Birds of Wisconsin Boreal Forests

by Michael J. Mossman, Eric Epstein, and Randy M. Hoffman

Boreas was the ancient Greek personification of the north wind, and today the term "boreal" refers generally to the north or far north. Ecologically, it also describes a more specific biogeographic region, the boreal forest biome, which in North America occupies a broad zone from Alaska south and east through Canada to the Atlantic Ocean. These are the extensive tracts of spruce, fir, birch and poplar, which—to those who have visited the region in summer—may be associated with long summer days, cool nights, northern lights, the antics of campside Gray Jays, and the songs of spruce-woods warblers, Swainson's Thrushes and White-throated Sparrows.

Although Wisconsin lies well outside the boreal forest biome, it has some very "boreal-like" tracts, as well as a number of boreal breeding-bird species. Of the 20 species whose breeding distribution is virtually limited to the boreal forest region of Canada, all but 2 have been known to occur in Wisconsin during the breeding season (Table 1). However, none are common anywhere in the state, and 11 are considered of rare and irregular occurrence during summer. Fifteen are known to have nested in Wisconsin, although for most of these, records are extremely rare.

In this, the tenth article in the Wisconsin bird habitat series, we describe Wisconsin "boreal" forest and its breeding-bird community, and compare this with other bird communities, especially those of Canada's true, boreal forests and other Wisconsin habitat types. This leads us to identify special characteristics of Wisconsin boreal forest bird communities as well as suggest some protection and management considerations, and high-quality sites worth visiting.

What is "true" Canadian boreal forest? On uplands, white spruce (*Picea glauca*) and balsam fir (*Abies balsamea*) are the usual canopy dominants, but hardwoods such as paper birch (*Betula papyrifera*), trembling aspen (*Populus tremuloides*) and balsam poplar (*P. balsamifera*) reach high levels of importance in some stands. Black spruce (*Picea mariana*) usually prevails in the canopy of lowland forests, and sometimes in uplands as well. Aspen, pop-

Table 1. Wisconsin breeding-season abundance and status of species occurring primarily in the boreal forest biome.

Species	Breeding-Season Status[1]
Spruce Grouse	Uncommon*
Northern Hawk-Owl	Rare, irregular*
Great Grey Owl	Rare, irregular*
Boreal Owl	Rare, irregular
Three-Toed Woodpecker	Rare, irregular
Black-backed Woodpecker	Rare, regular*
Gray Jay	Rare, irregular*
Boreal Chickadee	Rare, irregular*
Ruby-crowned Kinglet	Uncommon*
Philadelphia Vireo	Absent
Tennessee Warbler	Rare, regular*
Orange-crowned Warbler	Absent
Cape May Warbler	Uncommon*
Palm Warbler	Uncommon
Bay-breasted Warbler	Rare, irregular*
Blackpoll Warbler	Rare, irregular
Wilson's Warbler	Rare, regular*
Rusty Blackbird	Rare, irregular*
Pine Grosbeak	Rare, irregular*
White-winged Crossbill	Rare, irregular*

[1]Data from Barger et al. 1988. * = verified nesting in state.

lar, birch and (on xeric sites) jack pine (*Pinus banksiana*) tend to pioneer upland sites cleared by logging, fire, or windthrow, eventually farming a light canopy under which the more shade-tolerant fir and spruce develop and ultimately succeed the hardwoods and pine. Individual birches may persist in spruce-fir stands long after aspens have died off. The understory of spruce-fir forests generally includes only more spruce and fir, along with a dense ground layer of low ericaceous shrubs (e.g., *Vaccinium, Ledum*), and mosses. The understory of hardwood stands is better developed, particularly under canopy gaps, and may include alder (*Alnus crispa*), willows (*Salix* spp.), mountain maple (*Acer spicatum*) and other broadleaf shrubs and saplings, as well as spruce or fir. Erskine (1977) further describes true boreal forest.

Northward, the boreal forest thins gradually into treeless tundra. To the south it grades into the mixed hardwood-coniferous forest biome of the Great Lakes and St. Lawrence region, which includes the various northern Wisconsin forests described by Curtis (1959) and our present series of articles (Mossman and Matthiae 1988, Hoffman 1989). This mixed "northern hardwoods" region is typically dominated by combinations of hemlock (*Tsuga canadensis*), sugar maple (*Acer saccharum*), red maple (*A. rubrum*), pines (*Pinus* spp.) yellow birch (*Betula lutea*), and white cedar (*Thuja occidentalis*). Southward, mixed forest is replaced by the eastern deciduous forest biome of southern Wisconsin and much of the eastern United States.

Within the mixed hardwood-coniferous forest of northern Wisconsin, "outliers" of boreal forest occur near Lake Superior and in other areas characterized by cool, humid, equable climate, short growing season, deep snow, and often, heavy wet soils with at least seasonally poor internal drainage. These outliers are distinctive in that they contain species and characteristics of both boreal and mixed hardwood-coniferous forests. Although their transitional nature may best be described as "boreal coniferous-hardwood," we will refer to them simply as boreal.

