Breeding Bird Communities in Aspen Forests of the Sub-boreal Spruce (dk Subzone) in the Prince Rupert Forest Region

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Ministry of Forests Research Program

Canadian Cataloguing in Publication Data
Pojar, Rosamund A.
Breeding bird communities in aspen forests of the sub-boreal spruce (dk subzone) in the Prince Rupert Forest Region

(Land management handbook ; 33)
Includes bibliographical references: p.
ISBN 0-7726-2360-0

1. Forest birds - British Columbia - Prince Rupert Region. 2. Forest birds - Effect of habitat modification on - British Columbia - Prince Rupert Region. 3. Aspen - British Columbia - Prince Rupert Region. 4. Forest management - British Columbia - Prince Rupert Region. 5. Habitat (Ecology) - British Columbia - Prince Rupert Region - Management. I. British Columbia. Ministry of Forests. Research Branch. II. Title. III. Series.

QL685.5.B7P64 1995 598.297111 C95-960050-7

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B.C. Ministry of Forests

Published by
B.C. Ministry of Forests
Research Branch
31 Bastion Square
Victoria, B.C. V8W 3E7

Copies of this report may be obtained, subject to supply, from:
Production Resources
Forestry Division Services Branch
B.C. Ministry of Forests
333 Quebec Street
Victoria, B.C. V8W 3E7

ABSTRACT

A principal objective of this project was the study of the diversity of bird communities in different seral stages of the aspen ecosystem in the Sub-boreal Spruce (dk subzone) of the Prince Rupert Forest Region. In the spring of 1991 and 1992, I examined clearcuts (under 7 years), sapling aspen (7–23 years), mature aspen (50–60 years), old aspen with 100-year-old veterans, and mixed aspen-conifer stands. A preliminary survey of some conifer stands was also conducted. I counted birds over the 2 years using a modified point count method. One aspen stand was also examined by spot mapping.

Results showed a tendency for bird species richness, abundance, and diversity to all increase with increasing ecological age of the seral stage. Analysis of variance showed that differences in species numbers, bird abundance, and diversity between seral stages were significant for both breeding birds and total bird use. Numbers of breeding species, their abundance, and diversity indices were significantly lower in clearcuts than in sapling stands. Species abundance and diversity of breeding birds were greater in mixed aspen-conifer stands than in old and mature pure aspen combined. The number of breeding species in mixed stands was greater than that in pure aspen only in the second year of the study. Old aspen stands contained more birds and the species diversity was greater than in mature stands. The overall abundance of birds differed significantly between the 2 study years.

Analysis of the data using a Detrended Correspondence Analysis ordination procedure revealed that the bird communities in clearcuts and one of the three sapling stands were similar to each other, but quite different from those found in the other seral stages examined. The bird communities in the remaining stages were not distinct from each other, but rather there was an overlap from one bird community to another as the stands aged and the vegetation changed and became more complex.

Habitat relations of the 16 most abundant species were analyzed by multiple regression. Results suggest that most changes in bird abundance were species specific, and relate to changes in the proportions of the different layers of vegetation in the seral stages.

Lack of sufficient information on habitat requirements precludes the assignment of a single management indicator species for each stage. However, species that could potentially be used for managing different seral stages, or habitat components therein, are proposed.

The report suggests that removal of aspen, either commercially or by land clearing, might affect breeding birds using the different seral stages.

ACKNOWLEDGEMENTS

This project was funded by the Ministry of Forests and the Sustainable Environment Fund. My thanks to Ruth Lloyd, Stefan Schug, Will Mackenzie, Jason Lee, Dorothy Geisbrecht, and Kathleen Yates for their assistance in collecting the field data. A very special thanks goes to Elaine Wright for invaluable help with the data analysis and feedback on many aspects of this project. My thanks also to the Bulkley Forest District for access to the clearcuts, and especially to the many landowners of the valley for permission to use their property as study sites. The advice and suggestions of J.P. Savard, A.J. Erskine and Eric Lofroth in the design of the project, Vera Sit, Wendy Bergerud, and Amanda Nemec on statistical approach, Bruce McLellan and Doug Steventon for valuable feedback, are all greatly appreciated. Thanks also to those who reviewed this report, and especially to Dr. Art Lance for many extremely useful suggestions.

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1 INTRODUCTION

Aspen forests are important habitat for North American wildlife, providing both food and cover for many species (Gullion 1977, Winternitz 1980).

Trembling aspen (*Populus tremuloides*) is common at low to middle elevations in all but the wettest coastal sub-zones of the Prince Rupert Forest Region. The most extensive stands are located in the Sub-boreal Spruce (SBS) zone, especially in the valley bottoms and lowlands between Smithers and Burns Lake, and throughout the Lakes District.

Throughout North America, the aspen forests are declining because of many forest management practices, including the prevention and control of fire, and the conversion to other (often coniferous) forest types. Aspen stands have traditionally not been harvested. In the absence of naturally occurring destructive disturbance (e.g., fire), they will eventually develop into climax coniferous forests. Recently, an increasing demand for hardwoods as a source of woodfibre has accelerated the reduction of aspen forests.

In the Prince Rupert Forest Region, there has been little harvesting of aspen for logs or fibre until the last few years. Clearing of aspen for agricultural use, however, has been widespread and is continuing.

If this plant community is to be managed effectively to maintain biodiversity, it is essential that information be collected in a systematic manner on all species likely to be dependent on it. Little is known about the relationship between aspen and its avifauna, especially in the Prince Rupert Forest Region. Most of the existing knowledge about the use of aspen by birds is based on studies conducted in various parts of the United States, and in Canada east of the Rocky Mountains. While it is clear from these studies that aspen is important to songbirds, especially Neotropical migrants, it is not known if the observed relationships are applicable to the SBS zone of northern British Columbia. Most studies in British Columbia have occurred further south in the province and many have focused primarily on cavity-nesting birds (Erskine and McLaren 1976; Peterson and Gaulthier 1985; Keisker 1987; Harestad and Keisker 1989; and others). Apart from data gathered by naturalists for breeding bird surveys, there has been only one brief quantitative survey of bird communities in aspen in the Smithers area (Erskine 1977).

This 2-year study was initiated in 1991 to examine the diversity of bird communities in different seral stages of the aspen ecosystem at the western end of the dry cool subzone of the Sub-boreal Spruce (SBSdk) in the Prince Rupert Forest Region. Breeding birds were chosen because they tend to stay within a relatively confined area once they are on their territories, and, hence, are easier to count.

2 OBJECTIVES

The objectives of this study were to:

1) Survey the composition of breeding bird communities found in various seral stages of aspen forests in the Sub-boreal Spruce (dk subzone) of the Prince Rupert Forest Region.
2) Determine the habitat or seral relationships of these species.
3) Identify management indicator species that could represent the diversity of most birds likely to be affected by aspen management.

From the first two objectives it was hoped to determine what species are present in each seral stage, whether or not there are distinct bird communities associated with each seral stage, and, if possible, to determine what habitat features are important to the different species present. Forest managers can then use the results to help them manage aspen for both its wildlife and timber values.

3.1 Study area

The study sites were located within 35 km of Smithers, B.C. (lat. 54° 47' N: long. 127° 10' W) (Appendix 8).

3.2 Site selection

Potential sites were initially located on forest cover maps and aerial photographs. Subsequent ground checks determined the suitability (size, age, level of disturbance, etc.) of each of the pre-selected sites.

The original intent was to select sites representing the following seral stages:

a) recently cut stages (preferably originally dominated by aspen);
b) shrub/herb stage;
c) pole/sapling stage (< 15 years);
d) young aspen stages (15–49 years old);
e) mature (50 years or older);
f) mature mixed forests stages — stands of mature aspen mixed with conifers of harvestable age.

It proved difficult to find examples of all these stages. Most of the cleared aspen stands in the valley have been converted to pasture and were not considered. The three clearcuts chosen were originally covered by a mix of aspen and conifers. All were less than 6 years old at the time of selection, had a few scattered aspen saplings, and were dominated by shrubs (Table 1).

Similarly, there were few pole/sapling sites available. The three stands selected were very different from each other in size, age of aspen, and structure of the stand. The sapling stand S1 was uneven-aged, with the majority of the stems less than 20 years old. Sapling stands S2 and S3 contained very dense thickets of aspen saplings less than 7 years old and both had human-made openings. All three had well developed shrub and herb layers.

Most of the aspen stands in the area were uneven-aged, dating back to the last major wildfire in the valley. In most stands, the co-dominant aspen stems were 50–60 years old. However, some stands contained veteran aspen stems between 85 and 125 years old. The mix of stem sizes within these stands suggests that regeneration was probably by suckering from these veterans. As the veteran aspen rot and fall, the openings created are recolonized by aspen suckers. Natural, small, meadow-like openings dominated by herbs, low shrubs, and sapling aspen are therefore a common feature of mature or old aspen stands.

To ensure adequate sampling of the variation in aspen stem sizes encountered in the initial field work, I subjectively assessed the age of the stems in each plot, based on a visual estimate of diameter and stem height. The plots were then classified as being old (dominated by veterans), mature, or immature. I then attempted to establish an equal number of plots in each of these age classes. An examination of the ages from cores later revealed that there was no difference in the average age of the stems between the immature and mature plots, but that differences in stem size must be related to other factors (e.g., differences in site growth conditions). Consequently, the immature and mature plots were lumped together and all treated as mature—resulting in more than twice the number of plots sampled for this age class. Only 11 plots (in 2 stands) were classed as old.

There were very few stands of reasonable size in the study area that contained a mix of aspen and spruce (*Picea glauca* x *engelmannii*) and pine (*Pinus contorta*). Most mixed stands were highly fragmented. The three stands selected were different from each other in age, structure, and composition.

In summary, the seral stages selected and number of plots sampled were:

	Samples (replicates)	No. of stands
a) clearcuts (shrub/herb stage)	20 plots	3
b) pole/sapling	20 plots	3
c) mature	42 plots	5
d) old	11 plots	2
e) mixed aspen-conifer	20 plots	3

Most of the stands selected were either being lightly grazed, or had been grazed in recent years.

All three clearcuts were surrounded by stands of mixed conifer and deciduous trees. All the sapling stands were small and surrounded by either cleared hayfields or stands of mature trees.

All mature and old aspen stands and mixed stands in the area were highly fragmented and near land that had been cleared for pasture or hay. The influence of adjacent habitats on the avifauna of the study sites is not known, but cannot be discounted, especially in the smaller stands.

3.3 Vegetative sampling

Detailed descriptions of study sites, aerial photographs and sketch maps of transects are on file with the Research Branch, Ministry of Forests, Victoria, B.C.

Due to time constraints, the vegetation was sampled on only one-third of the bird census points in 1991. In 1992, the vegetation on all bird census plots was sampled. One 20 x 20 m plot was established around the centre of each of the 50 m diameter circular census points. The following information was collected for each vegetation plot:

1. number of stems of dominant tree species.
2. basal area of dominant tree species.
3. diameter at breast height (dbh) of dominant tree species.
4. percent cover and mean height (m) of dominant tree species.
5. number and diameter of snags.
6. ages of co-dominant and dominant trees.
7. percent cover and mean height of tall shrub layer (2–10 m).
8. percent cover and mean height of low shrub layer.
9. percent cover and mean height of herb layer.
10. percent cover of coarse woody debris (CWD).
11. percent cover bare ground.

I used a plotless sampling (prism cruising) method to collect data on density, basal area, and dbh of the trees. I determined the number of stems per hectare of saplings by counting all the live stems within two 3 m diameter circles located within the 20 x 20 m vegetation plots. The two values were then averaged. To determine the maximum dbh of saplings, I measured the dbh of the four largest stems in each of the circular plots. The age classes of the trees were determined from cores.

In addition, I measured an index of horizontal foliage density at 3, 6, 9, 12, 15, and 18 feet above ground. The method used was a modification of that described in MacArthur and MacArthur (1961). An extendable pole, bearing a checkerboard divided into 45 squares, was held at a distance of 20 m from the central point in each of the four cardinal directions. I then counted the number of squares visible at each height, averaged the counts for the four directions, and then converted the result to a percentage to obtain an index of foliage cover in a horizontal plane.

A list of the major species in each stratum was made, with notation on the dominant and sub dominant species.

Rough sketch maps of the vegetation and broad habitat features of the entire 50 m diameter plot were drawn for every count point (plot). This was done to show the

TABLE 1 *Size, grazing history, dominant tree species, and age of co-dominants in each stand*

Seral stage	Stand	No. of plots	Size (ha)	Grazing	Dominant tree species	Age**
Clearcut	C1	7	36.32	+	-	6
	C2	3	9.12	-	-	4
	C3	10	74.88	-	-	4
Sapling	S1	4	6.24	+	Aspen	<7
	S2	11	23.76	+	Aspen	<7
	S3	5	14.22	+	Aspen	<23
Mature	A1	6	45.76	+	Aspen	50-60
	A2	11	60.95	+	Aspen	50-60
	A3	5	23.52	+	Aspen	50-60
	A4	12	61.28	+	Aspen	50-60
	A5	8	33.60	+	Aspen	0-60 (91*)
Old	O1	8	56.96	-	Aspen	50-60 (>100*)
	O2	3	4.64	-	Aspen	106*
Mixed	M1	5	13.12	-	Aspen/spruce/pine	50-60
	M2	8	23.20	+	Aspen/spruce/pine	50-60
	M3	7	33.28	-	Aspen/spruce/pine	95 (114*)

** Age of co-dominant trees
* Maximum age of veteran aspen or oldest trees present
Note: Stand A5 had a few scattered veterans on two of eight plots sampled

approximate location and size of clearings, openings in the canopy, trails, roads, ponds, and broad changes in vegetation (e.g., clumps of saplings, conifers, or aspen).

3.4 Bird counts

My field assistant and I conducted bird counts between May 10 and July 10 in both years (1991 and 1992). All counts began within 10 minutes of sunrise (4–4:30 a.m.), and continued until no later than 9:30 a.m. All species, including those flying over the study sites, were recorded. This latter group, consisting primarily of swallows, corvids, and birds of prey, we classed as visitors unless nesting was verified.

We conducted counts in good weather only (i.e., good visibility, and little, or no, wind or precipitation). When weather conditions deteriorated during a count, we abandoned it.

3.4.1 Point counts

I used modified point counts (Reynolds, et al. 1980). Modifications and the establishment of census points (plots) followed those used and recommended by Savard (Savard and Seip, Savard and Waterhouse, personal communication). Census points were randomly positioned along transects within each stand. Examination of aerial photographs ensured that the transects fell within the vegetation type to be sampled. Stands representative of each seral stage were randomly selected in the vegetation types. The census points (plots) were sub-samples within the stand.

On arrival at each census point, we allowed a one minute equilibration period. We then counted all birds seen or heard within a 50 m radius circle (0.785 ha) during a 12-minute period. We also recorded all birds seen or heard outside the 50 m, but estimated to be within a 75 m radius. We noted the behaviour of the birds, especially any evidence of breeding.

We repeated the count at each point six times throughout the breeding season. To ameliorate problems with observer variability, two observers alternated between stands for consecutive counts and reversed the direction of traversing the transects. Observers made every effort to avoid double counting. In the second year, two dusk counts were carried out on one stand, representing each seral stage.

In the second year, we sampled the bird communities and vegetation on three small stands of pure, or almost pure, conifer to compare with the mixed stands. Only qualitative observations are available for these data. All three stands were very small, but were the only ones that could be found within the study area.

3.4.2 Spot mapping

The spot mapping method of surveying forest birds (Williams 1936) was carried out in the first year in stand A1 (see Table 1) for comparison with the point count from the same stand. This stand had previously been studied by Erskine in 1975 (Erskine 1977). Spot-mapping is generally considered to produce more accurate estimates of densities than other methods, including point counts (Verner 1985), but is quite time-consuming. Point counts, however, are recommended for comparing large numbers of stands, especially of differing silvicultural, or successional, history (Manuwal and Carey 1991).

A rectangular grid (350 x 550 m), with points every 50 m, was laid out in approximately the same location as that set up by Erskine (1977). I surveyed the grid once a week for 8 weeks. I walked the transect and recorded the location of each bird seen or heard in relation to the identified grid points. I also recorded the location of active nests, simultaneously singing males, the direction of movement, interactions, and evidence of breeding (carrying food or nesting material).

Upon completion, I transferred data to "species maps"— one per species. I drew estimated boundaries of territories by encircling clusters of registrations. A minimum of three registrations by an individual was required to designate a territory (Robbins 1970). Territories overlapping the boundary of the grid were designated as either one-half or one-quarter territories. I summed fractions to give the total number of territories. This method was not repeated in the second year because of time constraints.

3.5 Data Analysis

For the purpose of this report, data analysis focused on the number of birds present within the 50 m radius as determined by point counts. I calculated bird species abundance by using the maximum number of singing males registered over the six counts at each point. The term "singing males" included drumming in grouse. The maximum numbers of singing males at each point were then averaged over all points in a stand to give the mean number (bird abundance) for each species. I used the bird abundance in subsequent regression analyses. For analysis of variance, I used the total number of species, the total number of individuals (bird abundance), and density/10ha for all species combined, and species diversity indices to test for differences between seral stages.

Given that true randomness of site and plot selection was compromised to a certain degree, statistical procedures used here should be viewed as exploratory in nature, rather than conclusive demonstrations of significance.

The bird species diversity for each stand was calculated as:

$$H' = -\sum_{i=1}^{s} pi \log2 pi$$

where s = total number of species and pi = observed proportion of individuals that belong to the ith species (Shannon and Weaver 1963). The index is influenced by the number of species present and the evenness of their distribution. Hence, increasing values of H' reflect higher species diversity.

I calculated abundance and species diversity for all birds detected (total bird use) and for those assumed to be breeding (breeding birds). Species present on a site where there was a lack of suitable nesting habitat, I classed as visitors. Species present only during the first few censuses I assumed to be migrants and were not included. Unusually high counts of a species in the early censuses were assumed to have been inflated by migrating birds, and these counts were excluded from the abundance calculations. Species recorded only once on any one site I did not include in further analysis. Although there were very few registrations of woodpeckers in treed stands, the data were included in the analysis because the habitat was known to contain suitable nesting sites and it was assumed that there were other reasons for so few registrations.

To illustrate the differences and similarities between breeding bird communities and habitat features of the different seral stages, I used Detrended Correspondence Analysis (DECORANA or DCA [Hill 1979]). DECORANA is an ordination procedure widely used by ecologists to describe plant communities and by some to compare bird communities in different stands (Huff and Raley 1991; Smith et al. 1992); it is generally considered to more accurately reflect species responses to the environment than other ordination techniques (Peet et al. 1988).

Detrended correspondence analysis is a multivariate data-reduction and ordination technique that arranges in space a matrix of data on species abundance and composition *or* habitat variables (communities) by sample (in this case plots within stands). The communities are sorted along several axes. The many components of the original data set are reduced to a few to provide the best representation of the overall variability.

The position of each sample is plotted using DECORANA scores for the first and second axes. These two axes account for most of the variation in the original data sets and each axis may represent some identifiable environmental gradient. Hence, the DECORANA score represents the position of the sample (point count) along these environmental gradients. Samples with similar bird communities (or combination of habitat variables) are close together and dissimilar samples are far apart.

For analysis of variance (ANOVA), I used the total number of bird species and individuals recorded over the 2-year period on the same stands representing each seral stage. As time is not an experimental factor whose levels are randomly assigned to the subplots, I used a “univariate repeated measures” ANOVA to test the following hypotheses: a) there is no treatment (seral stage) x year interaction (i.e., the treatment effects did not vary with time) b) bird species composition and abundance did not differ among seral stages; and c) bird species composition and abundance did not change with time. In these analyses, the “between subjects” (seral stage) and “within subjects” (year) are fixed effects. I used SYSTAT (1988) in all statistical analyses and Bartlett’s test for homogeneity of variances (Zar 1974) prior to proceeding with ANOVA. In all cases, I accepted the null hypothesis that the population variances were equal. No transformations were applied.

I partitioned the treatment sums of squares into the following contrasts: clearcut plus sapling aspen combined versus mature aspen, old aspen and mixed stands combined; clearcut versus sapling aspen; mature aspen plus old aspen versus mixed stands; mature aspen versus old aspen. These contrasts were selected to address possible differences between older successional stages (mature aspen, old aspen, and mixed) and early seral stages (sapling aspen and clearcuts), suspected differences between deciduous and mixed forest conditions, and possible differences between mature and old deciduous stands.

I investigated the relationship between individual bird species numbers and the habitat variables using stepwise multiple linear regression analysis. A significance level of 0.15 to add or remove variables was used. I analyzed only the most common species (those present on at least 30% of the stands).

For each common species, the mean maximum number of birds detected per stand was used as the dependent variable in the regression analyses, except where a square root transformation was used to correct for a skewed distribution. All variables were assessed for normality using normal probability plots in SYSTAT. Where necessary, I used square root, arcsin, or log transformations to correct for skewed distributions in the habitat variables. The mean value for each habitat variable was calculated by using measurements from sampling plots located in each stand (replicate). These mean values served as the independent variables in the stepwise regression analyses. The analyses were done separately for 1991 and 1992.

Prior to commencing with the analyses, I examined habitat associations of the common bird species by computing Pearson product-moment correlation coefficients for each year. This analysis determined which variables were most associated with bird species abundance. Subsequent selection of habitat variables for the regression procedure was based on the strength of these correlations with the bird counts. All correlations with habitat variables of 0.300 and greater were considered as potential candidates in the regression model.

For a number of bird species there were insufficient occurrences in the sample plots to allow detailed analysis of their habitat preferences. Qualitative observations regarding suspected habitat preferences for these species are provided.

4 RESULTS AND DISCUSSION

4.1 Vegetation

The means and standard errors of all the habitat variables (vegetation data collected in the second year) are shown in Table 2. Vegetation of the seral stages became increasingly more complex, with more variation in the number and amounts of the different strata as successional age increased.

4.2 Bird Abundance in Different Seral Stages

4.2.1 Point count surveys

The abundance of all birds detected in each stand are presented in Appendix 1 (tables A1.1 to A1.10). Species thought to be breeding in the stands are marked with an asterisk. The scientific names of the species are listed in Appendix 7. No distinction was made between Dusky and Hammond's Flycatchers because of the difficulty of separating the two species in the field. Only one or two birds were thought to be possibly Hammond's.

The abundance of the different breeding bird species (tables A1.1 to A1.10, Appendix 1) should be interpreted with some caution as certain species are easier to detect than others. If it is assumed that the same errors in detection were made throughout the study, then data can be used to compare differences both within and between seral stages. This assumption may not be completely valid when comparing relatively noisy aspen forests with clearcuts. Alternatively, some species may compensate for the attenuating effect of a densely wooded stand by singing more loudly. One should apply caution in interpretation of the results, as the influence of adjacent habitats on birds detected cannot be discounted.

Criteria used for the selection of breeding species are outlined in the methods section. Wilson's and Townsend's Warblers were present in the aspen stands only during the first two or three censuses (until the third week of May) and were assumed to be migrants. Other species (e.g., the Red-winged Blackbird) were also detected in aspen stands, but, in the absence of suitable nesting habitat, were presumed to be foraging only. Similarly, a variety of species not known to nest in clearcuts (including Yellow-rumped Warbler, Black-capped Chickadee, Red-breasted Sapsucker, Ruby-crowned Kinglet, Gray Jay, and Mountain Bluebird) were occasionally observed foraging in clearcuts. The lack of suitable nesting habitat for these species suggests that they were not breeding there.

I have summarized the point count data (excluding flyovers) for breeding birds only in Table 3, and for all birds detected (total bird use) in Table 4. While the focus of this study was on breeding birds, it is obvious that the various seral stages are also important for foraging (and perhaps shelter) for migrants and species that chose to breed in habitats other than those studied here.

These results show that the numbers of species (species richness), bird abundance, and species diversity indices were different for each seral stage. There is a trend towards an increase in all parameters with increasing age (seral stage) of the stands. The total number of birds detected in many of the stands was higher in 1991 than in 1992.

The results of the "repeated measures" ANOVA to test for the effects of seral stage and year on the number of species, abundance and diversity of breeding birds, and total bird use are in tables 5 and 6, respectively. In the case of breeding birds, I analyzed species number and diversity separately for each year (Table 5 – Part 2: simple univariate ANOVA) because apparent differences between seral stages depend on year (i.e., the seral stage x year interaction is statistically significant).

Breeding Birds The ANOVA (Table 5) indicates that the differences in the number of species, bird abundance, and diversity indices detected between each seral stage were highly significant for both years ($p<0.001$).

