—	—
Chipping Sparrow (GF,FN)	—	3.1	2.3	—	1.5
Common Flicker (HT,CD)	—	5.3	4.0	5.3	5.3
Hairy Woodpecker (HT,CD)	—	2.8	2.8	3.7	3.7
Steller's Jay (HT,FN)	—	—	5.0	—	5.0
White-br. Nuthatch (HT,CD)	—	3.3	2.8	1.9	1.9
Black-headed Grosbeak (HT,FN)	—	—	—	—	1.5
Broad-td. Hummingbird (AF,FN)	—	—	0.8	—	—
Western Flycatcher (AF,CD)	—	—	—	3.0	1.5
Western Wood Pewee (AF,FN)	—	1.6	4.5	—	1.2
Violet-green Swallow (AF,CD)	—	—	—	4.9	3.3
Western Bluebird (AF,CD)	—	4.5	5.1	3.4	4.0
Foraging guilds					
Pickers and gleaners (PG)	—	5.6	11.5	11.0	12.7
Ground feeders (GF)	9.6	22.6	16.2	6.6	10.0
Hammerers and tearers (HT)	—	11.4	14.6	10.9	17.5
Aerial feeders (AF)	—	6.1	10.3	11.2	9.9
Nesting guilds					
Cavity and depression (CD)	—	16.7	15.7	28.4	24.1
Foliage nesters (FN)	5.3	19.4	30.8	3.8	16.2
Ground nesters (GN)	4.3	9.6	6.2	7.5	9.8
Totals	9.6	45.7	52.7	39.7	50.1

1975 the highest energy flow was on the silviculturally cut plot (97.1 kcal/ha-day) whereas the smallest was still on the clear cut plot (15.1 kcal/ha-day) (Table 20).

The birds which comprise the primary energy component in terms of existence energy varied between years and study plots. The analyses of energy flow patterns were based upon the total breeding avifaunas of the study areas. On the severely thinned plot four species (Robin, Gray-headed Junco, Common Flicker, and Western Bluebird) utilized 57% of the total energy flow in 1973. These same four species plus the Steller's Jay and Western Wood Pewee accounted for 57% of the total energy flow on the strip cut plot. On the control plot there were again four species (Common Flicker, Gray-headed Junco, Pygmy Nuthatch, and Violet-

TABLE 19
PARTICIPATION OF INDIVIDUAL SPECIES IN ENERGY FLOW THROUGH THE BIRD COMMUNITY IN
TERMS OF EXISTENCE ENERGY (kcal/ha-day) IN 1974

	Study plots				
	C. cut	S. Thn.	Strip	Silv.	Cntrl.
Species (guilds)					
Mountain Chickadee (PG,CD)	—	—	4.3	2.9	3.6
Pygmy Nuthatch (PG,CD)	—	1.0	1.4	6.8	6.8
Solitary Vireo (PG,FN)	—	3.4	6.8	3.4	1.7
Yellow-rumped Warbler (PG,FN)	—	—	1.6	8.0	1.6
Grace's Warbler (PG,FN)	—	2.3	7.2	7.2	4.6
Red-faced Warbler (PG,GN)	—	—	—	—	2.0
Western Tanager (PG,FN)	—	—	2.5	5.6	—
Hepatic Tanager (PG,FN)	—	—	2.8	—	—
Mourning Dove (GF,FN)	—	11.0	—	—	5.5
Rock Wren (GF,GN)	3.2	1.8	4.9	—	—
Robin (GF,FN)	—	6.5	10.9	4.4	—
Hermit Thrush (GF,GN)	—	—	—	0.6	1.2
Gray-headed Junco (GF,FN)	1.3	4.4	6.9	14.6	11.7
Rufous-sided Towhee (GF,FN)	6.2	—	—	—	—
Chipping Sparrow (GF,FN)	—	3.0	6.0	3.7	0.8
Common Flicker (HT,CD)	—	5.2	6.6	5.2	5.2
Hairy Woodpecker (HT,CD)	—	3.7	7.4	3.7	3.7
Steller's Jay (HT,FN)	—	12.4	12.4	10.0	14.9
White-br. Nuthatch (HT,CD)	—	5.6	5.6	14.6	6.6
Black-headed Grosbeak (HT,FN)	—	—	1.5	3.0	4.6
Common Nighthawk (AF,GN)	—	3.3	3.3	—	3.3
Broad-tl. Hummingbird (AF,FN)	—	2.6	3.7	1.3	2.2
Say's Phoebe (AF,FN)	—	—	2.0	—	—
Western Flycatcher (AF,CD)	—	—	—	2.5	3.3
Western Wood Pewee (AF,FN)	—	1.6	4.8	1.6	—
Violet-green Swallow (AF,CD)	—	—	1.6	4.8	4.8
Western Bluebird (AF,CD)	—	6.1	8.9	6.1	4.4
Mountain Bluebird (AF,CD)	0.8	—	—	—	—
Foraging guilds					
Pickers and gleaners (PG)	—	6.7	26.5	33.8	20.2
Ground feeders (GF)	10.8	26.7	28.6	23.3	19.2
Hammerers and tearers (HT)	—	26.9	33.4	26.5	34.9
Aerial feeders (AF)	0.8	13.6	24.3	16.3	18.1
Nesting guilds					
Cavity and depression (CD)	0.8	21.6	35.6	36.7	38.3
Foliage nesters (FN)	6.2	42.8	62.2	48.1	35.8
Ground nesters (GN)	4.5	9.5	15.0	15.2	18.2
Totals	11.6	73.9	112.8	100.0	92.3