Finley (1951) mapped the presettlement vegetation cover of Wisconsin from data contained in the notes of surveyors who conducted the statewide land survey in the mid-1800s. At that

time the boreal forest was best developed in the Lake Superior region, vegetating the northern quarter of Douglas County, northwestern Bayfield County, and the northern third of Ashland County. Scattered outliers were mapped in Iron, Vilas, Forest and Florence County, with a very disjunct area along Lake Michigan in northeastern Door County. The original surveyors' notes document the transitional nature of these forests, particularly with regard to the occurrence of hemlock, white cedar, yellow birch, and white pine (*P. strobus*).

The most extensive study of boreal forest in Wisconsin was that of John Curtis and his associates at the University of Wisconsin in the 1950s (Maycock 1957, Curtis 1959). Overall, they found the leading canopy dominants to be balsam fir, white pine, white cedar, paper birch and white spruce. Prevalent ground layer and understory species are not obligate to boreal forests, but are widespread in northern Wisconsin forests: Canada mayflower (*Maianthemum canadense*), bunchberry (*Cornus canadensis*), fly honeysuckle (*Lonicera canadensis*) starflower (*Trientalis borealis*), large-leaved aster (*Aster macrophyllus*), bluebead lily (*Clintonia borealis*), beaked hazel (*Corylus cornuta*) and swollen sedge (*Carex intumescens*).

Because of the limited presence of boreal forest in Wisconsin, Curtis did not differentiate stands along a dry/mesic/wet moisture gradient as he had for the major northern and southern Wisconsin forest types. However, soil moisture does affect boreal stand composition, structure and function; thus pines are often among canopy dominants on xeric sites, while white cedar, white spruce, yellow birch and hemlock occur more commonly in the mesic to wet portion of the moisture spectrum. Mesic boreal stands appear to have been largely successional, and quite ephemeral in nature. Although black spruce is typically restricted to bogs in Wisconsin, its ecological amplitude increases northward in the true and transitional boreal forests. Thus, at several sites near Lake Superior, black spruce is well represented in uplands, even in xeric stands of pine-fir. It is important to note that northern Wisconsin's typical bogs of black spruce and tamarack (*Larix laricina*) are not considered boreal; rather, they represent Curtis' northern wet forest type, which has yet to be featured in this series.

Curtis distinguished 3 "partially distinct," structural types of boreal forest in Wisconsin:

> "the first, the old stands of relatively pure conifers with balsam fir and white spruce as the major dominants, associated with large quantities of white pine, red pine (*Pinus resinosa*), or white cedar as found especially along Lake Superior; the second, the mixed conifer-hardwood stands, particularly on inland mesic sites, with the shade-tolerant hardwoods [e.g., sugar maple, yellow birch] gradually replacing the spruce and fir; and the third, the young stands of dense balsam fir and white spruce under an aging and decadent canopy of trembling aspen or white birch, as found throughout the range. [Many] hardwood species . . . are found in the second type. The hardwoods associated with the first type are white birch, mountain-ash (*Sorbus americana*), red maple (*Acer rubrum*), and mountain maple (*A. spicatum*), while the third type usually has only white birch or one of the aspens or poplars, with balsam poplar (*Populus balsamifera*) occasionally reaching significant levels of importance. Obviously, the last two types do not represent distinct and stable entities

but reflect successional recovery from recent disturbances."

These "recent disturbances" include logging and, often, subsequent fire. The UW researchers were able to locate very few stands for their study that had escaped gross disturbances due to human activity.

Curtis estimated that boreal forest covered approximately 672,300 acres, or slightly less than 2% of Wisconsin's land surface, at the time of European settlement. WDNR's statewide Natural Area Inventory, conducted between 1969 and 1983, located only about 750 acres of boreal forest presumably resembling the presettlement condition—a loss of 99%. By this time many of the successional stands described by Curtis for inland mesic sites had lost their boreal character due to senescence, blowdown, spruce budworm infestation, and succession to shade-tolerant hardwoods. Today these stands more closely resemble the second-growth mesic or dry-mesic forests (Curtis 1959, Hoffman 1989) so characteristic of northern Wisconsin. However, balsam fir still often occurs in the understory of these forest tracts; it is a vigorous colonizer of clearcuts, blowdowns, and burns, and is relatively unpalatable to browsing herbivores such as deer. Thus, it can achieve high stem densities and frequencies in young forests, but where stands have matured, particularly at inland sites, it is seldom an important canopy species.

Boreal forest has persisted mostly near Lake Superior, as stands of paper birch, trembling aspen, and balsam fir. These often occur on wet clay soils that may continue to favor the shallow-rooted boreal species over more mesic hardwoods such as sugar maple and basswood (*Tilia americana*). It would not be surprising, however, if other non-boreal species such as red maple, hemlock, yellow birch and white cedar eventually assumed codominance in these stands.

