BIRD COMMUNITIES ASSOCIATED WITH SUCCESSION AND MANAGEMENT OF LOWLAND CONIFER FORESTS

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Abstract.--Data from published bird censuses were used to determine changes in avian communities in relation to plant succession, fire, type conversion, and timber management practices in lowland conifer forests in the northeastern United States. With modifications in current logging practices, habitat for the bird species that nest in undisturbed stands can be provided. Management guidelines are recommended.

INTRODUCTION

Lowland conifer forests comprise over five million acres of the commercial forestland in the northeastern United States, and an even larger area of the type has been classified as noncommercial because of stunted and sparse timber growth. This paper deals with the northern lowland conifer communities, in which tamarack (Larix laricina), black spruce (Picea mariana), or northern white-cedar (Thuja occidentalis) are dominant. These forests have long been of interest to botanists because of the presence of insectivorous plants and numerous species of orchids, but the avian communities have received much less attention. Communities of birds associated with different successional stages will be identified, and guidelines will be discussed for making timber management practices compatible with the maintenance of avian habitat. Other lowland conifer species not considered here are Atlantic white-cedar (Chamaecyparis thyoides) which grows in a narrow belt along the Atlantic coast as far north as southern Maine, and loblolly pine (Pinus taeda) which grows on the Coastal Plain and Piedmont from Delaware south.

METHODS

Little study has been conducted on avian populations in lowland conifer stands. In order to identify the bird species associated with different successional stages, I drew together information from several sources. For information on species abundance, I relied mainly on Breeding Bird Censuses conducted in the northeastern United States and Canada (Audubon Field Notes 1959-1970; American Birds 1971-1977) and on other studies which used the same census technique (International Bird Census Committee 1970). These include studies by Brewer (1967), Kendeigh (1948), Martin (1960), Stewart and Aldrich (1952), and a study in progress on the Seney National Wildlife Refuge in Upper Michigan by the Migratory Bird and Habitat Research Laboratory, USDI Fish and Wildlife Service. Censused plots were grouped into six different lowland communities following Erskine (1977). Density figures were calculated based on the mean number of territorial males per 40 hectares on plots where each species was recorded. I also referred to regional references on birds, such as Roberts (1932) and Palmer (1949), and read the chapters in Bent's life history series (Bent 1937, 1938, 1939, 1942, 1953, 1968) to fill in when information on a species was scant. Since no density figures were available, I evaluated only whether these species would commonly be found. All these sources were also used as the basis for determining the effect of timber management practices on birds.

THE LOWLAND CONIFER FORESTS

Most of the lowland conifer forests in the northeastern United States are growing on organic soils or peat. Some of these peatlands have developed with the buildup of encroaching vegetation in small lakes and depressions left by glacial activity. Sedges and sedgelike plants grow toward the center of the basin from the shore, forming a floating mat of vegetation. Other peatlands formed with the accumulation of reed-sedge debris in poorly drained glacial lakebeds. The bog community becomes established as sphagnum moss

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and ericaceous shrubs invade the sedge mat. Tamaracks are generally the first trees to appear, and peat compressed by the weight of the sphagnum and increased shrub growth also provides a favorable seedbed for black spruce. With continued buildup of organic material and a lowering of the water table, a dense spruce forest can develop. If the peat has become consolidated and firm, northern white-cedar may slowly invade the lowland conifer forest.

The young cedars that become established can spread by vegetative reproduction, and eventually can prevent shrub growth and further regeneration of tamarack and black spruce. In most cases, shade-tolerant balsam fir (Abies balsamea) is the only other tree species to become established (Curtis 1959, Johnston 1972, Martin 1959). White pine (Pinus strobus) and deciduous species are found growing with northern white-cedar in the transition to uplands. The range of the lowland conifer species is shown in Figure 1. In the southernmost parts of the range, tamarack occurs in pure stands or in association with lowland hardwood species such as red maple (Acer rubrum).

