AVIAN COMMUNITIES AND MANAGEMENT GUIDELINES OF THE ASPEN-BIRCH FOREST

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Abstract.--Avian communities are discussed in relation to succession of the aspen-birch type. Management guidelines are given, but more information on habitats of stenotopic species is required if comprehensive management plans are to be formulated. Avian management and pulpwood management are generally compatible in the aspen-birch type, but some expenditures may be necessary to maximize bird species diversity.

INTRODUCTION

The aspen-birch type is an extensive and economically important forest type. Its importance to wildlife populations has been recognized for ruffed grouse (Gullion and Svoboda 1972) and white-tailed deer (Byelich, Cook, and Blouch 1972), but little is known about its potential for nongame species. The purpose of this paper is to describe selected bird communities occupying various successional stages of the aspen-birch type and present guidelines for the management of these communities. Emphasis is placed on the aspen-birch type in the north central and northeastern forest regions.

Payne and DeGraaf (1975) described the economic value derived from human enjoyment of nongame birds. They predicted an increase in nonconsumptive recreation associated with nongame wildlife. The need exists to develop nongame management plans and to evaluate effects of the present management practices on nongame species.

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THE ASPEN-BIRCH TYPE

The Society of American Foresters (SAF 1954) define the aspen-birch type as stands in which trembling aspen (Populus tremuloides), bigtooth aspen (P. grandidentata), and paper birch (Betula papyrifera) predominate. They occur in various combinations or in pure stands of any one species. Pin cherry (Prunus pensylvanica) and red maple (Acer rubrum) are common associates. In the eastern U.S. and Canada, 22 tree species are associated with trembling aspen, including balsam popular (Populus balsamifera), balsam fir (Abies balsamea), white spruce (Picea glauca), black spruce (P. mariana), and several northern hardwoods (Folwells 1965).

Beaked hazel (Corylus cornuta) and American hazel (C. americana) are common shrubs in the eastern part of the range of this type. Other shrubs frequently associated with the aspen-birch type are mountain maple (Acer spicatum), speckled alder (Alnus rugosa), green alder (A. crispa), raspberry (Rubus idaeus), gooseberries (Ribes spp.), and willows (Salix spp.) (Folwells 1965, Martin 1959).

Three other types, the aspen, paper birch, and gray birch-red maple types, are descriptively or ecologically similar to the aspen-birch type. The aspen type consists of trembling aspen, bigtooth aspen, and balsam poplar occurring singly, in combination with each other, or in combination with associates pin cherry and paper birch. Balsam fir is common in the understory (SAF 1954).

Paper birch occurs in pure stands or is the predominant species in the paper birch type. Associates include trembling and bigtooth aspen, balsam fir, red spruce (Picea rubens), white spruce, white pine (Pinus strobus), yellow birch (Betula lutea), and others. The understory may be coniferous or include tolerant hardwoods (SAF 1954).

The gray birch-red maple type is not dominated by aspen or paper birch, but is ecologically and structurally similar to the pre-

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viously described types. A mixture of gray birch (Betula populifolia) and red maple predominate, with gray birch usually more numerous. Trembling aspen, bigtooth aspen, pin cherry, yellow birch, and paper birch are common associates (SAF 1954).

The four types are combined and referred to as the aspen-birch type in the following discussion except where special reference to a particular type is necessary.

The range of the aspen-birch type is shown in Figure 1. The range was determined by combining the range limits of the four major species: trembling aspen, paper birch, balsam popular, and bigtooth aspen. It includes portions of the boreal, northern hardwood-conifer, and eastern deciduous forests (Aldrich 1963). Because of the extent of the range (approximately 110° of longitude and 30° of latitude) the climatic conditions are quite variable. The type is generally found in areas of long, cold winters with long periods of snow cover and summers that are cool and short (Folwells 1965).

The aspen-birch type is found primarily on uplands of glacial till with a high but moving water table (SAF 1954). Trembling aspen and paper birch develop best on well-drained sandy loams but are found on all but the wettest swamps and driest sands (Folwells 1965). The gray birch-red maple type occupies sand plains as well as heavier-soiled uplands and wet stream margins.

