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# THE INFLUENCE OF GROVE SIZE ON BIRD SPECIES RICHNESS IN ASPEN PARKLANDS

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Abstract.—The abundance and diversity of avifauna within 27 aspen (*Populus tremuloides*) groves in Saskatchewan parklands were correlated significantly with grove size. Species richness of both edge and forest dwelling species were each correlated significantly with area. Species richness of insectivores was correlated strongly with area, whereas for omnivores it was not. Migratory strategy was correlated with size of grove; species richness of permanent residents had the weakest correlation whereas long-distance migrants had the strongest. The densities of 15 bird species were correlated positively with area, densities of four species were correlated with isolation, three of those negatively and one positively, and the density of one species was correlated with both. Aspen groves as small as 1.2 ha may be essential for some species breeding in Saskatchewan parklands. *Received 16 June 1992, accepted 1 Dec. 1992.*

Studies of North American bird populations demonstrate that diversity of species and abundance of individuals in aspen forests generally are greater than in most other habitats (Winternitz 1980). Breeding Bird Survey data indicate that species diversity in aspen parklands ranks eighth out of 95 different physiographic regions (Robbins et al. 1986). The aspen parklands of Saskatchewan constitute an ecotone between boreal forest and grassland (Bird 1961), and the high diversity of avian species in the parklands may be partly related to their ecotonal nature.

It has been demonstrated that avian density (Askins et al. 1987, Blake and Karr 1987) and species richness or diversity (Whitcomb et al. 1981, Freemark and Merriam 1986, Askins et al. 1987, Blake 1991) are influenced by area of breeding habitat. Since aspen groves are being reduced in size or eliminated to supply the demand for agriculturally productive land, it is essential to develop a predictive capability that can be used to guide habitat management strategies. The objective of this study was to determine the relationship between aspen grove size and bird species richness in a naturally fragmented habitat, the aspen parklands of central Saskatchewan, Canada. This information will help managers to predict which species may exhibit area sensitivity (i.e., extirpation from a given size range of aspen groves) as breeding habitat is reduced and further fragmented.

## STUDY AREA AND METHODS

*Study area.*—The study was conducted in a 3500-$km^2$ area centered on Saskatoon, Saskatchewan (about 52°05′N, 106°40′E). The physiography of the area ranged from sandhill

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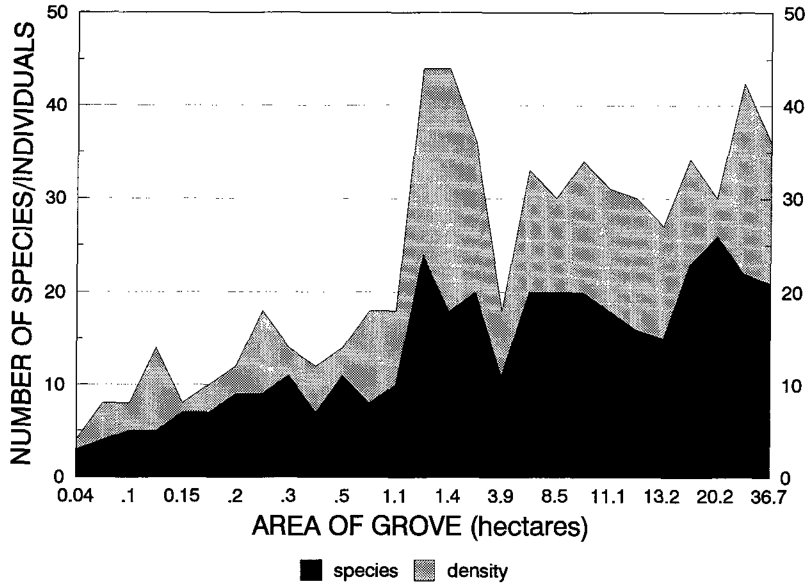


FIG. 1. Relationship between aspen grove size and species richness and density of birds in Saskatchewan, 1984–1986.

complexes to rolling moraine (Richards and Fung 1969). On the southern edge of the parklands, the aspen forest diminishes into discrete groves surrounded by remnant spear-wheat grass (*Stipa comata-Agropyron* sp.) and rough fescue (*Festuca altaica hallii*) grassland and cultivated fields (Maini 1960).