At present the best developed, least disturbed, and most protected boreal stands often occur on anomalous sites; on old beach ridges or sand spits, in narrow strips on flat dolomite bedrock along Lake Michigan, or on islands in Lake Superior. These stands have a strong boreal flavor, but all include components of the more typical regional forests and also express each site's unique conditions of microclimate, soils, exposure, remoteness, and natural disturbance regime. For example, some boreal forest stands on the Apostle Islands exhibit an incredible structural complexity in the shrub and subcancopy layers, due to lake- and island-related influences: frequent canopy openings from blowdown; mild, moist microclimate; and on some of the islands, the absence of deer. The abundant, often lush stands of Canada yew (*Taxus canadensis*), mountain maple, mountain ashes, and sapling white cedar, fir, spruce and hemlock present an aspect unlike anything encountered on the mainland. It also presents a tremendous challenge to those attempting to observe birds or sample vegetation.

To describe the breeding-bird community of Wisconsin's boreal forest we will focus on 7 stands, which represent most of the high quality, mature boreal forest remaining in the state, and include a wide range of structures, composition, and geographic settings. Kimball's Bay Boreal Forest is underlain by clay, along the Wisconsin-Minnesota border in far northwestern Wisconsin near Lake Superior. It is a

dry-mesic site dominated by white pine, white birch, and balsam fir, with frequent white spruce, and broadleaf shrubs, scattered white cedar, pockets of red pine (*Pinus resinosa*) and aspens, and little or no oak (*Quercus* spp.) or maple. It is recovering from severe logging and possibly burning, which occurred a century ago.

Port Wing Boreal Forest Natural Area also includes a dry-mesic boreal forest, with white spruce, fir and lesser amounts of hardwoods and white cedar growing beneath a taller canopy of white and red pines. The forest grows on an old beach ridge beside Lake Superior and the tract includes some adjacent, associated conifer bog and alder thicket.

High Lake Spruce-Balsam Forest Natural Area represents the inland, mesic, boreal forest described by Curtis (1959) as successional, and it was included in his studies. It is recovering from logging, windthrow, and fire, which probably spanned the period 1880–1915. Most white spruce and many firs have apparently succumbed to disease, senescence, and windthrow since Curtis' work. The canopy is mostly white birch, white and red pine, balsam fir, and white spruce, with fir and spruce scattered in the understory along with sugar maple seedlings.

Ridges Sanctuary Natural Area is the best remaining example of the boreal forest isolated on Door Peninsula. Unlike the 3 previous tracts, it is not set in an extensively forested region. It includes a series of Lake Michigan beach ridges forested primarily with black and white spruces, fir, and white pine, interdigitating with swales in which are white cedar and black spruce woods and open bog.

We have included surveys from 3 of the Apostle Islands, located at the northern tip of Wisconsin in Lake Superior (Temple and Harris 1985, Temple unpubl. data). All have good stands of mixed and boreal coniferous-hardwood forest. Devils and North Twin have an especially boreal aspect, and North Twin and Raspberry Islands have exceptional understory stands of Canada yew. The interior of Raspberry Island is generally dense yew 6–10 ft. tall, under mature white cedar, paper birch, yellow birch, and fir. Fir is abundant on the island's windswept edges. On much of Devils and North Twin are large, gnarly, open-grown yellow birch with paper birch, cedar, white pine, and—especially in gaps and edges—fir (Figure 1); the dense tall shrub layer

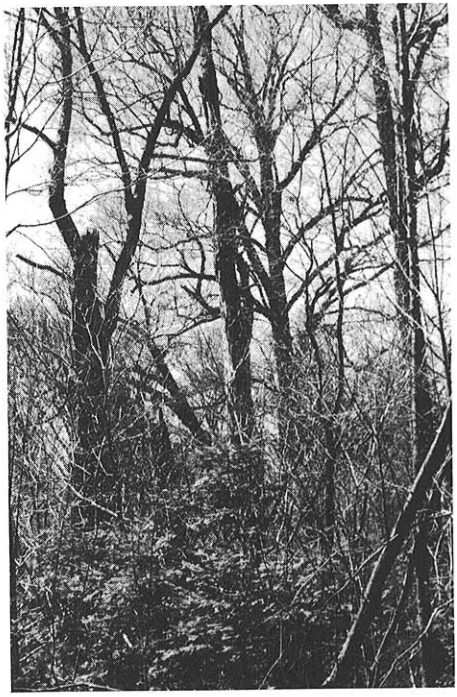

Figure 1. Old-growth yellow birch, with fir, white cedar, and a dense layer of yew. Devil's Island, Bayfield County.

consists of mountain maple and mountain ash, and—on North Twin—yew. Devils Island also has a substantial stand of black spruce, tamarack, and fir.

Standardized, breeding-bird survey data from these 7 stands are presented in Table 2. The table also characterizes each species on the basis of its breeding range, as determined by standard maps and texts (Erskine 1977, Peterson 1980, Godfrey 1986, Cadman et al. 1987) and our own experience in Wisconsin. For example, a "boreal" species is one that breeds primarily within the boreal forest biome while a "southern" species breeds primarily in the eastern deciduous forest biome; the breeding range of a "boreal-mixed forest" species spans both the boreal and mixed coniferous-hardwood forest biomes, but little or none of the eastern deciduous forest biome; and the range of a "widespread" species includes significant segments of all 3 biomes.