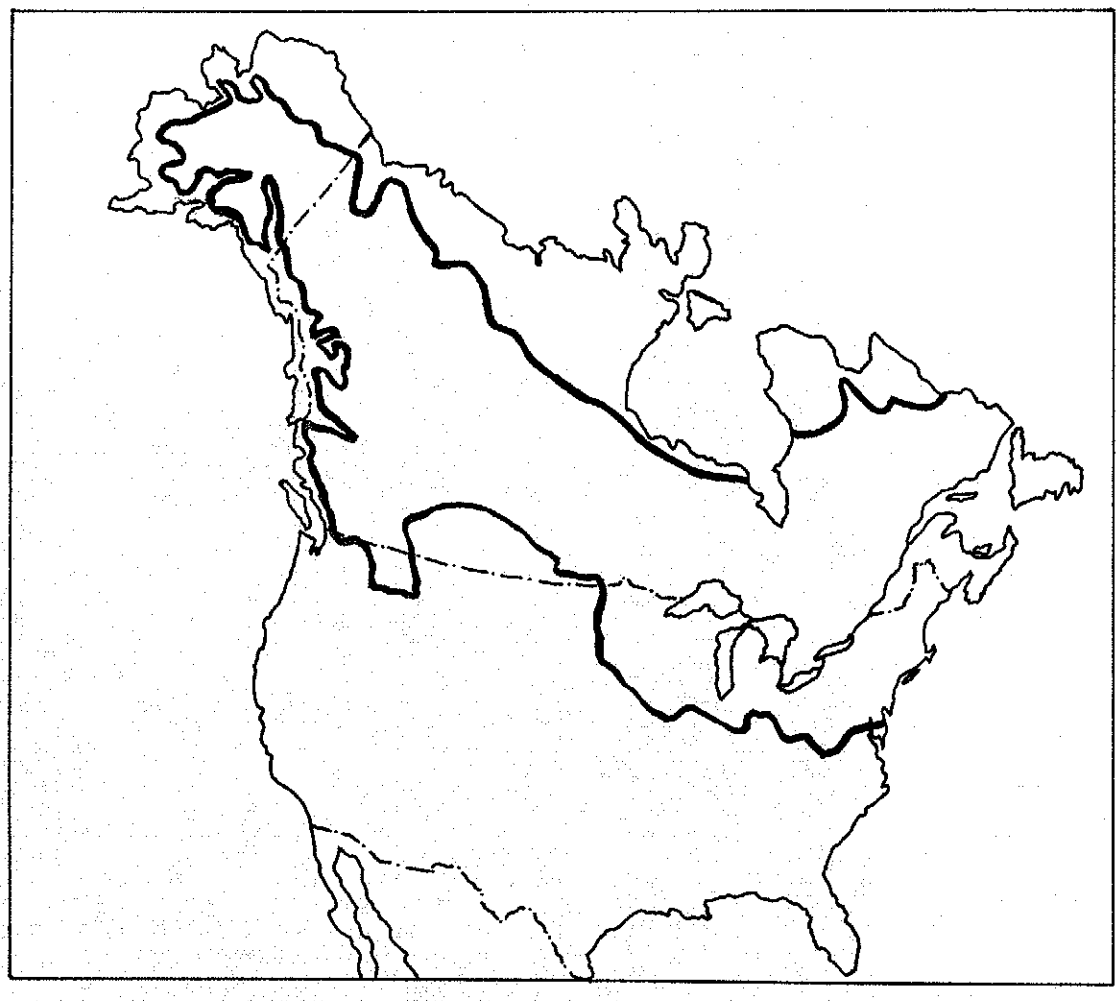

Figure 1.--The range of the aspen-birch type in North America.

SUCCESSIONAL PATTERNS

The aspen-birch type is a relatively short-live pioneer community. Both aspen and paper birch have lightweight seeds2/ which allow long distance dispersal by wind. However, the seeds quickly lose their viability. The seeds of aspen remain viable only two to three weeks under optimum conditions (Moss 1938) and paper birch seeds remain viable for months if the proper moisture conditions are maintained (Joseph 1929). A bare mineral soil is required because the seedling radicle is very delicate and can not penetrate litter (Hutnik 1954). Soil moisture conditions must remain high during the period of germination and root development, as the seedlings quickly succumb to desiccation.

Both species are also capable of vegetative reproduction; root suckering by aspen and stump sprouting by paper birch. The degree of vegetative reproduction depends on a variety of factors of which age and vigor of parent trees, predisturbance stocking, season of disturbance, and degree of canopy destruction are of major importance.