Within the groves, trembling aspen (*Populus tremuloides*) dominated the canopy while the shrub layer was dominated by aspen, rose (*Rosa* sp.), red-osier dogwood (*Cornus stolonifera*), beaked hazelnut (*Corylus cornuta*), saskatoon (*Amelanchier alnifolia*) and choke cherry (*Prunus virginianum*). The ground layer was composed primarily of rose, western snowberry (*Symphoricarpos occidentalis*), grasses (*Poa* spp., *Bromus* spp.), wild sarsaparilla (*Aralia nudicaulis*), and northern bedstraw (*Galium boreale*).

*Methods.*—I randomly selected 27 aspen groves 0.04 ha to 36.7 ha in size. Groves associated with wetlands and those subjected to heavy grazing pressure were excluded. I used the unlimited radius point count technique (Whitcomb et al. 1981) to census birds. Bird census points were establsihed near the center of each grove. Three 20-min visits were made to every point in each of the three breeding seasons (May 26–4 July of 1984, 1985, and 1986). During each census, all birds seen or heard were recorded. Point counts can accurately estimate bird density and diversity in the vicinity of the survey point (Whitcomb et al. 1981) but not necessarily over the entire aspen grove. The area of each study grove was measured, as well as the area and distance to all other groves within 1 km of the study grove. These data were applied to an isolation coefficient described by Whitcomb et al. (1981) to measure the relative isolation of each study grove.

The few records of Ruffed Grouse (*Bonasa umbellus*) were omitted from the calculation of species richness because drumming by male grouse had ceased by the time the censuses began. Six species of raptors as well as two corvids also were not included because their

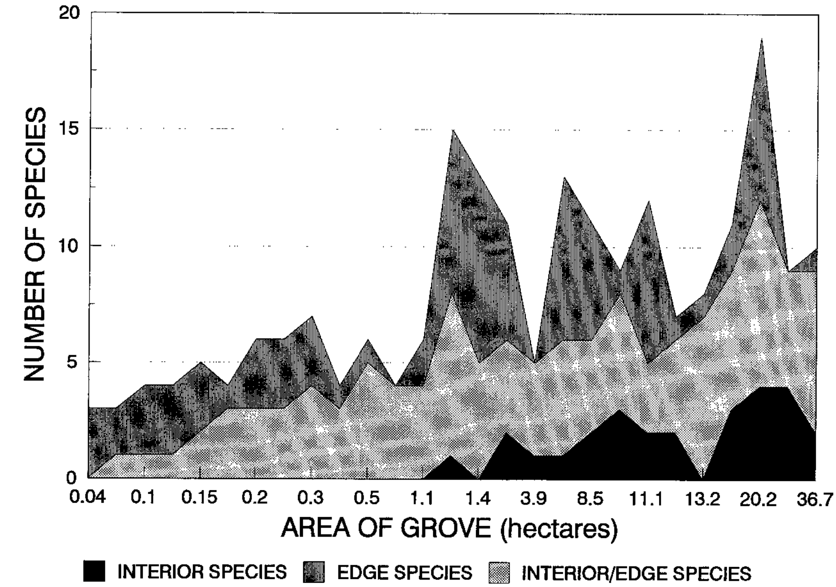


FIG. 2. Relationship between aspen grove size and interior, interior/edge and edge species in Saskatchewan, 1984–1986.

territories were so large that they may have occupied several groves of various sizes. This left a pool of 41 breeding species that were used to calculate species richness.

Bird species were grouped according to three life history categories: preferred breeding habitat, foraging strategy, and migratory status. Habitat preference categories (Freemark and Merriam 1986, Askins and Philbrick 1987, Faanes 1987, and personal observations from Saskatchewan) included: edge species (E = territories in aspen grove edges); forest interior-edge species (I/E = territories in both interior and edge habitats); and forest-interior species (FI = territories usually confined to the interior portions of the grove). Divisions within the foraging category (Blake 1983) were omnivore, insectivore, granivore, and nectarivore-frugivore. Migratory status (Whitcomb et al. 1981, Freemark and Merriam 1986, Askins and Philbrick 1987) included permanent residents (PR = species that remain in Saskatchewan throughout the entire year), short-distance or U.S. migrants (SDM = species wintering in the southern United States and northern Mexico), and long-distance or Neotropical migrants (LDM = wintering in tropical or subtropical regions).

I used stepwise multiple regression (SAS stepwise regression program, SAS Inst. 1985) to analyze relationships between community or species level responses of birds to area and isolation.

## RESULTS

*Area and isolation.*—In my study area, grove isolation was generally negatively related to an increase in area of groves ($P < 0.0001$). Small aspen groves tended to be highly isolated from their nearest neighbor as well as from large groves, whereas large groves (> 10 ha) were less isolated from other groves.

