

**Avian Diversity in Aspen and Conifer Forests :
A Test of the Structural Complexity Hypothesis**
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Abstract

In order to compare avian diversity (species richness and evenness) between aspen and conifer forest communities in Gothic, Colorado, point counts were conducted in three replicates of each habitat type. Additionally, tree density and light measurements were performed as a measure of structural complexity. Aspen plots had higher tree densities and lower incident light through the forest canopy compared with conifer plots. Twenty-two bird species were identified in the surveys, and aspen sites had a slightly higher number of species ($n=18$) than their coniferous counterparts ($n=16$). Conifer stands had a marginally higher abundance of birds, however. A Student's t-test showed no significant difference in diversity (as calculated by the Shannon Index) between forest types ($\alpha=0.05$). The calculated Jaccard community coefficient (CC_j) was 0.55, indicating a moderate degree of overlap in avian species between aspen and conifer communities. Nonetheless, each forest type had a unique subset of bird species, illustrating the importance of these two habitats for maintaining avian biodiversity in the East River Valley.

Introduction

Ecologists have attributed various factors to the creation and maintenance of biological diversity in communities. Spatial complexity has been implicated as one of these forces because it creates a wider array of ecological niches (Putman 1994). For forest communities, vegetational heterogeneity has been found to be important in structuring avian species assemblages. This is illustrated in a classic study by MacArthur and MacArthur (1961), who determined that foliage height diversity and bird diversity were positively correlated. They also found that this structural complexity was a better predictor of avian diversity than plant species diversity alone. The relationship between foliage height heterogeneity was also confirmed by Karr and Roth (1971).

Other investigations have compared bird diversity in different forest types of differing structural complexities. In a study of mixed bottomland forest stands and managed cottonwood stands, Twedt et al. (1999) found that avian species richness and diversity were greater in the former

habitat type. Unmanaged bottomland forests, which contained dead woody material such as snags and dead trees, had a greater degree of spatial complexity than cottonwood plantations, in which these components had been removed.

The East River Valley surrounding Gothic, Colorado comprises a variety of montane, subalpine and alpine habitats, and is home to a variety of bird species in many families. Aspen (*Populus tremuloides*) and conifer (Engelman Spruce, *Picea engelmannii* and Subalpine Fir, *Abies lasiocarpa*) monocultures predominate in this region, but are interspersed with small tracts of both tree types. Some bird species are closely associated with the two ends of this vegetational spectrum. For example, the Warbling Vireo (*Vireo gilvus*) is generally found in aspen forests where it nests, whereas the Gray Jay (*Perisoreus canadensis*) prefers coniferous habitats, foraging on conifer seeds. In the summer of 1998, Ruehmann and Camfield performed a study similar to this one, and hypothesized that bird diversity would be higher in aspen forests due to greater diversity in the associated plant community. Indeed, bird surveys by Karr and Roth (1971) in pine forests determined that these habitats had some of the lowest species richness of all habitat types sampled. It should be noted, though, that the understory of these forests was dominated by one species of fern.

This study tested the null hypothesis that no difference in avian diversity exists between aspen and conifer forests in the East River Valley. Alternatively, conifer forests might host a higher diversity of birds because they contain two tree species (versus one in aspen stands), have taller, larger trees with greater surface area, and appear to be more structurally heterogeneous, with many large fallen trees, streams and other components. Personal observations have shown that

many coniferous tracts in Gothic do in fact have a relatively diverse flowering plant community...

Materials and Methods

The study was conducted over six days (30-31 July, 2, 4-5, and 9 August 2004) in three aspen and three conifer stands located in Gothic, Colorado and the nearby Gunnison National Forest. The three aspen stands were located 1) 2.5 miles south of Gothic along Gothic Road, 2) in the Gunnison National Forest southeast of the Gothic Research Meadow and 3) immediately north of the Judd Falls Trail in the Gothic Research Area. Conifer stands (consisting of Engelmann Spruce, *Picea engelmannii* and Subalpine Fir, *Abies lasiocarpa*) were located 1) northwest of Benthic Meadow below Gothic Mountain, 2) at the Gothic campsite in the Gunnison National Forest and 3) in the Gunnison National Forest approximately 5 miles north of Gothic.

Avian diversity was surveyed using 15-minute point counts, in which two observers recorded all birds seen or heard within a 50-meter radius of a fixed location. Point counts for each site were performed twice, on separate days between 6:00-9:00 a.m. Unknown individuals were noted but were not included in statistical analyses. As indicators of vegetational composition and structure, dominant understory plant species were noted and the number of trees were counted in two randomly selected 10 x 10 meter plots. To determine the amount of incident light through the forest canopy, light readings were taken with an Extech Instruments™ light meter at the 0, 25 and 50 meter marks of a randomly chosen 50-meter transect.