Common Plants of the Open Bog

Shrubs
- Bog birch (Betula pumila and glandulosa)
- Bog laurel (Kalmia polifolia)
- Bog rosemary (Andromeda glaucophylla)
- Cranberry (Vaccinium macrocarpon)
- Labrador Tea (Ledum groenlandicum)
- Leatherleaf (Chamaedaphne calyculata)

Herbs
- *Bladderwort (Utricularia sp.)
- *Pitcherplant (Sarracenia purpurea)
- *Round-leaved sundew (Drosera rotundifolia)
- Cottongrass (Eriophorum angustifolium)
- Bog buckbean (Menyanthes trifoliata)
- **Arethusa (Arethusa bulbosa)
- **Grass pink (Calopogon pulchellus)
- **Rose pogonia (Pogonia ophioglossoides)

* insectivorous plants ** orchid species

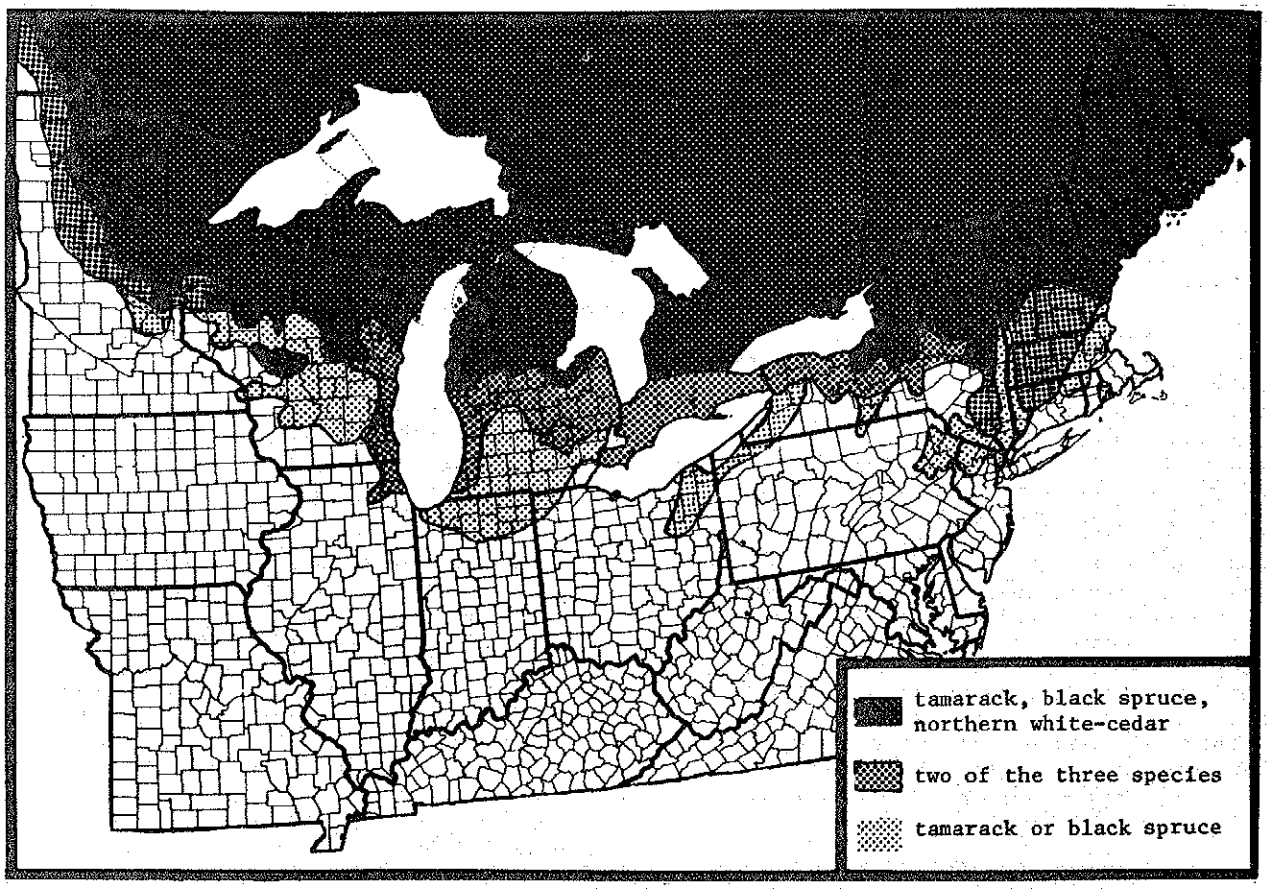

Figure 1.--Ranges of the northern lowland conifer forest species in the Northeastern United States. All species also occur farther south in isolated areas of the Appalachian Mountains and throughout most of Canada (Little 1971).

BIRDS OF LOWLAND CONIFER COMMUNITIES

Breeding birds of six different lowland conifer communities are shown in Table 1.[2/] Several species (designated with an asterisk) are only locally common (such as the Gray Jay and Northern Waterthrush) and may be found in high densities in some areas but absent in similar habitat within their breeding range. The breeding ranges of other species (e.g. Wilson's and Palm Warblers) extend southward only to the northernmost United States, and consequently these birds will not be present in most lowland conifer stands. Differences in breeding ranges also account for the absence of Connecticut Warblers in bogs in New England and Blackpoll Warblers in mature spruce forests in the North Central states. Other species have specific habitat requirements that preclude their nesting in most stands. Sharp-tailed Grouse have only been found in the extensive areas of open bog and scattered low conifers (Hanson 1953), such as those in northern Minnesota or Upper Michigan. Savannah Sparrows are common only in bogs with large open patches of grasses and sedges.