Comparisons of the different seral stages indicate that

TABLE 2 *Means (and standard error) of habitat variables for the different seral stages — based on 1992 data*

Seral stage	Number stems/ha: Deciduous	Number stems/ha: Conifer	Cover (%): Tree deciduous	Cover (%): Tree conifer	Cover (%): Tall shrub	Cover (%): Low shrub	Cover (%): Herb	Cover (%): Bare ground	CWD
Clearcut	0.00 (0.0)	0.00 (0.0)	0.00 (0.0)	0.00 (0.0)	0.75 (0.1)	52.90 (4.8)	66.60 (2.2)	4.19 (0.8)	4.86 (0.8)
Sapling	12030.44 (2580.4)	0.00 (0.0)	1.25 (1.0)	0.00 (0.0)	46.49 (12.9)	63.89 (5.4)	70.12 (8.9)	3.57 (1.5)	0.91 (0.3)
Aspen*	2054.59 (119.1)	0.00 (0.0)	67.66 (1.6)	0.00 (0.0)	18.23 (4.3)	67.01 (4.4)	70.66 (5.8)	0.43 (0.2)	0.97 (0.1)
Old**	732.93 (167.7)	0.00 (0.0)	44.48 (7.9)	0.00 (0.0)	16.19 (1.5)	68.65 (1.4)	88.44 (1.1)	0.00 (0.0)	2.46 (0.9)
Mixed	885.83 (311.4)	200.77 (24.8)	25.14 (1.7)	25.34 (1.0)	10.26 (2.3)	58.75 (3.3)	62.06 (2.9)	0.21 (0.1)	1.30 (0.5)

	Height (m): Tree deciduous	Height (m): Tree conifer	Height (m): Tall shrub	Height (m): Low shrub	Height (m): Herb	Canopy depth (m)	Average DBH (cm): Deciduous	Average DBH (cm): Conifer	Snag (No./ha)
Clearcut	0.00 (0.0)	0.00 (0.0)	1.94 (0.4)	0.86 (0.1)	0.57 (0.1)	0.00 (0.0)	0.00 (0.0)	0.00 (0.0)	0.00 (0.0)
Sapling	2.84 (2.3)	0.00 (0.0)	4.61 (0.7)	1.31 (0.0)	0.50 (0.1)	0.00 (0.0)	5.70 (1.0)	0.00 (0.0)	0.00 (0.0)
Aspen*	18.75 (0.9)	0.00 (0.0)	6.03 (0.6)	1.15 (0.1)	0.54 (0.1)	6.38 (0.7)	17.77 (1.0)	0.00 (0.0)	129.97 (32.6)
Old**	20.84 (0.8)	0.00 (0.0)	5.94 (0.7)	1.28 (0.0)	0.81 (0.0)	8.77 (0.2)	27.84 (0.8)	0.00 (0.0)	60.42 (16.2)
Mixed	19.65 (3.2)	23.35 (3.1)	6.50 (0.4)	0.93 (0.0)	0.41 (0.0)	8.00 (1.7)	20.20 (3.8)	33.13 (3.3)	45.24 (8.6)

	Basal area (m^2): Deciduous	Basal area (m^2): Conifer	Horizontal foliage cover (%): 3'	6'	9'	12'	15'	18'
Clearcut	0.00 (0.0)	0.00 (0.0)	22.92 (5.2)	19.39 (7.7)	6.98 (2.0)	2.85 (1.2)	2.78 (1.2)	0.15 (0.1)
Sapling	0.00 (0.0)	0.00 (0.0)	82.70 (2.3)	74.29 (2.9)	71.08 (1.5)	68.28 (5.4)	66.16 (8.6)	67.20 (12.2)
Aspen*	38.21 (3.6)	0.00 (0.0)	51.38 (8.8)	28.46 (7.8)	16.67 (5.4)	17.37 (5.8)	16.51 (4.6)	17.87 (5.2)
Old**	25.67 (1.2)	0.00 (0.0)	77.75 (1.7)	40.47 (5.7)	29.50 (2.3)	23.52 (3.4)	24.24 (3.0)	28.02 (2.9)
Mixed	19.64 (4.2)	12.70 (1.9)	60.83 (3.8)	45.59 (6.2)	42.26 (3.5)	47.98 (5.0)	49.22 (5.4)	51.27 (6.5)

* Mature aspen (40-60 yrs old)
** Stands containing veteran aspen (up to 120 yrs old)

the older stages (mature aspen, old aspen, and mixed stands combined) had significantly greater numbers of species and birds and higher diversity indices that the two younger stages (clearcuts and sapling aspen combined) in both years. The number of breeding species, their abundance, and diversity were all significantly greater in sapling stands than in clearcuts for both years.

Breeding birds were significantly more abundant in mixed stands than in mature and old aspen stands combined for both years. Whereas the number of species present in mixed stands was significantly greater than in the mature and old aspen combined in 1992, the numbers were not significantly different in 1991. There was significantly greater species diversity in mixed stands than in mature and old aspen combined for both years.

A comparison of old pure aspen with mature pure aspen shows that, although the number of species present did not differ, bird abundance and species diversity were significantly greater in older stands.

Total Bird Use (Table 6) the numbers of species, abundance, and diversity of all birds using the various seral stages were all significantly different ($p<0.001$). No treatment (seral stage) x time (year) interaction was detected, indicating that the relationship between bird use and seral stage was consistent between years.

The observed difference in the total number of birds detected over all stands in the 2 study years was also significant, with numbers being highest in 1991. Lower bird abundance in 1992 was due to fewer numbers of certain species, especially the American Redstart (see Appendix 1).

Comparisons of seral stages produced results similar to those for breeding birds. A notable exception is that the number of species and their abundance using clearcuts was not significantly different from those using sapling stands. Larger numbers of birds that were foraging only were found on clearcuts than were found in sapling aspen (Tables A1.1-1.4 – Appendix 1), and that may explain this result.

TABLE 3 *Means (and standard error) of species numbers, bird abundance, densities and species diversity (H') for breeding birds detected on point counts*

Seral stage	Age of stand (yrs.)*	No. plots	Number of species 1991	Number of species 1992	Bird abundance** 1991	Bird abundance** 1992	Density (No./10 ha) 1991	Density (No./10 ha) 1992	Species diversity 1991	Species diversity 1992
Clearcuts	4-7	20	13.00 (1.41)	10.67 (0.72)	10.40 (0.49)	8.79 (0.56)	132.48 (6.24)	111.92 (7.17)	3.19 (0.05)	2.98 (0.03)
Sapling	8-<23	20	19.00 (1.25)	16.00 (1.25)	15.66 (1.30)	13.49 (1.57)	199.44 (16.56)	171.86 (20.00)	3.78 (0.07)	3.65 (0.07)
Aspen	50-60	42	23.80 (1.48)	21.20 (1.31)	18.85 (0.80)	15.98 (0.71)	240.16 (10.18)	204.71 (8.95)	3.96 (0.07)	3.81 (0.09)
Old Aspen	>100	11	24.00 (0.71)	24.50 (1.77)	23.77 (0.07)	21.94 (1.37)	302.81 (0.94)	279.46 (17.46)	4.12 (0.02)	4.16 (0.04)
Mixed	50-60	20	21.40 (4.64)	23.00 (4.67)	18.81 (4.24)	18.21 (3.67)	239.57 (54.04)	232.00 (46.79)	3.40 (0.75)	3.45 (0.76)

TABLE 4 *Means (and standard error) of species numbers, bird abundance, densities and species diversity (H') for all birds detected on point counts (excluding flyovers) — Total bird use*

Seral stage	Age of stand (yrs.)*	No. plots	Number of species 1991	Number of species 1992	Bird abundance** 1991	Bird abundance** 1992	Density (No./10 ha) 1991	Density (No./10 ha) 1992	Species diversity 1991	Species diversity 1992
Clearcuts	4-7	20	17.00 (1.25)	15.00 (0.47)	12.12 (1.38)	10.43 (1.05)	154.40 (17.59)	132.89 (13.41)	3.51 (0.09)	3.36 (0.12)
Sapling	7-<23	20	21.00 (2.16)	20.00 (0.29)	16.03 (1.46)	14.70 (2.00)	204.23 (18.54)	187.24 (25.40)	3.86 (0.10)	3.87 (0.11)
Aspen	50-60	42	26.40 (1.80)	24.80 (1.43)	19.64 (0.82)	17.47 (0.78)	250.15 (10.46)	222.58 (9.96)	4.08 (0.08)	4.00 (0.08)
Old Aspen	>100	11	28.00 (1.41)	27.50 (2.48)	25.10 (0.16)	23.57 (1.81)	319.80 (2.06)	300.16 (23.08)	4.29 (0.02)	4.31 (0.06)
Mixed	50-60	20	30.67 (0.27)	32.33 (0.72)	24.68 (1.13)	23.25 (1.06)	314.35 (14.36)	296.16 (13.49)	4.42 (0.03)	4.45 (0.03)

* Maximum age of trees where present; otherwise age of stand since clearing
** Grand mean of the total number of individuals per plot, across all stands and species within a seral stage
Total = $\sum$ (Mean number singing males / points / species)

TABLE 5 *Results of analysis of variance comparing the number of species, bird abundance, species diversity (H') and density/10ha of breeding birds between seral stages*

1. Univariate repeated measures ANOVA

Source of variation	df	Species no. MS	Bird abundance+ MS	Species diversity (H') MS	Density (No./10ha) MS
Seral stage (SS)	4	241.15 ***	177.780 ***	1.3096 ***	28857.20 ***
Error	11	14.36	7.880	0.0376	1276.57
Year	1	8.86 *	26.390 ***	0.0479 **	4204.04 ***
SS x yr	4	7.42 *	0.933 n.s.	0.0217 *	136.19 n.s.
Error	11	1.47	0.948	0.0049	160.08
CC+SAP vs					
MA+OA+MX	1		571.770 ***		39092.21 ***
CC vs. SAP	1		74.390 *		12076.69 *
MA+OA vs. MX	1		42.607 *		6828.70 *
MA vs. OA	1		128.470 **		20654.05 **

2. Simple univariate ANOVA

Source of variation	df	Species no. MS	Bird abundance+ MS	Species diversity (H') MS	Density (No./10ha) MS
Year 1 (1991)					
Seral stage (SS)	4	94.120 ***		0.522 ***	
Error	11	8.860		0.020	
CC+SAP vs.					
MA+OA+MX	1	290.610 ***		1.434 ***	
CC vs. SAP	1	54.000 *		0.528 ***	
MA+OA vs. MX	1	31.080 n.s.		0.154 *	
MA vs. OA	1	5.790 n.s.		0.103 *	
Error	11	8.860		0.020	
Year 2 (1992)					
Seral stage (SS)	4	154.450 ***		0.809 ***	
Error	11	6.970		0.023	
CC+SAP vs					
MA+OA+MX	1	484.470 ***		2.221 ***	
CC vs. SAP	1	42.670 *		0.680 ***	
MA+OA vs. MX	1	101.460 **		0.331 **	
MA vs. OA	1	31.960 n.s.		0.290 **	
Error	11	6.970		0.023	

Levels of significance: *** = Significant at $p \leq 0.001$, ** = Significant at $p \leq 0.01$, * = Significant at $p \leq 0.05$, n.s. = Not significant
+ = Sum of mean number of singing males/point for all species by stand
CC = Clearcut; Sap = Sapling aspen; MA = Mature aspen; OA = Old aspen; MX = Mixed aspen-conifer

TABLE 6 *Results of analysis of variance comparing the number of species, bird abundance, species diversity (H') and density/10ha of all birds present (total bird use) between seral stages (repeated measures ANOVA)*

Source of variation	df MS	Species no. MS	Bird abundance+ MS	Species diversity (H') MS	Density (No./10ha)
Seral stage (SS)	4	218.830 ***	171.580 ***	0.882 ***	27842.690 ***
Error	11	22.700	12.160	0.060	1970.880
Year	1	3.470 n.s.	19.530 **	0.009 n.s.	3174.570 **
SS x yr	4	3.260 n.s.	0.220 n.s.	0.009 n.s.	35.590 n.s.
Error	11	3.110	1.390	0.006	225.600
CC+SAP vs MA+OA+MX		715.270 ***	570.730 ***	2.625 ***	92625.740 ***
CC vs. SAP		60.750 n.s.	50.190 n.s.	0.551 *	8139.640 n.s.
MA+OA vs. MX		115.800 *	36.730 n.s.	0.358 *	5959.680 n.s.
MA vs. OA		38.140 n.s.	142.270 **	0.328 *	23079.780 **

Levels of significance: *** = Significant at $p \leq 0.001$, ** = Significant at $p \leq 0.01$, * = Significant at $p \leq 0.05$, n.s. = Not significant
\+ = Sum of mean number of singing males/point for all species by stand
CC = Clearcut; Sap = Sapling aspen; MA = Mature aspen; OA = Old aspen; MX = Mixed aspen-conifer

The number of species and birds using mixed stands did not differ significantly from those using the mature and old pure aspen stands combined. However, the diversity of species in mixed stands was significantly greater than in the pure aspen stands. This is to be expected because of the presence of conifer-related species in mixed stands.

The number of species using old aspen did not differ significantly from the number using mature aspen. However, species diversity and relative abundance of all birds using old aspen stands were greater than for those using mature aspen.

Differences in the results between years and their biological significance cannot be readily explained by a study of such short duration. The variation in the numbers of species and birds in many of the stands between the years is most likely the result of naturally occurring annual fluctuations in bird populations. Such fluctuations are frequently related to yearly weather changes, and the cool, wet, early spring of 1992 may have affected the numbers of some species.

Although there was considerable variation among stands within a seral stage (Tables A1.1 – 1.10, Appendix 1), the number of species (species richness), bird abundance, and species diversity all tended to increase with the age of the successional stage, and as the stands become more vegetatively diverse. These results agree with the findings of Kendeigh (1948), Johnston and Odum (1956), Shugart and James (1973), Niemi and Pfanmuller (1979), Peterson (1982), and many other authors. However, Johnston and Odum (1956), Karr (1968), Karr and Roth (1971), Westworth et al. (1984), Morgan and Freedman (1986), and Probst et al. (1992) all reported that species diversity, density, or species numbers tended to increase through the earlier successional stages, but then levelled off, or declined, as the vegetation approached the climax. Changes in bird abundance have been related to the increasing structural complexity of the vegetation with age (Balda 1975) and, especially, to foliage height diversity (MacArthur and MacArthur 1961; Karr and Roth 1971).

Low bird species diversity in recent clearcuts (or very early successional stages) measured here agrees with the findings of Conner and Adkisson (1975), Conner et al. (1979), Peterson (1982), and Morgan and Freedman (1986). However, my results do not agree with Conner et al. (1975) and Scott and Crouch (1987) that clearcuts had the highest numbers of birds, or that the highest densities and numbers of species occurred 7 or 3–12 years after clearcutting (Conner and Adkisson 1975; Conner et al. 1979). It should be noted that revegetation on clearcuts in these latter studies was apparently much more rapid and dense than in my study area.

Back (1979) summarized several other studies and noted that species diversity was quite variable in the pole/sapling stage of development in aspen-birch forests. Both the highest and lowest bird species diversity were recorded for this stage. My results for sapling stands were also quite variable (Appendix A1.4). In stand S2, the number of species detected, abundance, and diversity were as great as, or greater than, those in some of the mature aspen stands, whereas the values in S1 were low by comparison. Kricher (1973) suggested that bird species diversity is the most variable where the ecosystem is the least complex (i.e., earlier stages of succession) and therefore the least stable.

Total relative abundance of birds was significantly greater in the old aspen stands than in all the mature stands combined. However, data for the individual stands show there was no clear difference in the number of different species and the species diversity indices between the old stands and two of the mature aspen (see A4 and A5 in Appendix A1.4). Greater species richness and diversity in these two stands may be partly explained by the presence of a few pockets of veteran aspen in A5 and scattered natural openings surrounded by young invading aspen stems in both stands. Flack (1976) reported that aspen stands with old trees had more species and higher species diversity. Young (1977) observed that species diversity was higher in aspen stands containing many aspen age groups. This may explain the lower diversity found in aspen stands A1 and A2, which were more even-aged with fewer openings. The absence of, or low numbers of, the Least Flycatcher in A1 and A2 was, in part, responsible for the differences in total abundance of birds between these and the remaining aspen stands where this species was abundant.

High species richness and diversity in mixed deciduous-coniferous stands have also been reported by Kendeigh (1948), Erskine (1977), Scott and Crouch (1988b), Morgan, et al. (1989), and Temple, et al. (1979), among others. It has been attributed to the increased vertical and horizontal complexity, or patchiness, of the vegetation (Temple, et al. 1979).

My results indicate that the older pure aspen stands with large veteran trees, uneven-aged stems, and natural openings (i.e., the most structurally and vegetatively diverse) contained the greatest diversity of birds. When conifers are mixed with the aspen, the diversity of the bird community is even greater. Removal of these forests would be expected to have a negative impact on the overall diversity of birds in the area and, in particular, on species that prefer deciduous stands.

4.2.2 Additional point counts on conifer stands

The results of the point counts in conifer stands (Table 7) must be interpreted with caution. All stands sampled were very small patches and the influence of adjacent habitats cannot be discounted. Also, sample sizes were very small.

The number of species, abundance, and the species diversity were lowest on Conifer 1, which was a dense stand of pure pine with very little structural diversity in the vegetation (Appendix A2.1 and A2.2). Low bird species richness in dense pure coniferous stands with single, or few, conifer species has also been reported by James and Wamer (1982) and Morgan, et al. (1989). The frequency of bird song was noticeably lower in Conifer 1 stand (personal observation), suggesting fewer active nesting territories.

Conifer 2 and 3 stands contained a small amount of aspen, were more open, and more diverse vegetatively. The number of birds tended to increase with a decrease in the number of conifer stems per hectare and a corresponding increase in the amount of foliage in the mid-canopy layer (2–10 m). The high species diversity index for Conifer 3 is probably related to the greater variety of different habitats present, including a small pond and a wet thicket.

TABLE 7 *A summary of bird data from point counts on three small conifer stands***

Stand	No. of plots	No. of species	Relative abundance*	Total density (No./10 ha)	Species diversity (H')
Conifer 1	2	15	10.5 (3.18)	133.76	3.71
Conifer 2	3	18	16.7 (3.66)	212.31	3.93
Conifer 3	3	23	16.0 (5.44)	203.82	4.20

* Sum mean number singing males / point / species
** Conifer 1 and 2 = results of six censuses; Conifer 3 = results of three censuses

Although there are insufficient data to draw firm conclusions, the number of species and their abundance does tend to be lower in conifer stands than in stands with a higher proportion of aspen (see Appendix A2.1). In addition, the majority of species present are those that more typically associate with conifers (Appendix A2.2). Aspen-preferring species, such as the Least Flycatcher and the Red-eyed Vireo, were noticeably absent.

4.2.3 Spot mapping

Spot mapping was done on stand A1 in 1991 to compare the estimated densities of breeding birds with those from point counts for the same stand (Table 8). Because spot mapping is very time-consuming, it was not repeated in the second year of the study. Also shown for comparison in Table 8 are the results of Erskine's 1975 breeding bird census for deciduous stands near Smithers. Erskine's results represent a combination of data for the aspen stand used in this study (referred to as Glentanna by Erskine) and another deciduous stand (called Tatlow by Erskine 1977).

The total density of all birds based on point counts was approximately four times greater than that estimated from spot mapping. I suggest that the inflated point count numbers were most likely due to an under-estimation of the distances of the birds from the observer. If spot mapping is assumed to be more accurate (Verner 1985), my results suggest that the abundance of many species was over-estimated using point counts.

The species composition and densities determined by spot mapping were similar to those described by Erskine (1977). Although results of both studies represent single counts, unreplicated over time, their similarity suggests that the songbird population of this stand may have remained relatively stable over the intervening 16 years. This is rather comforting, especially in light of the concerns expressed by Terborgh (1989) and others, regarding the decline of Neotropical songbirds in eastern deciduous stands.

There have been no major structural changes to this stand since Erskine's study, other than natural aging. Changes in the relative abundance of some of the species may possibly be explained by the natural changes in the vegetation due to increased maturity in the intervening 16 years. For example, the greater number of the Red-eyed Vireo, Yellow-rumped Warbler, and Hermit Thrush in 1991 than in 1975, agrees with the results of point count censuses and regression analyses suggesting that these species appear to prefer more mature deciduous stands. A greater abundance of the Warbling Vireo in the younger forest of 1975, together with regression results indicating a positive relationship between this species and tall shrub height (Section 4.5.1), could suggest that this species prefers younger, more dense stands.

The total density for breeding birds (529.86/km^2) is in the same range as the results of Freedman et al. (1981) for Nova Scotia hardwoods (633 ± 145 pairs/km^2), but is higher than that reported by Scott and Crouch (1988a) for aspen (301/km^2) in southern Colorado.

Despite differences in actual numbers of different species (abundance estimates), the results from both methods show the same trends, with the American Redstart being the most abundant species, followed by the Dusky Flycatcher, Warbling Vireo, and Yellow-rumped Warbler. Whitcomb, et al. (1981) also compared these two methods and felt that they showed consistent trends in species occurrence.

A total of 49 species were found to be regularly present in one or more of the study sites throughout the breeding season, and were assumed to be breeding there. Of these, the majority (61%) are Neotropical migrants that spend the winter months south of the U.S.-Mexico border (see Appendix 7).

In general, the Dark-eyed Junco and the Dusky Flycatcher were the most ubiquitous species and were detected on the majority of the plots, and in all seral stages (Table 9). The American Redstart and Dusky Flycatcher were the most abundant species detected.

4.3 Breeding Bird Uses of the Different Seral Stages

4.3.1 Bird communities

Clearcuts The breeding bird community was dominated by sparrows, with the Lincoln's Sparrow being the most abundant species. White-crowned and Savannah Sparrows were present only on clearcuts. Bird species typically detected were:

Lincoln's, White-crowned, Savannah, and Chipping Sparrows; Dark-eyed Junco; Rufous Hummingbird; Orange-crowned and MacGillivray's Warblers; Dusky Flycatchers; and American Robin.

The Clay-coloured Sparrow and Alder Flycatcher were present on C3, especially in 1992. The Warbling Vireo was present on the small clearcut (C2) in 1992, but not in 1991. The appearance of the Alder Flycatcher and Warbling Vireo on some of the clearcuts in 1992 may be related to an increase in sapling density, and hence cover, by the second year (personal observation).

Sapling aspen The bird community on sapling stand S3 was quite different from those on S1 and S2, and more closely resembled those found in clearcuts, with the addition of some species more typically associated with shrub thickets (e.g., Alder Flycatcher and Swainson's Thrush). I suggest that this was related to the presence of larger openings on S3. On S1 and S2 the typical species present were:

Ruffed Grouse; Dusky and Alder Flycatchers; Rufous Hummingbird; Swainson's Thrush; American Robin; Warbling Vireo; Yellow-rumped, Orange-crowned, and MacGillivray's Warblers; American Redstart; Dark-eyed Junco; and, in openings, Lincoln's Sparrow.

The species composition was very similar to that reported by Erskine (1977) and Peterson (1982) for tall shrub (thicket) communities. Of particular note was the appearance of forest-dwelling species such as the Warbling Vireo and Yellow-rumped Warbler in this seral stage. Conner and Adkisson (1975) noted that forest-dwelling species first appeared on 12-year-

TABLE 8 *Comparison of estimates of density/km² (100 ha) of breeding birds obtained from spot-mapping and point counts (with data from Erskine (1977) included for comparison) and order of abundance of six most common species shown in parenthesis*

Species	Spot-mapping	Density (breeding birds/km²) 1991	1992	Erskine (1977)
Ruffed Grouse	15.58	84.93	42.46	3 G+T
Yellow-bellied Sapsucker				1 T
Downy Woodpecker	10.39	21.33		1 T
Least Flycatcher	2.60		21.23	24 T
Dusky Flycatcher	88.31 (2)	297.24 (2)	191.08 (4)	32 G+T (3)
Western Wood Pewee			21.23	
Rufous Hummingbird	15.58	42.46	42.46	
Black-capped Chickadee	15.58	106.16	42.46	9 G+T
Red-breasted Nuthatch	5.19	21.23		
Ruby-crowned Kinglet			21.23	
American Robin	15.58	84.93	106.16	19 G+T (5)
Hermit Thrush	10.39	42.46	21.23	
Swainson's Thrush	27.27 (5)	63.69	127.39 (6)	53 G+T (4)
Red-eyed Vireo	10.39	42.46		2 G
Solitary Vireo			21.23	
Warbling Vireo	64.94 (3)	233.55 (3)	276.01 (2)	99 G+T (2)
Orange-crowned Warbler	10.39	42.46	106.16	11 G+T
Yellow-rumped Warbler	31.20 (4)	212.31 (4)	212.31 (3)	16 G+T
MacGillivray's Warbler	16.88	148.62 (6)	127.39 (6)	18 G+T (6)
American Redstart	137.66 (1)	339.70 (1)	403.40 (1)	150 G+T (1)
Brown-headed Cowbird	15.58	127.39	63.69	14 G+T
Purple Finch	5.19	21.23		7 T
Western Tanager	5.19	106.16	21.23	
Dark-eyed Junco	25.97 (6)	191.08 (5)	148.62 (5)	4 G+T
Total density/100 ha	529.86	2229.39	2016.98	578.00 **

\+ Density based on estimated number of territories
* Based on the mean of data from either 1 or 2 stands dominated by poplars; stand code after values
G Data from same stand surveyed in this study (labelled Glentanna by Erskine)
T Data only from stand labelled Tatlow by Erskine
** Overall mean density of 2 stands (range = 471-686 birds/km²) - Erskine (1977)

old mixed oak clearcuts in Virginia when the vegetation was 3–5 m high—about the same height as the vegetation recorded on S2 (and parts of C3 in 1992).

Ruffed Grouse were the most abundant in the thickets of this stage. Gullion and Svoboda (1972) report that the longest-lived grouse occupy dense hardwood stands where most stems are less than 6 inches diameter. Such stands provide better protection from predators, although hens prefer more open mature stands.