Results

On average, aspen stands had a slightly higher tree density ($x=.20$ trees/m²) than conifer stands ($x=.15$ trees/m²), but there was a lot of variation among replicates of each type. Densities ranged from .13-.28 trees/m² in aspen habitat and from .07-.23 trees/m² in conifer habitat. Canopy cover was greater in aspens as measured by light penetrance, which averaged 42,844 Lux, compared with 48,633 Lux for conifers. As with tree density measurements, a great deal of variation existed in light measurements for the two forest types. These measurements ranged from 19,733-77,067 Lux in aspen sites and 39,967-56,200 Lux in conifer sites.

A total of 22 bird species were identified in point counts; these are listed in Table 1. When the replicates for each forest type were pooled, aspen forests had slightly higher species richness than conifer forests (Figure 1). However, a slightly higher abundance of birds was recorded in conifer forests (Figure 2).

Statistical comparison of the Shannon Diversity Index (H') for each habitat type did not indicate a significant difference between the two ($t=0.096$; $\alpha=0.05$). The Jaccard coefficient of community value (CC_j) was 0.55 (where a value of 0 indicates no species common to both communities, and a value of 1 indicates that all species are found in both communities). Thus slightly more than 50% of all recorded species were found in both aspen and conifer sites. Although there were no significant differences in diversity between the two forest types, there were clear differences in species composition between aspen and conifer stands (Table 2). Aspen sites had six unique species, while conifer sites had four.

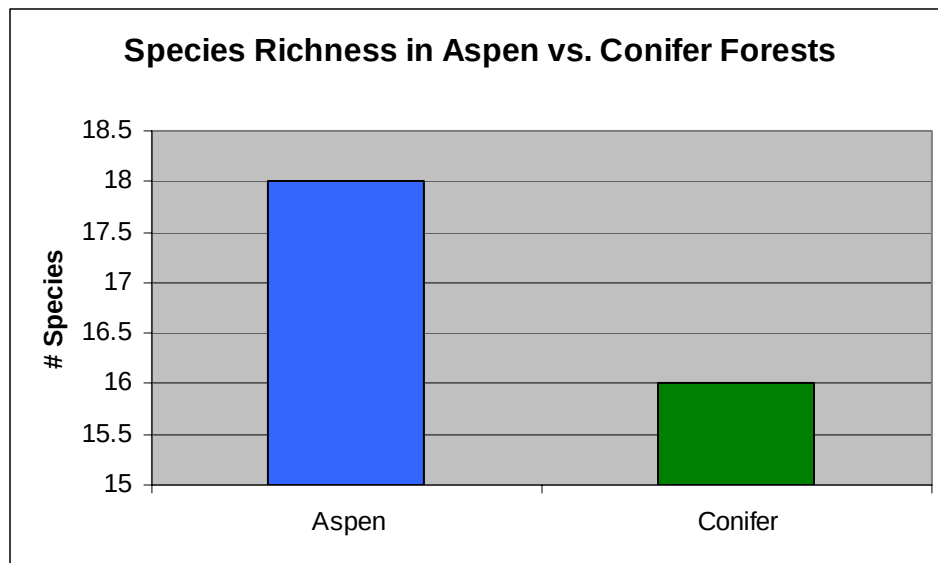


Figure 1. A comparison of species richness in aspen and conifer sites.

Common Name	Species Name
American Robin	<i>Turdus migratorius</i>
Black-capped Chickadee	<i>Poecile atricapilla</i>
Brown Creeper	<i>Certhia americana</i>
Cordilleran Flycatcher	<i>Empidonax occidentalis</i>
Common Raven	<i>Corvus corax</i>
Dark-eyed Junco	<i>Junco hyemalis dorsalis</i>
Dusky Flycatcher	<i>Empidonax oberholseri</i>
Golden-crowned Kinglet	<i>Regulus satrapa</i>
Gray Jay	<i>Perisoreus canadensis</i>
House Wren	<i>Troglodytes aedon</i>
Hummingbird (Broad-tailed and/or Rufous)	<i>Selasphorus platycercus</i> , <i>Selasphorus rufus</i>
Lincoln's Sparrow	<i>Melospiza lincolnii</i>
Mountain Chickadee	<i>Poecile gambeli</i>
Olive-sided Flycatcher	<i>Contopus cooperi</i>
Pine Siskin	<i>Carduelis pinus</i>
Red-breasted Nuthatch	<i>Sitta canadensis</i>
Red-naped Sapsucker	<i>Sphyrapicus nuchalis</i>
Red-shafted Flicker	<i>Colaptes auratus</i>
Swallow (Cliff, Tree or Violet-green)	<i>Petrochelidon pyrrhonota</i> , <i>Tachycineta bicolor</i> or <i>thalassina</i>
Warbling Vireo	<i>Vireo gilvus</i>
White-breasted Nuthatch	<i>Sitta carolinensis</i>
Western Wood-Pewee	<i>Contopus sordidulus</i>

Table 1. Common and scientific names of bird species recorded in point count surveys.