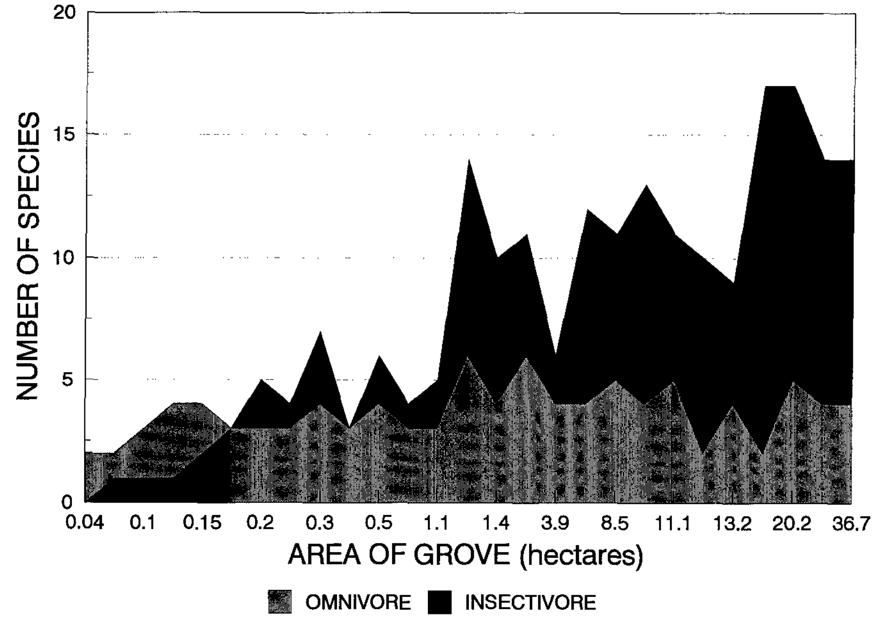


FIG. 3. Relationship between aspen grove size and insectivorous and omnivorous species of birds in Saskatchewan, 1984–1986.

*Species richness and abundance.*—Fifty species of birds were recorded from the 27 aspen groves studied during the breeding seasons of 1984 (39 species), 1985 (42 species), and 1986 (46 species), respectively. Among the study groves, grove area was a significant predictor of total species richness ($r^2 = 0.619$; $P < 0.0001$; Fig. 1). Grove area was also a significant predictor of breeding pair density ($r^2 = 0.602$; $P < 0.0001$; Fig. 1).

*Habitat preference.*—Forest interior species were dependent on both grove size and isolation ($r^2 = 0.469$; $P < 0.0001$). Interior/edge species were related to grove area ($r^2 = 0.738$; $P < 0.0001$; Fig. 2). Species preferring edge habitat were also related ($P < 0.0001$) to area; however, the relationship was not as strong ($r^2 = 0.307$) as that exhibited by interior or interior/edge species (Fig. 2). Edge species were more common in the community up to a grove size of 13.2 ha, but were outnumbered by forest species in most groves over 17 ha.

*Foraging guilds.*—There was no significant increase in omnivore species richness over the size range of groves studied ($r^2 = 0.227$; $P < 0.001$) (Fig. 3). There was a shift in species richness from an omnivore-dominated community in most groves less than 0.2 ha in size to an insectivore-dominated community at grove sizes >0.5 ha. Insectivore species richness increased significantly ($r^2 = 0.693$; $P < 0.0001$) with an increase in grove