To help evaluate the nature and significance of Wisconsin's boreal forest breeding-bird community, we will first describe the primary bird communities of true boreal forests. Erskine (1977) gives an excellent overview of the latter. To allow comparisons with Wisconsin surveys, we computed mean relative abundance values from Erskine's census data collected in those eastern and central boreal stands dominated, respectively, by spruce, fir, and birch-aspen.

True boreal spruce forest has a relatively simple structure. It is typically dominated by a few needle-leaved conifer species with little or no broadleaf component except for heath. Its breeding-bird community is correspondingly rather simple, but with a very large proportion of species whose breeding ranges are primarily boreal or span both boreal and mixed coniferous-hardwood forest biomes. Boreal species constitute approximately 24% of all individuals and 36% of all species, while boreal-mixed forest species are represented by 71% of individuals and 54% of species. In total, boreal and boreal-mixed forest species constitute the vast majority of individuals (95%) and species (89%) breeding in boreal spruce forest. The most common species in these stands were White-throated Sparrow, Nashville Warbler, Yellow-rumped Warbler, and Golden-crowned Kinglet, although Erskine considered the Swainson's Thrush, Yellow-rump, and Dark-eyed Junco to be especially "ubiquitous and dominant."

Fir-dominated boreal forests are typically more diverse than spruce forests, with a greater mixture of tree and understory species and ages, including some birch or aspen. They generally have a more diverse bird community than do spruce stands, partly because of the addition or increased densities of several species such as Ovenbird, Red-eyed Vireo, and American Redstart, which have more southern, widespread breeding ranges. Besides these 3 "hardwoods" species, Erskine considered the following to be characteristic: Red-breasted Nuthatch, Solitary Vireo, Tennessee Warbler, Purple Finch, and most distinctively the Black-throated Green Warbler, Blackburnian Warbler, and Bay-breasted Warbler. Altogether, approximately 75% of individuals and 64% of species belong to boreal and boreal-mixed forest categories. His census data showed the most abundant species to be Bay-breasted Warbler (especially in mature

stands), Magnolia Warbler (especially in young stands), White-throated Sparrow, and Ovenbird.

Spruce, and especially fir-dominated forests are subject to periodic outbreaks of spruce budworm (*Choristoneura fumiferana*). These infestations are exploited by boreal warblers such as the Cape May Warbler, Bay-breasted Warbler, and Tennessee Warbler, whose populations may increase in response many fold. Even populations of more generalized species such as Red-breasted Nuthatch, Purple Finch, and Evening Grosbeak may increase substantially at these times.

Another species group that exhibits irruptive population changes is the cardueline finches, especially the Evening Grosbeak, Purple Finch, Pine Grosbeak, Pine Siskin, Red Crossbill, and White-winged Crossbill. These are primarily seed-eaters that range widely and sometimes nest in great numbers or in areas outside their normal range, when these sites happen to produce heavy cone crops. Of these species, the Evening Grosbeak, Pine Siskin, and White-winged Crossbill are known to be especially responsive to spruces.

The third type of the boreal forest pertinent to our discussion includes those early successional stands dominated by birch and aspen. In Erskine's censuses of this type, 50% of species and only 25% of individuals were primarily of boreal or boreal and mixed forest affinity. The 4 most abundant species (Ovenbird, Red-eyed Vireo, Least Flycatcher, and American Redstart) are distributed widely across eastern North America, and they comprised over half of all individuals in the type. Erskine also considered the following to characterize aspen-birch woods: Ruffed Grouse, Yellow-bellied Sapsucker, Black-capped Chickadee, American Robin, Swainson's Thrush, Veery, Black-and-White Warbler, Canada Warbler, and Rose-breasted Grosbeak.

The breeding-bird community of Wisconsin boreal forest (Table 2) has many species in common with those of the true boreal forest types, but differs considerably in the relative abundances of species. It is actually fairly typical of mixed coniferous-hardwood forest and edge (i.e., Curtis' northern Wisconsin forest types), but with an especially high prevalence of the more northern and conifer-loving species, including the addition of some that are truly boreal. It is characterized overall by having a few boreal species that occur in very low numbers, relatively high numbers of several "boreal and mixed forest" species, and a predominence of fairly widespread species (Tables 2, 3).

Birds with widespread breeding ranges comprise over one-third of the species and nearly half of the individuals in Wisconsin boreal forest. Although most of the widespread species are uncommon or rare, 8 are fairly common (e.g., Least Flycatcher), 2 are common (Cedar Waxwing, Black-and-White Warbler), and 3 are abundant (Black-capped Chickadee, Red-eyed Vireo, Ovenbird). Several of the widespread species, such as Swamp Sparrow, Red-winged Blackbird, Common Grackle, Song Sparrow, and American Goldfinch, are generalized species of edges and damp shrubby areas. Others, including the abundant species, are generalized breeders of deciduous and mixed forests, even in boreal regions of Canada.