Mature and old aspen The composition of the bird communities in mature and old aspen was very similar to those reported for aspen in B.C. (Erskine 1977). If congeneric species (or species occupying the same niche) are substituted, species composition is similar to that found in aspen and other hardwoods east of the Rocky Mountains (Flack 1976; Erskine 1977; Westworth et al. 1984; Morgan and Freedman 1986). Species regularly found were:

Dusky and Least Flycatchers; Western Wood Pewee; Swainson's Thrush; American Robin; Cedar Waxwing; Warbling and Red-eyed Vireos; Yellow-rumped, Orange-crowned, and MacGillivray's Warblers; American Redstart; and Dark-eyed Junco.

The Western Tanager, Purple Finch, Ruby-crowned Kinglet, and Ruffed Grouse were present, although in smaller numbers. Northern Waterthrush was present in stands where there was open water (ponds or creeks nearby). The Red-eyed Vireo was found only in mature treed stands and was usually associated with aspen.

The Hermit Thrush, a species normally associated with conifers, was more abundant in mature pure aspen stands than in any of the other seral stages. Erskine (1977) noted that this species, when found in broad-leaved stands, is usually in association with needle-leaved species scattered through the stand. However, the stand containing the most Hermit Thrush – A5 – had no conifers present in the understorey and only three veteran conifer trees in the entire stand (33.60 ha). The Hermit Thrush did not appear to prefer low shrubby stages, or younger aspen, as reported by Erskine (1977) and Westworth et al. (1984), respectively. The consistent presence of this species in association with the aspen-related Least Flycatcher and Red-eyed Vireo (shown in the ordination results) is difficult to explain, although Morgan and Freedman (1986) demonstrated a positive correlation between the Hermit Thrush and the Least Flycatcher.

Mixed aspen-conifer The mixed aspen-conifer stands contained many of the same species found in mature and old aspen stands, together with the following conifer-related species:

Gray Jay, Brown Creeper, Winter Wren, Golden-crowned and Ruby-crowned Kinglets, Magnolia and Blackpoll Warblers, Pine Siskin, and Red Crossbill.

Magnolia and Blackpoll Warblers and the Winter Wren were detected only in the oldest of the three stands (M3). Ruby-crowned and Golden-crowned Kinglets were the most abundant of the conifer-related species.

The Brown-headed Cowbird was present on all stands except clearcuts and Sapling 3. It is presumed that they were absent from the open stands of the early seral stages because of the lack of suitable host species. Flack (1976) demonstrated a positive relationship between the presence of cowbirds and canopy-foraging species.

4.3.2 Nesting and foraging guilds

Breeding species were assigned to nesting guilds (Table 9) based on their primary nesting strategy, as described by Diem and Zeveloff (1980) and Sadoway (1988). Some modifications were made, based on previous field observations and observations made during the course of this study. The shrub and small tree guild was further sub-divided to correspond to the vegetation strata measured in this study. Nesting guilds were: Ground, low shrub (0–2 m tall), tall shrub (2–10 m tall), tree canopy, primary cavity, secondary cavity, and other. The foraging guilds used were derived from Balda and Masters (1980) and were: Ground gleaning, foliage gleaning, bark gleaning and wood drilling, aerial foraging (salliers), and nectar foraging.

There was a predominance of ground feeding and ground or low shrub nesting species (especially sparrows) in very early seral stages (clearcuts and one of the sapling stands). This was also reported by other authors Erskine (1977), De Byle (1981), Morgan (1984), Westworth et al. (1984), and Scott and Crouch (1988a). The numbers of ground-nesting species declined with increasing canopy cover. Ground-gleaning species composition changed, with thrushes and juncos being the dominant ground gleaners in treed stands. Most of the species present in sapling stands belong in the tall-shrub (low canopy) nesting and foliage-gleaning guilds.

Tree canopy nesters and foliage gleaners increased with increasing successional age. Tall-shrub nesters were also abundant in mature and old pure aspen stands with a well-developed tall shrub layer. Aerial foragers (salliers) were the most numerous in mature and old aspen, the majority being the abundant, aspen-related Least Flycatcher and American

TABLE 9 *Breeding bird species, assigned foraging and nesting guilds and distribution (presence or absence) in different seral stages*

Species	Guild		Seral stage					
	Foraging	Nesting	Clearcut	Sapling	Mature aspen	Old aspen	Mixed aspen	Pure conifer*
Northern Goshawk	Other	Can					+	
Ruffed Grouse	Gr.	Gr.	+	x	x	x	x	
Pileated Woodpecker	Bark	1Y cav.			x	x	x	
Hairy Woodpecker	Bark	1Y cav.			x	x	x	
Downy Woodpecker	Bark	1Y cav.			x	x	x	
Three-toed Woodpecker	Bark	1Y cav.				x	x	
Red-breasted Sapsucker	Bark	1Y cav.			x	x		
Northern Flicker	Gr.	1Y cav.	x		x	x	x	
Rufous Hummingbird	Nect.	L. Shr.	x	x	x	x	x	
Calliope Hummingbird	Nect.	L. Shr.		x				
Dusky Flycatcher	Aer.	L. Shr.	x	x	x	x	x	x
Least Flycatcher	Aer.	T. Shr.			x	x	x	
Alder Flycatcher	Aer.	T. Shr.	x	x				
Western Wood Pewee	Aer.	Can.		(x)	x	x	x	
Gray Jay	Other	Can.					x	
Black-capped Chickadee	Bark	1Y cav.		(x)	x	x	x	
Red-breasted Nuthatch	Bark	1Y cav.		(x)	x	x	x	x
Brown Creeper	Bark	2Y cav.					x	
Winter Wren	Gr.	2Y cav.					x	
Golden-crowned Kinglet	Fol.	Can.					x	x
Ruby-crowned Kinglet	Fol.	Can.			x	x	x	x
American Robin	Gr.	Can.	x	x	x	x	x	x
Varied Thrush	Gr.	Can.					x	
Hermit Thrush	Gr.	Can.			x	x	x	
Swainson's Thrush	Gr.	Can.	x	x	x	x	x	x
Cedar Waxwing	Fol.	Can.		x	x	x	x	x
Solitary Vireo	Fol.	Can.			x	x	x	x
Warbling Vireo	Fol.	Can.?		x	x	x	x	x
Red-eyed Vireo	Fol.	T. Shr.			x	x	x	
Yellow-rumped Warbler	Fol.	Can.		x	x	x	x	x
Orange-crowned Warbler	Fol.	Gr.	x	x	x	x	x	
MacGillivray's Warbler	Fol.	L. Shr.	x	x	x	x	x	
Magnolia Warbler	Fol.	Can.					x	
Blackpoll Warbler	Fol.	Can.					x	
American Redstart	Aer.	T. Shr.		x	x	x	x	x
Northern Waterthrush	Gr.	Gr.		x	x	x	x	
Western Tanager	Fol.	Can.			x	x	x	x
Dark-eyed Junco	Gr.	Gr.	x	x	x	x	x	x
Chipping Sparrow	Gr.	L. Shr.	x	x		(x)	x	
White-crowned Sparrow	Gr.	L. Shr.	x					
Song Sparrow	Gr.	L. Shr.	x	x	x	x		
Lincoln's Sparrow	Gr.	Gr.	x	x	x	x		
Clay-coloured Sparrow	Gr.	L. Shr.	x	x				
Savannah Sparrow	Gr.	Gr.	x	x				
Pine Siskin	Fol.	Can.					x	x
Purple Finch	Fol.	Can.			x	x	x	
Red Crossbill	Fol.	Can.					x	
Red-winged Blackbird	Fol.	Other		x				
Brown-headed cowbird	Gr.	Other		x	x	x	x	

Foraging guilds: Gr. = Ground gleaning; Fol. = Foliage gleaning; Aer. = aerial salliers Bark = Bark gleaning and drilling; Nect. = nectar forager; Other = predators/RWBB
Nesting guilds: Gr. = ground; L. Shr. = Low Shrub (0-2 m); T. Shr. = Tall shrub (2-10 m) Can. = Canopy; 1Y cav. = Primary cavity; 2Y cav. = secondary cavity; Other = nest parasite/RWBB
(x) = based on very few records and breeding status questionable; + = based on a single record
* Conifer stand 1 (pure pine) for comparison

Redstart. The majority of conifer-related species present in mixed stands were foliage gleaners and canopy nesters. The Least Flycatcher, an aerial sallier, which prefers stands with a more open understorey (Breckenridge 1956; Sherry 1979), and avoids conifers (Erskine 1977), was present, but in smaller numbers, in mixed stands.

Cavity-nesting species collectively are discussed in Section 4.5.3.3.

Removal of the canopy through harvesting or clearing of mature forests (pure aspen or mixed) can be expected to result in a reduction of the numbers of foliage gleaners (Franzreb and Ohmart 1978), and tends to favour the appearance of ground-nesting and ground-gleaning species. Clearcutting also results in reduced numbers of cavity nesters, except the Northern Flicker where snags are left standing (Scott and Crouch 1988a), and also of aerial salliers (Peterson 1982; Morgan et al. 1989).

4.4 Breeding bird communities and different seral stages

4.4.1 Ordination of bird data

Breeding bird species abundance data was ordinated on a plot-by-plot basis to detect similarities and/or differences between the bird communities in the different seral stages. Species for which there were fewer than 10 registrations over all six counts in both years (which included all the woodpeckers) were treated as "rare" and removed from the data set to avoid distortion of the analysis (Hill 1979). Data for 1991 and 1992 were analyzed separately because of the differences in bird communities observed in the young seral stages between the 2 years.

The DCA (Detrended Correspondence Analysis) ordination of bird species abundances for all 113 plots produced eigenvalues of 0.490 and 0.125 (1991) and 0.498 and 0.147 (1992) for axes 1 and 2, respectively. DCA scores (Figure 1) indicated that there was some overlap between the bird communities found in mixed aspen-conifer, mature aspen, and old aspen stands in both years. Similarly, there was some overlap in the bird communities found in sapling stands and those in mature or old aspen stands. There were no obvious differences between the bird communities in old aspen and mature aspen.

For 1991 data, plots on all three clearcuts and on one of the sapling stands (S3) clustered together on Axis 1, and the bird communities on these plots appeared to be quite different from those in the rest of the plots (Figure 1, 1991). In 1992 there appeared to be a shift in the composition of the bird community found on the smallest clearcut (C2), since it separated out closer to the sapling stands S1 and S2. The presence of the Warbling Vireo on C2 in 1992, but not in 1991, was the most obvious difference between the 2 years.

DCA species scores on Axis 1 (Figure 2) were positive for birds typically associated with habitats that were open or covered in low shrubs (i.e., mainly ground-gleaning and low-shrub, or ground-nesting, sparrows). Scores were strongly negative for species typically found in stands with a well-developed tree canopy (i.e., foliage-gleaning, canopy-nesting species). Hence, the gradient on Axis 1 was from birds preferring older, closed-canopy stands to those preferring younger, more open seral stages.

Although reversed, ordinations of data for 1991 and 1992 both showed a similar clustering. Scores for the Pine Siskin, Ruby-crowned Kinglet, Golden-crowned Kinglet, Red-breasted Nuthatch, Purple Finch, and Solitary Vireo all clustered together on Axis 2. All of these species typically associate with, or prefer, the presence of conifers. At the opposite end of the gradient were found some species that would be expected to only occur in, or prefer, pure aspen stands (Least Flycatcher, Red-eyed Vireo, and Western Wood Pewee). The Hermit Thrush also clustered with this group.

Ordination of bird data after removal of mixed aspen/conifer and clearcut plots (Figure 3) did not reveal any clear differences between the bird communities present in the mature and old aspen stands. However, had the data for cavity-nesting species been included, it is possible that some difference might have been indicated. Scores on Axis 2 showed a gradient from plots containing species that more typically associate with pure aspen to those with species that would be expected to prefer the presence of conifers. Since conifers were absent from these plots, some other habitat (or environmental) variable was influencing the presence of this latter group of bird species.

Bird communities on sapling plots in stands S1 and S2 tended to cluster in the centre of the ordination, indicating a community that is intermediate and contains a mix of closed- and open-canopy preferring birds. Again, the bird communities on plots in sapling stand S3 were different from all other plots.

4.4.2 Ordination of habitat variables (vegetation data)

The DCA ordination of the vegetation data set for all plots collected in 1992 is shown in Figure 4. Data on horizontal foliage cover were not included. Eigenvalues are 0.450 and 0.076 for Axes 1 and 2, respectively.

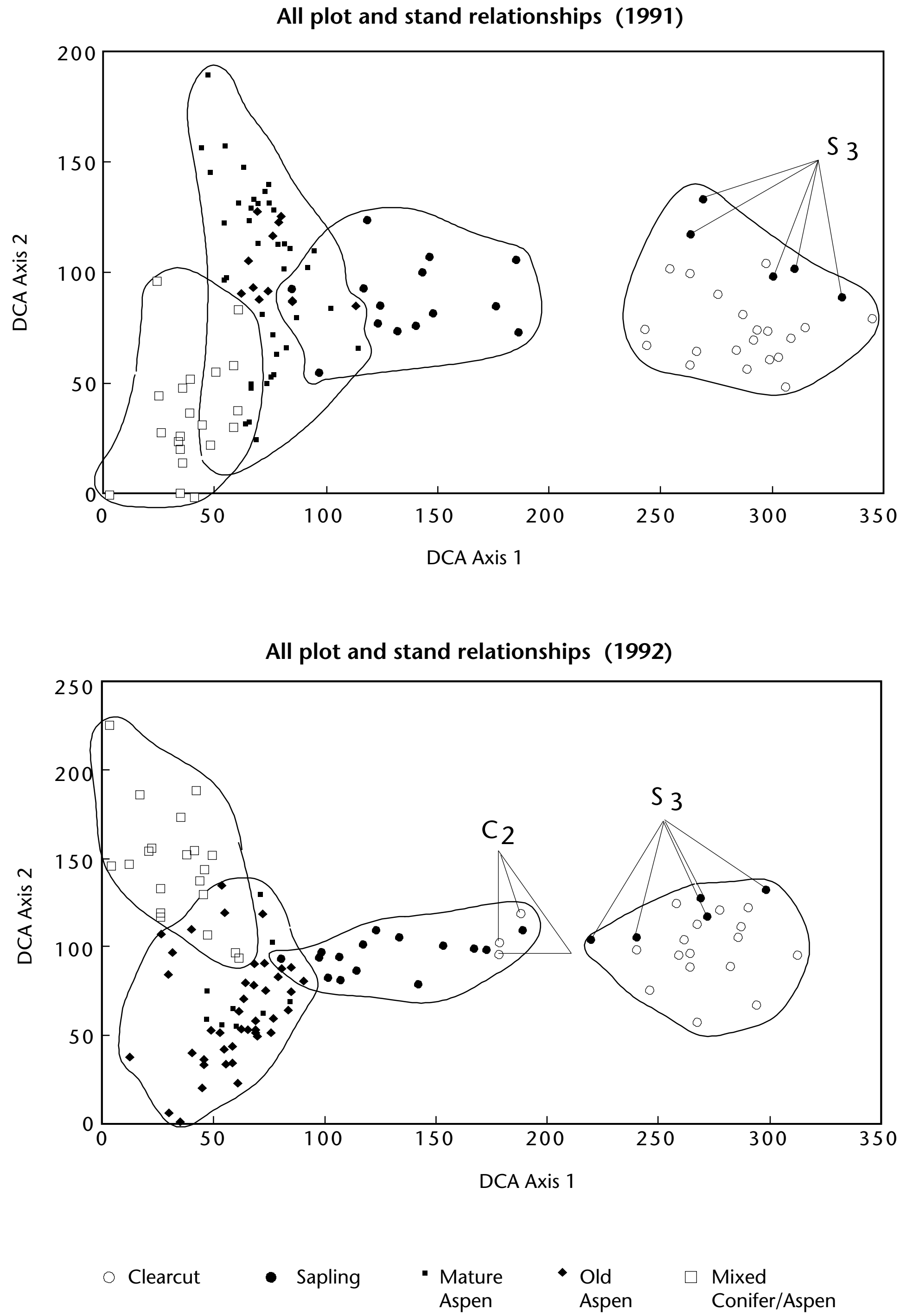
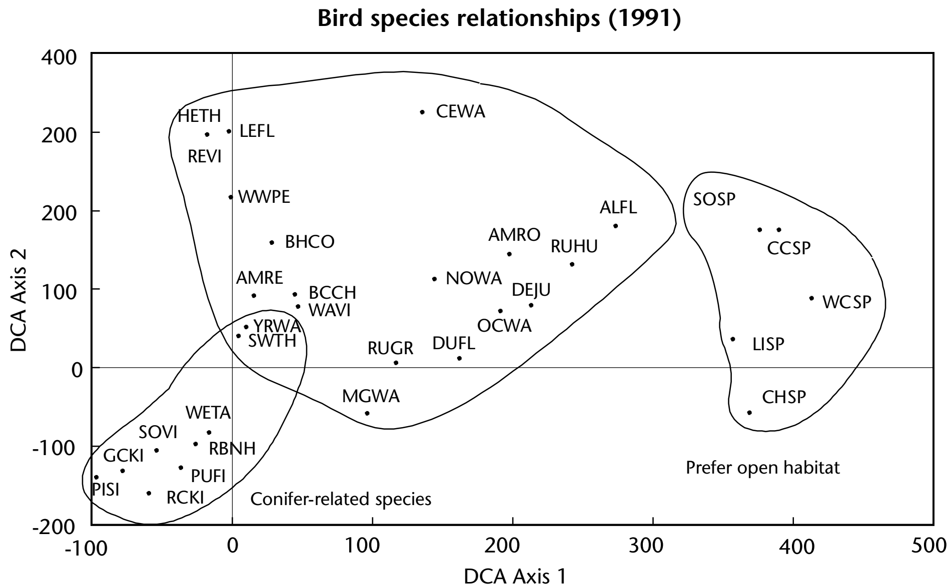


FIGURE 1 *Detrended Correspondence Analysis (DECORANA) of breeding bird abundance data. DCA scores for Axis 1 and Axis 2 are plotted to illustrate the relationships between all plots and stands for 1991 and 1992.*



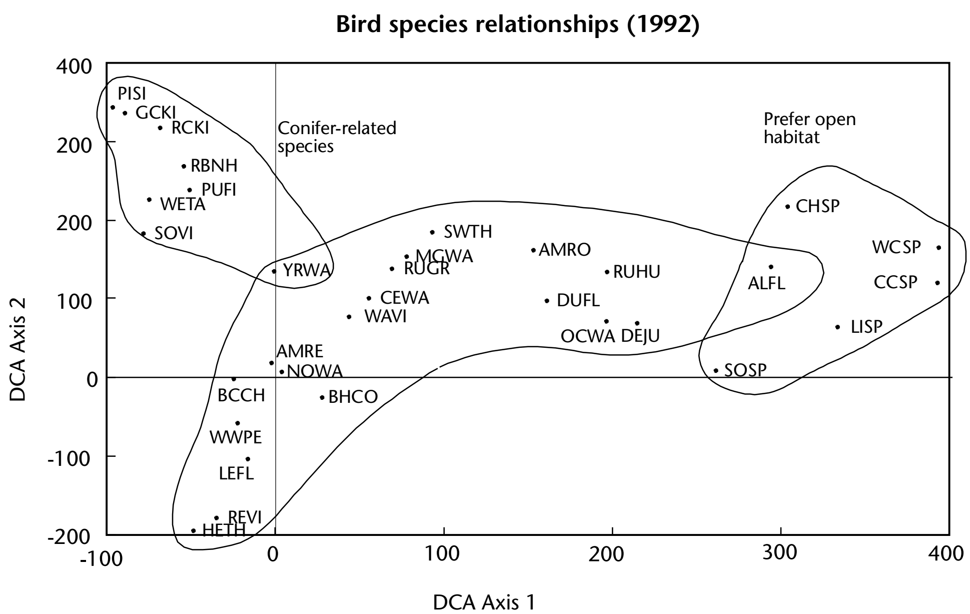
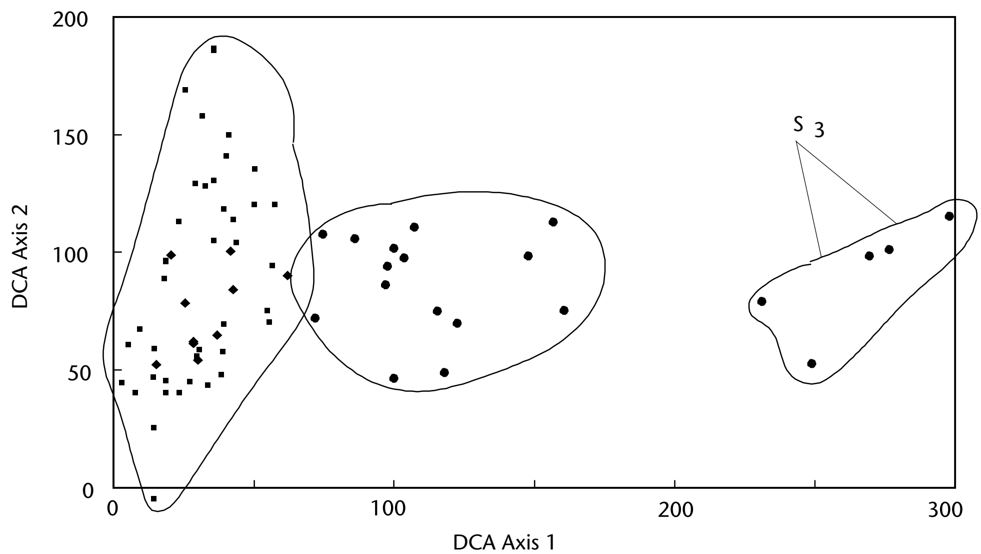


FIGURE 2 *Detrended correspondence analysis (DECORANA) of breeding bird abundance data. Species scores on Axis 1 and Axis 2 are plotted to show the relationships between the species for 1991 and 1992. (Codes for bird names are given in Appendix 7.)*

Plot relationships with deciduous trees only (1991)



Plot relationships with deciduous trees only (1992)

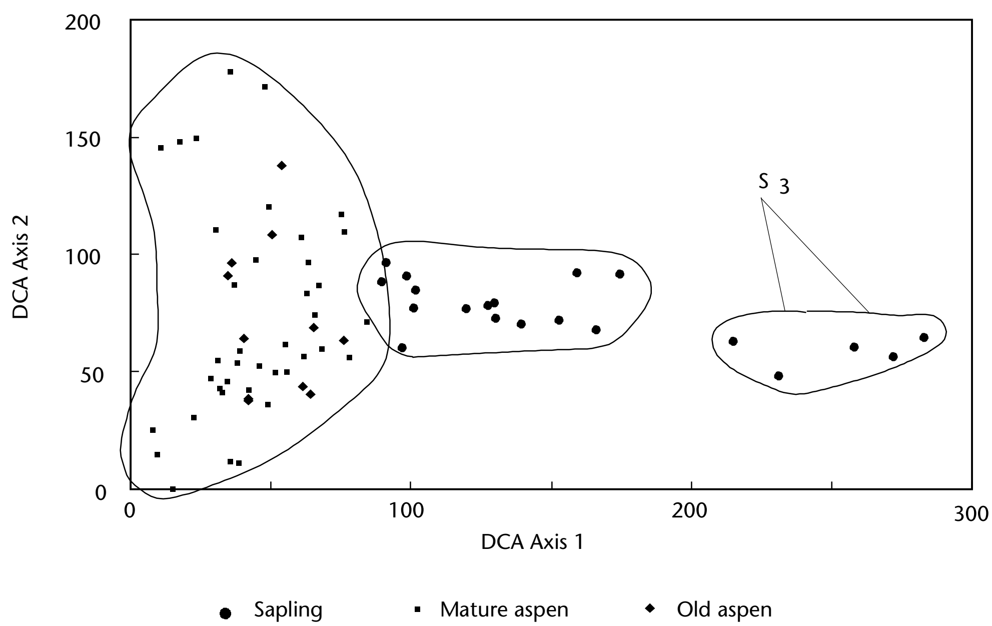


FIGURE 3 *Detrended correspondence analysis (DECORANA) of breeding bird abundance. DCA scores on Axis 1 and Axis 2 are plotted to illustrate the relationships on plots with deciduous trees only – i.e., clearcuts and mixed plots are removed.*

DCA scores on Axis 1 (Table 10) were positive for variables associated with the presence of conifers (number of stems/ha, basal area, percentage cover of conifer canopy, and height of conifers) and negative for the same variables describing deciduous trees. On Axis 2, scores were strongly positive for the amount of bare ground and coarse woody debris, and negative for variables associated with the presence of conifers.

Based on vegetative features, all clearcut plots separated out from the remaining plots along Axis 2 (Figure 4A), suggesting that the different bird community present on the clearcuts may have been determined, in part, by the amount of bare ground or log cover. Plots on the S3 sapling stand clustered with the other two sapling stands. Hence, although the bird species community on S3 was more like that on the clearcuts (Figure 1), the three sapling stands were vegetatively similar. Therefore, the bird community on S3 might possibly have been responding to some habitat variable that was not adequately measured in the vegetation plots used here. (e.g., the presence of several large openings).