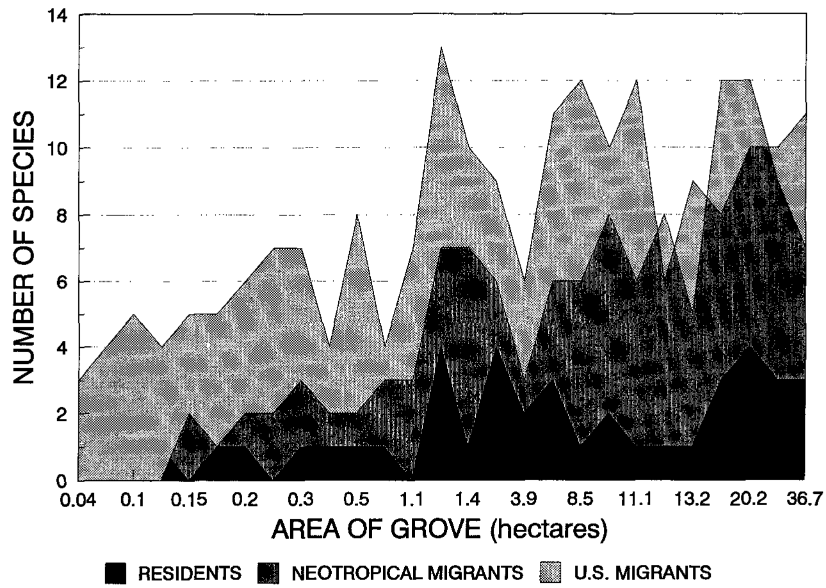


FIG. 4. Relationship between aspen grove size and U.S. migrants, Neotropical migrants and permanent residents in Saskatchewan, 1984–1986.

area (Fig. 3). Since nectarivore-frugivore and granivore guilds each contained only two species, regression analysis was not attempted.

*Migratory status.*—The number of species of Neotropical and U.S. migrants and permanent residents each increased significantly ($P < 0.0001$) with area (Fig. 4). The Neotropical migrants exhibited the strongest relationship ($r^2 = 0.641$) with U.S. migrants and permanent residents having the weakest ($r^2 = 0.312$ and $r^2 = 0.328$, respectively) (Fig. 4).

*Responses of individual species.*—Individual species' responses were calculated for 31 species of birds; fifteen of those showed a significant increase with an increase in grove area (see Table 1). One species, the Clay-colored Sparrow (scientific names in Table 1) showed a significant increase with increased isolation while three other species, Veery, Ovenbird and Connecticut Warbler demonstrated a significant negative trend with increased isolation. The local density of Least Flycatcher was related to both area (+) and isolation (−) (Table 1).

Several species of birds appeared to have a minimum grove size requirement before a grove was occupied; other species were ubiquitous, being present throughout the size range of groves studied (Fig. 5). The Clay-colored Sparrow was ubiquitous while the Hermit Thrush was present only in groves larger than 24 ha. Species such as the Northern Oriole and Hairy Woodpecker were present in groves of at least 1.2 ha (Fig. 5).

TABLE 1

SPECIES RELATIONSHIPS WITH AREA AND ISOLATION OF ASPEN PARKLAND BIRDS

| Species | Predictor | $R^{2a}$ |
|---|---|---|
| Mourning Dove (*Zenaida macroura*) | AREA | 0.53**** |
| Black-billed Cuckoo (*Coccyzus erythropthalmus*) | AREA | 0.28* |
| Ruby-throated Hummingbird (*Archilochus colubris*) | — | NS |
| Yellow-bellied Sapsucker (*Sphyrapicus varius*) | — | NS |
| Downy Woodpecker (*Picoides pubescens*) | AREA | 0.28* |
| Hairy Woodpecker (*P. villosus*) | AREA | 0.34** |
| Northern Flicker (*Colaptes auratus*) | — | NS |
| Least Flycatcher (*Empidonax minimus*) | AREA | 0.70**** |
| | AREA, −ISOL | 0.72**** |
| Great-crested Flycatcher (*Myiarchus crinitus*) | AREA | 0.29** |
| Black-capped Chickadee (*Parus atricapillus*) | AREA | 0.44**** |
| House Wren (*Troglodytes aedon*) | AREA | 0.52**** |
| Mountain Bluebird (*Sialia currucoides*) | — | NS |
| Veery (*Catharus fuscescens*) | −ISOL | 0.53**** |
| American Robin (*Turdus migratorius*) | — | NS |
| Gray Catbird (*Dumetella carolinensis*) | — | NS |
| Brown Thrasher (*Toxostoma rufum*) | — | NS |
| Cedar Waxwing (*Bombycilla cedrorum*) | AREA | 0.47**** |
| European Starling (*Sturnus vulgaris*) | — | NS |
| Warbling Vireo (*Vireo gilvus*) | AREA | 0.51**** |
| Red-eyed Vireo (*V. olivaceus*) | AREA | 0.70**** |
| Yellow Warbler (*Dendroica petechia*) | — | NS |
| American Redstart (*Setophaga ruticilla*) | AREA | 0.29** |
| Ovenbird (*Seiurus aurocapillus*) | −ISOL | 0.50**** |
| Connecticut Warbler (*Oporornis agilis*) | −ISOL | 0.26* |
| Rufous-sided Towhee (*Pipilo erythrophthalmus*) | AREA | 0.39*** |
| Clay-colored Sparrow (*Spizella pallida*) | ISOL | 0.24* |
| Vesper Sparrow (Pooecetes gramineus) | AREA | 0.28* |
| Brown-headed Cowbird (*Molothrus ater*) | AREA | 0.33** |
| Northern Oriole (*Icterus galbula*) | AREA | 0.63**** |
| American Goldfinch (*Carduelis tristis*) | — | NS |

[a] Results of stepwise multiple regression, * $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$, **** $P < 0.0001$.

