Wednesday, January 24

NONGAME BIRD HABITAT MANAGEMENT

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MANAGEMENT OF NORTHEASTERN PINE FORESTS FOR NONGAME BIRDS

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Abstract.--Forests of white, red, jack, and pitch pine may be managed to provide productive habitat for nongame birds. Diverse avian communities often inhabit stands of pine, but few species are restricted to pine forests. Single-species and multi-species wildlife management philosophies are discussed and are related to four principles of managing forest habitat for nongame birds. Even-aged silviculture is recognized as the predominant harvesting practice in pine forests. Forest management which promotes natural regeneration, hardwood understories, and old-growth stands is recommended to enhance habitat for birds. The endangered Kirtland's warbler nests only in young stands of jack pine and is a reminder that pine forests should not be overlooked as wildlife habitat.

INTRODUCTION

Wildlife managers often regard pine forests as "biological deserts" (Castles 1974). Indeed, an intensively managed pine forest may represent a structurally "sterile" habitat for birds (Wiens 1978), and there is a resulting tendency to ignore nongame bird populations in pine forests. Shugart et al. (1978) cautioned that a disregard for bird communities of pine forests could create future shortages in critical habitat for some species. The endangered status of the Kirtland's warbler, which occurs only in stands of jack pine, serves to remind us of this point. Intensive timber management may effectively create biological deserts where extensive stands of pine forests occur; alternatively pine stands may be managed to provide productive habitats for birds.

The objectives of this paper were (1) to review the silvics and management of pine forest types which occur in the northeastern and north central states; (2) to describe the bird communities associated with pine forest types; and (3) to propose management considerations and practices which will allow pine forests to be managed as productive habitat for nongame birds. I have suggested management alternatives which favor nongame birds, and have ignored, within reason, other demands upon the resources of forests. It will be the function of this paper, then, to provide recommendations which will allow optimum benefits for nongame birds in pine forest habitats. Hereafter, wildlife biologists involved in natural resource decision-making processes may be better prepared to propose management compromises which will benefit the nongame resource.

Scientific names of all animals and plants mentioned in this paper are presented in Appendix I.

SILVICS AND SILVICULTURE OF PINE FORESTS

Jack Pine

Jack pine grows farther north than any other American pine (fig.1). It occurs in regions where rainfall is rather low and the frost-free period ranges from 80 to 120 days. The species can sustain itself on quite dry sandy or gravelly soils, but does best on well-drained loamy sands (Fowells 1965). Jack pine is most often found on areas which have been burned. This species is a major component of four forest cover types. It is dominant in the jack pine type, and shares dominance with

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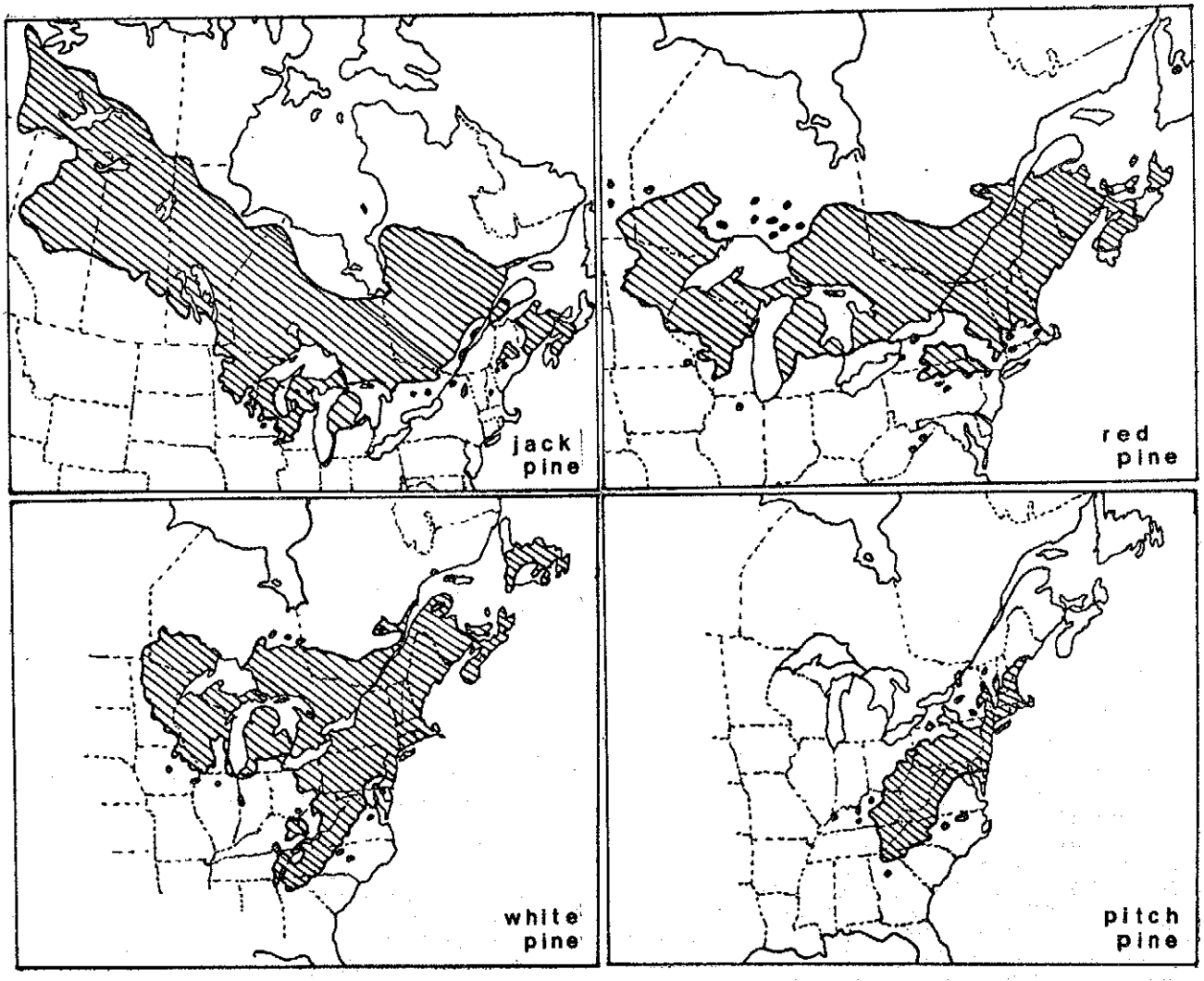

Figure 1.--Ranges of pine forests in north central and northeastern United States and Canada (Little 1971).

paper birch, black spruce, and aspen in other types.

Jack pine characteristically has serotinous cones, which usually do not open until exposed to fire or ground surface temperatures. Nonserotinous cones are common in limited portions of the range (Benzie 1973a). Regeneration is by seeding and usually follows fire. Both germination and seedling survival is best on mineral soil where there is some shade (Fowells 1965).