Our sample of 7 stands includes only 2 species that can be considered pri-

Table 2. Breeding range and relative abundance[1] of birds occurring in 7 boreal forest stands in Wisconsin.

Species	Breeding Range[2]	Overall Abundance[3]	Relative abundance in indicated stands[4]						
			KB	PW	HL	RS	RI	DI	NT
Bald Eagle	W	U					+		+
Broad-winged Hawk	W	U					0.2	0.4	
Merlin	BM	R						+	
Ruffed Grouse	W	R	1.4						
Spotted Sandpiper	W	U					+	0.7	+
American Woodcock	SM	U					0.2		1.5
Mourning Dove	S	R	2.0						
Black-billed Cuckoo	SM	U	2.0	0.9					
Northern Saw-whet Owl	W	R					+		
Chimney Swift	W	FC		0.4		1.9	4.0	2.0	3.1
Ruby-throated Hummingbird	SM	U		0.1		0.4			
Belted Kingfisher	W	U					+	+	0.5
Red-headed Woodpecker	SM	R				0.7			
Yellow-bellied Sapsucker	BM	FC			4.9	0.4	0.3	0.7	+
Downy Woodpecker	W	U	0.1			1.2			0.5
Hairy Woodpecker	W	U	0.1			0.7	0.5	+	1.5
Northern Flicker	W	U		0.1		2.3	0.2		
Pileated Woodpecker	W	R				0.4			
Olive-sided Flycatcher	BM	R						1.4	
Eastern Wood-Pewee	SM	U	0.1	0.6		0.4		0.7	0.5
Yellow-bellied Flycatcher	BM	U		0.1					1.0
Alder Flycatcher	BM	U		2.0		0.7			
Least Flycatcher	W	FC	4.1	1.1			0.2	+	1.5
Eastern Phoebe	SM	R					0.3		
Great Crested Flycatcher	SM	U	0.1	0.9		1.5	0.3		0.5
Eastern Kingbird	W	R		0.6					
Purple Martin	SM	R				1.2			
Tree Swallow	W	FC		3.2		1.5	+	2.7	3.1
Cliff Swallow	W	U					1.5	+	+
Barn Swallow	W	U					+	1.4	
Gray Jay	B	R						0.7	
Blue Jay	SM	C	3.4	2.0	2.4	6.2	1.2	0.7	3.6
American Crow	W	FC		2.0		3.9	0.7	+	1.0
Common Raven	BM	U			2.4		0.7	+	0.5
Black-capped Chickadee	W	A	4.7	1.4	4.9	7.4	6.9	8.1	3.1
Red-breasted Nuthatch	BM	FC	2.0	0.3	2.4	2.3	0.3	0.7	2.6
White-breasted Nuthatch	SM	U	0.1	0.6			0.5		
Brown Creeper	BM	U	1.4			0.4			1.0
Winter Wren	BM	C			4.9	1.9	3.9	0.7	2.6
Golden-crowned Kinglet	BM	U		0.3		2.7	0.3	0.7	
Veery	M	C	12.2	3.3		0.7	4.1	+	2.6
Swainson's Thrush	BM	FC					+	0.7	5.2
Hermit Thrush	BM	FC		0.4	9.8	0.4	0.2		
American Robin	W	FC	4.7	3.4		3.5	0.8	+	+
Gray Catbird	SM	U		0.3		0.7	0.2		
Brown Thrasher	SM	R		0.1					
Cedar Waxwing	W	C	0.1	4.5		1.9	1.3	24.9	
Solitary Vireo	BM	R		1.0					
Warbling Vireo	SM	R					0.2		
Red-eyed Vireo	W	A	8.8	2.4	19.5	1.2	12.8	2.0	5.7
Golden-winged Warbler	M	R					+		
Tennessee Warbler	B	R	0.1						

continued

Table 2. (*Continued*)