Mixed aspen/conifer plots were spread out along Axis 1 because of the wide variation in the relative amounts of deciduous and coniferous trees on the different plots within the stands. Along Axis 2, however, mixed plots tended to cluster together and did not overlap with the pure aspen plots (Figure 4a).

Plots in pure aspen stands (sapling, mature, and old) all clumped together, with the exception of two plots, one each from the two old stands.

Plots from mixed stands and clearcuts were removed from the data set and the remaining plots re-ordinated (Figure 4B). Sapling plots clustered closely together — again with no apparent differences between plots on S3 and those on the other two sapling stands. Most of the old plots tended to separate from the mature plots based on increasing mean dbh and height of the trees and height of tall shrubs and herbs along Axis 2, and based on the increasing number of snags on Axis 1. This ordination indicated that there were some vegetative differences between mature and old plots, even though the bird community (minus cavity-nesting species) did not differ. Whether or not the observed vegetative differences between mature and old stands influences the numbers of cavity-nesting species present requires further study.

TABLE 10 *Vegetation ordination: Scores for habitat variables on the first two DCA axes*

Habitat variable	Axis 1	Habitat variable	Axis 2
No. conifers/ha	305	Cover bare ground (%)	526
Basal area conifers	293	Cover CWD (%)	495
Cover conifers (%)	290	Height herb layer (m)	276
Height conifers (m)	273	Cover herb layer (%)	263
Mean DBH conifers	270	Cover low shrubs (%)	227
Cover CWD (%)	229	Height low shrub (m)	217
Height deciduous (m)	197	Cover deciduous (%)	123
Cover bare ground (%)	190	Height tall shrub (m)	119
Mean DBH deciduous	171	Mean DBH deciduous	102
Height tall shrub (m)	167	No. of snags	95
Cover herb layer (%)	154	Basal area deciduous	93
Cover low shrubs (%)	152	Height deciduous (m)	85
Height herb layer (m)	148	Cover tall shrub (%)	63
Height low shrub (m)	134	No. deciduous/ha	33
No. of snags	93	Height conifers (m)	-49
Basal area deciduous	81	No. conifers/ha	-56
Cover deciduous (%)	70	Cover conifers (%)	-56
Cover tall shrub (%)	36	Mean DBH conifers	-57
No. deciduous/ha	0	Basal area conifers	-83

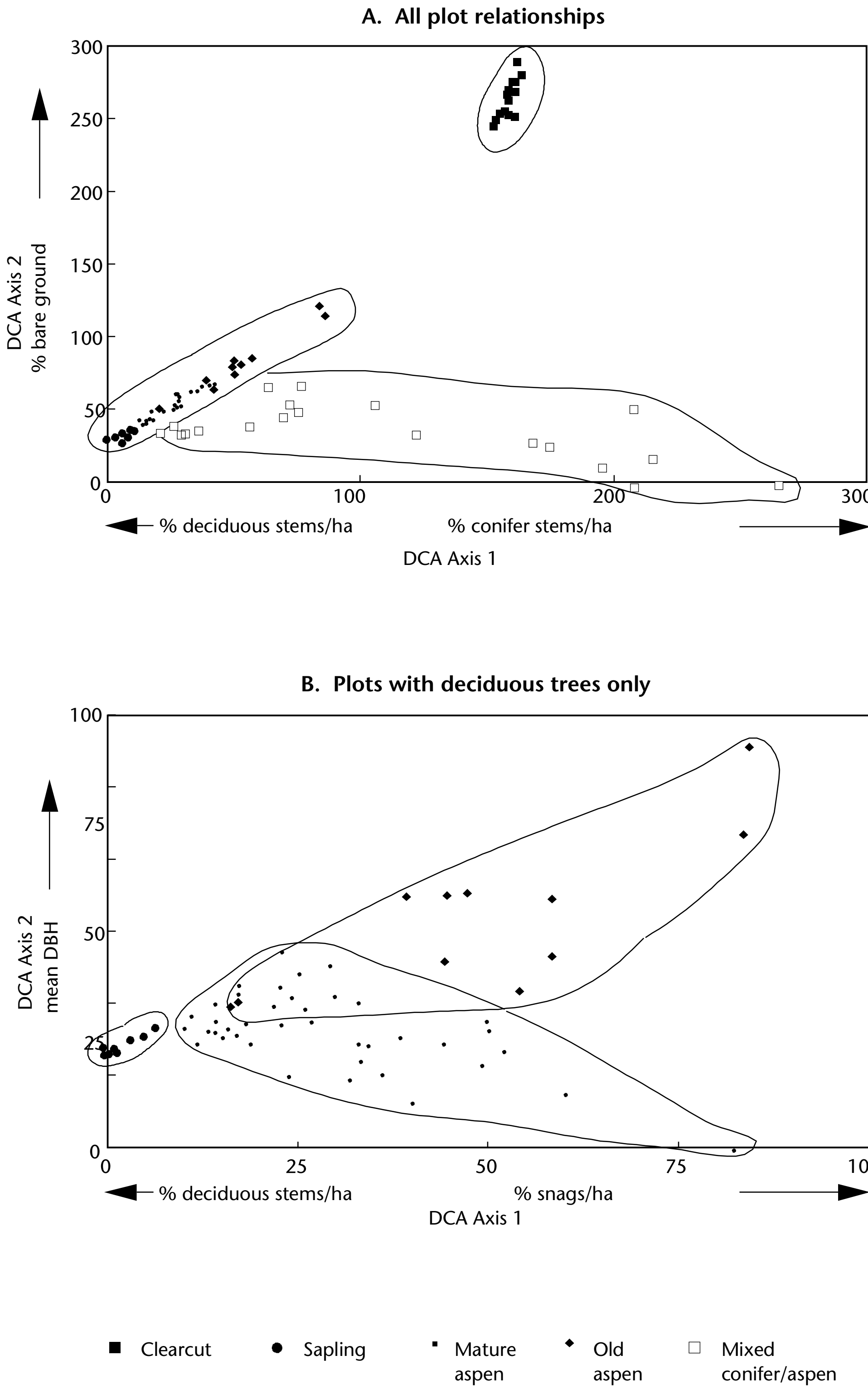


FIGURE 4 *Detrended Correspondence Analysis (DECORANA) of habitat variables. DCA scores on Axis 1 and Axis 2 are plotted to illustrate the relationship between (A) all plots and (B) plots with deciduous trees only — i.e., clearcuts and mixed stands removed.*

In summary, only clearcuts and one of the sapling stands have a different (distinct) bird community, but even this community may have changed over the 2-year duration of the study. While the other seral stages differ with respect to the presence or absence of some species, there is no clearly distinct bird community associated with any one stage of succession. Rather, there is an overlap or gradual transition from one bird community to another as the stands age and the vegetation changes. This was also reported by Webb et al. (1977), Peterson (1982), Hamilton and Noble (1975), Morgan and Freedman (1986), and others.

4.5 Bird species-habitat relationships

4.5.1 Regression analysis

I examined the relationship between the numbers of the 16 common bird species and habitat using stepwise regression analysis. This was done separately for 1991 and 1992. All 32 regression equations of bird species relationships to habitat were significant (Table 11). In general, the linear relationships were good, with 25 of the 32 regression models having an R2 greater than 0.500, 12 of which were greater than 0.700. Seral stage was entered as a categorical variable, using dummy variables, into each regression model. However, it was not selected for any of the species tested. This is not surprising, since none of the species tested showed any strong preference for one seral stage over another. Had there been sufficient numbers of the species that did show a preference for a particular seral stage (e.g., the Alder Flycatcher or Golden-crowned Kinglet) seral stage may have been selected.

Variables selected in the final regression equations for the Black-capped Chickadee, Least Flycatcher, Western Wood Pewee, Warbling Vireo, Red-eyed Vireo, and Brown-headed Cowbird were consistent between years. At least one of the same habitat variables was selected in the final regression equations in both years for the Rufous Hummingbird, Yellow-rumped Warbler, Orange-crowned Warbler, MacGillivray's Warbler, American Redstart, Dark-eyed Junco, and Lincoln's Sparrow. For the remaining species, variables were not consistent between years.

A strong positive relationship between both the Least Flycatcher, Red-eyed Vireo, and Western Wood Pewee with deciduous tree related habitat variables is consistent with other reports that these species prefer mature deciduous trees (Flack 1976; Erskine 1977; Ambuel and Temple 1983). The Dusky Flycatcher numbers increased as the percentage cover of tall shrubs, herbs, and horizontal foliage at 3 feet increased, supporting previous observations that this species tends to prefer tall shrubbery and forage in the lower strata (Godfrey 1986).

The Black-capped Chickadee is a cavity nester, hence the positive relationship with the number of snags was to be expected. However, the association of this species with tall shrub height is not as easy to explain, unless the chickadees were selecting tall shrubs for foraging or merely because there are more shrubs adjacent to the snags.

The Swainsons's Thrush was the only species for which a positive association with a conifer-related variable was detected in either year. It also had a positive association with tall shrub height and foliage cover at 12 feet. These results agree with reports that this species prefers deciduous tall shrubbery and is frequently associated with coniferous stands (Erskine 1977; Godfrey 1986).

Harrison (1979) reported that the Warbling Vireo prefers to nest in tall shrubs, whereas others (Flack 1976; Winternitz 1976; and Sadoway 1988) have classed this species as a tree canopy nester that prefers aspen. The strong relationship between this species and tall shrub height observed in this study agrees with the Harrison's observations.

Examination of the standard partial regression coefficients (Appendix A3.1) indicates that the height of tall shrubs accounted for most of the variation in the numbers of the American Redstart. This agrees with the reports of Sherry (1979) that this species prefers the mid-canopy stratum (tall shrubs) for both feeding and nesting.

The Yellow-rumped Warbler is usually considered to be a species associated with conifers in western forests (Erskine 1977). However, no positive relationship with any conifer-related habitat variables was indicated, although there was a negative relationship between this species and some deciduous habitat variables (percentage cover and height).

Most of the variation in Brown-headed Cowbird numbers was explained by tall shrub height, suggesting an affinity for tall shrubs. Brittingham and Temple (1983) reported that cowbird density was inversely related to the distance from openings (forest edge or within-stand openings) — areas where shrub growth is usually well developed. Species that prefer to nest in tall shrubs (American Redstart, Red-eyed Vireo, and Warbling Vireo) have been reported to be some of the most susceptible to cowbird parasitism (Friedmann 1963).

The negative relationship between the Lincoln's Sparrow and the height of tall shrubs and the log of

TABLE 11 *Step-wise multiple regression of independent habitat variables with dependent variable of mean number of birds per point of the 16 most abundant species of breeding birds*

Dependent/ Independent Variable	1991 Regression Coefficient	1991 Standard Error	1991 P	1992 Regression Coefficient	1992 Standard Error	1992 P
Dusky Flycatcher	(df=2,13; R2=0.701 p=0.0004)			(df=1,14; R2=0.462 p=0.0038)		
Intercept	-1.662	0.622	0.019	0.822	0.212	0.002
Foliage cover @ 3'	0.018	0.004	0.001			
Percent herb cover	0.029	0.008	0.003			
Height tall shrub				0.136	0.039	0.004
Least Flycatcher*	(df=2,13; R2=0.701 p=0.0004)			(df=1,14; R2=0.540 p=0.0012)		
Intercept	0.758	0.137	0.000	0.740	0.098	0.000
% cover deciduous trees	0.010	0.003	0.010	0.009	0.002	0.001
Western Wood Pewee*	(df=1,14; R2=0.579 p=0.0006)			(df=1,14; R2=0.558 p=0.0009)		
Intercept	0.690	0.064	0.000	0.079	0.055	0.000
dbh deciduous trees	0.017	0.004	0.001	0.014	0.003	0.001
Rufous Hummingbird*	(df=2,13; R2=0.641 p=0.0010)			(df=2,13; R2=0.552 p=0.0050)		
Intercept	0.805	0.088	0.000	0.597	0.112	0.000
Herb height	0.312	0.147	0.053	0.004	0.001	0.005
Percent bare ground	0.048	0.010	0.000			
Foliage cover @ 6'				0.445	0.170	0.000
Black-capped Chickadee*	(df=2,13; R2=0.695 p=0.0000)			(df=2,13; R2=0.663 p=0.001)		
Intercept	0.624	0.093	0.000	0.624	0.088	0.000
Height tall shrubs	0.066	0.022	0.010	0.041	0.021	0.069
Log snag number	0.069	0.045	0.144	0.098	0.043	0.038
American Robin	(df=2,13; R2=0.548 p=0.0060)			(df=2,13; R2=0.0810 p=0.0000)		
Intercept	0.438	0.533	0.426	0.512	0.061	0.000
Percent herb cover	0.015	0.007	0.047			
Foliage cover @ 6'	-0.010	0.004	0.017			
dbh deciduous trees				0.035	0.005	0.000
% cover deciduous trees				-0.006	0.002	0.005
Swainson's Thrush	(df=2,13; R2=0.725 p=0.0000)			(df=2,13; R2=0.810 p=0.0000)		
Intercept	-0.341	0.230	0.162	-0.075	0.137	0.595
Height tall shrub	0.190	0.045	0.001			
% cover conifer trees	0.020	0.009	0.041			
dbh deciduous trees				0.030	0.007	0.000
Foliage cover @ 12'				0.015	0.003	0.000
Warbling Vireo*	(df=1,14; R2=0.697 p=0.0001)			(df=1,14; R2=0.614 p=0.003)		
Intercept	0.570	0.124	0.000	0.610	0.140	0.001
Height tall shrubs	0.130	0.023	0.000	0.122	0.026	0.000

TABLE 11 *(Continued)*

Dependent/ Independent Variable	1991 Regression Coefficient	1991 Standard Error	1991 P	1992 Regression Coefficient	1992 Standard Error	1992 P
Red-eyed Vireo*	(df=1,14; R2=0.537 p=0.0013)			(df=1,14; R2=0.329 p=0.0201)		
Intercept	0.705	0.040	0.000	0.704	0.054	0.000
% cover deciduous trees	0.004	0.001	0.001	0.003	0.001	0.020
Yellow-rumped Warbler*	(df=3,12; R2=0.940 p=0.0000)			(df=6,9; R2=0.932 p=0.0000)		
Intercept	0.549	0.074	0.000	0.553	0.089	0.000
dbh deciduous trees				0.016	0.009	0.105
Height tall shrub	0.093	0.017	0.000	0.090	0.025	0.005
Log snag number	0.339	0.065	0.000	0.613	0.128	0.001
% cover deciduous trees	-0.005	0.002	0.035	-0.007	0.003	0.019
Height deciduous trees				-0.038	0.013	0.018
Orange-crowned Warbler	(df=1,14; R2=0.305 p=0.0265)			(df=2,13; R2=0.652 p=0.0010)		
Intercept	0.564	0.180	0.007	-0.305	0.234	0.216
Foliage cover @ 9'	0.011	0.005	0.027	0.004	0.002	0.082
Herb height				1.776	0.365	0.000
MacGillivray's Warbler	(df=5,10; R2=0.934 p=0.0000)			(df=1,14; R2=0.571 p=0.0007)		
Intercept	-0.435	0.276	0.146	-1.159	0.395	0.011
Percent low shrub	0.039	0.005	0.000	0.027	0.006	0.001
Basal area deciduous	-0.009	0.004	0.000			
dbh deciduous trees	0.043	0.006	0.000			
Log # deciduous stems	-0.194	0.033	0.000			
Percent herb cover	-0.019	0.004	0.000			
American Redstart*	(df=3,12; R2=0.965 p=0.0000)			(df=3,12; R2=0.948 p=0.0000)		
Intercept	-0.194	0.146	0.210	-0.123	0.169	0.482
Height deciduous trees	0.013	0.004	0.005			
Height tall shrub	0.148	0.018	0.000	0.141	0.017	0.000
Percent cover herb	0.010	0.002	0.000	0.008	0.002	0.002
% cover deciduous trees				0.005	0.001	0.002
Dark-eyed Junco	(df=2,13; R2=0.683 p=0.0006)			(df=2,13; R2=0.716 p=0.0003)		
Intercept	1.313	0.263	0.000	1.811	0.117	0.000
Herb height	0.923	0.388	0.033			
Log # deciduous stems	-0.188	0.043	0.001	-0.099	0.047	0.056
Foliage cover @ 3'				-0.006	0.003	0.050
Lincoln's Sparrow*	(df=3,12; R2=0.967 p=0.0000)			(df=2,13; R2=0.953 p=0.0000)		
Intercept	0.168	0.054	0.000	1.657	0.061	0.000
Basal area deciduous	0.006	0.003	0.048			
Height tall shrubs	-0.084	0.013	0.000	-0.079	0.014	0.000
Log snag number	-0.331	0.049	0.000	-0.239	0.029	0.000
Brown-headed Cowbird*	(df=1,14; R2=0.511 p=0.0019)			(df=1,14; R2=0.364 p=0.0134)		
Intercept	0.595	0.148	0.001	0.670	0.141	0.000
Basal area deciduous	0.105	0.027	0.002	0.073	0.026	0.013

* Square root transformation of mean bird number = (square root (x+0.5)); log = log(x+1)

snag numbers in both years, suggests that this species appeared to be avoiding tall shrubs and dense trees. This is consistent with previous reports that it prefers open bushy areas (Godfrey 1986) and openings within treed aspen stands (Westworth et al. 1984). The positive relationship with deciduous basal area is not readily explained.

MacGillivray's and Orange-crowned Warbler numbers were partially explained by the density of foliage in the low shrub or herb strata, which agrees with the findings of Morrison (1981). The increase in MacGillivray's Warbler with decreasing numbers of deciduous stems supports my observations that this species prefers more open areas within treed stands (see Section 4.5.3).

The American Robin, Rufous Hummingbird, and Dark-eyed Junco are all generalist species that occupy a wide range of habitats. Since juncos nest and forage primarily on the ground, it would be expected that they would prefer good protective cover. Hence, it is surprising that they showed a negative association with the amount of foliage cover at 3 feet. The numbers of the Rufous Hummingbird were probably influenced by the abundance of flowering shrubs in the vicinity of the nest—a variable that was not measured. American Robin nests were observed in clearcuts, saplings, and the high canopy of both deciduous and coniferous trees. The lack of correlation with any particular habitat variable is, therefore, not surprising.

Although seral stage was not selected by any of the 16 most common species analyzed, many had strong relationships with habitat features associated with aspen stands. Some of these features (e.g., tall deciduous shrub cover) may be found at different stages of succession. Others (e.g., snags) are present only in older stages. Managing aspen to allow for retention of a mix of stages across the landscape, as well as ensuring the retention of structural features important to the birds within the individual stands, will help to meet the needs of many of these species.

Problems in elucidating bird-habitat relationships for some species using regression analysis can probably be related to the inadequacy of sampling techniques or the sample size used. Lundquist and Mariani (1991), summarizing the work of several authors, suggest that such problems relate to a variety of factors. These include incomplete sampling of habitat gradients, variability in species' response to habitat features, sampling scale, and not sampling the correct variables (i.e., those of importance to birds). I suspect that all of these factors are probably relevant to this study.

The inadequacy of the vegetation sampling because of time constraints (i.e., one 20 x 20 m plot to describe the vegetation of a 50 m radius bird sampling area, which often contained quite varied micro-habitats) was certainly a cause for concern in this study. Because of this concern, I looked at the variation in the vegetation within the 50 m radius circle, and how it compared with the area sampled. Sketch maps of the entire circle, indicating obvious changes in habitat, were useful in interpretating some bird observations (see Section 4.5.3).

4.5.2 Comparison of ordination and regression results

The clustering of some of the species in the DCA ordination output in Figure 2 can be explained, in part, by the results of the regression analysis. For example, the Least Flycatcher, Red-eyed Vireo, Western Wood Pewee, and Hermit Thrush clustered together. The first three of these species showed a positive relationship in the regression analysis with deciduous tree canopy variables. All four species were either most abundant, or found only, in stands with a well-developed deciduous canopy.

Warbling Vireo, American Redstart, Black-capped Chickadee, Brown-headed Cowbird, Yellow-rumped Warbler, and Swainson's Thrush clustered together and all showed a positive association with some variable related to the presence of tall shrubs or cover at mid-canopy heights. Some species also showed a positive relationship with deciduous canopy variables. All were abundant in either stands of saplings or in mature deciduous stands with a well-developed understorey of tall shrubs.

Clustered in the centre of the DCA ordination (Figure 2) was a mix of species including those that were either very flexible in their habitat choice (American Robin, Dusky Flycatcher, Dark-eyed Junco), or that showed a positive relationship with low shrub or herb cover related variables (Orange-crowned and MacGillivray's Warblers, Rufous Hummingbird). All could be found in many of the seral stages. The only species that preferred saplings (Alder Flycatcher) clustered with this group, but was not analyzed in the regression.

Species that prefer open habitats clustered close together. The only one analyzed by the regression was Lincoln's Sparrow, which decreased with an increase in the variables related to the presence of a tree canopy or tall shrubs. All species in this cluster were the most abundant on clearcuts.

None of the conifer-related species were analyzed by regression analysis, but their expected preference for conifers would explain their tendency to cluster together in the DCA ordination.

4.5.3 Habitat relations of selected species

MacGillivray's Warbler, Orange-crowned Warbler, and Northern Waterthrush During the collection of field data, I noticed that there appeared to be a relationship between the presence of openings in the canopy (or clearings) in aspen stands and the location of MacGillivray's and Orange-crowned Warblers. Also, the presence of the Northern Waterthrush apparently coincided with the presence of ponds in the stands.

By superimposing the bird field data (showing distance and location of the bird from the centre of the count point) on top of the rough sketch maps, I found that the MacGillivray's and Orange-crowned Warblers tended to be located in, or on the edge of, openings in mature and old aspen stands (Table 12). Such openings usually contain shrubs or are being invaded by sapling aspen suckers. On clearcuts and in sapling stands, both species, given a choice, appear to prefer sapling aspen or tall shrubs rather than bare openings or areas containing low shrubs.

Similarly, a comparison between the location of the Northern Waterthrush and the presence of ponds or streams indicates that most of the time this species was located near (i.e., at the edge of) a water body (Table 12). Waterthrushes were not always present when there was a pond in the count plot, but on many occasions a single male was observed flying between (and singing near) several ponds.

Least Flycatcher and American Redstart Erskine (1977) reported that the Least Flycatcher is usually associated strictly with aspen and avoids stands with conifers. My results do not show such a clear preference. Whereas there were no Least Flycatchers in the mature aspen stand A2, which contained scattered conifers in the understorey, this species was present in the mixed conifer-aspen stands. However, it was present in considerably lower numbers in the mixed stand with the most conifer cover (M3).

I suspected that the differences in the numbers of the Least Flycatcher and American Redstart observed between stands (especially treed mature aspen) may be related to differences in the amount of foliage cover, or, conversely, openness in the mid-canopy, (tall shrub stratum) as reported by Breckenridge (1956) and Sherry (1979). The index of foliage cover at 12, 15, and 18 feet above ground compared with the abundance of these two species (Figure 5). It shows that the Least Flycatcher tends to be more abundant in stands with less foliage in the mid-canopy and vice-versa for the American Redstart. Sherry (1979) suggests that, because these two occupy the same foraging niche, they tend to compete. The Least Flycatcher tends to forage more successfully in stands where the mid-canopy is open and affords good visibility. Redstarts are more tolerant of denser foliage in this stratum.

Cavity-nesting species Overall, there were very few registrations of primary cavity-nesting birds (woodpeckers). Pileated, Downy, and Hairy Woodpeckers were not detected on stands lacking large-diameter trees. The Northern Flicker was present on two of the three clearcuts.

Other cavity-nesters (Black-capped Chickadee and Red-breasted Nuthatch) were present on all stands with trees and two of the sapling stands (S1 and S2). Since the diameter of the saplings was too small for these species to nest in (<7.5 cm dbh), I suggest that these birds were only foraging in the sapling stands. These cavity-nesters were most abundant in the mixed stands.

Because there were so few registrations, I did not enter data for cavity-nesting species into either the DCA ordination or the regression analysis. When the data for all cavity-nesters were pooled and compared with means of habitat variables for each stand for both years, the mean number of cavity-nesters tended to increase with the mean dbh of the deciduous stems. It tended to decrease with an increase in the number of deciduous stems per hectare (Figure 6). Results also suggest that more cavity nesters were present in stands containing fewer snags. However, this unusual result may reflect problems encountered with accurate measurement of snag numbers. Larger snags tend to be farther apart, and fewer are measured in small plots. Numbers computed from cruise plot data (not given) differed widely from counts that were made on the 20 x 20 m vegetation plots. Neither method of estimation seemed entirely satisfactory.

Other studies have shown that the Yellow-bellied Sapsucker is relatively abundant in aspen forests (Flack 1976; Keisker, 1987). The only sapsucker species detected in this study was the Red-breasted Sapsucker and there were too few detections to indicate or draw firm conclusions about its true abundance and habitat preference. Other studies (Bent 1939; Campbell et al. 1990) suggest that this species may prefer moister forest than the mesic ones chosen for this study. Although one nest was detected in the mesic old aspen stand O2, this species was most frequently observed in riparian mixed stands during the course of site selection (Pojar, personal observation).