Two natural agents of destruction that were capable of providing suitable conditions for both methods of reproduction in the primeval forests were fire and wind (Cline and Spurr 1942). Heinselman (1973) found that the composition and structure of the presettlement vegetation as well as the vegetation mosaic on the landscape were largely determined by fire for the Boundary Waters Canoe Area in northeastern Minnesota. The aspen-birch type was part of the mosaic. Kittredge (1938) found trembling aspen and paper birch were two of several species with light, windborn seeds or capable of reproduction from underground parts that colonized after fire.

The type which succeeds aspen-birch depends on the nature of the breakdown process, tolerance and stocking level of associate species, and site conditions. Martin (1959) found that in Ontario balsam fir-white spruce succeed aspen-birch after 50-75 years. The spruce and fir are released from the understory as the aspen and birch gradually die out. On xeric sites, northern red oak (*Quercus rubra*) and bur oak (*Q. macrocarpa*) replace the aspen-birch (Hansen and Kurmis 1972). On rich, moist sites the beech-birch-maple or maple-basswood type succeed the pioneer type (Stewart and Aldrich 1952, Hansen and Kurmis 1972). In New England, aspen and birch commonly invade abandoned fields along with white pine, which eventually becomes dominant (Cline and Lockhard 1925, Back 1976).

2/ There are approximately 3 million aspen seeds per pound and 1.5 million paper birch seeds per pound (Folwells 1965).

TIMBER MANAGEMENT PRACTICES

The aspen and aspen-birch types account for approximately 35 percent or 17.9 million acres of commercial Lake States forest3/. Fifty-four percent of the merchantable hardwoods in Canada are aspens (Maini 1972). Aspen and birch together made up 49.2 percent of the total Lake States pulpwood production from roundwood in 1976 (Blyth and Hahn 1978). Paper birch also has value as a veneer quality hardwood in northern New England where it reaches its best development (Folwells 1965).

The silvics of aspen and birch dictate that they should be managed in even-aged stands. Clearcutting to remove merchantable trees followed by elimination of residual stems greater than 1.5 inches (3.8cm) d.b.h. is the basic prescription (Graham, Harrison, and Westell 1963, Marquis, Solomon, and Bjorkbom 1969). The minimum size of the cuts, to be economically attractive, is 10-20 acres (4-8 ha) 3/. The size of the cutting, seedbed preparation, and season of cutting can be altered to favor birch over aspen (Marquis *et al.* 1969). Intermediate cultural treatments such as cleaning and thinning have been shown to increase growth and yield of aspen (Schlaegel 1972, Hubbard 1972) and paper birch (Marquis *et al.* 1969). However, economic feasibility requires that the stands have high site index values, potential for veneer or saw quality trees, and are close to the mill (Hubbard 1972).

Prescribed burning following logging has been shown to increase aspen sucker density (Perala 1972) and create favorable seedbed conditions for paper birch and aspen. Although ground fires easily girdle thin-barked paper birch and allow the introduction of wood rotting fungi to fire damaged aspen, the fuel required for crown fires that result in regeneration of the type are not abundant. The shortage of fuel in aspen types prompted Castle and Engle (1972) to suggest that aspen-hardwood types could be used as fuel breaks in pine areas. The conditions required for a high degree of canopy kill in aspen-hardwood types would

3/ Lundgren, A.L. Economics of aspen management. A paper presented at the joint meeting of Great Lakes Deer Group and the Ruffed Grouse Workshop, Quadna Mt. Lodge, Hill City, MN, Sept. 22, 1970.

cause sever fires in other fuel types4/.

BIRD HABITAT ASSOCIATIONS

Breeding Birds

Approximately 116 forest bird species breed in the central and eastern portion of the aspen-birch type. The number of individuals and species vary with several habitat parameters such as habitat patchiness (MacArthur, MacArthur, and Preer 1962, Roth 1976), total foliage volume (Willson 1974), vertical stratification (MacArthur and MacArthur 1961), canopy mixture of hardwoods and conifers (Hooper, Crawford, and Harlow 1973), moisture gradient (Smith 1977), and successional stage (Johnston and Odum 1956, Shugart and James 1973).

For comparative purposes in the following discussion of published literature, the stand development of the aspen-birch type has been divided into three categories: 1) seedling-sapling atage; 2) sapling-pole stage; 3) pole-mature stage.