Although several species, such as the Spruce Grouse, Yellow-bellied Flycatcher, Palm Warbler, Northern Waterthrush, and Lincoln's Sparrow, are more common and reach higher densities in these habitats, neither these nor any other characteristic species are unique to these forest types. Birds of the open bog-shrub community can also be found nesting in alder thickets or in the shrubby growth along lakes and streams. Likewise, a mature black spruce stand has an avian community similar to an upland spruce-fir forest.

The avian community of a stand in which tamarack is dominant includes bird species common in shrubby areas as well as species generally associated with hardwood forests. Tamarack, though a conifer, is deciduous; during late fall and early spring when needles are absent, the increased sunlight reaching the forest floor stimulates shrub growth. Even during the summer months, the fine needles and relatively open canopy cast little shade, so that mature tamarack stands generally have a much denser understory than mature spruce or white-cedar forests. At the time many of the birds are arriving in the spring, tamarack swamps resemble hardwood forests more than lowland conifer stands. Though few northern white-cedar stands have ever been censused, high densities of Northern Parulas and Black-throated Green Warblers make the avian community distinct.

If trees are killed by fire, high water, insects, or disease, woodpeckers and Brown Creepers may come in to forage for insects on snags and downed timber. The Black-backed Three-toed Woodpecker in particular is likely to be found in areas in which there are many standing dead trees. In addition, there are twenty species of birds that may nest in cavities in dead or dying trees.

Cavity-nesting Birds of Northern Bogs and Coniferous Forests

Common Goldeneye	Black-backed Three-toed Woodpecker
Common Merganser	Northern Three-toed Woodpecker
Red-breasted Merganser	Great Crested Flycatcher
Hooded Merganser	Tree Swallow
American Kestrel	Black-capped Chickadee
Saw-whet Owl	Boreal Chickadee
Yellow-shafted Flicker	Red-breasted Nuthatch
Pileated Woodpecker	House Wren
Yellow-bellied Sapsucker	Starling
Hairy Woodpecker	
Downy Woodpecker	

During outbreaks of insect pests, populations of certain bird species have been shown to increase. Though the spruce budworm (*Choristoneura fumiferana*) mainly attacks balsam fir and white spruce (Picea glauca), it can maintain itself over a period of years on black spruce (Blais 1957). Kendeigh (1947) and Morris *et al*. (1958) reported strong increases in densities of several warbler species, particularly the Bay-breasted and Tennessee Warblers, in response to outbreaks of the spruce budworm in spruce-fir forests. Buckner and Turnock (1965) found the fringillids (grosbeaks, finches, and sparrows) to be more important than the warblers as predators of the larch sawfly (*Pristiphora erichsonii*) in tamarack bogs. Small flocks of nonresident avian species were also observed foraging in areas of high sawfly densities.

Though few hawks and owls have been recorded in censuses of lowland conifer stands, several species of raptors do nest in and use these habitats. Roberts (1932) reported nesting of the Sharp-shinned Hawk, Broad-winged Hawk, Great Horned Owl, and Long-eared Owl in conifer swamps in Minnesota. The few nesting records of the Great Gray Owl in the northeastern United States have been in tamarack bogs (Roberts 1936, Nero 1970), and Nero *et al*. (1974) also reported the successful occupancy by this species of an artificial nest placed in a tamarack tree. Keran (1978) pointed out the need for a variety of habitat types by nesting Broad-winged Hawks. Although oak-aspen was the preferred forest type, the presence of a wet area and some type of upland

2/ Scientific names in Appendix.