Jack pine is quite intolerant of shade, and usually functions as a pioneer species. It is one of the fastest-growing conifers in its range for the first 20 years. In the absence of fire, jack pine is usually replaced by more tolerant species, but may form an edaphic climax on the poorest, driest sites (Fowells 1965).

Jack pine currently occupies about 1 million hectares of forest land in the Lake States, but this acreage is decreasing as jack pine stands are converted to other species (Benzie 1977a). Overall management objectives are twofold (Benzie 1977a): (1) to maintain the jack pine type where it is the best suited species, i.e. on dry, outwash, sandy soils; and (2) to replace it with more productive species on better sites at the end of the jack pine rotation.

Clearcutting is the recommended silvicultural system for harvesting mature trees (Benzie 1973a, 1977a). The serotinous cones on slash from clear-cuts will open and seed

naturally with normal ground-surface temperatures. Intensive site preparation, which usually involves prescribed burning, and planting or broadcast seeding is also used. The seed tree system is an alternative practice, but prescribed burning is necessary to prepare the seedbed and open serotinous cones. A shelterwood system is recommended as another alternative, but is most practical in well-stocked stands where cones are nonserotinous (Benzie 1973a).

Jack pine is a short-lived species, hence rotation ages are less than recommended for other pines. Stands are often cut for pulpwood at 40 to 50 years of age with no intermediate commercial thinnings. Thinnings may be prescribed on better sites where merchantable poles and sawtimber may be grown on 70-year rotations. Numerous diseases and insects affect jack pine and prompt managers to restrict rotation ages as much as possible.

Red Pine

The present range of red pine corresponds closely with areas affected by late Pleistocene glaciation (fig. 1). Its distribution corresponds with a zone of low to moderate rainfall, and frost-free periods which range from 80 to 160 days. Red pine grows on better soils than jack pine, and is found chiefly where soils are acidic and have good drainage and aeration. The species is a component of three forest cover types: red pine, jack pine, and white pine. Most species associated with red pine, except white pine, are usually found in the understory (Fowells 1965).

Reproduction is by seed and regeneration is most successful on mineral soil. Seedlings will not grow beneath heavy litter, sod, dense slash, or heavy ashes. Many old-growth stands have been established after fire when a good seed year corresponded with a light cover of ashes. Red pine seedlings grow slowly, and shaded seedlings may require 15 years to reach breast height. Growth rate is more rapid from the sapling stage to maturity, however, and basal area growth may still be constant at 200 years of age (Fowells 1965).

Red pine is less tolerant of shade than most of its associates, but more so than jack pine (Fowells 1965). A forest sere in the Lake States may be from jack pine to red pine to white pine, and finally to northern hardwoods. On infertile, sandy sites, succession may stop short of hardwoods, and red pine may be a persistant subclimax (Benzie 1973b). In the eastern portion of its range, red pine may be a successional stage in a spruce-fir or hemlock climax, rather than a climax of northern hardwoods.

A century ago, red pine covered about 2.8 million hectares of forest land in the Lake States. Today it covers only a little more than 400,000 hectares, mostly planted since 1930 (Benzie 1977b), and is the most intensively managed coniferous type in the region. The usual management objective is to grow red pine in essentially pure, even-aged stands. Benzie (1973b) stated that clearcutting is the most commonly used silvicultural practice, and considered seed tree systems inefficient. However, Heeney (1978) recommended against clearcutting, in favor of seed tree or shelterwood systems. A strip-shelterwood practice is often employed where narrow strips of mature trees are left in an initial cut which completely clears wider strips. A later cut, after regeneration of the clearcuts, removes the mature trees and leaves the narrow strips to be used as access for later operations (Benzie 1973b, Heeney 1978).

The most favored management for red pine involves all the forestry operations which are commonly associated with pine monocultures (Benzie 1977b). Site preparation often involves mechanical treatment, herbicidal applications, and/or prescribed burning. Broadcast seeding is encouraged, but the most reliable method of establishing a red pine stand is to plant nursery-grown trees. Treatments to release seedlings usually involve herbicides. Mechanical cleaning is often needed when the trees are in the sapling stage. Thinning is advisable in the pole and sawtimber stages and stands that are thinned regularly need artificial pruning to produce good saw logs. Prescribed burning is recommended to reduce undergrowth before harvesting a mature stand. Rotations of 60 to 100 years are most commonly recommended, but the maintenance of some old growth stands to 200 years of age is suggested.

Eastern White Pine

The range of eastern white pine corresponds with a cool, humid climate and a growing season of 100 to 200 days (fig. 1). White pine grows on practically all soils within its range, but is most closely associated with well-drained sandy soils. The species is a major component of four forest types, one of which is the white pine type, and is an associate in 14 other types (Fowells 1965).

Regeneration is exclusively by seeding, and good seed crops occur at intervals of 3 to 5 years (Fowells 1965). A seedbed of moist, mineral soil is necessary for germination. Scarification and prescribed burning are often used to create favorable seedbeds (Little et al. 1973). Early growth of white pine is slow, but becomes more rapid between 10 and 20 years. It is a long-lived species and almost never

becomes stagnant in pure stands (Fowells 1965).

Ecologically, white pine is a versatile species and may function as a pioneer, a long-lived intermediate, or a component of the climax forest. It is considered to be intermediate in tolerance to shade, but is quite susceptible to shade when in the slow-growing seedling stage (Fowells 1965).

Little et al. (1973) list clearcutting, strip cutting, seed tree cutting, shelterwood cutting, and group selection as the silvicultural methods used in regenerating white pine. Some foresters believe that white pine cannot succeed itself, and indeed, this is partially true without proper forest management practices. A two-cut shelterwood system is the preferred practice (Lancaster and Leak 1978). The first cut removes 40 to 60 percent of the overstory and is made during or immediately after a good seed year. The second cut to remove the shelter trees comes 5 to 10 years later when the seedlings have begun a rapid growth. It is often recommended that hardwood regeneration be treated with a herbicide before the first cut and sometimes repeated before the second cut (Lancaster and Leak 1978).

Many of the stand prescriptions in Lancaster and Leak's (1978) silvicultural guide suggest management of white pine in harmony with hardwoods where site conditions are good. Group selection is often the recommended silvicultural practice in these stands.

Pitch Pine

Pitch pine grows in humid climates along the Atlantic coast (fig. 1). Its distribution is spotty because it is usually found on poor, shallow soils of sandy or gravelly texture. It does, however grow in a wide range of moisture conditions. The species is a minor component in 12 forest cover types, but is only dominant in one type. It is often found in association with one of several species of scrub oaks (Fowells 1965).

The most extensive stands of pitch pine are found in southern New Jersey (Fowells 1965). Here, the "pine barrens" occupy over 470,000 ha of wildlands which are only minutes away from Philadelphia and New York City (McCormick 1970). The region is almost entirely free from industrial and agricultural development. Pitch pine forests are of little, if any, commercial importance for timber.