Seedling-Sapling Stage

The species and density of territorial males reported in six censuses that represent the seedling-sapling stage are given in Table 1. Three species, chestnut-sided warbler (Dendroica pensylvanica), white-throated sparrow (Zonotrichia albicollis), and mourning warbler (Oporornis philadelphia), were present in all six censuses. The same three species and the song sparrow (Melospiza melodia) had the highest densities. The presence of house wrens (Troglodytes aedon) on two of the burned areas may have been due to the availability of cavities in the burned snags (Bergstedt and Niemi 1974). A high density of least flycatchers (Empidonax mimimus) on only one of the burned areas may have been due to a difference in snag density. The 2-year old burn with the high density of least flycatchers had a tree density of 900 per acre (2,220 per ha), of which 90 percent were burned snags (Bergstedt and Niemi 1974). The 3-year old burn had a snag density of 264 per acre (650 per ha) (Niemi 1974a) and a low density of least flycatchers. Yellowthroats (Geothlypis trichas), blackburnian warblers (Dendroica fusca), and rose-breasted grosbeaks (Pheucticus ludovicianus) were found in an island of mature trees within the burned area (Bergstedt and Niemi 1974) and may not be representative of the first development stage.

Of the 36 species recorded in the seedling-sapling stage, 18 species were recorded in only one census. Twenty-four species had maximum densities less than 10 per 100 acres (40 ha). The bird species diversity (BSD) index5/ values were generally low, the highest being 2.50 for the 10-15 year old clearcut.

The dominant tree species of the six census areas was aspen; paper birch was not a major component of any area. The greatest stem density reported was 30,700 aspen suckers per acre (76,000 per ha) on the 3-year old burn (Niemi 1974a). The stands ranged from 3 feet (0.9 m) tall for the 1-year old cut to 10-15 feet (3-4.6 m) for the 10-15 year old clearcut.

Sapling-Pole Stage

Seventeen more bird species were recorded in the sapling-pole stage than in the seedling-sapling stage. Only the ovenbird (Seiurus aurocapillus) and red-eyed vireo (Vireo olivaceus) were recorded in all five censuses (Table 2). Veerys (Hylocichla fuscescens), yellowthroats, and indigo buntings (Passerina cyanea) had higher densities and were recorded in more censuses in the second stage than in the first stage of development. Three species not recorded in the first stage but relatively abundant in the second stage were the black-capped chickadee (Parus atricapillus), catbird (Dumetella carolinensis), and goldfinch (Spinus tristis). The robin (Turdis migratorius) remained about the same density. The white-throated sparrow, chestnut-sided warbler, and song sparrow had decreased densities while the mourning warbler was not recorded in any of the five sapling-pole stage censuses.

The second-growth forest in Vermont, censused two consecutive years by Breault and Farrar (1972) and Farrar (1973), had the greatest BSD value (3.29) and the greatest number of species recorded (36) of the sapling-pole stage. Approximately 50 percent of the tree density was trembling aspen and paper birch and 33 percent was white pine. It was the only census area in which the wood thrush (Hylocichla mustelina) was relatively abundant.

4/ Sando, R. Burning aspen-hardwood stands. A paper presented at the joint meeting of Great Lakes Deer Group and the Ruffed Grouse Workshop, Quadna Mt. Lodge, Hill City, MN, Sept. 22, 1970.

5/ The bird species diversity index provides a numerical basis for comparing avian communities. It incorporates both the number of species and the abundance of each species present (MacArthur and MacArthur 1961).

Table 1.--Territorial male birds per 100 acres (40 hectares) of six censuses of the seedling-sapling stage.