Table 1.--Abundance of breeding bird species found in various stages of lowland conifer succession.[1]

Bird Species	Dominant Plants					
	Open bog-low shrubs (4)[2]	Shrubs, scattered conifers (13)	Young or low Black Spruce (2)	Medium-mature B.Spruce (5)	Tamarack (3)	Northern White-cedar (3)
American Bittern	U[3]					
Sora	U					
Killdeer	U	+				
Mallard	U	+				
Black Duck	2	+				
*Sharp-tailed Grouse	U	U				
Marsh Hawk	U	U				
American Goldfinch	U	6				
Common Snipe	C	+				
Eastern Kingbird	8	+				
Red-winged Blackbird	7	2				
Savannah Sparrow	C	6				
Lincoln's Sparrow	C	12	+			
Swamp Sparrow	133	15			4	
Song Sparrow	21	35			53	+
Common Yellowthroat	87	19	15	2	39	+
Alder Flycatcher	2	6			4	
Rufous-sided Towhee	U	14			17	+
Chestnut-sided Warbler	U	5	U	2	U	1
Palm Warbler		6	5			
American Robin		4	U	+	11	3
Canada Warbler		53	U	6	6	50
Cedar Waxwing		8	4	6	3	1
Hermit Thrush		5	5	3	C	+
Slate-colored Junco		8	6	2	C	+
Nashville Warbler		19	4	13	28	14
Myrtle Warbler		3	5	12	U	7
White-throated Sparrow		14	7	15	60	21
*Northern Waterthrush		77	9	2	4	+
Ruby-crowned Kinglet		2	15	11	C	7
Magnolia Warbler		1	7	14	C	
Boreal Chickadee		1	U	4		
Swainson's Thrush		+	4	7	U	33
Chipping Sparrow		2	U	8	3	1
Winter Wren		5	U	3	1	11
Blackburnian Warbler		7	2	2	U	8
Black-and-white Warbler		+	2	4	2	10
Olive-sided Flycatcher		+	U	2	U	+
*Tennessee Warbler		U		12	U	37
*Blackpoll Warbler		37	U	U	U	U
Purple Finch		4	2	1	1	2
Yellow-bellied Flycatcher		3	U	2		24
Spruce Grouse		+	U	2		
*Gray Jay		+	2	2		
*Connecticut Warbler		U	U			
*Wilson's Warbler		+	+			
*Rusty Blackbird		2				
Golden-crowned Kinglet			8	6		9
Red-breasted Nuthatch			U	7	1	2
Cape May Warbler			U	16		
Blue Jay				5	3	3
Ovenbird			U	30	14	17
*Evening Grosbeak				U	U	U
Pine Siskin			U	2		
White-winged Crossbill			U	4		1
Brown Creeper				2	2	9
Veery				6	47	+
Northern Parula				U	U	23
*Bay-breasted Warbler				2		37
Ruffed Grouse					3	1
Rose-breasted Grosbeak					9	1
American Woodcock					3	+
Eastern Wood Pewee					+	4
Wood Thrush					+	2
Scarlet Tanager					+	2
Black-throated Green Warbler						26

[1] Bent 1937, Bent 1938, Bent 1939, Bent 1942, Bent 1953, Bent 1968, Bond 1959, Brewer 1967, Bridge and Bridge 1964, Brunton and Crins 1975, Chapman 1907, Erskine 1977, Hall 1961-1963, Kendeigh 1948, Linehan 1968; Loery 1966, 1969-1970; Martin 1960, Palmer 1949, Roberts 1932, Root 1942, Speirs and Oranstein 1975, Stewart and Aldrich 1952; Van Velzen 1972-1974, 1977.

[2] Number of censuses.

[3] Mean density per 40 hectares on plots where species was recorded. When density figures were not available, C = common, U = uncommon.

+ denotes presence on plot, but no established territory was determined.

* locally common

opening seemed a requirement for nest-site selection. In a study of four species of raptors (Broad-winged Hawk, Red-tailed Hawk, Barred Owl, and Great Horned Owl), Fuller (1979) found differential habitat use between individuals of the same species. White-cedar and tamarack swamps made up over 26% of the total home range and over 18% of the total detected locations of a female Barred Owl; another radioed female used tamarack in proportion to its availability. However, since lowland conifers made up a much smaller percentage of her home range (only 2%), use of upland types was significantly higher for this bird. He also reported changing habitat use and preference by individuals as home range shifted to new areas and different habitats occurred within the range. He attributed this shifting of habitat use to resource availability and potential competition with other species of raptors. Of the species studied, only the Red-tailed Hawk did not use lowland areas extensively. Although lowland conifer stands may not be preferred for nesting habitat, they may be important to this group of birds for other activities and at other times of the year. Forbes and Warner (1974) found a northern white-cedar swamp to be the preferred roosting habitat of a radioed Saw-whet Owl in central Minnesota. Tamarack swamps were most used by this species during winter in a study in Michigan (Mumford and Zusi 1958).