green Swallow) accounting for 56% of the energy flux (in terms of existence energy). On the silviculturally cut plot (before treatment) the primary energy component consisted of five species (Grace's Warbler, Gray-headed Junco, Common Flicker, Steller's Jay, and Western Bluebird) which accounted for 54% of the total energy flow. Only three species, the Common Flicker, Gray-headed Junco, and Western Bluebird, were members of the primary energy component on all study areas.

TABLE 20
PARTICIPATION OF INDIVIDUAL SPECIES IN ENERGY FLOW THROUGH THE BIRD COMMUNITY IN
TERMS OF EXISTENCE ENERGY (kcal/ha-day) IN 1975

	Study plots				
	C. cut	S. Thn.	Strip	Silv.	Cntrl.
Species (guilds)					
Mountain Chickadee (PG,CD)	—	0.8	—	2.2	1.5
Pygmy Nuthatch (PG,CD)	—	0.7	4.2	8.5	6.4
House Wren (PG,CD)	—	—	1.4	—	—
Solitary Vireo (PG,FN)	—	3.5	3.5	3.5	1.8
Yellow-rumped Warbler (PG,FN)	—	1.7	1.7	5.0	—
Grace's Warbler (PG,FN)	—	3.0	4.0	7.9	2.4
Red-faced Warbler (PG,GN)	—	—	—	—	0.7
Western Tanager (PG,FN)	—	—	2.6	3.9	2.6
Mourning Dove (GF,FN)	—	8.5	—	5.7	5.7
Rock Wren (GF,GN)	2.8	3.7	3.7	—	—
Robin (GF,FN)	1.5	4.5	4.5	4.5	—
Hermit Thrush (GF,GN)	—	—	—	—	1.9
Gray-headed Junco (GF,GN)	1.0	4.1	8.1	10.1	8.1
Rufous-sided Towhee (GF,FN)	7.2	—	—	—	—
Chipping Sparrow (GF,FN)	—	1.6	3.1	2.3	1.6
Common Flicker (HT,CD)	2.7	5.4	5.4	5.4	5.4
Acorn Woodpecker (HT,CD)	—	4.0	—	—	—
Hairy Woodpecker (HT,CD)	—	2.0	3.8	3.8	3.8
Steller's Jay (HT,FN)	—	5.1	5.1	5.1	10.2
White-br. Nuthatch (HT,CD)	—	3.9	7.7	9.7	1.9
Black-headed Grosbeak (HT,FN)	—	—	1.6	3.1	3.1
Common Nighthawk (AF,GN)	—	3.4	3.4	3.4	3.4
Broad-td. Hummingbird (AF,FN)	—	2.4	2.4	0.8	0.8
Western Flycatcher (AF,CD)	—	—	—	1.5	1.5
Western Wood Pewee (AF,FN)	—	1.7	5.0	0.8	—
Violet-green Swallow (AF,CD)	—	—	1.7	4.2	4.2
Western Bluebird (AF,CD)	—	2.3	11.5	5.8	2.3
Foraging guilds					
Pickers and gleaners (PG)	—	9.7	17.3	30.9	15.3
Ground feeders (GF)	12.4	22.2	19.4	22.6	17.2
Hammerers and tearers (HT)	2.7	20.2	23.6	27.1	24.5
Aerial feeders (AF)	—	9.8	24.0	16.5	12.2
Nesting guilds					
Cavity and depression (CD)	2.7	18.9	35.7	41.0	27.0
Foliage nesters (FN)	8.7	31.8	33.3	42.5	28.1
Ground nesters (GN)	3.7	11.1	15.2	13.6	14.0
Totals	15.1	61.8	84.2	97.1	69.1