Species	Breeding Range[2]	Overall Abundance[3]	Relative abundance in indicated stands[4] KB	PW	HL	RS	RI	DI	NT
Nashville Warbler	BM	C	4.7	8.6	2.4	2.7	1.7	2.7	+
Northern Parula Warbler	M	C		4.6	2.4	1.9	3.4	2.0	8.3
Yellow Warbler	W	U		1.3		0.4	0.3		
Chestnut-sided Warbler	M	FC		0.9			2.7	2.0	1.0
Magnolia Warbler	BM	FC		0.7		0.4	1.0		10.7
Cape May Warbler	B	R		1.0					
Black-throated Blue Warbler	M	U		0.3			2.4		
Yellow-rumped Warbler	BM	C	4.7	3.9	2.4	2.7	1.3	2.0	2.1
Black-throated Green Warbler	BM	A	4.1	4.2	9.8	4.7	12.2	2.7	5.7
Blackburnian Warbler	BM	C	2.7	6.2	7.3	0.7	3.0	2.7	2.1
Pine Warbler	M	U	0.1	2.9		0.7		0.7	
Palm Warbler	B	R		0.7					
Bay-breasted Warbler	B	R		0.1					
Blackpoll Warbler	B	R		0.1					
Black-and-White Warbler	W	C		4.5	2.4	3.0	7.1	0.7	4.1
American Redstart	W	FC		2.4		2.3	4.2	0.7	1.3
Ovenbird	W	A	10.8	2.0	22.0	3.5	7.9	3.4	0.5
Connecticut Warbler	BM	U					1.0	2.0	
Mourning Warbler	BM	FC	6.1	0.6		1.2	2.0		0.5
Common Yellowthroat	W	FC	2.0	3.4		7.0	0.4		0.5
Wilson's Warbler	B	U					+	0.7	
Canada Warbler	BM	C	1.4	0.1			1.7	2.7	9.7
Scarlet Tanager	SM	U		0.3		0.4			0.5
Northern Cardinal	S	R				1.2			
Rose-breasted Grosbeak	SM	U	2.7	0.7		0.4	0.3		0.5
Chipping Sparrow	W	U		1.3		2.7	0.2		1.0
Song Sparrow	W	FC	0.1	2.2		5.4	0.8	0.7	4.1
Swamp Sparrow	W	R		3.3					
White-throated Sparrow	BM	C	5.4	2.3		4.7	2.5	10.1	5.2
Dark-eyed Junco	BM	U		0.1				3.4	
Red-winged Blackbird	W	R		4.9					
Common Grackle	W	R				4.7			
Brown-headed Cowbird	SM	U	2.7	0.7		0.7			
Pine Grosbeak	B	R						0.7	
Purple Finch	BM	FC		0.4		0.7		4.7	
White-winged Crossbill	B	U						6.8	
Pine Siskin	BM	R		0.3					
American Goldfinch	W	U		0.9		2.3			
Evening Grosbeak	M	R		0.3					
Acreage			290	188	40	860	296	318	175
Years surveyed			1	4	1	3	1	1	1
Hours/year			3	2	1	2	13	6	6

[1]Numbers refer to the percentage of individual birds counted in a given stand that belong to a particular species (e.g., Ruffed Grouse comprised 1.4% of all birds counted at Kimballs Bay). A "+" means the bird was detected only once, but not while censusing.

[2]Primary breeding range: B = Boreal (boreal forest biome), S = Southern (eastern deciduous forest biome), M = Mixed (mixed hardwood-coniferous forest biome), W = Widespread.

[3]A = Abundant (occurred in all 7 Wisconsin stands, with total mean relative abundance ≥ 5%). C = Common (occurred in at least 5 stands, with mean abundance ≥ 2%). FC = Fairly Common (occurred in at least 3 stands, with mean abundance ≥ 0.8%). U = Uncommon (occurred in at least 2 stands, or in just 1 stand but with mean abundance ≥ 1%). R = Rare (occurred on only 1 stand, with mean abundance < 1%).

[4]KB = Kimball's Bay. PW = Port Wing. HL = High Lake. RS = Ridges Sanctuary. RI =

Table 3. Composition of Wisconsin's boreal forest breeding-bird community according to species' primary breeding ranges.

Breeding range[1]	Community Composition[2]		
	Number of species	% of species	% of individuals
Widespread	32	35	45
Boreal	9	10	2
Boreal-Mixed	25	27	37
Mixed	7	8	9
Southern-Mixed	16	18	7
Southern	2	2	1
TOTAL	91	100	100

[1]Range categories defined in Table 2.
[2]Values represent totals in Table 2.

marily "southern" birds of the eastern deciduous forest biome, and they are both rare in Wisconsin boreal stands. One is the Northern Cardinal, which has expanded its range northward in recent decades with the rising popularity of winter bird feeding, and although generally a southern bird, it often selects northern, coniferous habitat when available (Mossman and Lange 1982).

Wisconsin boreal forest includes several species of birds whose primary range spans both the deciduous and mixed forest biomes. Except for the habitat generalist Blue Jay, these species are all uncommon or rare in the community, and they constituted a total of only 7% of the individuals encountered on surveys.

Most of these species, especially the Scarlet Tanager, White-breasted Nuthatch, Warbling Vireo, Black-billed Cuckoo, Eastern Wood-Pewee, and Rose-breasted Grosbeak, are known to select hardwood microhabitats when in mixed forest; however, the Blue Jay, and to some extent the pewee, may also use pines (e.g., Mossman and Lange 1982). This also appears to be their distribution in Wisconsin boreal forest.

There are a few Wisconsin birds whose ranges are centered on the mixed coniferous-hardwood forest biome, and 7 of these occurred in the boreal forest surveys. These include species that are rare in the community (Golden-winged Warbler and Evening Grosbeak), uncommon (Pine and Black-throated Blue Warblers), fairly common (Chestnut-sided Warbler), and common (Veery and Northern Parula). Four of these are birds of dense broadleaf understory.