Winter populations of birds in lowland conifer stands vary with the seed crop. Black spruce trees bear seeds as early as ten years of age and become dependable producers, with heavy crops occurring about every four years (USDA Forest Service 1965). In addition, seeds are shed slowly and throughout the year. In good seed years or when seed crops are low elsewhere, an influx of northern finches (Pine Grosbeak, Pine Siskin, Red Crossbill, White-winged Crossbill) is not uncommon in black spruce stands. In contrast, nearly 98% of the tamarack seed crop in northeastern Minnesota was reported to fall before the end of October (Duncan 1954). Likewise, most of the seeds of northern white-cedar are dispersed by November (USDA Forest Service 1965). Even in heavy seed years, these species do not provide a good food source; birds present in winter in stands where tamarack or northern white-cedar are dominant are likely to be limited to permanent residents. The grouse, owls, woodpeckers, jays, chickadees, siskins, and crossbills do winter in northern forests.

FACTORS AFFECTING STAND COMPOSITION AND AVIAN COMMUNITIES

Fire

During periods of drought, the surface layers become dry enough to make bogs and swamps susceptible to fire. If the burn is light, the bog community will become reestablished when water levels return to normal (Curtis 1959). However, if the upper layers of peat are destroyed, an open bog-sedge meadow community may develop, with a mixture of leatherleaf and sedges growing in a loose sphagnum mat (Curtis 1959, Vogl 1964). This type of area may attract Savannah Sparrows which would not ordinarily be found in a bog with heavy shrub cover.

Although the lowland conifers are not resistant to fire, all reproduce well on burned organic soils if seed-bearing trees are nearby. Many of the extensive acreages of even-aged black spruce or white-cedar swamp and forest in the Lake States originated after fire (Curtis 1959). If the burned peat is dry enough however, paper birch (Betula papyrifera) and quaking aspen (Populus tremuloides) are likely to become established, making the successional pattern similar to that after fire on upland sites. These hardwoods, shrubs, and other competing vegetation will overtop many of the conifer seedlings and slow their growth, but, except on the best sites, the conifers will eventually become dominant. The results of a census conducted on the Seney National Wildlife Refuge[3/] show the bird species present on an 8 hectare burned black spruce plot with many snags. Cape May and Magnolia Warblers, Ovenbirds, and Golden-crowned Kinglets, all present in a mature black spruce forest nearby, were not found in the burned stand.

Breeding Birds of a Burned Spruce Forest
Seney National Wildlife Refuge, 1978[3/]

	# territorial males per 40 ha*
White-throated Sparrow	30
Chipping sparrow	25
Slate-colored Junco	15
American Robin	10
Myrtle Warbler	10
Nashville Warbler	7
Black-backed Three-toed Woodpecker	5
Winter Wren	5
Brown Creeper	2
Killdeer	+
Hairy Woodpecker	+
Lincoln's Sparrow	+

*actual counts expanded to be comparable with densities in Table 1.

3/ Unpublished data, U.S. Fish & Wildlife Service.

Type Conversion and Peat Mining

During the late 1800's and early 1900's, many of the southernmost conifer swamps were drained for conversion to agricultural crops (Curtis 1959). Similar attempts were made farther north, but the harsher climate made agricultural ventures largely unsuccessful.

The extensive bogs and swamps of the Lake States are again receiving attention with the interest in the use of peat as an energy source. Peat has been mined on a small scale for years, mainly for horticultural purposes, with the northern Lake States accounting for over 40% of the total produced in the United States in 1977 (USDI Bureau of Mines 1978). Current research is focusing on the feasibility of mining peat on a much larger scale for conversion to a synthetic natural gas or for direct use as a fuel. If some of these peatlands are to be developed, guidelines for reclamation would have to be established and unique natural areas identified and preserved. Finland has been successfully using reclaimed peatlands for forestry purposes; production of forage and seed crops, cool season grasses and vegetables, or wild rice is also being considered on former peatland (Farnham 1978).

Mining and the resulting conversion to another vegetation type would undoubtedly have a great impact on birds. These activities would center in the peatlands where disturbance has been minimal in the past--those that do not produce merchantable timber, and, because of high water tables and unstable terrain, have received little recreational use.

Timber Management Practices

Though much of its acreage is classified as noncommercial, the lowland conifer type represents 13% of the total commercial forestland in the northern Lake States and nearly 5% of the commercial forestland in the New England states and New York (Kingsley 1976, Kingsley 1977, Peters and Bowers 1977, Spencer and Thorne 1972, Ferguson and Mayer 1970, Ferguson and Kingsley 1972). Black spruce and tamarack are cut as pulpwood where stands are large enough to make logging profitable, and white-cedar is harvested for use as posts, poles, and lumber products where its resistance to decay is of prime importance.