In 1974 the primary energy components consisted of several more species, because of the general increase in density and diversity. The smallest total energy flow was on the clear cut plot and the largest energy flow was on the strip cut plot. On the severely thinned plot the same four species as in 1973, plus the White-breasted Nuthatch, Mourning Dove, and Steller's Jay, accounted for 69% of the total energy flow. On the strip cut plot five of the six species in 1973 (minus the Western Wood Pewee), plus five additional species (White-breasted Nuthatch,

Solitary Vireo, Chipping Sparrow, Hairy Woodpecker, and Steller's Jay), accounted for 55% of the total energy flow on the control plot. Four species (Common Flicker, Western Bluebird, Gray-headed Junco, and Steller's Jay) were members of the primary energy components on all the forested plots in 1974.

The primary energy components on all the forested plots in 1975 consisted of between five and seven species of birds. The lowest energy flux in terms of bird communities was on the clear cut plot, whereas the highest energy flux was on the silviculturally cut plot. On the severely thinned plot seven species (White-breasted Nuthatch, Gray-headed Junco, Robin, Mourning Dove, Common Flicker, Steller's Jay, and Acorn Woodpecker) accounted for 57% of the total energy flux. Seven species (White-breasted Nuthatch, Gray-headed Junco, Common Flicker, Steller's Jay, Western Bluebird, Robin, and Western Wood Pewee) accounted for 56% of the energy flow on the strip cut plot. On the control plot five species (Pygmy Nuthatch, Gray-headed Junco, Mourning Dove, Common Flicker, and Steller's Jay) accounted for 52% of the total energy flow and on the silviculturally cut plot the same five species plus the Grace's Warbler, Western Bluebird, and White-breasted Nuthatch comprised 60% of the energy flow. The Gray-headed Junco, Steller's Jay, and Common Flicker were members of the primary energy component on all plots with foliage.

BODY WEIGHT

Most of the species (23 of 28) clustered in the lower half of the weight range for each guild (Table 16). The pickers and gleaners and aerial feeders exhibited a fairly contracted body weight range. The pickers and gleaners ranged from 7.8 to 37.8 g, whereas the aerial feeders ranged from 3.5 to 51.2 g. On the other hand, hammerers and tearers and ground feeders have a very wide range of weight. The hammerers and tearers ranged from 18.4 g to 112.8 g, and the ground feeders from 12.6 to 122.8 g.

DISCUSSION

COMMUNITY COMPOSITION

Species numbers and densities.—Comparisons of different bird communities in the ponderosa pine forest in Arizona are limited to those by Haldeman et al. (1973) who reported 27 species in similar areas of northern Arizona, and by Balda (1969) who recorded 31 species of breeding birds in the Chiricahua Mountains of southeastern Arizona. These numbers contrast with the high of 22 species in this study found on the strip cut plot in 1974, and an overall number of 28 breeding species. Balda (1969) recorded eight species in the Chiricahua Mountains found in the present study (Brown Creeper; Whip-poor Will, *Caprimulgus vociferus*; Virginia's Warbler, *Vermivora virginiae*; Band-tailed Pigeon, *Columba fasciata*; Coues' Flycatcher, *Contopus pertinax*; Mexican Junco, *Junco phaeonotus*; Olive Warbler, *Peucedramus taeniatus*; Mexican Chickadee, *Parus sclateri*; and Pygmy Owl, *Glaucidium gnoma*). The Mexican Junco and the Mexican Chickadee are replaced by ecological equivalents, the Gray-headed Junco and the Mountain Chickadee. The Brown Creeper, Virginia's Warbler, and Pygmy Owl are known to breed in the ponderosa pine forest of northern Arizona. The remaining species (Coues' Flycatcher, Olive Warbler, and Band-tailed Pigeon) are found only in the ponderosa pine forests of southern Arizona or in different habitats in northern