The ability of pitch pine to regenerate vegetatively is outstanding. Dormant buds, often protected in seedlings by a basal crook, sprout prolifically after fire or other damage to the stem. The form and growth rates of sprouts decrease with increased age of the root crown beyond 20 years. Wildfires at frequent intervals, then, can result in a stand of slow-growing sprouts from old root systems. Pitch pine may live for 200 years, but growth starts to decline as early as 20 years of age (Fowells 1965). It is a species which is intolerant of shade, and requires mineral soil for germination. Fire has largely maintained the pitch pine type, and has been responsible for the sprout origin and poor form that characterize the species (Little and Moore 1949, Fowells 1965).

AVIAN COMMUNITIES

I have restricted the discussion of avian communities of northeastern pine forests to the breeding season. This limitation is necessary because published information pertains largely to breeding birds, and is somewhat justified because the number of terrestrial bird species may be reduced by as much as 50 percent in the winter months (calculated from Gauthreaux 1978). It should be recognized, however, that pine forests may be more important habitats for birds in the winter, than during the nesting season, because of an energetic advantage provided by dense foliage (Kelty and Lustick 1977).

Data from published breeding bird censuses (*Audubon Field-Notes* and *American Birds*) were summarized for this discussion of the composition of avian communities and trends in avian succession which correspond to the forest sere. I divided this section into communities characteristic of white, red, and jack pine forests and those of pitch pine forests. This division was rationalized because of structural, silvical, and silvicultural similarities among white, red, and jack pine forests and corresponding differences in pitch pine environments. It is widely accepted that breeding birds select habitats on the basis of vegetative structure rather than plant species composition (Hilden 1965, Balda 1975, and others).

White-Red-Jack Pine

Species Composition and Richness

The Kirtland's warbler, an endangered species, and the pine warbler, which is never abundant, are the only two species which occur in the northeastern states and are found exclusively in pine forests. Numerous species occuring predictably in pine forests, but also present in other coniferous types, deciduous types, or mixed pine and hardwood forests are the black-capped chickadee, red-breasted nuthatch, golden-crowned kinglet, ruby-crowned kinglet, yellow-rumped warbler, and chipping sparrow. Pine forests may support a rich community of breeding birds (table 1).

Table 1.--Occurrence and density of 48 species of breeding birds in seral stages of white, red, and jack pine forests. Density is expressed as number of territorial males per 10 ha: xxxx = ≥ 10; 5 ≤ xxx < 10; 1 ≤ xx < 5; x < 1. Frequency indicates the number of times each species occurred in published breeding bird censuses (*Aud. Field-Notes* and *Am. Birds*).

Breeding birds	Seral stages: Seedling-sapling[1/]	Pole	Mature	Mixed pine/hardw.	Total freq.
Common flicker	-	-	-	xx 1	1
Pileated woodpecker	-	-	-	x 1	1
Yellow-bellied sapsucker	-	-	xx 1	xx 1	2
Hairy woodpecker	-	-	-	x 1	1
Downy woodpecker	-	-	-	x 1	1
Great-crested flycatcher	xx 1	-	xx 1	-	2
Eastern wood pewee	xx 1	-	xx 1	xx 2	4
Olive-sided flycatcher	-	-	-	x 2	2
Blue jay	x 1	xx 3	x 3	-	7
Black-capped chickadee	xx 1	xx 3	xx 2	x 2	8
White-breasted nuthatch	-	-	x 1	x 1	2
Red-breasted nuthatch	-	-	xx 2	-	2
Brown thrasher	xx 4	-	-	-	4
American robin	xx 3	xxxx 1	xx 3	xx 2	9
Hermit thrush	-	xx 2	x 2	xx 2	6
Wood thrush	-	-	xx 2	-	2
Veery	-	-	xx 3	xxx 1	4
Golden-crowned kinglet	-	-	xx 1	-	1
Ruby-crowned kinglet	-	-	x 1	-	1
Cedar waxwing	xx 3	xx 1	-	xx 1	5
Solitary vireo	-	-	x 2	x 1	3
Red-eyed vireo	x 1	-	xx 2	xx 2	5
Black & white warbler	-	xx 1	xx 2	x 2	5
Nashville warbler	xx 1	xx 2	-	-	3
Yellow warbler	x 1	xxxx 1	-	-	2
Magnolia warbler	xx 1	-	-	xx 1	2
Yellow-rumped warbler	xx 1	xx 2	xx 2	xx 1	6
Black-throated green warbler	-	-	xxx 2	xx 2	4
Blackburnian warbler	-	-	xxx 3	x 2	5
Chestnut-sided warbler	-	-	-	x 2	2
Pine warbler	-	-	xxx 1	-	1
Kirtland's warbler	x 1	-	-	-	1
Ovenbird	-	xx 3	xxx 4	x 2	9
Mourning warbler	-	xx 1	-	xx 1	2
Common yellowthroat	xx 2	xxx 1	-	xx 2	5
Canada warbler	-	-	xx 1	xx 1	2
American redstart	-	-	-	x 2	2
Scarlet tanager	-	-	xx 2	x 1	3
Rose-breasted grosbeak	x 1	-	x 1	x 1	3
Purple finch	xx 2	-	xx 1	x 1	4
American goldfinch	xxx 1	xxx 1	xx 1	x 2	5
Rufous-sided towhee	xx 2	xxx 3	xx 2	x 1	8
Vesper sparrow	xx 3	-	-	-	3
Dark-eyed junco	xxx 1	-	xx 3	x 1	5
Chipping sparrow	xxx 4	xxxx 1	xx 3	xx 1	9
Field sparrow	xxx 3	xx 1	-	-	4
White-throated sparrow	x 1	-	x 2	xxx 2	5
Song sparrow	xxxx 2	xx 1	-	xxx 1	4
Number of censuses	4	4	4	2	14

[1/] One of the young sapling study plots contained some scattered dead hardwoods, which resulted in the occurrence of species such as great-crested flycatcher and black-capped chickadee.

Table 2.--Richness and density of breeding birds in seral stages of white, red, and jack pine forests. Refer to Appendix II for additional habitat and census data.

Forest stand description	Size of study plot (ha)	No. species	No. territories		Location, Reference
			Study plot	Km^2	
Jack pine regeneration	6.5	12	12.5	193	Michigan, Munn 1974
Young red pine plantation	4.8	6	15	312	Ontario, MacDonald 1965
Young mixed pine plantation	8	31	62.5	813	Ontario, Oelke 1967a
Pole-stage white pine plantation	7.5	7	11.5	153	Massachusetts, Lloyd-Evans 1975b
Pole-stage red pine plantation	4.8	1	1	21	Ontario, MacDonald 1965
Pole/mature jack pine forest	28	11	25	88	Ontario, Erskine 1971
Mature jack pine forest	12	14	50	417	Minnesota, Niemi 1974
Mature white pine forest	7	27	50.5	694	Ontario, Oelke 1967b

Richness (i.e. number of species) is characteristically lower in coniferous forests than in deciduous or mixed forests (Tramer 1969); and pure pine forests do not provide exception to this rule (Driscoll 1977, Dickson 1978, Meyers and Johnson 1978). Table 2 contains a summary of the findings of eight bird censuses in seral stages of white, red, or jack pine stands. Fewer than 15 species of birds were present on all but two plots, and scattered hardwoods on these two areas may have accounted for the increased richness (appendix II). Twenty or more species are characteristically found in deciduous stands or mixed forests (Tramer 1969, Meyers and Johnson 1978).