Harvesting and Site Preparation

Clearcutting is the recommended method for harvesting and reproducing the lowland conifers (Johnston 1977a,b; Heinselman 1959). Black spruce and tamarack reproduce best in full sunlight, and wind damage to these shallow-rooted species is minimized in the resulting even-aged stands. Northern white-cedar is highly preferred by white-tailed deer (*Odocoileus virginianus*) for winter shelter and browse, and timber management practices have in the last decade been influenced by their need for large, dense even-aged stands in traditional yarding areas (Verme 1965).

Cutting of cedar is generally done in strips or small blocks, leaving alternate rows of the same width for a seed source. Clearcut strips can vary in width from 1 chain (~20 meters) to 3 chains, depending on the height of trees in the adjacent uncut stands (Johnston 1977b). After the cutover areas are restocked (usually within 10 years), the uncut strips should be logged to prevent the new stands from becoming over-seeded and to reduce overbrowsing of the reproduction in the clearcuts by deer. Generally, shelterwood cuts are recommended at this point to ensure a seed source for the newly logged areas (Johnston 1975, 1977b). In most cases, however, this followup is not done, and the uncut strips remain. Black spruce and tamarack stands are cut either in strips or in large blocks, usually 40 acres (~16 hectares) or greater (Johnston 1977, Duncan 1952). If broadcast-burning of the cutover area is needed to improve the seedbed, to control disease, or to remove brush and undesirable residual stems, block cutting is more economical and preferred. However, since natural seeding cannot be relied on further than about 260 feet (~80 meters) from mature trees (Johnston 1975), direct seeding is usually required with this harvest method. Strip cutting is best applied in large stands that do not require broadcast-burning.

Clearcut-logging sets the vegetation of a stand back to an earlier successional stage. The avian communities will revert likewise, with bird species associated with open shrubby areas replacing those which nested in the mature forests (see Table 1). Unfortunately, the study of birds in lowland conifer communities has been confined almost entirely to natural stands; hence there is little documentation of avian use of logged areas. It does seem evident that species composition and densities will vary with the treatment after logging.

Black spruce, tamarack, and northern white-cedar reproduce best where slash cover is minimal. Burning is generally the recommended method for disposing of heavy slash, but, particularly in small cuts, full-tree skidding is less expensive and most often practiced (Johnston 1977a,b). Stands harvested by full-tree skidding or broadcast-burned following logging will not attract as many birds as cuts in which more slash is left. With little or no slash, Brewer's

Blackbirds and Common Yellowthroats are probably the most likely species to nest in a recently logged area. The bird species present on a lowland plot on Seney National Wildlife Refuge in Upper Michigan[4/] censused by the spot-mapping method (Williams 1936) are shown below. Though actually altered by fire, the vegetation structure of this plot is very similar to that of a clearcut-logged area with heavy slash, with toppled trees and a few standing snags. In addition, Winter Wrens may be attracted to brush piles along the edge of a clearcut. Other species, though nesting elsewhere, will feed in snags and among the slash, or take advantage of the openings created by logging for hunting or flycatching.

Breeding Birds of a Burned Tamarack Forest
Seney National Wildlife Refuge, 1978[4/]

Yellow-shafted Flicker	Brewer's Blackbird
Tree Swallow	White-throated Sparrow
American Robin	Lincoln's Sparrow
Nashville Warbler	Song Sparrow
Common Yellowthroat	

Intermediate Treatment

On good sites, growth of deciduous brush (alder, dogwood, etc.) may severely suppress the conifer reproduction (Johnston 1977a,b). Aerial herbicide spraying is currently the most commonly used method of killing overtopping shrubs and hardwoods, despite the greater risk in lowland areas of contaminating open water. More research is being done (Johnston 1973) to determine if different broadcast-burning methods (season and severity) will sufficiently control shrub growth. Stands that are brushy will attract more species and have higher densities of birds than non-brushy stands or stands where shrub growth has been controlled. Sites allowed to revert to lowland brush may even attract species more common in upland deciduous clearcuts, such as the Chestnut-sided and Golden-winged Warblers.

In older stands of northern white-cedar, thinning improves both timber quality and deer habitat. Because the canopy closes gradually after thinning, stands must be rethinned periodically to maintain enough light for advance tree reproduction to continue growth (Johnston 1972). In these stands and in those which are understocked or have been direct-seeded, Ruby-crowned Kinglets, Magnolia Warblers, Myrtle Warblers, and Slate-colored Juncos will probably be common bird species. Blackburnian Warblers, Ovenbirds, Cape May Warblers, and Golden-crowned Kinglets are likely to be found breeding in the densest stands.