The infrequent registrations of woodpeckers may have been a function of the timing of this study. Woodpeckers start to establish territories in April

(Bent 1939), and most of their territorial behaviour had probably ceased by the time census taking took place. A slight increase in the number of detections towards the end of the season may be the result of interactions between newly fledged young and their parents. It is also possible that the methods chosen are inadequate in the census taking of woodpeckers, who generally have larger territories.

Other species There was no attempt to analyze the habitat relations of the remaining 22 species by statistical means because of the large number of zero abundance values across the stands. However, some general qualitative observations can be made.

Species that appeared only in mixed stands were presumed to be dependent in some way on the presence of the conifer component. The Winter Wren was present only in the most mature of the mixed stands (M3) and the two older conifer stands. All of these stands contained a mix of conifer species, and all were wetter than the other stands with conifers.

The Alder Flycatcher was present in thickets of sapling aspen, or aspen mixed with young cottonwood or willow, but absent from stands where trees were older and more widely spaced. A possible relationship between the Alder Flycatcher and the density of deciduous stems found in younger seral stages was also reported by Westworth et al. (1984) and Morgan and Freedman (1986).

The presence of Savannah and White-crowned Sparrows on clearcuts only, together with the fact that these two species are common in subalpine krummholz (Pojar, personal observation), suggests that they prefer open habitats with low shrubs. I also observed that many of the sparrows (and other species) favoured slash piles, stumps, and remnant snags or stubs in clearcuts for perching, territorial singing, and foraging. Similar observations were made by Tobalske et al. (1991) in Douglas-fir clearcuts in Montana and by Mackenzie (1991 unpublished data) in spruce-fir cutblocks in the Prince Rupert Forest Region.

4.6 Selection of potential management indicator species

If the overall objective is to manage hardwoods to maintain the full range of diversity of birds associated with the different seral stages, it is essential that any Management Indicator Species (MIS) chosen will be representative of all species and habitat components within each stage.

An initial selection and assessment of potential management indicator species was carried out using a modification of the process adopted in the United States and described in Sidle and Suring (1986). Radcliffe et al. (1994) have already undertaken a process for selection of MIS for the Prince Rupert Forest Region. I followed their recommendations for the selection and/or elimination of species relevant to this study (see Appendix 8).

The process requires the rejection of all species that migrate and winter primarily south of the

TABLE 12 *Comparison between the location of MacGillivray's Warbler (MGWA), Orange-crowned Warbler (OCWA), and Northern Waterthrush (NOWA) and the presence of broad habitat features*

Seral stage	MGWA (observations)* Openings in	MGWA (observations)* Openings not in	OCWA (observations)* Openings in	OCWA (observations)* Openings not in	NOWA (observations)* Pond/Stream near	NOWA (observations)* Pond/Stream not near
Mature and old Aspen	162	49	204	59	79	9
	MGWA In the open	MGWA Among saplings **	OCWA In the open	OCWA Among saplings **	Pond/Stream near	Pond/Stream not near
Clearcuts	1	10	13	20	1	0
Sapling stands	8	13	90	144	4	0

* Total number of observations over all stands of specified seral stage
** Includes tall shrubs (over 2 m) of other species

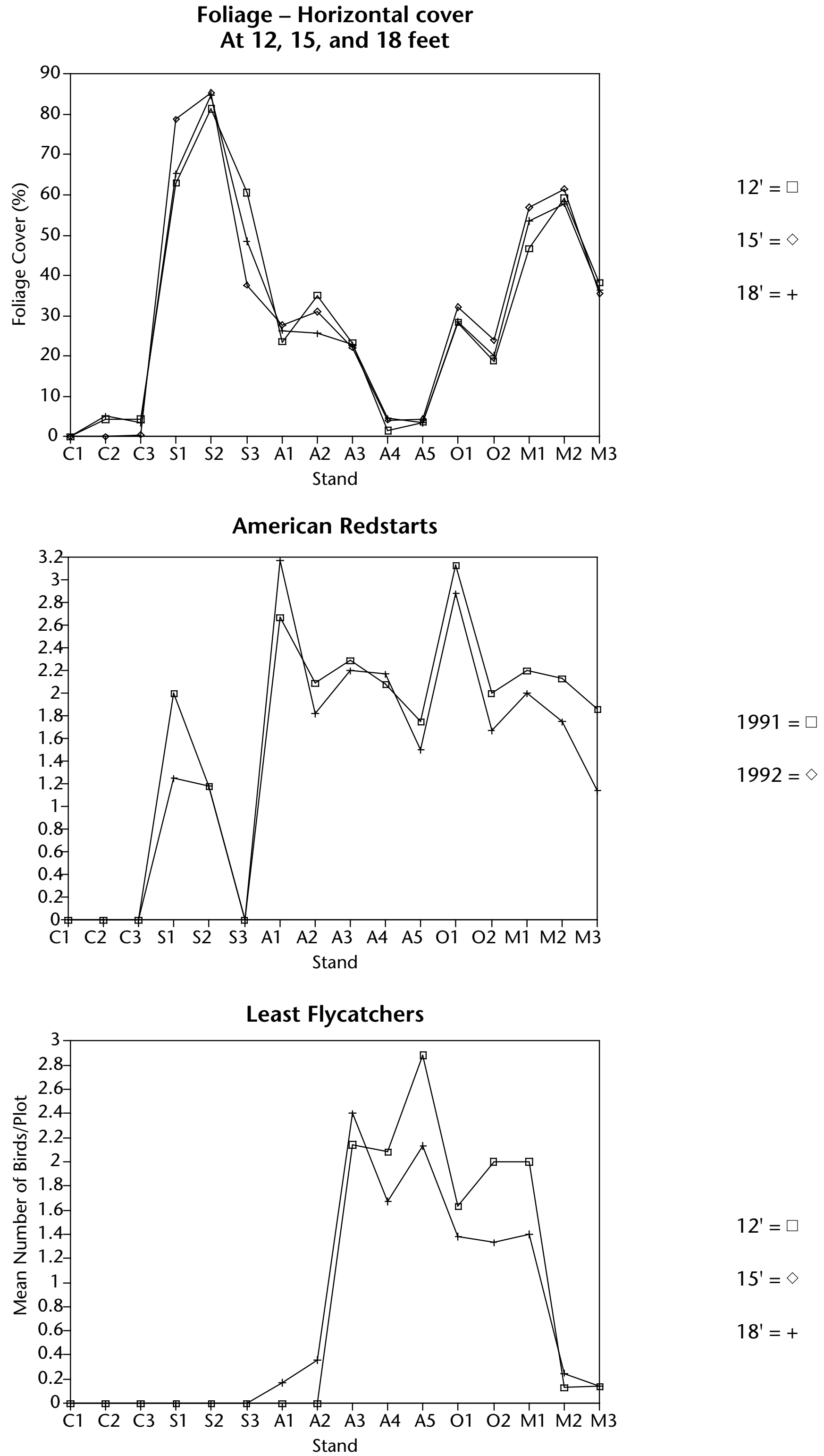


FIGURE 5 *Comparison of the abundance (sum of mean number of birds/point for each stand) of the Least Flycatcher and American Redstart and the amount of horizontal foliage cover (%) at 12, 15, and 18 feet (3.65, 4.57, 5.49 m, respectively)*

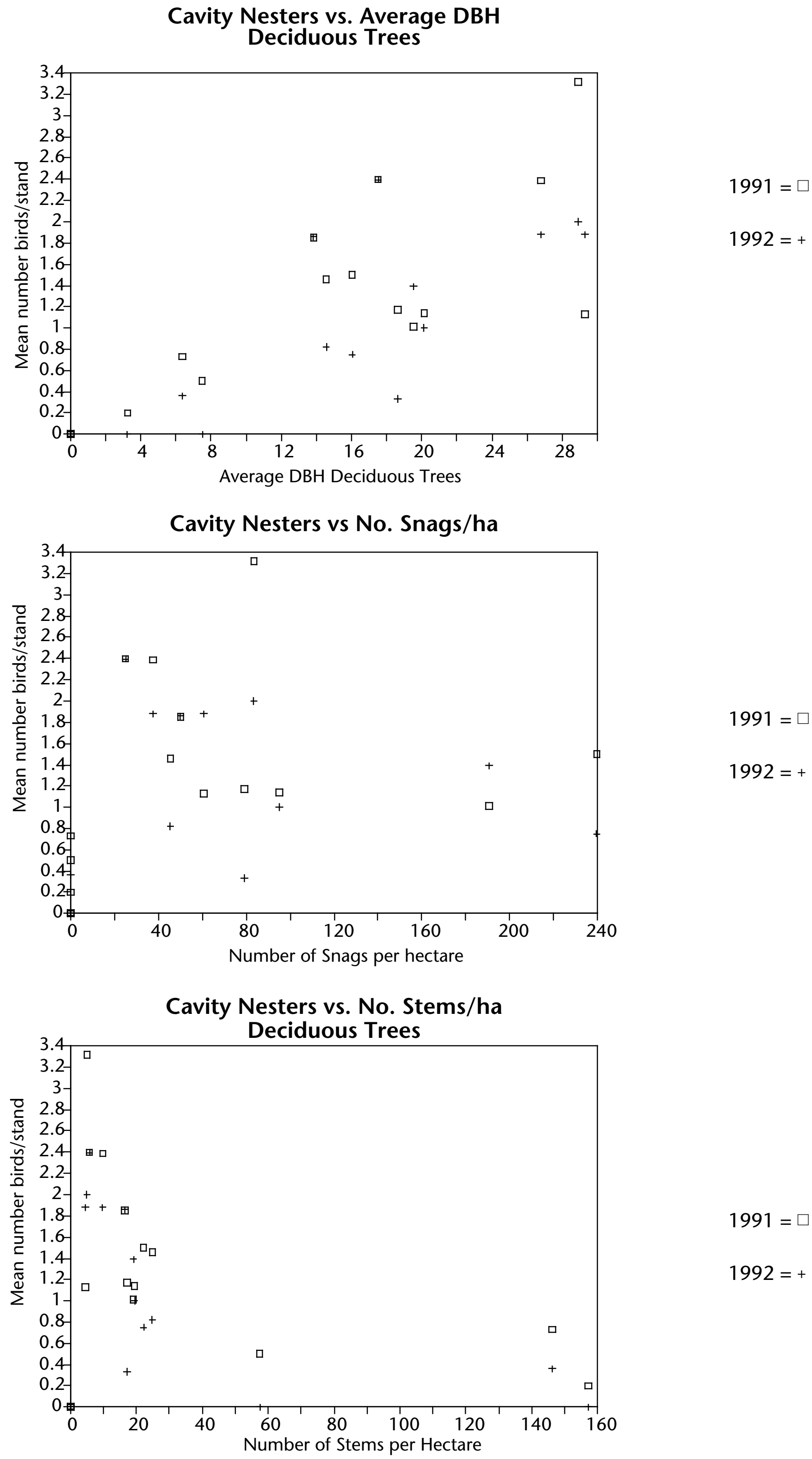


FIGURE 6 *Comparison of the number of all cavity-nesting birds per stand with the mean dbh of deciduous trees, the number of deciduous stems/ha and the number of snags/ha*

southern U.S. border, because they are subject to influences (e.g., loss of winter habitat) beyond the control of forest managers. By removing migratory species, most of the species that appear to be typically associated with the different aspen seral stages were eliminated from further consideration. Hence, it was concluded that this process of MIS selection was inappropriate for the selection of indicators for the different successional stages of aspen.

I also rejected the alternative of selecting species to represent guilds (guild-indicator species). MIS or guild-indicator species are both used either to monitor population trends for other species, or to determine the quality of the habitat and its suitability for other species, communities, or ecosystems. The concept that one species can represent the requirements of all other species in a given habitat or guild is inherently flawed and has been critically reviewed by Landres et al. (1988), Block et al. (1987), Verner (1984), and others, and nicely summarized by Radcliffe et al. (1994).

Radcliffe et al. suggested that, until more information is available about the requirements of different species or species groupings for meeting management objectives, it may be more appropriate to manage for specific habitat components. To this end they proposed a series of "management assemblages"—groupings of species based on their use of particular habitats or components of these habitats. I have applied this concept to my results and treated the communities of birds observed in each seral stage (described in Section 4.3) as "management assemblages." I then selected species typically associated with either a seral stage or a particular habitat component within that stage that could be used for monitoring (Table 13). I have assessed each species selected for its ease of monitoring.

It should be stressed that this list is only a tentative proposal and use of these species as indicators is not without problems. For example, while the Alder Flycatcher was only found in sapling aspen in this study, this species may also be found in thickets of other deciduous species. The Least Flycatcher is probably a good indicator for aspen stands with an open understorey. However, managing for this species alone by removing the understorey, for example, may be detrimental to the American Redstart. In addition, use of some of these species as indicators may only be applicable to the area in which this study took place, since species composition and habitat use varies geographically (Erskine 1977).

5 SUMMARY AND CONCLUSIONS

The numbers of species (species richness), total abundance, and species diversity of both breeding birds and all birds (total bird use), all tended to increase with increasing age of successional stages of aspen. These trends are thought to be related to increasing complexity of the vegetation. Differences between seral stages were highly significant for both study years.

A significant interaction between seral stage and year for species richness and species diversity of breeding birds suggests that the proportion of birds detected in each seral stage was different for each year of the study.

Breeding bird species richness, abundance, and diversity was significantly lower in clearcuts than in sapling aspen stands in both years. Mixed stands contained significantly more species, and greater bird numbers than mature and old aspen stands combined in both years. Species diversity was greater in mixed stands than in pure aspen in 1992, but not so in 1991. While the number of species present in mature aspen stands was not significantly different to that in old aspen stands, bird abundance and diversity were significantly lower in mature aspen stands.

Results for total bird use were similar. Whereas the number of breeding birds differed between clearcuts and sapling stands, total bird use did not. This is thought to be due to the presence of larger numbers of birds that were using the clearcuts for foraging.

There was a significant difference in the overall abundance of birds detected between the two years studied. Differences appear to be largely due to lower numbers of certain species in 1992, especially the American Redstart.

Spot mapping results on one mature aspen stand indicate that the total density of breeding birds and species composition were very similar to that recorded for the same stand 16 years earlier (Erskine 1977), suggesting the possibility of some stability in the populations of songbirds in the study area over the long term.

Ordination of bird data indicated that the bird community (i.e., species composition) on all the clearcuts and on one of the sapling stands was quite

TABLE 13 *Proposed species that could be monitored as representatives of different seral stages of aspen and/or to indicate the presence of specific habitat components of these stages*

Management Assemblage	Species	Ease of Monitoring
Open/low-shrub community (e.g., clearcuts)	Lincoln's Sparrow	2 (visual) 1 (song)
	White-crowned Sparrow	1 (visual, song)
Tall shrub thicket (e.g., sapling aspen)	Alder Flycatcher	2-3 (song, visual)
	Swainson's Thrush	1 (visual, song)
	Ruffed Grouse	2 (drumming)
Mature and old aspen		
with open understorey	Least Flycatcher	1 (song)
with denser understorey	American Redstart	1 (visual) 2-3 (song)
	Red-eyed Vireo	2 (song)
	(Warbling Vireo)*	3 (visual, song)
	(Western Wood Pewee)*	1 (song)
Mixed aspen-conifer (conifer presence)	Golden-crowned Kinglet**	3 (visual, song)

Species associated with habitat component only	Species	Ease of Monitoring
Snags or live stems greater than 30-40cm dbh	Pileated Woodpecker	3 (drumming)
	Red-breasted Sapsucker	2 (visual, drumming)
Standing or running water	Northern Waterthrush	1 (song) 3 (visual)
Shrubby openings	Orange-crowned Warbler	1 (song)
	MacGillivray's Warbler	1 (song) 2 (visual)

* Species not strictly associated with pure mature or old aspen
** In association with one of the species selected for mature or old aspen
Monitoring codes: 1 = easiest; 3 = most difficult; explanation of mode of monitoring in parentheses

different from that found in the rest of the stands studied. Ordination of habitat variables did not detect any obvious differences in the vegetation of the three sapling stands that would explain the differences in the bird species composition found therein. The clearcut bird community, dominated by ground-gleaning, ground-nesting, or low-shrub-nesting species, especially sparrows, is not considered distinct. Rather, it is thought to be only a temporary community. Slight changes in the species composition on some clearcuts, with the addition of new species in the second year, suggested that the bird community may have already been in transition towards a community more typical of the sapling aspen stage.

Although some species were only detected in certain stages, the bird communities in the sapling S1 and S2, mature aspen, old aspen, and mixed stages of succession were not distinct from each other. Rather, there was a gradual transition from one seral stage to another, with some birds appearing, then disappearing, as the vegetation changed. This was also observed by Webb et al. (1977). There was an overall change from open-canopy preferring species to closed-canopy preferring species with increasing ecological age of the stands.

There was a trend towards an increase in the number of species and abundance of birds in the foliage-gleaning, canopy-nesting, and cavity-nesting guilds with increasing successional age. The number of ground-nesting species declined with increased canopy cover, but ground-gleaning bird numbers did not decline, reflecting a change in species composition in this guild. Aerial salliers were most abundant in mature and old aspen, and declined in mixed forests. Tall-shrub nesters were the most abundant in sapling aspen and older aspen stands with dense understorey vegetation.

Species-habitat requirements analyzed by regression analysis were not possible for all species because of insufficient data on all but the 16 most common species. However, results of both statistical and non-statistical analyses indicate that relationships were complex and species specific. In general, species-habitat requirements related to the relative proportions in each seral stage of the cover (vertical and horizontal) of the different vegetative strata.

Variation in the numbers of the Least Flycatcher and Red-eyed Vireo, and those of the Western Wood Pewee, was related to the amount of canopy cover and mean dbh (respectively) of deciduous trees. The Warbling Vireo, American Redstart, Brown-headed Cowbird, Yellow-rumped Warbler, and Swainson's Thrush all showed a strong relationship with the height of tall shrubs. The Black-capped Chickadee numbers appeared to be explained by tall shrubs and the number of snags. Cavity-nesting species collectively did not show a strong relationship with snag numbers. MacGillivray's and Orange-crowned Warblers appeared to prefer openings, and numbers were, in part, explained by the amount of low shrub cover. Lincoln's Sparrow avoided stands with tall shrubs and snags, and preferred more open areas.

Species were proposed that could potentially be used as indicators for management of different seral stages or habitat components thereof. However, selection of a single species as a management indicator for any one seral stage (or guilds within a stage) seemed inappropriate at this time because there are insufficient data on habitat requirements.

Results of this study indicate that, while the bird communities present in each seral stage of aspen were not distinct, each stage was important to certain species. Also, the oldest successional stages (old pure aspen and mixed aspen-conifer stands) were both the most diverse in terms of the structure of the vegetation, and contained the most diverse bird communities. Hence, it follows that removal (or loss) of any seral stage of aspen will have a negative impact on some species, but loss of the older stages of succession will likely result in declines of proportionately more species. Removal of pure aspen, whether for land clearing, conversion to conifers, or for fibre, will certainly result in declines of species that appear to be dependent on, or prefer, deciduous stands (e.g., Least Flycatcher, Swainson's Thrush, Red-eyed Vireo, Warbling Vireo, American Redstart, and some cavity-nesting species). Loss of young stages of aspen, especially through vegetation management to remove deciduous shrubs on conifer plantations, will affect those species associated with, or using, sapling thickets (e.g., Ruffed Grouse and Alder Flycatcher). Removal of aspen will favour open-canopy species initially until regenerating aspen reaches heights tall enough to suit tall shrub and canopy-nesting species.

Many of the aspen-preferring species observed in this study (61%) are Neotropical migrants. Just how important the aspen stands in British Columbia are to the total populations of these species is yet to be determined. Populations of Neotropical migrants that breed in the west are small compared with those east of the Rocky Mountains. Terborgh (1989) suggested that they may be particularly vulnerable to loss of habitat because the deciduous stands they prefer are so restricted in distribution in the west (mainly to narrow valley bottoms in the mountains).

If maintenance of the diversity of all the birds associated with all the different seral stages of aspen is the management objective, forest managers should aim to retain a mosaic of successional stages of different age classes and stand sizes at a landscape level, as recommended by Zeedyk and Evans (1975), Morgan and Freedman (1986), Thompson and Capen (1988), and others.

If pure aspen is to be harvested and managed as a commercial species, a variety of structural features important to birds needs to be retained within the stands to maintain bird diversity. Small openings, veteran or old aspen trees (potential snags), a variety of stem ages, and differing amounts of understorey shrubs, are just some of the features that should be retained. Hence, at the stand level, management objectives should be clearly defined and prescriptions for silvicultural manipulation should include consideration of which species will benefit, and which will be adversely affected. It is unlikely that any one prescription will satisfy the requirements of all species.

One limitation of this study is that it did not answer the question of how important aspen is to certain species. Other unanswered questions are: How important is the aspen component of a mixed aspen-conifer stand to aspen-preferring birds? How much aspen is enough for them? I suspect that aspen (or some deciduous species) is essential for some bird species. I have never observed the Least Flycatcher and Warbling Vireo in pure coniferous stands within the study area. Further studies could determine how much aspen in mixed stands meets the requirements of these species, and, hence, how much should be retained in conifer plantations.

Because of the geographical variation in distribution of bird species, caution must be observed when attempting to apply the findings presented here to other parts of British Columbia, and even within the Prince Rupert Forest Region. Censuses of breeding bird communities in aspen at the eastern end of the region would determine if there are any differences at the regional level.

Further studies are needed to confirm the suspected importance of fire veterans, or old aspen, to cavity-nesting species. Although it is outside the scope of this study, the relationships between forest fragmentation, stand size, abundance of certain forest interior species or area-sensitive species, and susceptibility to Cowbird parasitism are all cause for concern (Whitcomb et al. 1981; Ambuel and Temple 1983; Terborgh 1989; Brittingham and Temple 1983). These topics need further research, as do the identification of rare species and their habitat requirements.