## DISCUSSION

Spatial niche requirements vary among bird species, each species responding to a particular combination of habitat features, and different responses to variations in aspen grove size therefore were expected. Habitat size often is linearly and positively related to number of species (Forman et al. 1976). Several investigators (Vuilleumier 1970, Moore and Hooper 1975, Anderson and Robbins 1981, Kitchener et al. 1982, Freemark and Merriam 1986) found that the number of bird species increased with the size of the forest "island". Others (Robbins 1979, Whitcomb et al. 1981) conclude that only Neotropical migrants (generally forest species)

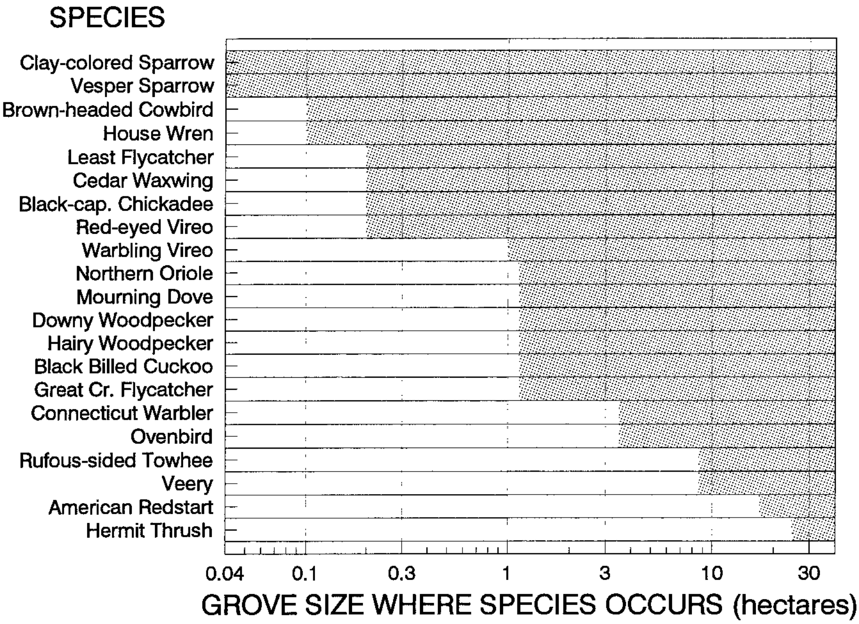


FIG. 5. Species use of aspen groves in Saskatchewan, 1984–1986.

show an increase of species diversity and total density as a function of patch area. Correlation between area and species richness may be partly a consequence of increased habitat diversity which increases the chance of a species encountering suitable habitat in larger areas. Lynch and Whigham (1984) found bird abundance related to area, isolation, structure, and floristics or combinations of these elements. They concluded that, for many species, structural and floristic characteristics were more important than stand size. In this study, groves in the 1.4 ha size range had a higher-than-expected species richness. This increased richness may be partly explained through further examination of vegetative characteristics within the groves.

My study indicates that aspen grove size influences the composition of the bird community. In Saskatchewan parklands, small groves are dominated by short-distance migrating omnivores that prefer edge habitat, whereas large groves tend to be dominated by long-distance migrating insectivores that live in the interior portions of aspen stands. These data are consistent with those of Forman et al. (1976) and Blake and Karr (1984) studying artifically fragmented habitats.

With the continuing impacts upon aspen forest habitat in the parklands, it will be necessary to preserve key landscapes in order to maintain bird species richness. Any reduction in size of aspen groves may be as detrimental to area-sensitive species as total removal of that habitat. Since large groves are sparse in the southern parklands, we should strive to preserve those that remain.

This does not imply that smaller groves are unimportant. Beginning at a grove size of 1.2 ha there is a marked increase in bird species richness over that of smaller groves. These smaller groves (<1.2 ha), although not used extensively for breeding, should be maintained to provide corridors or rest stops for species' dispersal (Blake 1986) during migration to the larger woods, and small groves left untouched should develop into larger groves in time. The effects of size and isolation of aspen groves on bird populations should be considered in future landscape planning.

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