To ensure that northern white-cedar will remain dominant in the next stand, preparatory treatment, 5 to 10 years before harvesting, is recommended where intensive management for timber or deer habitat can be justified (Johnston 1977b). Hardwoods and undesirable trees are generally cut if they are merchantable, but girdling and application of herbicide are also used to kill these trees and control their vegetative reproduction. If cutting of these hardwoods creates an opening in the forest, shrub growth may increase and provide habitat for a bird species, such as the Nashville Warbler, not normally found nesting in the forest interior. Snags left by girdling or herbicide treatment may be used as avian nesting and feeding sites.

Rotation Age

Growth rates of lowland species vary tremendously with site. The best sites have moderately well decomposed woody peat and occur where the soil water is continuous with the ground water system and enriched by nutrients from areas with mineral soil (Johnston 1977a,b). The growth rates for tamarack and black spruce are poorest in open bogs, where site fertility is almost totally dependent on precipitation. White-cedar particularly requires actively moving soil water and, in lowland areas, it achieves its maximum growth rate along streams or drainage ditches (Johnston 1977b).

Though site, stocking, and the presence or risk of wind damage and disease may determine the actual harvest age, the recommended rotation for black spruce generally does not exceed 100 years, because butt rot becomes common thereafter on organic soils (Johnston 1977a). A rotation range of from 70 to 160 years has been established for white-cedar (Johnston 1977b), depending again on site and on the desired timber product. Stands managed to maximize board feet (110 years and older) provide optimum winter shelter for deer (Johnston 1977b) and also provide more years of available habitat for birds associated with mature forests. There is no information available on the minimum area of contiguous forestland required by these species. However, study being conducted in the Eastern deciduous forests (Whitcomb *et al.* 1979) indicates that certain bird species will no longer be present as forests are fragmented into small areas.

4/ Unpublished data, U.S. Fish & Wildlife Service.

In general, treatment and succession following logging provide breeding habitat for the bird species that nest in natural lowland conifer stands. Species associated with relatively open bog areas with only scattered trees, such as the Palm Warbler, probably will not find cutover areas and the resulting stands suitable; their prime nesting habitat is generally in the extensive acreages of lowland conifers classified by foresters as noncommercial and little of this habitat is altered by logging activities. However, birds normally associated with shrubs, such as the Common Yellowthroat, Swamp Sparrow, and Song Sparrow, are wide-ranging and seem partial to the shrub vegetation form; hence they will find suitable growth in logged as well as undisturbed habitats. Populations of some species, such as the Nashville Warbler, may rise with the increase in the amount of edge between mature and young growth created by logging. Provided that large blocks of forest remain uncut, the recommended rotation age and the usual reliance on adjacent stands as the seed source for cutover areas ensures the presence of habitat required by bird species associated with mature conifers.

SUMMARY AND RECOMMENDATIONS

Since birds assist in controlling insect populations, and with the increased enthusiasm for recreational birding and the greater appreciation of nongame species as part of the ecosystem, the land manager should develop some guidelines for increasing bird habitat. With modifications in current logging practices, habitat for more species and greater densities of birds can be provided. Some recommendations for management follow.

1. Timber sales should be planned so as to maintain large blocks of mature forests. If strip cutting is to be used, the width of uncut strips should be increased, particularly if a followup cut is not anticipated.

2. As often as possible, rotation cycles should be lengthened to provide more years of available habitat for birds requiring mature forests.

3. A few snags and live trees should be left standing in a clearcut. Snags provide nesting and feeding sites for many bird species and are also good perches for raptors hunting in the openings created by logging.

4. Some slash should be left in a clearcut to increase bird use in the first growing season after logging.

5. If direct seeding is to be used to establish second growth, openings should be left where shrub growth would not need control.

6. Brush control should not be used unless the young conifers definitely need release. If herbicides are to be used, application late in the summer will reduce the chances of interference with nesting.

7. In the recommended thinning and preparatory treatment for northern white-cedar, undesirable trees should be girdled and not cut.

8. More information about avian use of lowland conifer habitats would be valuable. Research is especially needed on how bird communities change during the successional stages following logging.