In Wisconsin boreal forest, as elsewhere, the Veery and the Golden-winged Warbler, Chestnut-sided Warbler, and Black-throated Blue Warbler are birds of dense broadleaf understory, such as beneath canopy gaps or edges; however the Black-throated Blue occurs in these situations primarily in large, mature stands, and perhaps occasionally in dense coniferous understory. The Pine Warbler occurs in medium to large pines within Wisconsin boreal forest, for example at Kimball's Bay, where it occurred only in a grove of tall red pines. It is restricted to pine stands in the Apostles (Temple and Harris 1985). The Northern Parula breeds among both pines and spruce-fir, generally in the

presence of *Usnea* lichens. The Evening Grosbeak is a rare Wisconsin breeder. Although it was rare in our sample, and although Temple and Harris (1985) did not find it breeding in the Apostles, Robbins (in press) feels it probably breeds regularly in the boreal forests south of Lake Superior and near the Upper Peninsula border, where it feeds on maple seeds and spruce budworms.

Many species, and over one-third of the individuals recorded on Wisconsin boreal surveys, are birds of both boreal and mixed forest biomes. Of the 15 species that are common or abundant in Wisconsin boreal forest, nearly half (7) belong to this range category. These include the abundant Black-Throated Green Warbler, and 6 common species: Winter Wren, White-throated Sparrow, and the Yellow-rumped, Nashville, Blackburnian, and Canada Warblers.

These species are fairly well distributed within both the boreal and mixed forest regions, and in Wisconsin they occur in a variety of northern community types, often as far south as central and southern Wisconsin in mixed-forest upland relics and conifer bogs (Mossman and Lange 1982). In upland Wisconsin boreal forests, their habitat preferences, described below, are similar to their preferences described for other boreal forests.

The Black-throated Green Warbler prefers fairly mature, mixed coniferous hardwood forest with a well-developed canopy structure. The relatively high importance of species such as sugar maple, yellow birch, and hemlock in Wisconsin boreal forest make this species more prevalent here than in true boreal forest. The Winter Wren occurs mostly in moist sites, often with fallen logs and a moderately dense understory. The White-throated Sparrow has a very generalized habitat distribution, breeding in most coniferous and mixed forests and edges, adjacent bogs and cutovers. The Yellow-rumped Warbler is also fairly generalized among conifer woods and edges, and like the previous species, is a very common bird of true boreal forest. Nashvilles occur mostly in aspen-birch, often at the forest edge, and sometimes in jack pines. Blackburnians are in mature spruce, fir, pines, and hemlock. Canada Warblers are found in moist sites, often on slopes, with a rich understory of mixed hardwood shrubs.

Although the surveys recorded 9 of the 20 Canadian species (Table 1) that are indicative of true boreal forest, they were all rare or uncommon, constituting only 2% of all individuals. Of these, the Pine Grosbeak, White-winged Crossbill, Gray Jay, and the Cape May, Palm, Bay-Breasted, and Blackpoll Warblers, are, to varying degrees, considered birds of spruce-fir, while the Tennessee and Wilson's Warblers are not. In the 7 Wisconsin survey areas, the most numerous of these were the crossbill, which occurred only on Devils Island but in relatively large numbers; and Wilson's Warbler, which occurred in low numbers on 2 of the Apostles, but also on 4 other of the islands (Temple and Harris 1985).

Because boreal bird species and their habitats are so uncommon in Wisconsin, we know little about their ecology here. Information on breeding status and distribution is sorely needed for most species. However, a few generalizations can be drawn from our limited knowledge and published information from other regions (e.g., Er-

skine 1977, Peck and James 1987, Cadman et al. 1987).

The White-winged Crossbill feeds almost exclusively on conifer seeds, and is especially fond of spruce-fir. It wanders extensively and is irruptive according to seed crops, and may breed at any time of the year. It is not necessarily nesting when here during the summer.

Cape May Warblers live mostly in the upper sections of spruce and fir trees. They and Bay-breasted Warblers are spruce-fir insectivores that are known to increase their numbers dramatically during budworm outbreaks, but it is unclear the extent to which this happens during Wisconsin's relatively mild budworm infestations.

The Blackpoll Warbler is considered "the most exclusively northern breeding warbler" in Ontario (Cadman et al. 1987), where its habitat is open, conifer and mixed scrub. It probably does not nest in Wisconsin, despite breeding-season records.

In the boreal forest biome, Tennessee Warblers breed in conifer, hardwood, and mixed stands, alder and willow swales, and cutovers. Temple and Harris (1985) found them in openings of mixed coniferous-hardwood forest on the boreal-like Apostle Islands, especially near conifers. We have also found them in aspens of boreal forest edges and of northern jack pine barrens.

The Wilson's Warbler is a bird of shrubby broadleaf thickets and edges in the boreal forest biome, and it inhabits the same sort of site on the Apostle Islands. Temple and associates documented the first known breeding of this species in Wisconsin, on Devil's Island in 1977.

In Wisconsin, boreal forest is not the only breeding habitat for boreal bird species. Many of these species occur more or less often in black spruce bogs—classified by Curtis (1959) as northern wet forest. Because of the greater extent of lowland black spruce, this community may be equally or more important for some boreal bird species than is the upland boreal forest described in this article. For example, the Spruce Grouse, Boreal Chickadee, Ruby-crowned Kinglet, and Palm Warbler occur primarily in these lowlands. The Gray Jay is found most often in areas with fairly widespread spruce or cedar swamps or boreal uplands.