Successional Trends

Breeding bird censuses of pine forests were assigned to four habitat classes: seedling and sapling, pole stage, mature forest, and mixed pine and hardwoods. The first three classes are common management delineations, while the mixed forest class represents an advanced seral stage in the succession towards a hardwood climax.

The seedling-sapling stage was dominated by granivorous birds and some common edge species (table 1). Richness was predictably low in two studies (Munn 1974, MacDonald 1965), but unusually high on a tract studied by Oelke (1967a) where patches of hardwoods, including snags, and nest boxes contributed to high numbers of breeding birds (table 2).

Brooks (1970, 1975, 1977, 1978) conducted breeding bird censuses in a scotch pine plantation for 8 consecutive years and provided another example of increased species richness and density when woody vegetation was associated with young pines (table 3). The high densities of birds in Brooks' studies were largely song sparrows and chipping sparrows. The numbers of American robins and purple finches gradually decreased as plant succession progressed during the 8 years of Brooks' censuses. Accordingly, breeding pairs of common yellowthroats increased steadily as woody undergrowth increased (table 3).

The diversity of breeding birds may be at its lowest in dense pole-stage pine stands because closure of the canopy leads to elimination of the understory and ground cover. Pine plantations with trees spaced at regular intervals will feature the most complete canopy closure. The resulting dearth of nesting in closed stands was most dramatically illustrated by MacDonald (1965) who found only one territorial male, a yellow-rumped warbler, on a 4.8 ha plot in a red pine plantation. Naturally-stocked stands of pole-stage pines may have closed canopies as well, but patchy openings in the canopy are more likely and will allow development of the understory.

Species richness and density were found to increase in mature stands of pine and mixed pine and hardwood forests (tables 1,2). This observation was consistent with general trends of increasing diversity and density associated with forest succession (Shugart and James 1973, Kricher 1973). Oelke (1967b) reported a particularly rich census of breeding birds, 27 species,

Table 3.--Breeding birds of an upland scotch pine plantation, Allegany Co., New York from 1970 - 1977 (Brooks 1970 - 1975, 1977, 1978).

Description of habitat: Meadow planted to scotch pine in 1958; trees trimmed annually since 1962 to 2 m high and harvested regularly since 1970; grass and forb cover between trees; choke cherry and brambles increased from 1973 - 1977. Plot was 9.3 ha with diverse edges.

Year	Species	No. territories 9.3 ha	No. territories km^2	No. territories Song sparrow	Chipping sparrow	American robin	Purple finch	Common yellowthroat
1970	12	106	1144	31	26	21.5	10	1
1971	18	84	902	23	14.5	13	8	+
1972	17	108	1155	31	23	13	9	+
1973	15	89	956	23	17	11	8	2
1974	18	94	1005	28	17	10	8	4
1975	14	80	854	23	19	7.5	4	6
1976	23	105	1128	28	21	5	5	8
1977	23	86	924	25	20	4	4	9
Mean	17.5	93.8	1008.5	26.5	19.7	10.6	7	3.9
Range	12-23	84-107	854-1155	23-31	14.5-26	4-21.5	4-10	+-9
C.V.				13	19	52	33	88

Other abundant species (mean no. territories): Field sparrow (7.9), Rufous-sided towhee (3.6), American woodcock (2.7), Yellow-rumped warbler (2.6).

in a white pine forest with an open canopy and a diverse hardwood understory.

Pitch Pine

Species Composition and Richness

The checklist of birds for the pine barrens of New Jersey lists the occurrence of 144 species (McCormick 1970), but many of these are water birds, rare species, and records of migratory birds which do not nest in pitch pine forests. The breeding avifauna of pitch pine forests is characterized by few species represented by numerous individuals (table 4).

Many of the birds found nesting in pitch pine forests select the characteristic understory of scrub oaks and the blueberry and huckleberry ground cover rather than the pine overstory. The rufous-sided towhee most typifies pitch pine forests, but is a shrub and ground-dwelling species. Other species which prefer understory vegetation and predictably breed in pitch pine stands are common yellowthroats, prairie warblers, and brown thrashers. Frequent fires produce abundant cavity-nesting sites for several species of woodpeckers, black-capped chickadees, and eastern bluebirds. The open habitat of pitch pine forests is preferred by bluebirds. In addition to the abundant towhee, ground-nesting species most common in pitch pine include whip-poor-wills, common nighthawks, and ovenbirds. Only pine warblers, eastern wood pewees, and blue jays are found consistently in the canopy.

Successional Trends

Because pitch pine forests are not extensively harvested and frequent fires prevent old growth, succession is typically accelerated in the early stages and truncated before maturity. Thus the avian community is characteristic of mid-successional vegetative structure. Lloyd-Evans (1973, 1975a, 1977) conducted censuses which allowed comparisons of richness and abundance of breeding birds in pitch pine stands at different intervals following fire (table 5). His studies indicate that understory plants and breeding birds of the low vegetative strata responded vigorously only one year after a burn.

Fables (1947, 1948, 1954) censused breeding birds in the New Jersey pine barrens for 17 consecutive years (table 6). His studies began 8 years after a fire and continued until the study plot had been free from fire for 24 years. This long-term study showed remarkable stability in the richness and density of the avifauna of a mid-successional pitch pine forest.

SILVICULTURAL MANAGEMENT OF HABITAT

An historical and comprehensive review of man's silvicultural influence on wildlife habitat was presented by Perkins (1974). A subsequent review by Schemnitz (1976) emphasized the

Table 4.--Occurrence and density of 29 species of breeding birds in successional stages of pitch pine forests following fire. Density is expressed as number of territorial males per 10 ha: xxxx = ≥ 10; 5 ≤ xxx < 10; 1 ≤ xx < 5; x < 1. Frequency indicates the number of times each species occurred in published breeding bird censuses (*Aud. Field-Notes* and *Am. Birds*).