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APPENDIX

Scientific Names of Bird Species

Ducks through Owls

Mallard	Anas platyrhynchos
Black Duck	Anas rubripes
Common Goldeneye	Bucephala clangula
Common Merganser	Mergus merganser
Red-breasted Merganser	Mergus serrator
Hooded Merganser	Lophodytes cucullatus
Sharp-shinned Hawk	Accipiter striatus
Marsh Hawk	Circus cyaneus
Red-tailed Hawk	Buteo jamaicensis
Broad-winged Hawk	Buteo platypterus
American Kestrel	Falco sparverius
Spruce Grouse	Canachites canadensis
Ruffed Grouse	Bonasa umbellus
Sharp-tailed Grouse	Pedioecetes phasianellus
American Bittern	Botaurus lentiginosus
Sora	Porzana carolina
Killdeer	Charadrius vociferous
American Woodcock	Philohela minor
Common Snipe	Capella gallinago
Great Horned Owl	Bubo virginianus
Long-eared Owl	Asio otus
Barred Owl	Strix varia
Great Gray Owl	Strix nebulosa
Saw-whet Owl	Aegolius acadicus

Woodpeckers

Yellow-shafted Flicker	Colaptes auratus
Pileated Woodpecker	Dryocopus pileatus
Yellow-bellied Sapsucker	Sphyrapicus varius
Hairy Woodpecker	Picoides villosus
Downy Woodpecker	Picoides pubescens
Black-backed Three-toed Woodpecker	Picoides arcticus
Northern Three-toed Woodpecker	Picoides tridactylus

Flycatchers and Swallows

Eastern Kingbird	Tyrannus tyrannus
Great Crested Flycatcher	Myiarchus crinitus
Yellow-bellied Flycatcher	Empidonax flaviventris
Alder Flycatcher	Empidonax alnorum
Eastern Wood Pewee	Contopus virens
Olive-sided Flycatcher	Nuttallornis borealis
Tree Swallow	Iridoprocne bicolor

Jays through Creepers

Blue Jay	Cyanocitta cristata
Gray Jay	Perisoreus canadensis
Black-capped Chickadee	Parus atricapillus
Boreal Chickadee	Parus hudsonicus
Red-breasted Nuthatch	Sitta canadensis
Brown Creeper	Certhia familiaris

Wrens through Starlings

House Wren	Troglodytes aedon
Winter Wren	Troglodytes troglodytes
American Robin	Turdus migratorius
Wood Thrush	Hylocichla mustelina
Hermit Thrush	Hylocichla guttata
Swainson's Thrush	Hylocichla ustulata
Veery	Hylocichla fuscescens
Golden-crowned Kinglet	Regulus satrapa
Ruby-crowned Kinglet	Regulus calendula
Cedar Waxwing	Bombycilla cedrorum
Starling	Sturnus vulgaris

Warblers

Black-and-white Warbler	Mniotilta varia
Golden-winged Warbler	Vermivora chrysoptera
Tennessee Warbler	Vermivora peregrina
Nashville Warbler	Vermivora ruficapilla
Northern Parula	Parula americana
Magnolia Warbler	Dendroica magnolia
Cape May Warbler	Dendroica tigrina
Myrtle Warbler	Dendroica coronata
Black-throated Green Warbler	Dendroica virens
Blackburnian Warbler	Dendroica fusca
Chestnut-sided Warbler	Dendroica pensylvanica
Bay-breasted Warbler	Dendroica castanea
Blackpoll Warbler	Dendroica striata
Palm Warbler	Dendroica palmarum
Ovenbird	Seiurus aurocapillus
Northern Waterthrush	Seiurus noveboracensis
Common Yellowthroat	Geothlypis trichas
Connecticut Warbler	Oporornis agilis
Wilson's Warbler	Wilsonia pusilla
Canada Warbler	Wilsonia canadensis

Blackbirds and Tanagers

Red-winged Blackbird	Agelaius phoeniceus
Rusty Blackbird	Euphagus carolinus
Brewer's Blackbird	Euphagus cyanocephalus
Scarlet Tanager	Piranga olivacea

Finches and Sparrows

Rose-breasted Grosbeak	Pheucticus ludovicianus
Evening Grosbeak	Hesperiphona vespertina
Purple Finch	Carpodacus purpureus
Pine Grosbeak	Pinicola enucleator
Pine Siskin	Spinus pinus
American Goldfinch	Spinus tristis
Red Crossbill	Loxia curvirostra
White-winged Crossbill	Loxia leucoptera
Rufous-sided Towhee	Pipilo erythrophthalmus
Savannah Sparrow	Passerculus sandwichensis
Slate-colored Junco	Junco hyemalis
Chipping Sparrow	Spizella passerina
White-throated Sparrow	Zonotrichia albicollis
Lincoln's Sparrow	Melospiza lincolnii
Swamp Sparrow	Melospiza georgiana
Song Sparrow	Melospiza melodia