Species	Stand						Average 7/
	1 yr. old clearcut1/	2 yr. old clearcut2/	2 yr. old burn3/	2 yr. old burn4/	3 yr. old burn5/	10-15 yr stand6/	
Chestnut-sided Warbler	11	24	40	58	42	33	34.7
White-throated Sparrow	32	49	36	20	27	33	32.8
Mourning Warbler	22	54	7	41	27	33	30.7
Song Sparrow	32	32	26			13	25.8
Yellowthroat	11	16		3		20	12.5
Robin	16	5			3	7	7.8
Common Snipe	5	11					
Woodcock	5	5					
Common Flicker		5	3		3		
Red-eyed Vireo			20	10	3		
House Wren			33	17		13	
Brown Thrasher			3		3		
Blue Jay				7	3	7	
Least Flycatcher				37	3		
Hairy Woodpecker				3	3		
Chipping Sparrow				3	6		
Veery				3		7	
Hermit Thrush					3	7	
Swamp Sparrow		5					
Common Grackle			13				
Yellow-bellied Sapsucker				7			
Ruffed Grouse				3			
Blackburnian Warbler				3			
Ovenbird				3			
Rose-breasted Grosbeak				7			
Downy Woodpecker					3		
Black-backed Three-toed Woodpecker					3		
Dark-eyed Junco					3		
Cedar Waxwing					3		
Indigo Bunting					3		
Common Nighthawk					3		
Nashville Warbler						13	
Black and White Warbler						7	
American Redstart						7	
Alder Flycatcher						7	
Red-breasted Nuthatch						7	
Total Density	134	211	181	225	144	214	184.8

1/Minnesota, Niemi 1974b.

2/Minnesota, Niemi 1975.

3/Minnesota, Bergstedt 1973.

4/Minnesota, Bergstedt and Niemi 1974.

5/Minnesota, Niemi 1974a.

6/Minnesota, Doran and Todd 1976.

7/The average was calculated only if a speices occurred in four or more censuses.

Table 2.--Territorial male birds per 100 acres (40 hectares) of five censuses of the sapling-pole stage.

Species	Stand Location					
	Maine1/	N. Dakota2/	Vermont3/	Vermont4/	Saskatchewan5/	Average6/
Ovenbird	20	38	20	8	32	23.6
Red-eyed Vireo	10	55	19	12	13	21.8
Veery	10	65	8	6		22.3
Black-capped Chickadee		10	13	8	2	8.3
Robin	10	5	6	4		6.3
Yellowthroat	45		10	8		21.0
White-throated Sparrow	25		15	16		18.7
Chestnut-sided Warbler	25		19	8		17.3
Catbird	25		17	6		16.0
American Redstart	30		4	6		13.3
American Goldfinch	15	15	2			10.7
Black and White Warbler			12	8	5	8.3
Indigo Bunting	20		2	2		8.0
Downy Woodpecker	15	3		2		6.7
Great Crested Flycatcher		10	4	6		6.7
Eastern Phoebe	15		2	2		6.3
Ruffed Grouse	10		4	2		5.3
Yellow Warbler	40	10				
Song Sparrow	15			2		
House Wren		20	1			
Wood Thrush			22	8		
Blue Jay			12	8		
Rufous-sided Towhee			12	4		
Blackburnian Warbler			8	6		
Brown Thrasher			6	4		
Eastern Wood Peewee			4	2		
Brown Creeper			4	6		
Yellow-rumped Warbler			4	2		
Scarlet Tanager			4	2		
Common Crow			2	2		
Cardinal			2	2		
Rose-breasted Grosbeak			2	8		
Field Sparrow			2	2		
Magnolia Warbler			4		1	
Others	10	114	13	12	38	
Total Density	340	345	259	174	91	241.8

1/Twenty-one year old birch stand, Townsend 1968.

2/Pole stage aspen stand, Clink 1969.

3/Pole stage mixed white pine-paper birch-trembling aspen, Breault and Farrar 1972.

4/Pole stage mixed white pine-paper birch-trembling aspen, Farrar 1973.

5/Young aspen stand, Erskine 1973a.

6/The average was calculated only if a species occurred in three or more censuses.

The aspen forest in Saskatchewan censused by Erskine (1973a) regenerated after a fire. The stand was approximately 30 years old and dominated by trembling aspen. The area had the lowest BSD value (1.64), the least number of species (10), and the lowest density of territorial males (91 per 100 acres) of the five census areas.

Pole-Mature Stage

The ovenbird, red-eyed vireo, and least flycatcher were recorded in all seven censuses of the mature aspen-birch type (Table 3). Mourning warblers which were not recorded in the sapling-pole stage were recorded in the pole-mature stage. The ovenbird, least flycatcher, and Swainson's thrush (Hylocichla ustulata) were more abundant in this stage than either of the first two stages. The red-eyed vireo, veery, black and white warbler, robin, and redstart (Setophaga ruticilla) had about the same abundance as in the sapling-pole stage. Chestnut-sided warblers, white-throated sparrows, black-capped chickadees, yellowthroats, catbirds, and goldfinches all decreased in abundance in the pole-mature stage.