Breeding birds	No. years following fire 0-1	2-10	11-20	21+	Total freq.
Mourning dove	-	x 3	x 2	x 2	7
Black-billed cuckoo	-	x 1	x 1	-	2
Yellow-billed cuckoo	-	x 1	x 1	x 2	4
Common nighthawk	-	x 2	x 2	x 1	5
Whip-poor-will	x 2	x 3	xx 3	x 2	10
Common flicker	xx 3	x 3	x 2	x 3	11
Hairy woodpecker	xx 1	xx 1	x 1	-	3
Downy woodpecker	x 1	x 2	x 3	x 2	8
Eastern kingbird	x 2	x 2	x 1	x 3	8
Eastern wood pewee	xx 3	x 2	x 3	x 2	10
Blue jay	xx 3	x 1	x 3	x 3	10
Eastern bluebird	xx 3	x 3	x 3	x 2	11
Hermit thrush	xx 3	xx 1	-	xx 1	5
American robin	xx 2	xx 1	x 2	-	5
Gray catbird	-	x 1	x 3	xx 1	5
Brown thrasher	xx 2	xx 3	x 3	x 2	10
Black-capped chickadee	x 1	x 2	-	xx 1	4
Tufted titmouse	-	-	x 1	x 2	3
House wren	xx 1	xx 3	x 3	x 2	9
Black & white warbler	-	x 2	x 2	x 2	6
Pine warbler	-	xx 2	xx 3	x 2	7
Prairie warbler	xxxx 2	xxx 3	x 1	xxxx 2	8
Ovenbird	-	x 1	x 1	x 2	4
Common yellowthroat	xxx 2	xxx 3	xx 3	xxx 3	11
American goldfinch	-	-	x 3	x 1	4
Rufous-sided towhee	xxxx 3	xxx 3	xxx 3	xxxx 3	12
Chipping sparrow	-	x 2	x 3	x 2	7
Field sparrow	xxx 1	xx 3	x 2	xx 1	7
Song sparrow	-	x 2	x 3	x 2	7
Number of censuses	3	3	3	3	12

Table 5.--Richness and density of breeding birds in stands of pitch pine-scrub oak following fire and insect damage (Lloyd-Evans 1973, 1975a, 1977). Refer to Appendix III for additional habitat and census data.

Descriptive variables	Forest stand identification IV-74	IV-75	III	II	V	I
Size of census plot (ha)	7.5	7.5	7.5	7.5	7.5	7.5
Years after fire	0	1	2	10	1/	30
No. bird species	6	18	13	16	22	12
No. territories	16	33	46	60	38	52
Territories/km^2	207	440	553	807	500	693

1/ 5 years after insect infestation killed pines.

Table 6.--Breeding birds of typical New Jersey pitch pine barrens, 1938-1954 (Fables 1947, 1948, 1954).

Description of habitat: 1930- most of plot was burned; 1938- pine regeneration 2 m high, scrub oak 1.6 m high; 1941- burned and unburned areas similar in appearance; 1945- pine spreading laterally; 1954- nine summer homes erected on plot. Study plot was 31 ha and included a 2 ha cedar bog.

Species	Mean (15 yrs)[1/]	Range	No. years after 1930 fire: 8-12 (1938-42)	13-18 (1943-48)	21-24 (1951-54)
			Mean no. territories		
Rufous-sided towhee	20.7	12-33	16	22	24
Prairie warbler	7.4	3-15	8	9	4
Common yellowthroat	4.9	3-8	5	5	4
Whip-poor-will	2.8	1-7	1	4	2
Pine warbler	2.7	1-8	3	3	1
Brown thrasher	2.5	1-4	3	3	2
Gray catbird	2.5	0-5	2	3	2
House wren	2.3	0-5	3	2	1
Chipping sparrow	2.2	1-4	2	3	2
Field sparrow	1.9	0-4	3	2	1
Total no. species	35.1[2/]	30-42	35	35	35
Total territories	87.3	64-104	81	94	88
Territories/km^2	277	208-338	270	275	287

[1/] Data from 1949-50 not available.
[2/] Many species were associated with diverse habitats adjacent to the study plot.

many investigations where effects of silvicultural practices on single species of wildlife were studied. Current and future research must concentrate on silvicultural management of entire faunal communities to complement management philosophies which are increasingly holistic in scope.

Philosophies of Management

Wildlife management, if not most resource management, has been characterized in the past by a single agency implementing decisions concerning a single resource. The philosophy still prevails on much federal, state, and private land, but was legally altered on National Forests in 1960 with the passage of The Multiple Use and Sustained Yield Act. This act dictated a change in thinking and in practice, but multiple-use, nevertheless, has been implemented more by decree and compromise than by design. The trade-offs necessary for scientific multiple-use management depend upon an improved knowledge of inputs and outputs of a resource system (Ripley and Buffington 1974), and upon a better understanding of public desires (Payne and Thomas 1974).

The philosophy of simultaneous consideration of multiple resources led to the featured species concept of managing wildlife (Holbrook 1974, Zeedyk and Hazel 1974, Gould 1977). This concept represented a hybrid between single-species and multiple-resource management. It was predicated on the management of a single wildlife species, but recognized that maximization of both the wildlife resource and the timber resource must be compromised. The featured-species concept should be regarded as no more than a step in the right direction towards a more comprehensive system of management.

A current management philosophy, one with an ecological rather than an economical foundation, is a multi-species concept based on providing habitat diversity (Siderits 1975, Siderits and Radtke 1977). Natural diversity should be pursued, but maximum diversity *per se* is not a suitable management objective (Webb 1977, Weins 1978). High diversity is often equated with ecosystem stability, but that relationship is questionable and is currently being tested (Goodman 1975).

The ultimate management objective is to base decisions on the balance of entire ecosystems. Ecosystem management is a concept which is being addressed by research ecologists (Wagner 1977) as well as resource managers (Graul et al. 1976). Wagner (1977) stated that ecosystem management will ultimately depend upon an understanding of energy flow and community structure.

Principles of Managing Avian Communities

Lack (1933) was one of the first to study habitat selection by birds, and since his early studies much research has addressed resource division among avian species. Many of these studies have been conducted in the past decade or two and complement each other so well that I have identified the following "principles" of managing habitat for avian communities.

1. *Habitat structure is more important in resource partitioning than other dimensions of the ecological niche.* The ecological niche, as defined by Hutchinson (1958), consists of many dimensions, one of which may be comprised of the structural components of the habitat. This dimension is often referred to as the *habitat niche* (Smith 1977). Schoener (1974) reviewed resource partitioning and concluded that for birds habitat dimensions were more important than food-type dimensions or temporal dimensions. He also stated that as the number of species increased, the number of niche dimensions must increase as well. This consideration leads to the conclusion that the diversity of bird species will be strongly dependent upon habitat diversity. Furthermore, diverse habitat for birds may be largely equated with diverse vegetative structure (see Balda 1975 for review).

A classic study by MacArthur and MacArthur (1961) documented a strong relationship between the diversity of breeding birds in a forest and layers of foliage. The results of MacArthurs' study became so widely accepted that biologists (e.g. Meslow 1978) commonly equated vegetative structure with foliage height diversity. Vegetative structure may be defined by many variables, however, and foliage height is only one component of the habitat niche. The recent uses of multivariate statistical analyses in studies of habitat structure have identified numerous habitat variables that may be important in the management of avian habitat (James 1971, Anderson and Shugart 1974, Shugart et al. 1975, Conner and Adkisson 1976).