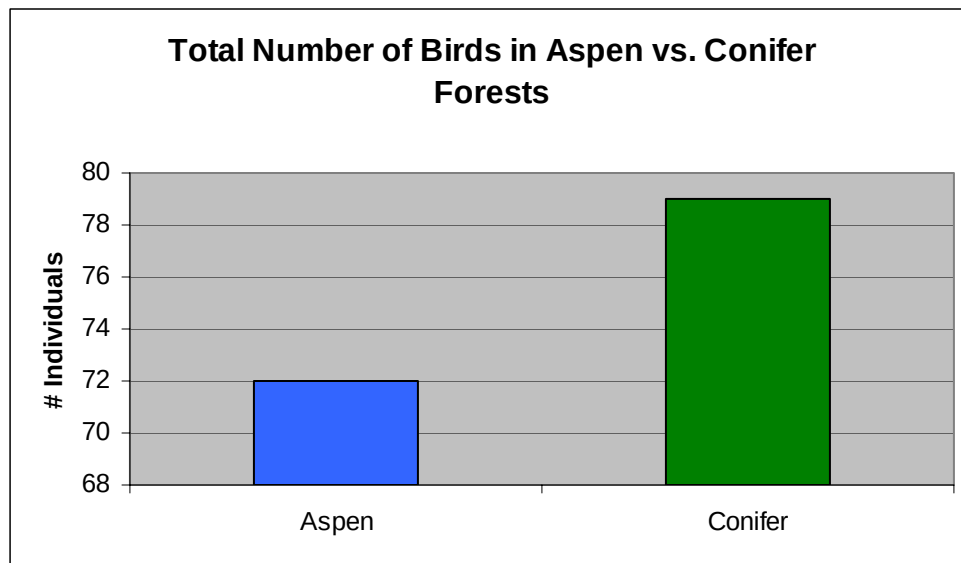


Figure 2. Bird abundance in aspen and conifer sites.

Aspen	Conifer	Both
Black-capped Chickadee	Brown Creeper	American Robin
Common Raven	Cordilleran Flycatcher	Dark-eyed Junco
Dusky Flycatcher	Golden-crowned Kinglet	Hummingbird (Broad-tailed and/or Rufous)
House Wren	Gray Jay	Lincoln's Sparrow
Swallow (Cliff, Tree or Violet-green)		Mountain Chickadee
Warbling Vireo		Olive-sided Flycatcher
		Pine Siskin
		Red-breasted Nuthatch
		Red-naped Sapsucker
		Red-shafted Flicker
		Unknown
		Western Wood-Pewee
		White-breasted Nuthatch

Table 2. Species observed in aspen and conifer stands only, and those found in both habitats.

Discussion

The results of this study are similar to those of Ruehmann and Camfield (1998), who found no significant difference in avian diversity between aspen and conifer forest sites. Interestingly, H' was higher in conifer stands than aspens, in contrast to this study. As with this study, the 1998 surveys found that while aspen and conifer forests shared a large number of bird species, each had a number of unique ones. The authors also noted a total of six species (Mountain Bluebird, Barn Swallow, White-crowned Sparrow, Western Tanager, Hermit Thrush, Yellow Warbler) not encountered in this study. This is likely caused by a seasonal difference between the 1998 and 2004 surveys; the former study was probably conducted earlier in the summer, when these species still reside in the Gothic area, or are still breeding and can thus be more readily detected.

Point counts for this study were conducted in late July and early August, when the majority of summer residents have finished breeding. With the breeding season finished, male birds do not sing or call to defend territories, and are more difficult to detect. This resulted in low numbers of individuals in the point counts, and probably fewer total species.

The relationship between habitat structure and avian diversity in the two forest types remains unclear, largely due to the time constraints of this project. Furthermore, structural variation among aspen and conifer replicates was high, and likely obscured any distinctions between forest types. Further studies should attempt to standardize plots for tree density, age and dominant understory vegetation so that overall differences between aspen and conifer stands will become more apparent.

Literature Cited

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