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APPENDIX 1 Mean number of singing males per point (+ standard errors) and density/10 ha 1991 and 1992 results for each seral stage

TABLE A1.1 *Clearcuts — Mean number of singing males per point (+ standard errors) and density/10 ha, 1991 results*

Stand	C1			C2			C3		
species	Mean	S.E.	Density (No./10ha)	Mean	S.E.	Density (No./10ha)	Mean	S.E.	Density (No./10ha)
Ruffed Grouse*	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.09	1.27
Common Snipe*	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.09	1.27
Red-breasted Sapsucker	0.00	0.00	0.00	0.11	0.27	4.25	0.10	0.09	1.27
Northern Flicker*	0.14	0.13	1.82	0.00	0.00	0.00	0.10	0.09	1.27
Rufous Hummingbird*	0.71	0.17	9.10	1.33	0.27	16.99	0.70	0.14	8.92
Calliope Hummingbird*	0.14	0.13	1.82	0.00	0.00	0.00	0.00	0.00	0.00
Dusky Flycatcher*	0.71	0.17	9.10	0.67	0.27	8.49	0.3	0.14	3.82
Alder Flycatcher*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Gray Jay	0.00	0.00	0.00	0.33	0.27	4.25	0.00	0.00	0.00
Black-capped Chickadee	0.29	0.17	3.64	0.67	0.27	8.49	0.00	0.00	0.00
Ruby-crowned Kinglet	0.00	0.00	0.00	1.00	0.00	12.74	0.10	0.09	1.28
Townsend's Solitaire	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.30	1.27
American Robin*	1.00	0.20	12.74	1.33	0.27	16.99	1.40	0.51	17.83
Warbling Vireo*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Yellow-rumped Warbler	0.14	0.13	1.82	0.00	0.00	0.00	0.10	0.30	1.27
Orange-crowned Warbler*	0.43	0.19	5.46	1.00	0.00	12.74	0.40	0.15	5.10
MacGillivray's Warbler*	0.14	0.13	1.82	1.00	0.00	12.74	0.10	0.09	1.27
Wilson's Warbler	0.00	0.00	0.00	1.00	0.00	12.74	0.00	0.00	0.00
Northern Waterthrush*	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.09	1.27
Dark-eyed Junco*	1.43	0.19	18.20	2.33	0.27	29.72	1.70	0.28	21.66
Chipping Sparrow*	1.29	0.17	16.38	1.00	0.47	12.74	0.60	0.15	7.64
White-crowned Sparrow*	1.57	0.19	20.02	0.33	0.27	4.25	0.90	0.09	11.46
Song Sparrow*	0.57	0.19	7.28	0.00	0.00	0.00	0.30	0.14	3.82
Lincoln's Sparrow*	2.29	0.17	29.12	1.33	0.27	16.99	1.80	0.19	22.93
Clay-coloured Sparrow*	0.00	0.00	0.00	0.67	0.27	8.49	0.30	0.14	3.82
Savannah Sparrow*	0.57	0.19	7.28	0.00	0.00	0.00	0.30	0.14	3.82
Pine Siskin	0.00	0.00	0.00	1.00	0.00	12.74	0.00	0.00	0.00
Breeding birds — totals									
Species numbers	13			10			16		
Bird numbers and density	11.00		140.13	11.00		140.13	9.20		117.2
Species diversity (H')	3.21			3.07			3.29		
All birds — totals									
Species numbers	15			16			20		
Bird numbers and density	11.43		145.59	15.33		195.33	9.60		122.29
Species diversity (H')	3.35			3.71			3.47		

* Species thought to be breeding in different stands

TABLE A1.2 *Clearcuts — Mean number of singing males per point (+ standard errors) and density/10 ha, 1992 results*

Stand	C1			C2			C3		
species	Mean	S.E.	Density (No./10ha)	Mean	S.E.	Density (No./10ha)	Mean	S.E.	Density (No./10ha)
Northern Harrier	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.09	1.27
Blue Grouse	0.14	0.13	1.82	0.00	0.00	0.00	0.00	0.00	0.00
Ruffed Grouse*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Northern Flicker*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Rufous Hummingbird*	0.14	0.13	1.82	1.00	0.00	12.74	0.40	0.15	5.10
Calliope Hummingbird*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dusky Flycatcher*	1.14	0.13	14.56	1.33	0.27	16.99	0.60	0.15	7.64
Alder Flycatcher*	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.09	1.27
Black-capped Chickadee	0.00	0.00	0.00	0.33	0.27	4.25	0.00	0.00	0.00
Ruby-crowned Kinglet	0.00	0.00	0.00	0.67	0.27	8.49	0.00	0.00	0.00
Mountain Bluebird	0.14	0.13	1.82	0.00	0.00	0.00	0.00	0.00	0.00
American Robin*	0.57	0.19	7.28	0.67	0.27	8.49	0.30	0.14	3.82
Cedar Waxwing	0.00	0.00	0.00	0.33	0.27	4.25	0.00	0.00	0.00
Warbling Vireo*	0.00	0.00	0.00	1.00	0.00	12.74	0.00	0.00	0.00
Yellow-rumped Warbler	0.14	0.13	1.82	1.00	0.00	12.74	0.50	0.16	6.37
Orange-crowned Warbler*	0.29	0.17	3.64	1.00	0.00	12.74	1.00	0.20	12.74
MacGillivray's Warbler*	0.14	0.13	1.82	1.00	0.00	12.74	0.00	0.00	0.00
Wilson's Warbler	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.09	1.27
Northern Waterthrush*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dark-eyed Junco*	1.86	0.13	23.66	1.67	0.27	21.23	1.40	0.15	17.83
Chipping Sparrow*	0.86	0.13	10.92	0.33	0.27	4.25	0.00	0.00	0.00
White-crowned Sparrow*	1.57	0.19	20.02	0.00	0.00	0.00	0.50	0.16	6.37
Song Sparrow*	0.14	0.13	1.82	0.00	0.00	0.00	0.30	0.14	3.82
Lincoln's Sparrow*	2.00	0.20	25.48	1.00	0.00	12.74	2.20	0.13	28.03
Clay-coloured Sparrow*	0.43	0.19	5.46	0.00	0.00	0.00	0.40	0.15	5.10
Savannah Sparrow*	0.71	0.26	9.10	0.00	0.00	0.00	0.30	0.14	3.82
Pine Siskin	0.14	0.13	1.82	1.00	0.00	12.74	0.00	0.00	0.00
Purple Finch	0.00	0.00	0.00	0.33	0.27	4.25	0.00	0.00	0.00
Breeding birds — totals									
Species numbers	12			9			11		
Bird numbers and density	9.86		125.57	9.00		114.65	7.50		95.54
Species diversity (H′)	3.04			2.98			2.91		
All birds — totals									
Species numbers	16			15			14		
Bird numbers and density	10.43		132.85	12.67		161.36	8.20		104.46
Species diversity (H′)	3.28			3.64			3.17		

* Species thought to be breeding in different stands

TABLE A1.3 *Sapling Aspen — Mean number of singing males per point (+ standard errors) and density/10 ha, 1991 results*

Stand species	S1 Mean	S1 S.E.	S1 Density (No./10ha)	S2 Mean	S2 S.E.	S2 Density (No./10ha)	S3 Mean	S3 S.E.	S3 Density (No./10ha)
Ruffed Grouse*	0.25	0.22	3.18	1.00	0.13	12.74	0.00	0.00	0.00
Common Snipe	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.18	2.55
Rufous Hummingbird*	0.50	0.25	6.37	0.82	0.12	10.42	1.20	0.18	15.29
Calliope Hummingbird*	0.00	0.00	0.00	0.00	0.00	0.00	0.80	0.33	10.19
Dusky Flycatcher*	2.00	0.00	25.48	2.09	0.09	26.64	1.00	0.00	12.74
Least Flycatcher	0.00	0.00	0.00	0.36	0.27	4.63	0.00	0.00	0.00
Alder Flycatcher*	0.75	0.22	9.55	0.82	0.12	10.42	1.20	0.18	15.29
Western Wood Pewee*	0.00	0.00	0.00	0.27	0.14	3.47	0.00	0.00	0.00
Black-capped Chickadee*	0.50	0.25	6.37	0.64	0.15	8.11	0.20	0.18	2.55
Red-Breasted Nuthatch*	0.00	0.00	0.00	0.09	0.09	1.16	0.00	0.00	0.00
American Robin*	0.75	0.22	9.55	0.91	0.16	11.58	0.20	0.18	2.55
Hermit Thrush	0.00	0.00	0.00	0.09	0.09	1.16	0.00	0.00	0.00
Swainson's Thrush*	0.25	0.22	3.18	1.18	0.26	15.06	0.00	0.00	0.00
Cedar Waxwing*	0.25	0.22	3.18	1.00	0.40	12.74	0.20	0.18	2.55
Warbling Vireo*	1.00	0.00	12.74	2.09	0.16	26.64	0.40	0.36	5.10
Yellow-rumped Warbler*	0.50	0.25	6.37	1.09	0.16	13.90	0.00	0.00	0.00
Orange-crowned Warbler*	1.25	0.22	15.92	1.82	0.18	23.16	1.40	0.22	17.83
MacGillivray's Warbler*	0.50	0.25	6.37	0.27	0.19	3.47	0.00	0.00	0.00
Wilson's Warbler	0.00	0.00	0.00	0.18	0.12	2.32	0.00	0.00	0.00
Yellow Warbler	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.18	2.55
American Redstart*	2.00	0.35	25.48	1.18	0.23	15.06	0.00	0.00	0.00
Northern Waterthrush*	0.00	0.00	0.00	0.09	0.09	1.16	0.40	0.22	5.10
Dark-eyed Junco*	0.75	0.22	9.55	1.09	0.21	13.90	0.80	0.18	10.19
Chipping Sparrow*	0.00	0.00	0.00	0.27	0.14	3.47	0.20	0.18	2.55
White-crowned Sparrow*	0.25	0.22	3.18	0.00	0.00	0.00	1.80	0.33	22.93
Song Sparrow*	0.00	0.00	0.00	0.09	0.09	1.16	1.20	0.18	15.29
Lincoln's Sparrow*	1.25	0.22	15.92	0.73	0.30	9.26	1.60	0.22	20.38
Clay-coloured Sparrow*	0.00	0.00	0.00	0.00	0.00	0.00	1.20	0.18	15.29
Savannah Sparrow*	0.00	0.00	0.00	0.09	0.09	1.16	0.40	0.22	5.10
Red-winged Blackbird*	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.18	2.55
Purple Finch	0.00	0.00	0.00	0.09	0.09	1.16	0.00	0.00	0.00
Brown-headed Cowbird*	1.00	0.00	12.74	1.18	0.18	15.06	0.00	0.00	0.00
Breeding birds — totals									
Species numbers	17			22			18		
Bird numbers and density	12.75	3.30	175.16	17.64		239.72	14.40		183.44
Species diversity (H′)	3.68			3.95			3.72		
All birds — totals									
Species numbers	17			26			20		
Bird numbers and density	13.75		175.16	19.55		248.99	14.80		188.54
Species diversity (H′)	3.68			4.09			3.82		

* Species thought to be breeding in different stands

TABLE A1.4 *Sapling Aspen — Mean number of singing males per point (+ standard errors) and density/10 ha 1992 results*

Stand	S1			S2			S3		
species	Mean	S.E.	Density (No./10ha)	Mean	S.E.	Density (No./10ha)	Mean	S.E.	Density (No./10ha)
Ruffed Grouse*	0.50	0.25	6.37	0.73	0.19	9.26	0.00	0.00	0.00
Common Snipe	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.18	2.55
Northern Flicker	0.00	0.00	0.00	0.09	0.09	1.16	0.00	0.00	0.00
Rufous Hummingbird*	0.75	0.22	9.55	0.82	0.17	10.42	0.60	0.22	7.64
Calliope Hummingbird*	0.00	0.00	0.00	0.00	0.00	0.00	0.80	0.33	10.19
Dusky Flycatcher*	1.50	0.25	19.11	2.09	0.20	26.64	1.00	0.00	12.74
Least Flycatcher	0.50	0.25	6.37	0.73	0.96	9.27	0.00	0.00	0.00
Alder Flycatcher*	0.75	0.41	9.55	0.73	0.19	9.26	1.20	0.18	15.29
Western Wood Pewee*	0.00	0.00	0.00	0.09	0.09	1.16	0.00	0.00	0.00
Empidonax sp.	0.00	0.00	0.00	0.36	0.15	2.32	0.00	0.00	0.00
Black-capped Chickadee*	0.00	0.00	0.00	0.36	0.15	4.63	0.00	0.00	0.00
Red-Breasted Nuthatch*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ruby-crowned Kinglet	0.00	0.00	0.00	0.91	0.20	11.58	0.00	0.00	0.00
American Robin*	0.75	0.22	9.55	0.91	0.20	11.58	0.40	0.22	5.10
Swainson's Thrush*	0.50	0.25	6.37	1.55	0.20	19.69	1.00	0.00	12.74
Cedar Waxwing*	0.25	0.22	3.18	0.55	0.15	6.95	0.00	0.00	0.00
Warbling Vireo*	0.75	0.22	9.55	2.00	0.26	25.48	0.00	0.00	0.00
Yellow-rumped Warbler*	0.00	0.00	0.00	1.27	0.13	16.21	0.20	0.18	2.55
Orange-crowned Warbler*	1.00	0.00	12.74	1.09	0.16	13.90	0.80	0.18	10.19
Wilson's Warbler	0.25	0.22	3.19	0.18	0.12	2.32	0.20	0.18	2.55
MacGillivray's Warbler*	0.00	0.00	0.00	0.45	0.15	5.79	0.00	0.00	0.00
Tennessee Warbler	0.00	0.00	0.00	0.09	0.09	1.16	0.00	0.00	0.00
Common Yellowthroat	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.18	2.55
American Redstart*	1.25	0.22	15.92	1.18	0.17	15.06	0.00	0.00	0.00
Northern Waterthrush*	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.18	2.55
Western Tanager	0.00	0.00	0.00	0.09	0.09	1.16	0.00	0.00	0.00
Dark-eyed Junco*	0.75	0.22	9.55	0.91	0.09	11.58	0.80	0.18	10.19
Chipping Sparrow*	0.00	0.00	0.00	0.09	0.09	1.16	0.00	0.00	0.00
White-crowned Sparrow*	0.00	0.00	0.00	0.00	0.00	0.00	1.60	0.36	20.38
Song Sparrow*	0.00	0.00	0.00	0.18	0.12	2.32	0.00	0.00	0.00
Lincoln's Sparrow*	0.75	0.22	9.55	1.00	0.34	12.74	1.80	0.33	22.93
Clay-coloured Sparrow*	0.00	0.00	0.00	0.00	0.00	0.00	1.20	0.18	15.29
Savannah Sparrow*	0.00	0.00	0.00	0.00	0.00	0.00	0.40	0.22	5.10
Red-winged Blackbird*	0.75	0.41	9.55	0.00	0.00	0.00	0.00	0.00	0.00
Brown-headed Cowbird*	0.75	0.22	9.55	1.27	0.29	16.21	0.20	0.00	2.55
Breeding birds — totals									
Species numbers	14			19			15		
Bird numbers and density	11.00		140.13	17.27		220.04	12.20		155.41
Species diversity (H′)	3.59			3.83			3.53		
All birds — totals									
Species numbers	16			26			18		
Bird numbers and density	11.75		149.69	19.55		248.99	12.80		163.06
Species diversity (H′)	3.75			4.14			3.71		

* Species thought to be breeding in different stands

TABLE A1.5 *Mature Aspen — Mean number singing males per point (+ standard errors) and density/10 ha 1991 results*

Stand	A1			A2			A3		
species	Mean	S.E.	Density (No./10ha)	Mean	S.E.	Density (No./10ha)	Mean	S.E.	Density (No./10ha)
Ruffed Grouse*	0.67	0.19	8.49	0.45	0.15	5.79	0.43	0.28	5.46
Pileated Woodpecker*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hairy Woodpecker*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Downy Woodpecker*	0.17	0.15	2.12	0.00	0.00	0.00	0.14	0.13	1.82
Red-breasted Sapsucker*	0.00	0.00	0.00	0.09	0.09	1.16	0.00	0.00	0.00
Northern Flicker*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Rufous Hummingbird*	0.33	0.19	4.25	0.36	0.15	4.63	0.57	0.19	7.28
Dusky Flycatcher*	2.33	0.19	29.72	1.91	0.09	24.32	1.14	0.13	14.56
Least Flycatcher*	0.00	0.00	0.00	0.00	0.00	0.00	2.14	0.24	27.30
Western Wood Pewee*	0.00	0.00	0.00	0.09	0.09	1.16	0.71	0.17	9.10
Black-capped Chickadee*	0.83	0.28	10.62	0.82	0.17	10.42	1.00	0.20	12.74
Red-breasted Nuthatch*	0.17	0.15	2.12	0.55	0.15	6.95	0.00	0.00	0.00
Ruby-crowned Kinglet*	0.00	0.00	0.00	0.64	0.19	8.11	0.00	0.00	0.00
American Robin*	0.67	0.19	8.49	0.55	0.15	6.95	1.00	0.00	12.74
Hermit Thrush*	0.33	0.19	4.25	0.09	0.09	1.16	0.14	0.13	1.82
Swainson's Thrush*	0.50	0.20	6.37	1.09	0.16	13.90	1.43	0.19	18.20
Cedar Waxwing*	0.00	0.00	0.00	0.00	0.00	0.00	0.29	0.17	3.64
Solitary Vireo*	0.00	0.00	0.00	0.27	0.13	3.47	0.00	0.00	0.00
Warbling Vireo*	1.83	0.28	23.35	1.82	0.17	23.16	1.71	0.17	21.84
Red-eyed Vireo*	0.33	0.19	4.25	0.00	0.00	0.00	0.43	0.19	5.46
Yellow-rumped Warbler*	1.67	0.19	21.23	1.64	0.19	20.85	1.57	0.19	20.02
Orange-crowned Warbler*	0.33	0.19	4.25	0.82	0.17	10.42	0.71	0.17	9.10
MacGillivray's Warbler*	1.17	0.15	14.86	1.09	0.09	13.90	0.57	0.19	7.28
Townsend's Warbler	0.67	0.19	8.49	0.27	0.13	3.47	0.71	0.33	9.10
Wilson's Warbler	0.00	0.00	0.00	0.18	0.12	2.32	0.00	0.00	0.00
Blackpoll Warbler	0.00	0.00	0.00	0.09	0.09	1.16	0.00	0.00	0.00
American Redstart*	2.67	0.19	33.97	2.09	0.24	26.64	2.29	0.17	29.12
Northern Waterthrush*	0.00	0.00	0.00	0.00	0.00	0.00	0.14	0.13	1.82
Western Tanager*	0.83	0.15	10.62	0.27	0.13	3.47	0.00	0.00	0.00
Dark-eyed Junco*	1.50	0.20	19.11	0.91	0.16	11.58	1.00	0.20	12.74
Chipping Sparrow*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Song Sparrow*	0.00	0.00	0.00	0.00	0.00	0.00	0.14	0.13	1.82
Lincoln's Sparrow*	0.00	0.00	0.00	0.09	0.09	1.16	0.14	0.13	1.82
Red-winged Blackbird	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pine Siskin	0.17	0.15	2.13	0.00	0.00	0.00	0.00	0.00	0.00
Purple Finch*	0.17	0.15	2.12	0.45	0.20	5.79	0.29	0.17	3.64
Brown-headed Cowbird*	1.00	0.24	12.74	0.27	0.13	3.47	1.14	0.13	14.56
Breeding birds — totals									
Species numbers	19			22			23		
Bird numbers and density	17.50		222.93	16.36		208.45	19.14		243.85
Species diversity (H′)	3.70			3.87			3.98		
All birds — totals									
Species numbers	21			25			24		
Bird numbers and density	18.33		233.55	16.91		215.40	19.86		252.96
Species diversity (H′)	3.56			3.72			3.70		

* Species thought to be breeding in different stands

TABLE A1.5 *(Continued)*

Stand species	A4 Mean	A4 S.E.	A4 Density (No./10ha)	A5 Mean	A5 S.E.	A5 Density (No./10ha)
Ruffed Grouse*	0.42	0.16	5.31	0.25	0.15	3.18
Pileated Woodpecker*	0.17	0.12	2.12	0.00	0.00	0.00
Hairy Woodpecker*	0.17	0.12	2.12	0.38	0.17	4.78
Downy Woodpecker*	0.08	0.09	1.06	0.13	0.12	1.59
Red-breasted Sapsucker*	0.08	0.09	1.06	0.00	0.00	0.00
Northern Flicker*	0.00	0.00	0.00	0.13	0.12	1.59
Rufous Hummingbird*	0.42	0.16	5.31	0.63	0.17	7.96
Dusky Flycatcher*	1.33	0.15	16.99	1.13	0.21	14.33
Least Flycatcher*	2.08	0.20	26.54	2.88	0.12	36.62
Western Wood Pewee*	0.83	0.17	10.62	1.13	0.12	14.33
Black-capped Chickadee*	0.92	0.20	11.68	0.50	0.18	6.37
Red-breasted Nuthatch*	0.08	0.09	1.06	0.00	0.00	0.00
Ruby-crowned Kinglet*	0.08	0.09	1.06	0.25	0.15	3.18
American Robin*	1.25	0.19	15.92	2.25	0.42	28.66
Hermit Thrush*	0.67	0.20	8.49	0.63	0.17	7.96
Swainson's Thrush*	0.67	0.20	8.49	0.75	0.15	9.55
Cedar Waxwing*	0.00	0.00	0.00	0.50	0.35	6.37
Solitary Vireo*	0.08	0.09	1.06	0.13	0.12	1.59
Warbling Vireo*	1.50	0.16	19.11	1.13	0.21	14.33
Red-eyed Vireo*	0.58	0.16	7.43	0.38	0.17	4.78
Yellow-rumped Warbler*	1.75	0.19	22.29	1.38	0.17	17.52
Orange-crowned Warbler*	0.92	0.24	11.68	0.38	0.17	4.78
MacGillivray's Warbler*	0.33	0.15	4.25	0.38	0.25	4.78
Townsend's Warbler	0.50	0.14	6.37	0.25	0.15	3.19
Wilson's Warbler	0.33	0.14	4.25	0.13	0.12	1.59
Blackpoll Warbler	0.00	0.00	0.00	0.00	0.00	0.00
American Redstart*	2.08	0.38	26.54	1.75	0.23	22.29
Northern Waterthrush*	0.42	0.16	5.31	0.38	0.17	4.78
Western Tanager*	0.25	0.19	3.18	0.38	0.17	4.78
Dark-eyed Junco*	1.25	0.19	15.92	1.38	0.17	17.52
Chipping Sparrow*	0.00	0.00	0.00	0.00	0.00	0.00
Song Sparrow*	0.17	0.12	2.12	0.00	0.00	0.00
Lincoln's Sparrow*	0.00	0.00	0.00	0.13	0.12	1.59
Red-winged Blackbird	0.33	0.14	4.25	0.13	0.12	1.59
Pine Siskin	0.17	0.11	2.12	0.00	0.00	0.00
Purple Finch*	0.25	0.14	3.18	0.13	0.12	1.59
Brown-headed Cowbird*	0.92	0.08	11.68	2.13	0.33	27.70
Breeding birds — totals						
Species numbers	28	0.00	0.00	27	0.00	0.00
Bird numbers and density	19.75	0.00	251.59	21.50	0.00	274.00
Species diversity (H′)	4.16	0.00	0.00	4.10	0.00	0.00
All birds — totals						
Species numbers	32	0.00	0.00	30	0.00	0.00
Bird numbers and density	21.08	0.00	268.59	22.00	0.00	280.89
Species diversity (H′)	3.94	0.00	0.00	4.11	0.00	0.00

* Species thought to be breeding in different stands

TABLE A1.6 *Mature Aspen — Mean number of singing males per point (+ standard errors) and density/10 ha, 1992 results*

Stand	A1			A2			A3		
species	Mean	S.E.	Density (No./10ha)	Mean	S.E.	Density (No./10ha)	Mean	S.E.	Density (No./10ha)
Northern Goshawk	0.17	0.15	2.12	0.00	0.00	0.00	0.00	0.00	0.00
Ruffed Grouse*	0.33	0.19	4.25	0.09	0.09	1.16	0.20	0.18	2.55
Great-horned Owl	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pileated Woodpecker*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hairy Woodpecker*	0.00	0.00	0.00	0.09	0.09	1.16	0.00	0.00	0.00
Downy Woodpecker*	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.18	2.55
Red-breasted Sapsucker*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Northern Flicker*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Rufous Hummingbird*	0.33	0.19	4.25	0.27	0.13	3.47	0.20	0.18	2.55
Dusky Flycatcher*	1.50	0.20	19.11	1.82	0.22	23.16	1.60	0.22	20.38
Least Flycatcher*	0.17	0.15	2.12	0.36	0.15	4.63	2.40	0.22	30.57
Western Wood Pewee*	0.17	0.15	2.12	0.18	0.12	2.32	0.80	0.18	10.19
Black-capped Chickadee*	0.33	0.19	4.25	0.55	0.15	6.95	0.80	0.18	10.19
Red-breasted Nuthatch*	0.00	0.00	0.00	0.18	0.12	2.32	0.00	0.00	0.00
Brown Creeper	0.00	0.00	0.00	0.09	0.09	1.16	0.00	0.00	0.00
Ruby-crowned Kinglet*	0.17	0.15	2.12	0.36	0.15	4.63	0.00	0.00	0.00
American Robin*	0.83	0.28	10.62	0.55	0.15	6.95	1.00	0.00	12.74
Varied Thrush	0.00	0.00	0.00	0.45	0.15	5.79	0.00	0.00	0.00
Hermit Thrush*	0.17	0.15	2.12	0.18	0.12	2.32	0.60	0.22	7.64
Swainson's Thrush*	1.00	0.41	12.74	0.73	0.26	9.26	0.80	0.18	10.19
Cedar Waxwing*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Solitary Vireo*	0.17	0.15	2.12	0.00	0.00	0.00	0.00	0.00	0.00
Warbling Vireo*	2.17	0.15	27.60	1.64	0.19	20.85	1.40	0.22	17.83
Red-eyed Vireo*	0.00	0.00	0.00	0.00	0.00	0.00	0.40	0.22	5.10
Yellow-rumped Warbler*	1.67	0.19	21.23	1.55	0.15	19.69	1.60	0.22	20.38
Orange-crowned Warbler*	0.83	0.15	10.62	0.45	0.15	5.79	0.20	0.18	2.55
MacGillivray's Warbler*	1.00	0.24	12.74	0.82	0.12	10.42	0.40	0.22	5.10
Townsend's Warbler	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Wilson's Warbler	0.67	0.30	8.49	0.18	0.12	2.32	0.20	0.18	2.55
Magnolia Warbler	0.00	0.00	0.00	0.27	0.19	3.47	0.00	0.00	0.00
American Redstart*	3.17	0.28	40.34	1.82	0.25	23.16	2.20	0.18	28.03
Northern Waterthrush*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Western Tanager*	0.17	0.15	2.12	0.27	0.13	3.47	0.00	0.00	0.00
Dark-eyed Junco*	1.17	0.15	14.86	0.82	0.12	10.42	1.20	0.18	15.29
Chipping Sparrow*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Song Sparrow*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Lincoln's Sparrow*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pine Siskin	0.17	0.15	2.12	0.18	0.12	2.32	0.40	0.36	5.10
Purple Finch*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Evening Grosbeak	0.00	0.00	0.00	0.09	0.09	1.16	0.60	0.54	7.64
Brown-headed Cowbird*	0.50	0.20	6.37	0.45	0.15	5.79	1.00	0.00	12.74
Breeding birds — totals									
Species numbers	19			20			18		
Bird numbers and density	15.83		201.70	13.18		167.92	17.00		216.56
Species diversity (H′)	3.56			3.72			3.70		
All birds — totals									
Species numbers	22			26			21		
Bird numbers and density	16.38		214.44	14.45		184.13	18.20		231.85
Species diversity (H′)	3.74			4.01			3.89		