2. *Plant succession determines avian species composition, diversity, and biomass.* The fact that certain species of birds are characteristic of different stages of the forest sere is well accepted and has been documented in many forest types (Adams 1908, Johnston and Odum 1956, Kendeigh 1948, Martin 1960, Karr 1968). Seed-eating sparrows are predictably found in bare fields and grassland just as bark-probing woodpeckers are associated with mature forests.

Theoretical properties of succession were presented by Margalef (1968) and Odum (1969). Among other attributes, it is believed that successional trends lead to increased species diversity and biomass. Species diversity is most commonly defined by a formula (Shannon and Weaver 1963) which is comprised of two components: *richness* (number of species) and *equitability* (evenness of abundance among species). Odum (1969) predicted that both components increased with succession. Species richness in breeding birds is highly correlated with diversity (Tramer 1969), and richness is commonly accepted as an index of diversity.

Breeding bird diversity roughly corresponds to expected successional trends (Johnston and Odum 1956, Shugart and James 1973, Karr 1968). However, Shugart et al. (1975) cautioned that studies of avian succession have illustrated considerable variability in diversity, and stated that a typical trend has not yet emerged. Variability is also evident when examining trends in density and biomass through succession, but the general pattern in birds is for higher values of both variables as the forest matures (Shugart et al. 1975).

3. *Avian diversity is dependent upon* (a) *vertical habitat diversity,* (b) *horizontal habitat diversity,* (c) *patchiness of habitats,* and (d) *size of forest habitats.* Whittaker (1965) distinguished between within-habitat or "alpha" diversity and between-habitat or "beta" diversity. In the context of habitat management, those distinctions can be viewed as vertical foliage layering within a stand (alpha-diversity), and the juxtaposition of stands of different successional stages and species composition (beta-diversity). Overall avifaunal diversity can be enhanced by increasing opportunities for the vertical distribution of birds within a stand (Dickson and Noble 1978), and/or by providing structural diversity among stands (Edgerton and Thomas 1978, Wiens 1978). This is to say that total avifaunal diversity is greater in the entire forest sere than in any particular seral stage.

Spatial heterogeneity also determines avian diversity. This concept is referred to as habitat patchiness and is least likely to be achieved under intensive even-aged forest management. MacArthur et al. (1962) and Roth (1976) found high correlations between bird species diversity and indices of spatial variability.

The size of forest habitats and the fragmentation of forests should be important concerns in formulating management plans which consider habitat for nongame birds (Forman et al. 1976). Galli et al. (1976) found increased species richness as the size of forest islands increased. "Habitat islands" have also been studied by Whitcomb (1977) and MacClintock et al. (1977). Their research

suggested that certain bird species of the forest interior will occur only in large blocks of habitat, although the size of these blocks may be reduced if "habitat corridors" prevent isolation. The importance of habitat islands and corridors is evident, but implications for management are poorly understood at the present time.

4. *Habitat management for nongame birds should consider species assemblages.* It is unlikely that extensive nongame bird management will be conducted on a single-species basis; and I cautioned earlier against managing solely for maximum diversity. Rather, habitat management should be oriented towards carefully-defined groups of species. Several approaches have been suggested to identify suitable species assemblages. *Guilds* contain functionally related species that show similarities in foraging, nesting, and food habits. Theoretically, birds in different guilds do not compete for resources. Assigning birds to guilds may be helpful in identifying management assemblages, but tolerances of individual species to specific niche dimensions should not be overlooked.

Thomas et al. (1976) assigned species to 16 different *life forms*. It was predicted that most species of any life form would respond similarly to a specified management practice. Webb et al. (1977) used experimentation to determine that certain groups of birds responded in predictable ways to habitat alteration. Webb (1977) identified *response groups*, such as the blackburnian warbler group that responded adversely to even a partial removal of the forest canopy. Such response groups might be identified by multivariate statistical techniques such as cluster analysis, utilized by Evans (1978).

General Effects of Even-Aged Management

Even-aged forest management is, and will probably continue to be, the overriding silvicultural practice in forests of white, red, and jack pine. Previous authors (Edgerton and Thomas 1978, Meslow 1978) have predicted the following general effects of even-aged management on bird habitat.

(1) *Early stages of succession are accelerated* through practices of intensive site preparation, seeding, and planting. These practices lead to the rapid replacement of early successional bird species by those that select shrub and sapling habitat.

(2) *Old growth habitats are commonly eliminated.* Long rotations are uncommon in managed pine forests hence the diverse avian communities of mature stands are not encouraged.

(3) *Snags and cavities are often eliminated* by thinning or are not allowed to develop because of short rotations. This effect is more characteristic of intensive clearcutting than of other even-aged practices.

(4) *Monocultures are encouraged.* Monocultures usually lack diverse vegetative structure. They are susceptible to damage from diseases and insects which may lead to preventative measures such as chemical treatments and shortened rotations. For birds, the cures may be worse than the diseases.

Silvicultural Recommendations

Regeneration Cutting

Commercially important northern pine forests managed in even-aged stands are harvested by clearcutting, shelterwood, or seed tree cutting. Clearcutting has the most obvious impact on the vertical structure of habitat and will result in a conversion of the avian community. Such conversions will *generally* reduce species richness and biomass. This may not be the case in pine stands, however, because they are often harvested when commercially mature, rather than ecologically mature, hence richness and biomass may already have been at a minimum.

Clearcutting followed by intensive site preparation effectively reduces the habitat niche to only two dimensions and strongly impacts bird populations. The effects are usually of short duration, however, because herbaceous cover develops rapidly on the burned areas. Clearcutting with *natural regeneration* is a preferred alternative.

The other even-aged management alternatives, shelterwood and seed tree harvesting are much less disruptive to the avian community. Although much of the habitat structure is removed by both methods of harvest, opportunities for several functional groups of birds are preserved through the seed-producing trees which are left.

If clearcutting is the selected management option, the size, shape, and location of clearcuts can be planned to enhance avian communities. Wildlife biologists have long maintained that clearcut areas should be intermixed as much as possible to produce a habitat with maximum horizontal diversity. However, we have never agreed on an optimum size for these clearcuts. The smaller the cuts, and the greater the admixture of age-classes, the more edge is provided; and wildlifers traditionally have been taught to manage for the edge.

Edge habitat might not be in short supply in a harvesting scheme involving clearcuts of

different ages; but areas in the forest interior might be, and there are "forest-interior species" just like there are edge species. How large should stands be to provide for the species of forest interiors? Research on this subject is needed (see Robbins, this Proceedings). This may be merely an academic question in intensively managed pine forests, because forest interior species are usually associated with old-growth habitat. Hence, managers must first lengthen the rotation period to produce mature stands, then be concerned for species of the forest interior.

Intermediate Treatments

Intensive pine silviculture and habitat enhancement for birds are often in conflict as stands develop. The removal of hardwood regeneration by chemical or mechanical means drastically reduces the vertical structure of developing pine stands. On a short-rotational system, maximum avian diversity may occur in the sapling stage prior to closure of the overstory, but pre-commercial thinning to remove the hardwood understory will prevent a rich avifaunal composition in the sapling stage.