The censuses of the mature stage were scattered from New Brunswick to Saskatchewan. The dominant tree species of four of the censuses were trembling aspen, balsam poplar, and paper birch. Balsam fir and white spruce were the major subdominants (Erskine 1969, 1970, 1971, Price and Speirs 1971).

The greatest BSD value (3.12) and number of species recorded (28) for the mature stage occurred on a Minnesota site dominated by paper birch and red maple (Doran and Todd 1976). Another forest dominated by paper birch in Saskatchewan, however, had the lowest BSD (1.79) and fewest number of species (11) (Erskine 1973b).

The stand censused in Manitoba (Erskine 1972) was the only mature stand in which conifer species were not present. Balsam poplar, trembling aspen, and paper birch were the major canopy species. The understory was also deciduous. The redstart had an estimated territorial male density of 80 per 100 acres, which was more than double the density for any other census of all stages of development.

Successional Trends

The general pattern of bird species diversity through succession is for increased BSD with increased ecological age (Shugart, Anderson, and Strand 1975). The BSD values of the censuses cited above did not follow this general trend. The BSD values tended to increase from the first to the second stage of stand development, but were quite variable in the third stage of development (Table 4). Both the highest and lowest BSD values were obtained from censuses of the sapling-pole stage.

Willson (1974) found the greatest increase of bird species occurred with the initial development of the tree layer and only a small increase as the tree layer developed further. Seventeen more species were recorded on the sapling-pole stage census areas than on the seedling-sapling stage areas. The addition of only three species on the mature stage areas also agrees with her findings. The average number of species per census of the three development stages were 12.8, 22.3, and 18.4.

As expected, changes in relative abundance and species composition of the avian community occurred as the age of the stands increased. Figure 2 shows some of the patterns exhibited. In general, the species which were abundant in the first stage decreased as the stands developed and the species which were abundant in the mature stands were infrequent in the seedling-sapling stage. The chestnut-sided warbler, white-throated sparrow, mourning warbler, song sparrow, and yellowthroat were the characteristic species of the seedling-sapling stage. The pole-mature stage was dominated by the ovenbird, red-eyed vireo, least flycatcher, and veery. The intermediate stage had a mixture of the dominant species of both the first and third stages. Qualitative studies by Adams (1908), Stewart and Aldrich (1952), and Beals (1960) reported similar findings.

Winter Birds

Relatively few birds were found in the aspen-birch type in the winter. Six censuses recorded only 14 species (Wunderle and Schemnitz 1969, Goulden 1973, Kienzler 1973, 1974, Park and Goulden 1974, Burgason 1975). The black-capped chickadee and ruffed grouse (Bonasa umbellus) were recorded in all six censuses and the downy (Dendrocopos pubescens) and hairy woodpeckers (D. villosus) were recorded in five censuses. All other species were found only in 1-3 censuses. The black-capped chickadee had the highest density; 23 per 100 acres in one census.

Table 3.--Territorial male birds per 100 acres (40 hectares) of seven censuses of the pole-mature stage.

Species	Stand Location							Average 8/
	New Brunswick 1/	Minn. 2/	Ontario 3/	Ontario 4/	Ontario 5/	Manitoba 6/	Saskatchewan 7/	
Ovenbird	38	22	56	25	20	23	47	33.0
Red-eyed Vireo	11	27	60	10	10	29	51	28.3
Least Flycatcher	5	27	76	32	33	8	15	28.0
Veery	13	16	32	3	4	17		14.2
Swainson's Thrush	7	5	2	10	6	6		6.0
Black and White Warbler		5	12	4	1	14		7.2
American Redstart	11			2	2	80		23.8
Mourning Warbler		11	10	10	10			10.3
Chestnut-Sided Warbler		22		2	4	1		7.3
Rose-breasted Grosbeak	5	11	8			3	2	5.8
White-throated Sparrow	4	5		6	8			5.8
Hermit Thrush	2	11	4					
Magnolia Warbler	2	5			1			
Canada Warbler		22	4			5		
Black-trhoated Green Warbler		5	16				15	
Winter Wren		5		2	4			
Ruffed Grouse			4	2	2			
Philadelphia Vireo				21	25	9		
Bay-breasted Warbler				2	2		5	
Red-breasted Nuthatch	4	11						
Blackburnian Warbler		5	12					
Purple Finch		5	4					
Downy Woodpecker		5				1		
Great Crested Flycatcher			12			5		
Woodcock				2	1			
Tennessee Warbler						2	10	
Others	16	46	52	0	3	7	11	
Total Density	132	282	366	138	143	211	156	204.0

1/Thirty-forty year old aspen birch stand, Erskine 1969.