* Species thought to be breeding in different stands

TABLE A1.6 *(Continued)*

Stand species	A4 Mean	A4 S.E.	A4 Density (No./10ha)	A5 Mean	A5 S.E.	A5 Density (No./10ha)
Northern Goshawk	0.00	0.00	0.00	0.00	0.00	0.00
Ruffed Grouse*	0.25	0.13	3.18	0.00	0.00	0.00
Great-horned Owl	0.08	0.08	1.62	0.00	0.00	0.00
Pileated Woodpecker*	0.00	0.00	0.00	0.00	0.00	0.00
Hairy Woodpecker*	0.08	0.08	1.06	0.00	0.00	0.00
Downy Woodpecker*	0.08	0.08	1.06	0.38	0.17	4.78
Red-breasted Sapsucker*	0.00	0.00	0.00	0.00	0.00	0.00
Northern Flicker*	0.00	0.00	0.00	0.00	0.00	0.00
Rufous Hummingbird*	0.25	0.13	3.18	0.38	0.17	4.78
Dusky Flycatcher*	1.75	0.21	22.29	1.50	0.18	19.11
Least Flycatcher*	1.67	0.22	21.23	2.13	0.28	27.07
Western Wood Pewee*	0.58	0.14	7.43	0.88	0.12	11.15
Black-capped Chickadee*	0.42	0.14	5.31	0.63	0.17	7.96
Red-breasted Nuthatch*	0.17	0.11	2.12	0.38	0.17	4.78
Brown Creeper	0.00	0.00	0.00	0.00	0.00	0.00
Ruby-crowned Kinglet*	0.17	0.11	2.12	0.00	0.00	0.00
American Robin*	0.75	0.13	9.55	0.63	0.25	7.96
Varied Thrush	0.00	0.00	0.00	0.00	0.00	0.00
Hermit Thrush*	0.08	0.08	1.06	0.63	0.17	7.96
Swainson's Thrush*	0.42	0.14	5.31	0.63	0.25	7.96
Cedar Waxwing*	0.00	0.00	0.00	0.00	0.00	0.00
Solitary Vireo*	0.08	0.08	1.06	0.38	0.17	4.78
Warbling Vireo*	1.00	0.12	12.74	0.88	0.12	11.15
Red-eyed Vireo*	0.33	0.14	4.25	0.75	0.15	9.55
Yellow-rumped Warbler*	1.67	0.14	21.23	1.50	0.18	19.11
Orange-crowned Warbler*	1.00	0.12	12.74	0.75	0.15	9.55
MacGillivray's Warbler*	0.33	0.14	4.25	0.50	0.18	6.37
Townsend's Warbler	0.33	0.18	2.25	0.63	0.25	7.96
Wilson's Warbler	1.17	0.20	14.86	1.25	0.46	15.92
Magnolia Warbler	0.00	0.00	0.00	0.00	0.00	0.00
American Redstart*	2.17	0.16	27.60	1.50	0.31	19.11
Northern Waterthrush*	0.25	0.13	3.18	0.50	0.18	6.37
Western Tanager*	0.08	0.08	1.06	0.13	0.12	1.59
Dark-eyed Junco*	1.42	0.14	18.05	1.13	0.12	14.33
Chipping Sparrow*	0.00	0.00	0.00	0.00	0.00	0.00
Song Sparrow*	0.08	0.08	1.06	0.13	0.12	1.59
Lincoln's Sparrow*	0.00	0.00	0.00	0.25	0.15	3.18
Pine Siskin	0.08	0.08	1.06	0.00	0.00	0.00
Purple Finch*	0.25	0.13	3.18	0.00	0.00	0.00
Evening Grosbeak	0.00	0.00	0.00	0.00	0.00	0.00
Brown-headed Cowbird*	1.25	0.17	15.92	1.25	0.29	15.92
Breeding birds — totals						
Species numbers	26	0.00	0.00	23	0.00	0.00
Bird numbers and density	16.58	211.25	0.00	17.75	0.00	226.12
Species diversity (H')	3.94	0.00	0.00	4.11	0.00	0.00
All birds — totals						
Species numbers	30	0.00	0.00	25	0.00	0.00
Bird numbers and density	18.25	232.48	0.00	19.63	0.00	250.00
Species diversity (H')	4.12	0.00	0.00	4.24	0.00	0.00

* Species thought to be breeding in different stands

TABLE A1.7 *Old Aspen — Mean number of singing males per point (+ standard errors) and density/10 ha, 1991 results*

Stand	O1			O2		
species	Mean	S.E.	Density (No./10ha)	Mean	S.E.	Density (No./10ha)
Ruffed Grouse*	0.25	0.15	3.18	0.67	0.27	8.49
Pileated Woodpecker*	0.00	0.00	0.00	0.33	0.27	4.25
Hairy Woodpecker*	0.25	0.15	3.18	0.00	0.00	0.00
Downy Woodpecker*	0.00	0.00	0.00	0.33	0.27	4.25
Three-toed Woodpecker*	0.25	0.15	3.18	0.00	0.00	0.00
Red-breasted Sapsucker*	0.00	0.00	0.00	0.00	0.00	0.00
Northern Flicker*	0.13	0.12	1.59	0.33	0.27	4.25
Rufous Hummingbird*	0.63	0.17	7.96	0.67	0.27	8.49
Dusky Flycatcher*	2.00	0.18	25.48	2.67	0.27	33.97
Least Flycatcher*	1.63	0.25	20.70	2.00	0.47	25.48
Western Wood Pewee*	0.88	0.21	11.15	1.00	0.47	12.74
Gray Jay	0.13	0.12	1.59	0.00	0.00	0.00
Black-capped Chickadee*	0.88	0.12	11.15	1.33	0.27	16.99
Red-breasted Nuthatch*	0.88	0.12	11.15	1.00	0.00	12.74
Ruby-crowned Kinglet*	0.00	0.00	0.00	0.33	0.27	4.25
American Robin*	1.38	0.17	17.52	1.33	0.27	16.99
Hermit Thrush*	0.75	0.15	9.55	0.00	0.00	0.00
Swainson's Thrush*	1.13	0.12	14.33	0.33	0.27	4.25
Cedar Waxwing*	0.25	0.15	3.18	0.00	0.00	0.00
Solitary Vireo*	0.00	0.00	0.00	0.00	0.00	0.00
Warbling Vireo*	1.13	0.21	14.33	1.33	0.27	16.99
Red-eyed Vireo*	0.88	0.21	11.15	0.33	0.27	4.25
Yellow-rumped Warbler*	1.75	0.15	22.29	2.00	0.00	25.48
Orange-crowned Warbler*	1.50	0.18	19.11	1.33	0.27	16.99
MacGillivray's Warbler*	1.13	0.12	14.33	1.00	0.00	12.74
Townsend's Warbler	0.25	0.15	3.19	0.67	0.27	8.49
Wilson's Warbler	0.25	0.15	3.19	0.67	0.27	8.49
Yellow Warbler	0.25	0.15	3.19	0.00	0.00	0.00
American Redstart*	3.13	0.12	39.81	2.00	0.47	25.48
Northern Waterthrush*	0.50	0.35	6.37	0.00	0.00	0.00
Western Tanager*	0.25	0.15	3.18	0.00	0.00	0.00
Dark-eyed Junco*	1.25	0.15	15.92	1.67	0.54	21.23
Chipping Sparrow*	0.00	0.00	0.00	0.33	0.27	4.25
Song Sparrow*	0.00	0.00	0.00	0.00	0.00	0.00
Lincoln's Sparrow*	0.00	0.00	0.00	0.00	0.00	0.00
Red-winged Blackbird	0.13	0.12	1.59	0.00	0.00	0.00
Pine Siskin	0.00	0.00	0.00	0.33	0.27	4.25
Purple Finch*	0.13	0.12	1.59	0.33	0.27	4.25
Brown-headed cowbird*	1.00	0.00	12.74	1.00	0.00	12.74
Breeding birds — totals						
Species number	25			23		
Number birds and density	23.88		304.14	23.67		301.49
Species diversity (H′)	4.15			4.09		
All Birds — totals						
Species number	30			26		
Number birds and density	24.88		316.89	25.33		322.72
Species diversity (H′)	4.31			4.26		

* Species thought to be breeding in different stands

TABLE A1.8 *Old Aspen — Mean number of singing males per point (+ standard errors) and density/10 ha, 1992 results*

Stand	O1			O2		
species	Mean	S.E.	Density (No./10ha)	Mean	S.E.	Density (No./10ha)
Ruffed Grouse*	0.13	0.11	1.59	0.00	0.00	0.00
Pileated Woodpecker*	0.00	0.00	0.00	0.33	0.27	4.25
Hairy Woodpecker*	0.25	0.14	3.18	0.00	0.00	0.00
Downy Woodpecker*	0.25	0.14	3.18	0.00	0.00	0.00
Red-breasted Sapsucker*	0.00	0.00	0.00	0.33	0.27	4.25
Northern Flicker*	0.00	0.00	0.00	0.00	0.00	0.00
Rufous Hummingbird*	0.75	0.14	9.55	0.67	0.27	8.49
Dusky Flycatcher*	2.00	0.24	25.48	1.67	0.27	21.23
Least Flycatcher*	1.38	0.37	17.52	1.33	0.27	16.99
Western Wood Pewee*	0.88	0.11	11.15	0.33	0.27	4.25
Black-capped Chickadee*	0.88	0.26	11.15	0.67	0.27	8.49
Red-breasted Nuthatch*	0.50	0.17	6.37	0.67	0.27	8.49
Ruby-crowned Kinglet*	0.13	0.11	1.59	1.33	0.27	16.99
American Robin*	1.13	0.26	14.33	1.33	0.27	16.99
Hermit Thrush*	0.25	0.14	3.18	0.00	0.00	0.00
Swainson's Thrush*	1.50	0.24	19.11	0.67	0.27	8.49
Cedar Waxwing*	0.50	0.33	6.37	0.00	0.00	0.00
Solitary Vireo*	0.25	0.14	3.18	0.00	0.00	0.00
Warbling Vireo*	1.88	0.20	23.89	1.33	0.27	16.99
Red-eyed Vireo*	1.00	0.24	12.74	0.00	0.00	0.00
Yellow-rumped Warbler*	1.63	0.16	20.70	2.00	0.00	25.48
Orange-crowned Warbler*	1.38	0.29	17.52	1.33	0.27	16.99
MacGillivray's Warbler*	0.75	0.22	9.55	1.00	0.00	12.74
Townsend's Warbler	0.50	0.17	6.37	0.00	0.00	0.00
Wilson's Warbler	1.13	0.20	14.33	0.67	0.27	8.49
Yellow Warbler	0.13	0.11	1.59	0.00	0.00	0.00
American Redstart*	2.88	0.26	36.62	1.67	0.27	21.23
Northern Waterthrush*	0.63	0.16	7.96	0.00	0.00	0.00
Western Tanager*	0.25	0.14	3.18	0.33	0.27	4.25
Dark-eyed Junco*	1.38	0.16	17.52	1.00	0.00	12.74
Chipping Sparrow*	0.00	0.00	0.00	0.00	0.00	0.00
Song Sparrow*	0.00	0.00	0.00	0.67	0.27	8.49
Lincoln's Sparrow*	0.25	0.14	3.18	0.33	0.27	4.25
Pine Siskin	0.00	0.00	0.00	0.33	0.27	4.25
Purple Finch*	0.13	0.11	1.59	0.67	0.27	8.49
Evening Grosbeak	0.50	0.33	6.37	0.00	0.00	0.00
Brown-headed Cowbird*	1.00	0.00	12.74	0.33	0.27	4.25
Breeding birds — totals						
Species numbers	27			22		
Bird numbers and density	23.88		304.14	20.00		254.78
Species diversity (H')	4.21			4.11		
All birds — totals						
Species numbers	31			24		
Bird numbers and density	26.13		332.80	21.00		267.52
Species diversity (H')	4.40			4.22		

* Species thought to be breeding in different stands

TABLE A1.9 *Mixed Conifer/Aspen — Mean number of singing males per point (+ standard errors) and density/ 10 ha, 1991 results*

Stand	M1			M2			M3		
species	Mean	S.E.	Density (No./10ha)	Mean	S.E.	Density (No./10ha)	Mean	S.E.	Density (No./10ha)
Northern Goshawk*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ruffed Grouse*	0.80	0.18	10.19	0.38	0.17	4.78	0.00	0.00	0.00
Pileated Woodpecker*	0.00	0.00	0.00	0.00	0.00	0.00	0.14	0.13	1.82
Hairy Woodpecker*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Downy Woodpecker*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Three-toed Woodpecker*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Northern Flicker*	0.20	0.18	2.55	0.00	0.00	0.00	0.00	0.00	0.00
Rufous Hummingbird*	0.60	0.22	7.64	0.25	0.15	3.18	0.29	0.17	3.64
Dusky Flycatcher*	1.40	0.22	17.83	0.75	0.23	9.55	1.00	0.00	12.74
Least Flycatcher*	2.00	0.63	25.48	0.13	0.12	1.59	0.14	0.13	1.82
Western Wood Pewee*	0.80	0.18	10.19	0.13	0.12	1.59	0.57	0.19	7.28
Gray Jay*	0.00	0.00	0.00	0.25	0.15	3.18	0.29	0.17	3.64
Common Raven	0.20	0.18	2.55	0.00	0.00	0.00	0.00	0.00	0.00
Black-capped Chickadee*	1.40	0.22	17.83	0.50	0.25	6.37	0.43	0.19	5.46
Red-breasted Nuthatch*	0.80	0.18	10.19	0.63	0.17	7.96	1.14	0.13	14.56
Brown Creeper*	0.00	0.00	0.00	0.00	0.00	0.00	0.14	0.13	1.82
Winter Wren*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Golden-crowned Kinglet*	0.80	0.18	10.19	1.25	0.15	15.92	1.00	0.00	12.74
Ruby-crowned Kinglet*	1.60	0.22	20.38	1.38	0.17	17.52	2.43	0.19	30.94
American Robin*	1.00	0.28	12.74	1.13	0.21	14.33	0.86	0.24	10.92
Varied Thrush*	0.00	0.00	0.00	0.00	0.00	0.00	0.43	0.28	5.46
Hermit Thrush*	0.00	0.00	0.00	0.25	0.15	3.18	0.14	0.13	1.82
Swainson's Thrush*	1.20	0.18	15.29	1.50	0.18	19.11	1.43	0.19	18.20
Cedar Waxwing*	0.20	0.18	2.55	0.13	0.12	1.59	0.00	0.00	0.00
Solitary Vireo*	0.60	0.22	7.64	0.88	0.21	11.15	0.57	0.19	7.28
Warbling Vireo*	1.60	0.22	20.38	1.00	0.25	12.74	0.86	0.13	10.92
Red-eyed Vireo*	0.00	0.00	0.00	0.00	0.00	0.00	0.29	0.17	3.64
Yellow-rumped Warbler*	2.00	0.28	25.48	1.88	0.21	23.89	2.00	0.29	25.48
Orange-crowned Warbler*	0.80	0.33	10.19	0.13	0.12	1.59	1.43	0.19	18.20
MacGillivray's Warbler*	1.00	0.28	12.74	0.00	0.00	0.00	1.43	0.19	18.20
Townsend's Warbler	0.80	0.18	10.19	0.63	0.25	7.96	0.29	0.26	3.64
Wilson's Warbler	0.20	0.18	2.55	0.88	0.12	11.15	0.29	0.17	3.64
Magnolia Warbler*	0.00	0.00	0.00	0.00	0.00	0.00	1.14	0.43	14.56
Blackpoll Warbler*	0.00	0.00	0.00	0.13	0.12	1.59	0.00	0.00	0.00
Yellow Warbler	0.20	0.18	2.55	0.00	0.00	0.00	0.00	0.00	0.00
Common Yellowthroat	0.20	0.18	2.55	0.00	0.00	0.00	0.00	0.00	0.00
American Redstart*	2.20	0.18	28.03	2.13	0.21	27.07	1.86	0.13	23.66
Northern Waterthrush*	0.60	0.22	7.64	0.13	0.12	1.59	0.43	0.19	5.46
Western Tanager*	0.40	0.22	5.10	0.25	0.15	3.18	0.71	0.17	9.10
Dark-eyed Junco*	1.20	0.18	15.29	1.25	0.15	15.92	1.14	0.24	14.56
Chipping Sparrow*	0.00	0.00	0.00	0.25	0.23	3.18	0.00	0.00	0.00
Song Sparrow	0.20	0.18	2.55	0.00	0.00	0.00	0.00	0.00	0.00
Pine Siskin*	0.20	0.18	2.55	1.25	0.23	15.92	0.43	0.19	5.46
Purple Finch*	0.20	0.18	2.55	0.38	0.17	4.78	1.00	0.20	12.74
Red Crossbill*	0.00	0.00	0.00	0.75	0.58	9.55	0.00	0.00	0.00
Brown-headed Cowbird*	1.20	0.18	15.29	1.50	0.18	19.11	1.14	0.13	14.56
Breeding birds - totals									
Species numbers	25			28			29		
Bird numbers and density	24.80		315.92	20.50		261.15	24.86		316.62
Species diversity (H′)	4.38			4.30			4.36		
All birds - totals									
Species numbers	31			30			31		
Bird numbers and density	26.60		338.86	22.00		280.26	25.43		323.93
Species diversity (H′)	4.47			4.34			4.45		

* Species thought to be breeding in different stands

TABLE A1.10 *Mixed Conifer/Aspen — Mean number of singing males per point (+ standard errors) and density/ha, 1992 results*

Stand species	M1			M2			M3		
	Mean	S.E.	Density (No./10ha)	Mean	S.E.	Density (No./10ha)	Mean	S.E.	Density (No./10ha)
Northern Goshawk*	0.00	0.00	0.00	0.13	0.12	1.59	0.00	0.00	0.00
Ruffed Grouse*	0.20	0.18	2.55	0.25	0.15	3.18	0.00	0.00	0.00
Common Snipe	0.40	0.22	5.10	0.00	0.00	0.00	0.00	0.00	0.00
Great-horned Owl	0.00	0.00	0.00	0.13	0.12	1.59	0.00	0.00	0.00
Pileated Woodpecker*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hairy Woodpecker*	0.00	0.00	0.00	0.13	0.12	1.59	0.00	0.00	0.00
Downy Woodpecker*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Three-toed Woodpecker*	0.00	0.00	0.00	0.00	0.00	0.00	0.14	0.13	1.82
Northern Flicker*	0.40	0.22	5.10	0.00	0.00	0.00	0.00	0.00	0.00
Rufous Hummingbird*	1.00	0.00	12.74	0.25	0.15	3.18	0.29	0.17	3.64
Dusky Flycatcher*	2.00	0.00	25.48	1.25	0.15	15.92	1.43	0.19	18.20
Least Flycatcher*	1.40	0.46	17.83	0.25	0.15	3.18	0.14	0.13	1.82
Western Wood Pewee*	0.80	0.18	10.19	0.25	0.15	3.18	0.43	0.19	5.46
Gray Jay*	0.00	0.00	0.00	0.13	0.12	1.59	0.29	0.17	3.64
Black-capped Chickadee*	1.00	0.00	12.74	1.00	0.00	12.74	0.29	0.17	3.64
Red-breasted Nuthatch*	1.00	0.00	12.74	0.75	0.23	9.55	1.43	0.19	18.20
Brown Creeper*	0.00	0.00	0.00	0.00	0.00	0.00	0.14	0.13	1.82
Winter Wren*	0.00	0.00	0.00	0.00	0.00	0.00	0.86	0.13	10.92
Golden-crowned Kinglet*	0.60	0.22	7.64	1.00	0.00	12.74	1.00	0.00	12.74
Ruby-crowned Kinglet*	1.20	0.18	15.29	1.63	0.17	20.70	2.14	0.13	27.30
American Robin*	1.00	0.00	12.74	1.00	0.18	12.74	1.29	0.17	16.38
Varied Thrush*	0.00	0.00	0.00	0.13	0.12	1.59	0.14	0.13	1.82
Hermit Thrush*	0.00	0.00	0.00	0.13	0.12	1.59	0.00	0.00	0.00
Swainson's Thrush*	1.40	0.22	17.83	1.38	0.17	17.52	1.43	0.28	18.20
Cedar Waxwing*	0.60	0.22	7.64	0.00	0.00	0.00	0.14	0.13	1.82
Solitary Vireo*	0.60	0.22	7.64	0.75	0.23	9.55	0.57	0.19	7.28
Warbling Vireo*	1.60	0.22	20.38	1.25	0.15	15.92	0.57	0.19	7.28
Red-eyed Vireo*	0.40	0.22	5.10	0.00	0.00	0.00	0.00	0.00	0.00
Yellow-rumped Warbler*	2.00	0.00	25.48	2.00	0.18	25.48	1.86	0.24	23.66
Orange-crowned Warbler*	0.60	0.22	7.64	0.50	0.18	6.37	0.71	0.17	9.10
MacGillivray's Warbler*	0.20	0.18	2.55	0.25	0.15	3.18	0.57	0.28	7.28
Wilson's Warbler	0.80	0.33	10.19	0.50	0.18	6.37	0.14	0.13	1.82
Magnolia Warbler*	0.20	0.18	2.55	0.00	0.00	0.00	0.71	0.17	9.10
Blackpoll Warbler*	0.00	0.00	0.00	0.13	0.12	1.59	0.00	0.00	0.00
Yellow Warbler	0.00	0.00	0.00	0.13	0.12	1.59	0.00	0.00	0.00
American Redstart*	2.00	0.28	25.48	1.75	0.29	22.29	1.14	0.24	14.56
Northern Waterthrush*	0.60	0.22	7.64	0.38	0.17	4.78	0.29	0.17	3.64
Western Tanager*	0.40	0.22	5.10	0.38	0.17	4.78	0.57	0.28	7.28
Dark-eyed Junco*	1.20	0.18	15.29	1.38	0.17	17.52	1.29	0.33	16.38
Chipping Sparrow*	0.60	0.22	7.64	0.13	0.12	1.59	0.00	0.00	0.00
Song Sparrow	0.20	0.18	2.55	0.00	0.00	0.00	0.00	0.00	0.00
Lincoln's Sparrow	0.00	0.00	0.00	0.13	0.12	1.59	0.00	0.00	0.00
Pine Siskin*	0.20	0.18	2.55	1.25	0.23	15.92	0.57	0.19	7.28
Purple Finch*	0.20	0.18	2.55	0.38	0.17	4.78	0.57	0.19	7.28
Red Crossbill*	0.00	0.00	0.00	0.00	0.00	0.00	0.14	0.13	1.82
Evening Grosbeak	0.00	0.00	0.00	0.00	0.00	0.00	0.14	0.13	1.82
Brown-headed Cowbird*	1.00	0.00	12.74	1.38	0.13	17.52	0.14	0.35	1.82
Breeding birds - totals									
Species numbers	28			30				30	
Bird numbers and density	24.40		310.83	21.50		273.89		21.29	271.16
Species diversity (H')	4.38			4.30			4.36		
All birds - totals									
Species numbers	31			34				32	
Bird numbers and density	25.80		328.67	22.38		285.03		21.57	274.80
Species diversity (H')	4.51			4.42				4.41	

* Species thought to be breeding in different stands

TABLE A2.1 *Means of habitat variables for conifer plots, 1992*

Seral stage	Stand	No. Plots	Cover (%) Deciduous	Conifer tree	Tall shrub	Low shrub	Herb
Conifer	1	2	0.00	65.00	22.50	75.00	45.00
Conifer	2	3	5.00	43.50	21.70	63.30	63.30
Conifer	3	3	5.00	36.70	35.00	70.00	66.70

Seral stage		Height					Cover (%)		# snag
		Deciduous	Conifer	Tall shrub	Low shrub	Herb	Bare Grnd.	CWD	/ha
Conifer	1	0.00	21.80	5.00	1.00	0.60	3.50	1.00	4.00
Conifer	2	-	26.70	6.50	0.80	0.70	3.30	5.00	4.70
Conifer	3	-	24.30	8.70	1.00	0.80	2.30	5.30	3.70

Seral stage	Stand	No.	Canopy	Stems/ha		Basal Area (m^2)		Average dbh (cm)	
		Plots	Depth	Deciduous	Conifer	Deciduous	Conifer	Deciduous	Conifer
Conifer	1	2	9.20	0.00	945.60	0.00	36.00	0.00	20.30
Conifer	2	3	9.60	-	616.40	-	34.00	-	27.40
Conifer	3	3	13.20	-	450.50	-	30.00	-	30.10

Seral stage	Stand	Horizontal Foliage Cover (%)					
		3'	6'	9'	12'	15'	18'
Conifer	1	26.70	6.00	17.00	23.00	25.00	17.00
Conifer	2	58.00	44.00	33.00	45.00	35.00	35.00
Conifer	3	68.00	60.00	51.00	55.00	52.00	50.00

TABLE A2.2 *Bird data for conifer stands: Mean detections/point + standard errors, density/100 ha, and species diversity index (H')*