After crown closure, pine stands often reach a successional low-point in avian diversity. Thinning can improve the habitat at this point. If at all feasible, thinning or other timber stand improvement should be done in a random pattern to create patchiness in the stand. Standard row-thinning provides ephemeral stimulation of the understory at best. Stem girdling is a stand improvement practice which may be particularly beneficial to birds.

Pine Forest Types

Jack pine should be maintained on poor sites where it will not be out-competed. Habitat for birds will likely be improved by periodic fires. Conversion of jack pine to a more productive forest type is recommended on better sites. Red pine is often selected to replace jack pine, and it is with red pine that the silvicultural recommendations presented above are most applicable.

Many silvicultural options are available in forests of white pine. Shelterwood and seed tree systems or clearcutting in strips or patches are practices which may provide productive wildlife habitat. White pine may also be managed in uneven-aged stands. On good sites, group selection for white pine in association with management for hardwoods will provide excellent habitat for birds.

Management of pitch pine forests should highlight preservation and the encouragement of occasional fires. Conversion to a non-forested condition is the greatest threat to this forest type, although much pitch pine acreage is currently preserved as state-owned forest land.

KIRTLAND'S WARBLER--AN ENDANGERED SPECIES

The Kirtland's warbler has always been a rare species. Not until 1903 were the nesting grounds found in northern Lower Michigan. Singing males, censused as an index to the nesting population, have declined from 500 in 1961 to 200 in 1971 and have remained at or below that number (Byelich et al. 1976).

The breeding habitat requirements of the Kirtland's warbler are highly specialized (Radtke and Byelich 1963, Byelich et al. 1976). They nest in young stands of jack pine 80 ha or more in size, where homogeneous groups of pine occur in patchy distributions, interspersed with areas of small, grassy openings. The species nests on the ground usually under living pine branches near the ground. Suitable habitat is present only when jack pines are between 2 m and 5 m in height which normally occurs when the trees are 8 to 21 years of age. Preferred nesting habitat is found almost exclusively on a single soil type, Grayling sand.

Byelich et al. (1976) identified two factors which were limiting the population of Kirtland's warblers on the breeding grounds. The primary factor was a reduction in suitable nesting habitat because of fire control and other recent forest practices (Mayfield 1963). A second limiting factor was egg parasitism of Kirtland's warbler nests by brown-headed cowbirds. (Mayfield 1977).

Habitat management for the Kirtland's warbler is the epitome of single-species management, but is dictated by society's concern for a species faced with extinction and, of course, the Endangered Species Act of 1973. Preservation of this species is being carried out in accordance with a recovery plan approved by the U.S. Fish and Wildlife Service (Byelich et al. 1976).

Management of nesting habitat is designed to allow the reestablishment of a self-sustaining population of 1000 pairs of Kirtland's warblers throughout the known former range. The Michigan Department of Natural Resources is currently managing over 30,000 ha of state-owned land for the species, and the Huron National Forest has designated 55,400 ha as Kirtland's warbler habitat (personal communication, Michael T. Mang, William Irvine). These lands are being managed in blocks of 80 to 120 ha, where even-aged stands of jack pine are being regenerated at 10-year intervals. Clearcutting, burning, planting, and seed tree cutting are being used to create the desired habitat. Approximately 25 percent of each block is left in small openings. The management agencies opted to utilize the jack pine for commercial pulpwood thus doubling the total acreage of management blocks and harvesting on a 45 to 50-year rotation.

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ACKNOWLEDGMENTS

My interest in the subject matter of this paper and the basis for many of the ideas presented are products of current research on the topic of forest management and habitat associations of nongame birds. This research is generously supported by the Windham Foundation, Grafton, Vermont, and by Cooperative Forest Research Funds administered by the School of Natural Resources, University of Vermont. I thank Maureen Douglas, Marianna Heins, and Helen Schuster for their assistance in the preparation of the manuscript.

Appendix I .--Nomenclature of birds and plants mentioned in the text.

Birds

American woodcock	*Philohela minor*
Mourning dove	*Zenaida macroura*
Yellow-billed cuckoo	*Coccyzus americanus*
Black-billed cuckoo	*Coccyzus erythropthalmus*
Whip-poor-will	*Caprimulgus vociferus*
Common nighthawk	*Chordeiles minor*
Common flicker	*Colaptes auratus*
Pileated woodpecker	*Drycopus pileatus*
Yellow-bellied sapsucker	*Sphyrapicus varius*
Hairy woodpecker	*Picoides villosus*
Downy woodpecker	*Picoides pubescens*
Eastern kingbird	*Tyrannus tyrannus*
G.-crested flycatcher	*Myiarchus cinerascens*
Eastern wood pewee	*Contopus virens*
Olive-sided flycatcher	*Nuttalornis borealis*
Blue jay	*Cyanocitta cristata*
Black-capped chickadee	*Parus atricapillus*
Tufted titmouse	*Parus bicolor*
White-breasted nuthatch	*Sitta carolinensis*
Red-breasted nuthatch	*Sitta canadensis*
House wren	*Troglodytes aedon*
Gray catbird	*Dumetella carolinensis*
Brown thrasher	*Toxostoma rufum*
American robin	*Turdus migratorius*
Wood thrush	*Hylocichla mustalina*
Hermit thrush	*Catharus guttata*
Veery	*Catharus fuscescens*
Eastern bluebird	*Sialia sialia*
Golden-crowned kinglet	*Regulus satrapa*
Ruby-crowned kinglet	*Regulus calendula*
Cedar waxwing	*Bombycilla cedrorum*
Solitary vireo	*Vireo solitarius*
Red-eyed vireo	*Vireo olivaceus*
Black & white warbler	*Mniotilta varia*
Nashville warbler	*Vermivora ruficapilla*
Yellow warbler	*Dendroica petechia*
Magnolia warbler	*Dendroica magnolia*
Yellow-rumped warbler	*Dendroica coronata*
Black-throated green warbler	*Dendroica virens*
Blackburnian warbler	*Dendroica fusca*
Chestnut-sided warbler	*Dendroica pensylvanica*
Pine warbler	*Dendroica pinus*
Kirtland's warblar	*Dendroica kirtlandii*
Prairie warbler	*Dendroica discolor*
Ovenbird	*Seiurus aurocapillus*
Mourning warbler	*Oporornis philadelphia*
Common yellowthroat	*Geothlypis trichas*
Canada warbler	*Wilsonia canadensis*
American redstart	*Setophaga ruticilla*
Scarlet tanager	*Piranga olivacea*
Rose-breasted grosbeak	*Pheucticus ludovicianus*
Purple finch	*Carpidacus purpureus*
American goldfinch	*Carduelis tristis*
Rufus-sided towhee	*Pipilo erythrophthalmus*
Vesper sparrow	*Pooecetes gramineus*
Dark-eyed junco	*Junco hyemalis*
Chipping sparrow	*Spizella passerina*
Field sparrow	*Spizella pusilla*
White-throated sparrow	*Zonotrichia albicollis*
Song sparrow	*Melospiza melodia*

Plants

Eastern white pine	*Pinus strobus*
Red pine	*Pinus resinosa*
Jack pine	*Pinus banksiana*
Pitch pine	*Pinus rigida*
Scotch pine	*Pinus sylvestris*
Balsam fir	*Abies balsamea*
Black spruce	*Picea mariana*
Eastern hemlock	*Tsuga canadensis*
Paper birch	*Betula papyrifera*
Quaking aspen	*Populus tremuloides*
Choke cherry	*Prunus virginiana*
Scrub oaks	*Quercus ilicifolia*
- - -	*Quercus prinoides*
- - -	*Quercus minor*
Blueberry	*Vaccinium angustifolium*
- - -	*Vaccinium vacillans*
Huckleberry	*Gaylussacia baccata*
Wintergreen	*Gaultheria procumbens*
Bracken fern	*Pteridium aquilinum*

Appendix II.-Breeding birds in seral stages of white, red, and jack pine forests.