2/Thirty-forty year old paper birch-red maple stand, Doran and Todd 1976.

3/Mature aspen-birch forest, Price and Speirs 1971.

4/Mature poplar forest, Erskine 1970.

5/Mature poplar forest, Erskine 1971.

6/Mature aspen-birch forest, Erskine 1972.

7/Mature birch-aspen forest, Erskine 1973b.

8/The average was calculated only if a species occurred in four or more censuses.

Table 4.--Bird species diversity values (BSD) and total number of species recorded for three categories of stand development.

Stage of Development	BSD1/	Total Number of Species	Source
Seedling-sapling Stage			
1 year old clearcut	1.90	8	Niemi 1974b.
2 year old clearcut	2.03	11	Niemi 1975.
2 year old burn	1.94	9	Bergstedt 1973.
2 year old burn	2.16	16	Bergstedt and Niemi 1974.
3 year old burn	2.26	18	Niemi 1974a.
10-15 year old clearcut	2.50	15	Doran and Todd 1976.
Sapling-pole Stage			
21 year old stand	2.71	17	Townsend 1968.
Pole stage stand	2.22	14	Clink 1969.
Pole stage stand	3.29	36	Breault and Farrar 1972.
Pole stage stand	3.07	35	Farrar 1973.
Approx. 30 year old stand	1.64	10	Erskine 1973a.
Pole-mature Stage			
30-40 year old stand	2.32	14	Erskine 1969.
30-40 year old stand	3.12	28	Doran and Todd 1976.
Mature stand	2.61	26	Price and Speirs 1971.
Mature stand	2.30	16	Erskine 1970.
Mature stand	2.41	19	Erskine 1971.
Mature stand	2.08	15	Erskine 1972.
Mature stand	1.79	11	Erskine 1973b.

1/Calculated from the Shannon information formula, BSD = $H' = -\Sigma p_i \ln p_i$, where p_i = the proportion of species (i) of all birds in a census (MacArthur and MacArthur 1961).