Species	Conifer 1			Conifer 2			Conifer 3		
	Mean Detections /point	S.E.	Dens /10ha	Mean Detections /point	S.E.	Dens /10ha	Mean Detections /point	S.E.	Dens /10ha
Rufous Hummingbird	0.00	0.00	0.00	0.33	0.27	4.2	0.33	0.27	4.2
Dusky Flycatcher	0.50	0.35	6.40	1.00	0.00	12.7	0.33	0.27	4.2
Western Wood Pewee	0.00	0.00	0.00	1.00	0.00	12.4	0.33	0.27	4.2
Gray Jay	0.00	0.00	0.00	1.00	0.47	12.7	0.33	0.27	4.2
Black-capped Chickadee	0.00	0.00	0.00	0.67	0.27	8.5	0.67	0.27	8.5
Red-breasted Nuthatch	1.00	0.00	12.70	1.00	0.00	12.7	0.33	0.27	4.2
Winter Wren	0.00	0.00	0.00	0.33	0.27	4.2	0.67	0.27	8.5
Golden-crowned Kinglet	0.50	0.35	6.40	1.33	0.27	17.0	1.00	0.00	12.7
Ruby-crowned Kinglet	0.50	0.35	6.40	1.33	0.27	17.0	1.67	0.27	21.2
American Robin	1.00	0.00	12.70	1.67	0.27	21.2	0.67	0.54	8.5
Varied Thrush	1.00	0.00	12.70	0.00	0.00	0.0	0.00	0.00	0.0
Swainson's Thrush	0.50	0.35	6.40	1.00	0.00	12.7	1.00	0.00	12.7
Cedar Waxwing	0.50	0.35	6.40	0.00	0.00	0.0	0.00	0.00	0.0
Solitary Vireo	1.00	0.00	12.70	0.00	0.00	0.0	0.33	0.27	4.2
Warbling Vireo	0.50	0.35	6.40	0.00	0.00	0.0	0.33	0.27	4.2
Yellow-rumped Warbler	1.00	0.00	12.70	1.33	0.27	17.0	1.67	0.27	21.2
Orange-crowned Warbler	0.00	0.00	0.00	1.00	0.00	12.7	0.67	0.27	8.5
MacGillivray's Warbler	0.00	0.00	0.00	0.33	0.27	4.2	0.33	0.27	4.2
Magnolia Warbler	0.00	0.00	0.00	1.00	0.47	12.7	1.00	0.00	12.7
American Redstart	1.00	0.00	12.70	0.67	0.27	8.5	0.67	0.27	8.5
Northern Waterthrush	0.00	0.00	0.00	0.00	0.00	0.0	0.67	0.27	8.5
Western Tanager	0.50	0.35	6.40	0.00	0.00	0.0	0.67	0.27	8.5
Dark-eyed Junco	0.50	0.35	6.40	0.67	0.27	8.5	0.67	0.27	8.5
Pine Siskin	0.50	0.35	6.40	1.00	0.00	12.7	1.00	0.00	12.7
Purple Finch	0.00	0.00	0.00	0.00	0.00	0.0	0.67	0.27	8.5
Total number of species	15			18			23		
Total number of individuals + Standard Error	10.50	3.18		16.67	3.66		16.00	5.44	
Total density/10ha			133.76			212.31			203.82
Species diversity (H')			3.71			3.93			4.20

TABLE A3.1 *Standard partial regression coefficients*

Species	Variable	1991	1992
Dusky Flycatcher	% foliage @ 3'	0.632	
	% cover herb	0.549	
Black-capped Chickadee	height tall shrubs	0.601	0.415
	log number snags	0.309	0.483
Rufous Hummingbird	herb height	0.360	0.491
	% cover bare ground	0.783	
	% foliage @ 6'		0.625
American Robin	% cover herb	0.420	
	% foliage @ 6'	-0.552	
	DBH deciduous trees		1.179
	% cover deciduous trees		-0.555
Swainson's Thrush	height tall shrubs	0.353	
	% cover conifer trees	0.660	
	DBH deciduous trees		0.711
	% foliage @ 12'		0.567
Yellow-rumped Warbler	height tall shrubs	0.507	0.484
	log number snags	0.902	1.609
	% cover deciduous trees	-0.394	-0.579
	DBH deciduous trees		0.455
	height deciduous trees		-0.993
Orange-crowned Warbler	% foliage @ 9'		0.315
	herb height		0.816
MacGillivray's Warbler	% low shrub	0.832	
	basal area deciduous	-0.323	
	DBH deciduous trees	0.900	
	log # deciduous stems	-0.568	
	% cover herbs	-0.505	
American Redstart	height deciduous trees	0.286	
	height tall shrubs	0.685	0.678
	% cover herb	0.294	0.270
	% cover deciduous trees		0.327
Dark-eyed Junco	herb height	0.376	
	log # deciduous stems	-0.685	-0.449
	% foliage @ 3'		0.462
Lincoln's Sparrow	basal area deciduous	0.289	
	height tall shrubs	-0.461	-0.436
	log number snags	-0.886	-0.638

APPENDIX 4 Summary of species numbers, total bird abundance, densities, and species diversity (H') for breeding birds detected on point counts

TABLE A4.1 *Summary data – bird use*

Seral stage	Age of stand (yrs)*	# of plots	Number species 1991	Number species 1992	Bird ** abundance 1991	Bird ** abundance 1992	Density /10 ha 1991	Density /10 ha 1992	Species diversity (H') 1991	Species diversity (H') 1992
Clearcut 1	6-7	7	13	12	11.00	9.86	140.13	125.57	3.21	3.04
Clearcut 2	4-5	3	10	9	11.00	9.00	140.13	114.65	3.07	2.98
Clearcut 3	4-5	10	16	11	9.20	7.50	117.20	95.54	3.29	2.91
Sapling 1	<23	4	17	14	13.75	11.00	175.16	140.13	3.68	3.59
Sapling 2	7-8	11	22	19	18.82	17.27	239.72	220.04	3.95	3.83
Sapling 3	7-8	5	18	15	14.40	12.20	183.44	155.41	3.72	3.53
Aspen 1	50-60	6	19	19	17.50	15.38	222.93	201.70	3.70	3.56
Aspen 2	50-60	11	22	20	16.36	13.18	208.45	167.92	3.87	3.72
Aspen 3	50-60	5	23	18	19.14	17.00	243.85	216.56	3.98	3.70
Aspen 4	50-60	12	28	26	19.75	16.58	251.59	211.25	4.16	3.94
Aspen 5	50-60	8	27	23	21.50	17.75	274.00	226.12	4.10	4.11
Old Aspen 1	>100	8	25	27	23.88	23.88	304.14	304.14	4.15	4.21
Old Aspen 2	>100	3	23	22	23.67	20.00	301.49	254.78	4.09	4.11
Mixed 1	50-60	5	25	28	24.80	24.40	315.92	310.83	4.26	4.38
Mixed 2	50-60	8	28	30	20.50	21.50	261.15	273.89	4.21	4.30
Mixed 3	114	7	29	30	24.86	21.29	316.62	271.16	4.38	4.36

* Maximum age of trees where present; otherwise age of stand since clearing
** Sum of mean number singing males per point of all species detected on point counts by stand

APPENDIX 5 Summary of species numbers, total bird abundance, densities, and species diversity (H') for all species detected on point counts (excluding flyovers) – Bird use

TABLE A4.1 *Summary data – bird use (excluding flyover)*

Seral stage	Age of stand (yrs)*	# of plots	Number species		Bird ** abundance		Density /10 ha		Species diversity (H')	
			1991	1992	1991	1992	1991	1992	1991	1992
Clearcut 1	6-7	7	15	16	11.43	10.43	145.59	132.85	3.35	3.28
Clearcut 2	4-5	3	16	15	15.33	12.67	195.33	161.36	3.71	3.64
Clearcut 3	4-5	10	20	14	9.60	8.20	122.29	104.46	3.47	3.17
Sapling 1	<23	4	17	16	13.75	11.75	175.16	149.68	3.68	3.75
Sapling 2	7-8	11	26	26	19.55	19.55	248.99	248.99	4.09	4.14
Sapling 3	7-8	5	20	18	14.80	12.80	188.54	163.06	3.82	3.71
Aspen 1	50-60	6	21	22	18.33	16.83	233.56	214.44	3.82	3.74
Aspen 2	50-60	11	25	26	16.91	14.45	215.40	184.13	3.99	4.01
Aspen 3	50-60	5	24	21	19.86	18.20	252.96	231.85	4.06	3.89
Aspen 4	50-60	12	32	30	21.08	18.25	268.58	232.48	4.34	4.12
Aspen 5	50-60	8	30	25	22.00	19.63	280.26	250.00	4.19	4.24
Old Aspen 1	>100	8	30	31	24.88	26.13	316.88	332.80	4.31	4.40
Old Aspen 2	>100	3	26	24	25.33	21.00	322.72	267.52	4.26	4.22
Mixed 1	50-60	5	31	31	26.60	25.80	338.85	328.66	4.47	4.51
Mixed 2	50-60	8	30	34	22.00	22.38	280.26	285.03	4.34	4.43
Mixed 3	114	7	31	32	25.43	21.57	323.93	274.80	4.45	4.41

* Maximum age of trees where present; otherwise age of stand since clearing
** Sum of mean number individuals per point of all species detected on point counts

TABLE A6.1 *Means of habitat variables — based on 1992 data*

Seral stage	Stand	Cover (%) Deciduous	Conifer tree	Tall shrub	Low shrub	Herb
Clearcut	C1	0.00	0.00	0.57	42.86	67.14
Clearcut	C2	0.00	0.00	0.83	63.33	61.67
Clearcut	C3	0.00	0.00	0.85	52.50	71.00
Sapling	S1	3.75	0.00	48.75	72.50	85.00
Sapling	S2	0.00	0.00	72.73	68.18	76.36
Sapling	S3	0.00	0.00	18.00	51.00	49.00
Aspen*	A1	65.00	0.00	25.83	75.83	75.00
Aspen	A2	64.55	0.00	31.36	77.27	62.27
Aspen	A3	65.00	0.00	18.60	52.00	50.00
Aspen	A4	73.75	0.00	8.00	59.58	80.42
Aspen	A5	70.00	0.00	7.38	70.38	85.63
Old**	O1	55.63	0.00	18.38	70.63	86.88
Old	O2	33.33	0.00	14.00	66.67	90.00
Mixed	M1	24.40	23.00	15.20	65.00	61.00
Mixed	M2	21.88	25.88	10.00	51.25	68.75
Mixed	M3	29.14	27.14	5.57	60.00	56.43

Seral stage		Height					Cover (%)		# snag
		Deciduous	Conifer	Tall shrub	Low shrub	Herb	Bare grnd.	CWD	/ha
Clearcut	C1	0.00	0.00	1.08	0.61	0.40	6.00	6.71	0.00
Clearcut	C2	0.00	0.00	2.75	0.98	0.68	3.67	3.67	0.00
Clearcut	C3	0.00	0.00	1.99	1.00	0.64	2.9	4.20	0.00
Sapling	S1	8.53	0.00	5.50	1.38	0.48	0.00	0.50	0.00
Sapling	S2	0.00	0.00	5.32	1.29	0.62	4.82	1.73	0.00
Sapling	S3	0.00	0.00	3.02	1.27	0.40	5.9	0.50	0.00
Aspen*	A1	17.28	0.00	7.17	1.27	0.67	0.33	1.00	79.17
Aspen	A2	16.86	0.00	6.09	1.13	0.53	0.09	0.82	45.45
Aspen	A3	22.00	0.00	7.60	1.41	0.36	1.10	0.80	95.00
Aspen	A4	20.05	0.00	4.42	0.95	0.44	0.29	1.08	239.58
Aspen	A5	17.58	0.00	4.88	0.98	0.70	0.31	1.13	190.63
Old**	O1	19.68	0.00	6.88	1.26	0.76	0.00	1.25	37.50
Old	O2	22.00	0.00	5.00	1.30	0.87	0.00	3.67	83.33
Mixed	M1	14.50	19.56	7.30	0.91	0.43	0.20	0.70	25.00
Mixed	M2	17.00	19.50	5.63	0.86	0.38	0.44	0.63	50.00
Mixed	M3	27.46	30.99	6.57	1.01	0.44	0.00	2.57	60.71

* Mature aspen (40-60 yrs old)
** Stands containing veteran aspen (up to 120 yrs old)

TABLE A6.1 *(Continued)*

Seral stage	Stand	Canopy depth	Stems/ha Deciduous	Stems/ha Conifer	Basal area (m^2) Deciduous	Basal area (m^2) Conifer	Average dbh (cm) Deciduous	Average dbh (cm) Conifer
Clearcut	C1	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Clearcut	C2	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Clearcut	C3	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sapling	S1	0.00	5742.05	0.00	0.00	0.00	7.50	0.00
Sapling	S2	0.00	14624.30	0.00	0.00	0.00	6.36	0.00
Sapling	S3	0.00	15724.98	0.00	0.00	0.00	3.24	0.00
Aspen*	A1	5.15	1713.47	0.00	34.67	0.00	18.63	0.00
Aspen	A2	7.89	2480.71	0.00	32.55	0.00	14.55	0.00
Aspen	A3	8.87	1946.16	0.00	54.00	0.00	20.12	0.00
Aspen	A4	4.96	2215.86	0.00	34.83	0.00	16.03	0.00
Aspen	A5	5.06	1916.78	0.00	35.00	0.00	19.53	0.00
Old**	O1	8.98	970.00	0.00	24.00	0.00	26.78	0.00
Old	O2	8.55	495.87	0.00	27.33	0.00	28.90	0.00
Mixed	M1	5.67	571.20	229.00	10.00	9.20	17.50	27.86
Mixed	M2	6.2	1645.00	233.35	21.5	11.75	13.83	30.41
Mixed	M3	12.13	441.29	139.97	27.43	17.14	29.29	41.13

Seral stage	Stand	Horizontal foliage cover (%) 3'	6'	9'	12'	15'	18'
Clearcut	C1	10.16	7.7	2.62	0.00	0.00	0.00
Clearcut	C2	29.26	38.15	11.11	4.26	5.00	0.00
Clearcut	C3	29.33	12.33	7.22	4.28	3.33	0.44
Sapling	S1	79.03	68.33	68.33	62.92	65.28	78.75
Sapling	S2	80.86	73.99	74.7	81.36	84.75	85.30
Sapling	S3	88.22	80.56	70.22	60.56	48.44	37.56
Aspen*	A1	69.17	45.93	26.57	23.52	26.3	27.78
Aspen	A2	67.22	39.09	29.09	35.10	25.56	31.06
Aspen	A3	63.56	42.44	23.67	23.22	22.78	22.11
Aspen	A4	19.31	4.44	2.27	1.48	4.44	4.17
Aspen	A5	37.64	10.42	1.74	3.54	3.47	4.24
Old**	O1	80.14	48.54	32.71	28.33	28.47	32.15
Old	O2	75.37	32.41	26.3	18.70	20.00	23.89
Mixed	M1	69.89	57.56	46.33	46.67	53.56	56.89
Mixed	M2	58.40	47.64	46.88	59.1	57.85	61.46
Mixed	M3	54.21	31.59	33.57	38.17	36.27	35.48

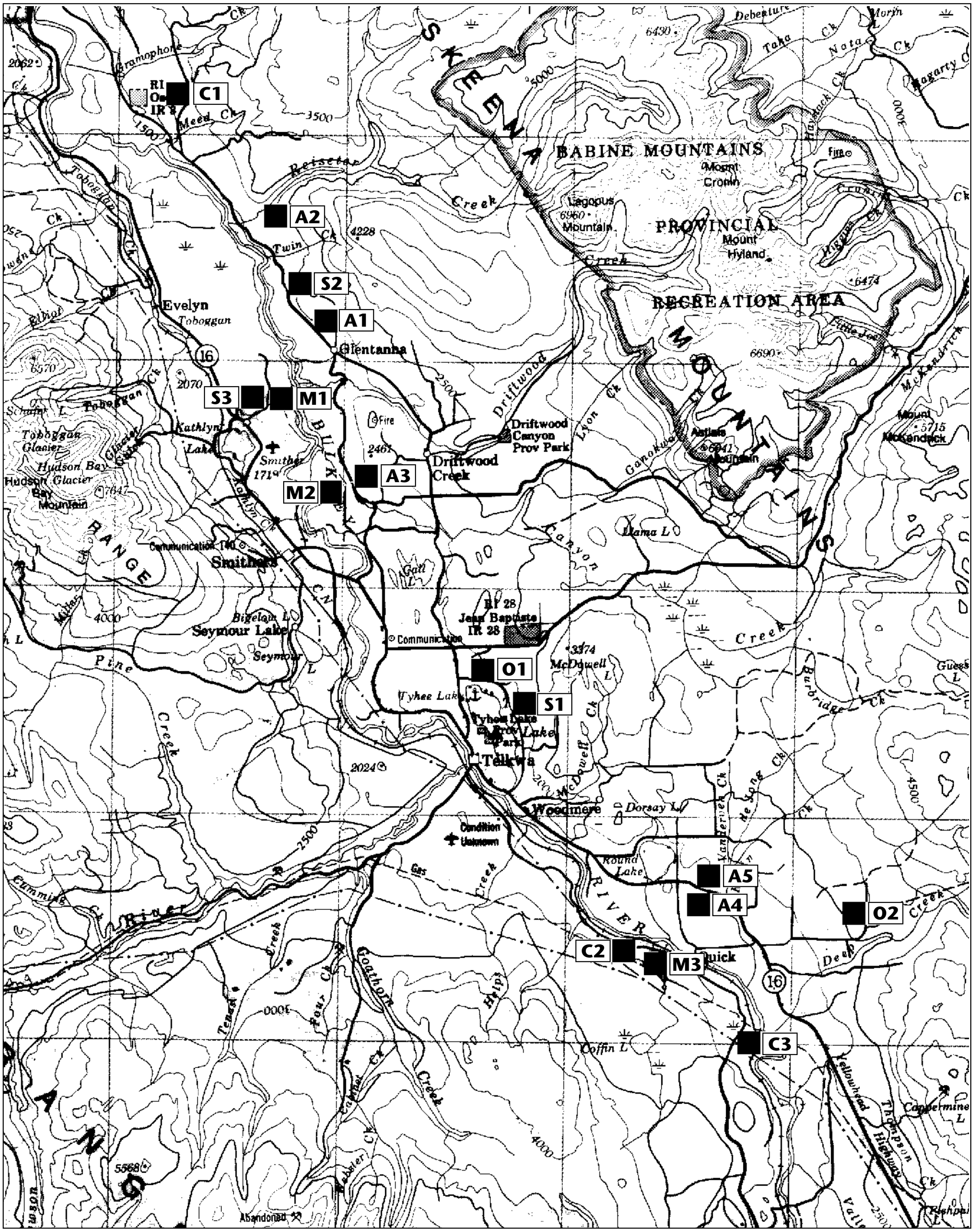
* Mature aspen (40-60 yrs old)
** Stands containing veteran aspen (up to 120 yrs old)

CODE**	Common name	Latin name+
COSN	Common Snipe	*Gallinago gallinago*
NOHA	Northern Harrier	*Circus cyaneus*
GOSH	Northern Goshawk	*Accipiter gentilis*
RUGR	Ruffed Grouse	*Bonasa umbellus*
BLGR	Blue Grouse	*Dendragapus obscurus*
GHOW	Great-horned Owl	*Bubo virginianus*
PIWO	Pileated Woodpecker	*Drycopus pileatus*
HAWO	Hairy Woodpecker	*Picoides villosus*
DOWO	Downy Woodpecker	*Picoides pubescens*
TTWO	Three-toed Woodpecker	*Picoides tridactylus*
RBSA	Red-breasted Sapsucker	*Sphyrapicus ruber*
NOFL	Northern Flicker	*Colaptes auratus*
RUHU	Rufous Hummingbird	*Selasphorus rufus**
CAHU	Calliope Hummingbird	*Stellula calliope**
DUFL	Dusky Flycatcher	*Empidonax oberholseri**
HAFL	Hammond's Flycatcher	*Empidonax hammondii**
LEFL	Least Flycatcher	*Empidonax minimus**
ALFL	Alder Flycatcher	*Empidonax alnorum**
WWPE	Western Wood Pewee	*Contopus sordidulus**
GRJA	Gray Jay	*Perisoreus canadensis*
CORA	Common Raven	*Corvus corax*
BCCH	Black-capped Chickadee	*Parus atricapillus*
RBNH	Red-breasted Nuthatch	*Sitta canadensis*
BRCR	Brown Creeper	*Certhia americana*
WIWR	Winter Wren	*Troglodytes troglodytes*
RCKI	Ruby-crowned Kinglet	*Regulus calendula**
GCKI	Golden-crowned Kinglet	*Regulus satrapa*
MOBL	Mountain Bluebird	*Sialia currucoides*
TOSO	Townsend's Solitaire	*Myadestes townsendi*
AMRO	American Robin	*Turdus migratorius**
VATH	Varied Thrush	*Ixoreus naevius*
SWTH	Swainson's Thrush	*Catharus ustulatus**
HETH	Hermit Thrush	*Catharus guttatus**
CEWA	Cedar Waxwing	*Bombycilla cedrorum**
SOVI	Solitary Vireo	*Vireo solitarius**
WAVI	Warbling Vireo	*Vireo gilvus**
REVI	Red-eyed Vireo	*Vireo olivaceous**
TEWA	Tennessee Warbler	*Vermivora peregrina**
OCWA	Orange-crowned Warbler	*Vermivora celata**
YRWA	Yellow-rumped Warbler	*Dendroica coronata*
MAWA	Magnolia Warbler	*Dendroica magnolia**
TOWA	Townsend's Warbler	*Dendroica townsendi**
BPWA	Blackpoll Warbler	*Dendroica striata**
YEWA	Yellow Warbler	*Dendroica petechia**
MGWA	MacGillivray's Warbler	*Oporornis tolmei**
WIWA	Wilson's Warbler	*Wilsonia pusilla**
NOWA	Northern Waterthrush	*Seiurus noveboracensis**
COYE	Common Yellowthroat	*Geothlypis trichas**
AMRE	American Redstart	*Setophaga ruticilla**
SAVS	Savannah Sparrow	*Passerculus sandwichensis**
SOSP	Song Sparrow	*Melospiza melodia*
CHSP	Chipping Sparrow	*Spizella passerina**
CCSP	Clay-coloured Sparrow	*Spizella pallida**
DEJU	Dark-eyed Junco	*Junco hyemalis*
WCSP	White-crowned Sparrow	*Zonotrichia Leucophrys*
LISP	Lincoln's Sparrow	*Melospiza lincolnii**
RWBB	Red-winged Blackbird	*Agelaius phoenicus**
BHCO	Brown-headed Cowbird	*Molothrus ater**
PISI	Pine Siskin	*Carduelis pinus*
WETA	Western Tanager	*Piranga ludoviciana**
RECR	Red Crossbill	*Loxia curvirostra*
PUFI	Purple Finch	*Carpodacus purpureus*
EVGR	Evening Grosbeak	*Coccothraustes vespertinus*

\+ Sequence and Latin Names follow National Geographic Society, *Field Guide to the Birds of North America*, First Edition, 1983

* Neotropical Migrants — Species which breed primarily in the Nearctic and winter generally south of the United States–Mexico border (after Finch, 1991)

** Codes after Campbell, R.W. and A.P. Harcombe, 1985. *Wildlife Habitat Handbooks for British Columbia: Standard Taxonomic List and Codes of Amphibians, Reptiles, Birds, and Mammals*. Joint Publ. Min. of Environ., Min. of For., and Min. of Prov. Sec. and Govt. Services, Victoria, B.C.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A2
S2
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S1
A5
A4
O2
C2
M3
C3
BABINE MOUNTAINS
PROVINCIAL
RECREATION AREA
Evelyn
Glentanna
Driftwood Creek
Driftwood Canyon Prov Park
Smithers
Seymour Lake
Telkwa
Woodmere
Tyhee Lake
Jean Baptiste IR 28
Round Lake
Dorsay L
Coffin L
Lama L
Mount Cronin
Mount Hyland
Hudson Bay Mountain
Kathlyn Lake
Copper mine L

APPENDIX 9 Steps in the selection of potential management indicator species based on a modification of the process outlined in Sidle and Suring (1986)

The following outlines the steps in the selection process for potential management indicator species (MIS) based on a modification of the process outlined in Sidle and Suring (1986), as well as the decisions I made.

Step 1. Identification of species within the following categories of potential MIS:

a) threatened and endangered species (species on the Province of B.C.'s red, blue or yellow lists), or species of management concern
   Pileated Woodpecker
   Ruffed Grouse

b) species of commercial value
   Ruffed Grouse

c) species of special interest (wildlife viewing)
   Red-breasted Sapsucker
   Pileated Woodpecker
   Northern Goshawk

d) species believed to be sensitive to forestry management practices
   Least Flycatcher
   Warbling Vireo
   Pileated Woodpecker
   Red-eyed Vireo

e) ecological indicator species
   Northern Goshawk

Step 2. Species felt not to represent a significant diversity or productivity issue at a local, regional or provincial level were no longer considered.

Step 3. Factors affecting population abundance were assessed:

a) species with irruptive occurrences were rejected. These include all finches (Purple Finch, Red Crossbill and Pine Siskin)

b) species subject to influences entirely beyond the control of forest managers; e.g., migratory species that winter primarily south of the border, were rejected. This excluded the majority of the species observed in this study leaving only the following (all winter residents) for further consideration: Ruffed Grouse; Pileated, Hairy, Downy and Three-toed Woodpeckers; Gray Jay; Red-breasted Nuthatch; Black-capped Chickadee; Brown Creeper; Golden-crowned Kinglet; and, possibly, Winter Wren.

Step 4. Monitoring Feasibility — the ease of monitoring each species was assessed and ranked from 1 (easy to monitor) to 3 (most difficult).

Species were also eliminated if they were too versatile or variable in their choice of habitat to make good indicators. Hence, Hairy and Downy Woodpeckers, Black-capped Chickadee and Red-breasted Nuthatch may not be good indicators, although Hairy Woodpeckers were chosen as an MIS for Alaska (Sidle and Suring, 1986). Ruffed Grouse may be an appropriate indicator for aspen, especially the sapling stage, if broad-scale management (landscape level) is the objective.