Descriptive variables	Young jack pine regeneration		Young red pine plantation		Young mixed pine plantation		Pole stage white pine plantation	
Year of census	1974		1962		1967		1974	
Size of plot (ha)	6.5		4.8		8		7.5	
Location	Michigan		Ontario		Ontario		Massachusetts	
Habitat								
Stand history	Fire in 1964		Planted in 1950		Reforested agricultural area		Planted in 1933-35	
Overstory	Numerous dead snags		None		Scattered hardwoods		White pine dominant (61% cover)	
Understory	Young jack pine		Young red pine		Jack, red, scotch, white pines		Scrub oak (5% cover)	
Ground cover	Dense		Dense		Dense		Sparse	
Edge	Uniform habitat		N/A		Fairly uniform		Uniform habitat	
Breeding Birds								
No. species	12		6		31		7	
No. territories	12.5		15		62.5		11.5	
Territories/km^2	193		312		813		153	
Species and no. territories/plot[1/]	Brown thrasher	2.5	Dark-eyed junco	4	Field sparrow	8.5	Ovenbird	4
	Vesper sparrow	2	Vesper sparrow	4	Chipping sparrow	5	Rufous-sided towhee	2.5
	Chipping sparrow	2	Chipping sparrow	3	Song sparrow	3.5	Black-capped chickadee	2
	Field sparrow	2	American robin	2	Cedar waxwing	2.5	Blue jay	1
	E. bluebird	1.5	Brown thrasher	1	Purple finch	2	Hermit thrush	1
Reference	Munn 1974		MacDonald 1965		Oelke 1967		Lloyd-Evans 1975b	

Appendix II.-Continued.

Descriptive variables	Pole stage red pine plantation	Pole/Mature jack pine forest	Mature jack pine forest	Mature white pine forest
Year of census	1962	1971	1974	1967
Size of plot (ha)	4.8	28	12	7
Location	Ontario	Ontario	Minnesota	Ontario
Habitat				
Stand history	N/A	N/A	N/A	N/A
Overstory	Red pine - closed	Jack pine, open and closed	Jack pine dominant (59% cover)	White pine canopy (40-50% cover); diverse subcanopy
Understory	Sparse	Sparse	Moderate	Sparse (5-10% cover)
Ground cover	Sparse	Moderate	Dense (78% cover)	Sparse (5% cover)
Edge	N/A	Uniform habitat	Uniform habitat	Moderate diversity
Breeding Birds				
No. species	1	11	14	27
No. territories	1	25	50	50.5
Territories/km^2	21	88	417	694
Species and no. territories/ plot	Yellow-rumped warbler 1	Hermit thrush 4.5 Ovenbird 4 Dark-eyed junco 3.5 Chipping sparrow 3 Yellow-rumped warbler 2.5	Ovenbird 12 Blackburnian warbler 10 Nashville warbler 7 Golden-crowned kinglet 4 Chipping sparrow 3	Blackburnian warbler 4.5 Pine warbler 4 Ovenbird 4 E. wood pewee 3 Wood thrush 3
Reference	MacDonald 1965	Erskine 1971	Niemi 1974	Oelke 1967

1/ Five most abundant species are listed.

Appendix III.–Breeding birds in seral stages of pitch pine-scrub oak forest. Plots of 7.5 ha were located in uniform habitat, Plymouth Co., Massachusetts (Lloyd-Evans 1973, 1975a, 1977).

Descriptive variables	Stand IV-74 Recent burn		Stand IV-75 Recent burn		Stand III Recent burn	
Year of census	1974		1975		1973	
Habitat:						
Stand history	Burned in May 1974		Burned in May 1974		Burned in May 1971	
Dominant tree (%)	Pitch pine (90)		Pitch pine (72)		Pitch pine (100)	
Dominant understory (%)	Scrub oak (97)		Scrub oak (94)		Scrub oak	
Tree cover (%)	5		5		6	
Dominant ground cover (%)	Oak, seedlings, fern, huckleberry		Huckleberry, wintergreen, blueberry		Huckleberry, blueberry	
Breeding Birds:						
No. species	6		18		13	
No. territories	15.5		33		45.5	
Territories/km^2	207		440		553	
Species and no. territories[1/]	Rufous-sided towhee	6.5	Prairie warbler	10.5	Prairie warbler	9.5
	Hermit thrush	3	Rufous-sided towhee	7.5	Rufous-sided towhee	9
	E. wood pewee	2	Common yellowthroat	2	Common yellowthroat	9
	E. bluebird	2	Brown thrasher	1.5	Field sparrow	5
	Common flicker	1	E. bluebird	1.5	Purple finch	2
	Blue jay	1	House wren	1.5	Brown thrasher	1

Descriptive variables	Stand II Regenerating		Stand V Insect damage		Stand I Mature	
Year of census	1973		1976		1973	
Habitat:						
Stand history	Burned in May 1963		97% of pines killed in 1971		Burned in 1943 or 1944	
Dominant tree (%)	Pitch pine (100)		Pitch pine (100)		Pitch pine (100)	
Dominant understory (%)	Scrub oak		Scrub oak (100)		Scrub oak	
Tree cover (%)	26		4.8		70	
Dominant ground cover (%)	Blueberry, huckleberry		Huckleberry, blueberry		Huckleberry, blueberry	
Breeding Birds:						
No. species	16		22		12	
No. territories	60.5		37.5		52	
Territories/km^2	807		500		693	
Species and no. territories	Prairie warbler	19	Rufous-sided towhee	18	Prairie warbler	16.5
	Rufous-sided towhee	13	Prairie warbler	10.5	Rufous-sided towhee	13
	Common yellowthroat	9	Common yellowthroat	5	Common yellowthroat	11.5
	Field sparrow	3.5	Field sparrow	1.5	Black-capped chickadee	3
	Brown thrasher	3	Hermit thrush	1.5	Field sparrow	2
	Hermit thrush	2	Catbird	0.5	Common flicker	1

1/ Six most abundant species are listed.