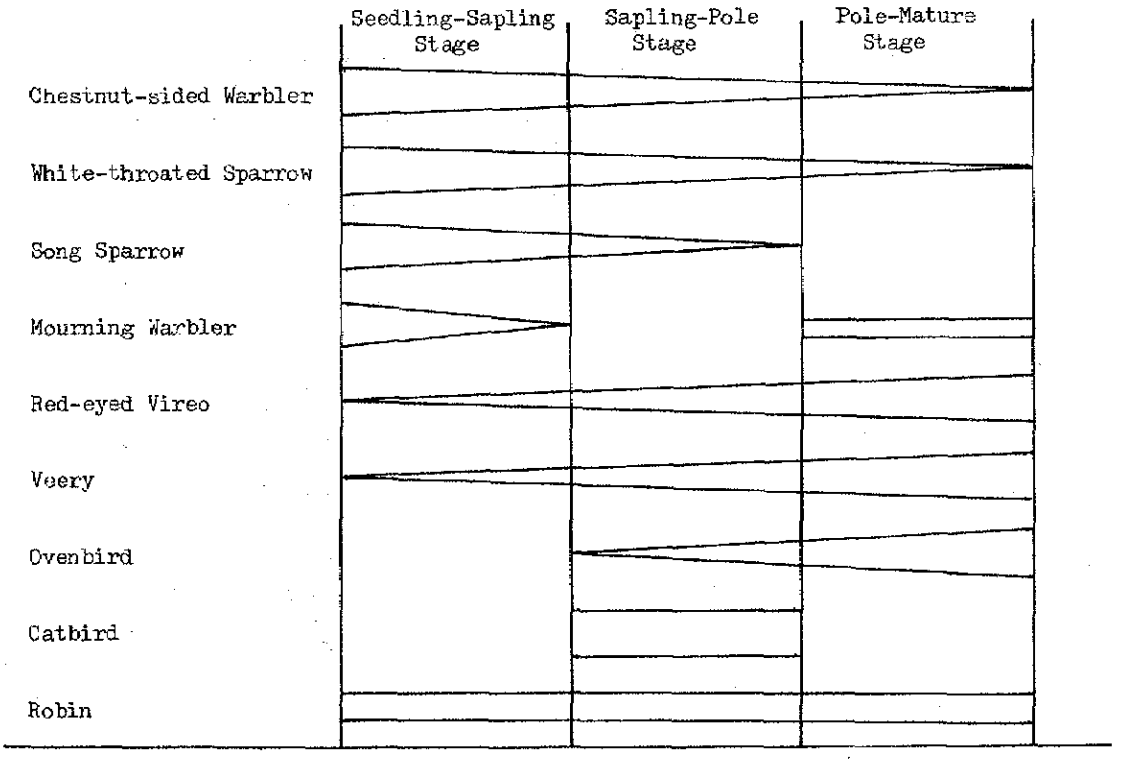

Figure 2.--Changes in species relative abundance in relation to ecological stand age.

MANAGEMENT GUIDELINES

The recent movement to develop management guidelines for nongame species has emphasized the concept of community management versus the traditional single species concept. This emphasis is to be lauded. However, a species exists only where the habitat provides its specific requirements. Some species have a wide range of tolerance for specific factors (eurytopic species) while others have a restricted range of tolerance (stenotopic species). It is necessary that the stenotopic species and their specific requirements be identified before the management prescriptions are formulated. Trade-offs in species diversity may be necessary to prevent the loss of stenotopic species.

It is obvious from the 18 censuses summarized in Tables 1-3 that only 16 of the 78 species recorded were abundant in one or more stages of stand development. Of the remaining 62 species, there are probably some for which the aspen-birch type in any form would be marginal habitat. Yellow-rumped (Dendroica coronata) and blackburnian warblers are examples of this category. They appear in low density in the aspen-birch type when coniferous species are present in the understory or canopy, but they are considered members of the spruce-fir avian community. For other species, presence of some special factor can be the difference between abundance and scarcity or even absence. Balda (1975) found the abundance and diversity of cavity nesting birds increased with increased availability of snags. The house wren apparently responded to the availability of cavities in snags on one census area (Bergstedt and Niemi 1974). Erskine (1972) was of the opinion that the dense deciduous understory was a factor in the extremely high density of redstarts in one Manitoba census. Other factors may have been responsible for high densities of yellow warblers (Dendorica petechia) and indigo buntings on one census area (Townsend 1968) as they were infrequent on the other census areas. Until the specific requirements for all species are identified, only basic guidelines of management can be formulated.

Maintenance of the aspen-birch type requires even-aged management in the form of seedtree or clearcutting prescriptions. In areas where a pulpwood market exists, avian management and pulpwood management are compat-

ible. The stands should be cut on a 40-60 year rotation, depending on site quality. The loss of vigor of parent trees after age 60 reduces their suckering and stump sprouting ability (Folwells 1965), resulting in possible type conversion to tolerant hardwoods or conifers. Slash removal is not necessary in a commercial cutting and may not be desirable for avian management. The larvae and adults of wood-boring beetles that attack slash are fed upon by several species of woodpeckers (Martin, Zim, and Nelson 1961, Conner and Crawford 1974). Prescribed burning of the felled timber can be used to regenerate the type where commercial outlets are not available. However, aspen fuels need to be cured before they can sustain a hot fire (Perala 1972).

The optimum size of the cuttings has not been determined. The minimum size of 10-20 acres needed to make pulpwood operations economically feasible is probably compatible with avian management. Shape of the cut should be considered for areas over 50 acres to provide a high ratio of edge to area. Rectangular strips or irregular shaped cuts create more edge than square cuts.

Several practices can be used to increase species diversity of an area. Cuttings should be spaced temporally to create several age classes on a management unit. Cuttings at 10-15 year intervals with a 40-60 year rotation would result in four age classes. The spacial arrangement of the cuttings should also be considered. "Snag management" as previously mentioned, can increase diversity. Special habitats within a stand (e.g. riparian vegetation) should also be maintained if maximum species diversity is an objective. These additional practices may reduce pulpwood yields or require some additional expenses.

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