In summary, Wisconsin's boreal forest is a distinctive mixture of components from both boreal and mixed coniferous-hardwood forest biomes. The bird communities are dominated by species of widespread distribution and others that breed in both boreal and mixed forest regions. Several distinctly boreal bird species also occur in this forest community, as well as in lowland spruce forest. Little is known about the Wisconsin breeding status and distribution of most of these uncommon species.

Compared to the true, Canadian boreal forest, Wisconsin's has a depauperate component of boreal bird species. In part, this is probably the result of the transitional nature of these tracts, with their dominant complement of nonboreal species such as sugar maple, hemlock, and white cedar. This is suggested by the fact that several boreal bird species appear to be more common in Wisconsin black spruce bogs, which closely resemble the structure of truly boreal spruce forests, in which boreal birds are most prevalent. Other factors contributing to this relative dearth of boreal birds

may relate to disturbance such as logging, or browsing by high deer populations, as indicated by differences in the understory of Apostle Islands that do or do not have deer.

Probably, a critical factor limiting populations of boreal birds in these Wisconsin outliers is tract size and isolation. This is apparent in the lack of distinctly boreal species in the isolated Ridges Sanctuary and in Temple and Harris' (1985) data from the Apostle Islands. For example, the number of boreal bird species increases from 0 on North Twin Island (175 acres), to 1 on Raspberry (296 acres), 5 on Devil's (318 acres, with especially good boreal forest), and 7 on Outer (7999 acres).

Wisconsin's boreal bird community is a unique aspect of our natural heritage, and worthy of protection. It is important to maintain boreal and northern wet forest communities on the Apostle Islands and present State Natural Areas. Yet these may not provide sufficient habitat for the full complement of species that once probably occurred regularly in these community types, or even, in the long run, for those few species that now occur fairly regularly, considering the possible local impacts of disturbances such as fire, disease, and fragmentation of surrounding, unprotected forest.

Several boreal species, for example the Spruce Grouse, Boreal Chickadee, and Ruby-crowned Kinglet, are not known to breed on any of the sites reported here, nor on any of the Apostles. We suggest the creation of a large, landscape-scale management and protection project within Wisconsin's boreal forest region—preferably along Lake Superior, which would incorporate a range of boreal forest successional types as well as lowland conifer communities. At the very least, in investigating the possibilities of such a project we would gain needed knowledge of the distribution, status, and habitat needs of these northern birds.

Description of Sites

We have selected four of the boreal forest tracts from Table 1 for detailed descriptions:

Devil's Island

Size.—318 acres.

Location.—This Lake Superior island is within the Apostle Islands National Lakeshore, and is the northernmost point of land in Wisconsin.

Access.—By private boat only. Interior access can be acquired at a public dock on the island's southern end; or by small craft (canoe, kayak or dingy) launched during favorable conditions from a larger boat offshore, onto the rocky shore just east of the lighthouse.

Site Description.—This is one of the smaller and outermost of the Apostles. Most of the island is forested, except for a narrow lane that connects the lighthouse/radio tower on the north end with the docking area on the south end. The island is up to sixty feet above Lake Superior and ringed with a scenic rocky shore. Spectacular, wave-cut cliffs, caverns, and pillars occur on the northwest shore. The forest is approximately 69% boreal and mixed conifer-hardwoods, and 28% lowland conifer. Dominants are yellow birch, white cedar and balsam fir, with lesser numbers of white pine, white spruce, paper

birch, balsam poplar, trembling aspen, red maple, and mountain ash. The very dense shrub layer is dominated by mountain maple and yew. There is a pronounced krumholz effect near the north and west shores, where the constant battering of trees by wind has produced a gnarled, stunted, and open aspect to the forest. Common herbs in the ground layer include bluebead lily, goldthread (*Coptis trifolia*), and star flower. Mosses are particularly common.

Birds.—Temple and Harris (1985) recorded 56 breeding species in 1977, including several with distinctly boreal affinities (Table 1), and a few (e.g., Spotted Sandpiper) that are not true forest birds. The most frequently observed species were Cedar Waxwing, White-throated Sparrow, Black-capped Chickadee, White-winged Crossbill, Purple Finch, Dark-eyed Junco, and Ovenbird. Whereas the crossbill is fairly indicative of true boreal forest, the other species are more often associated with mixed hardwood-coniferous forests. Other boreal species found here are the Gray Jay and Pine Grosbeak.

Raspberry Island

Size.—296 acres.

Location.—This island is just off the northern tip of the Bayfield Peninsula, within the Apostle Islands National Lakeshore.

Access.—By private or commercial boat. To explore the island for its natural values, it is necessary to have a private launch. Commercial boats stop only at the historic lighthouse, and allow little time for exploration.

Site Description.—This island has a 100-foot topographic relief. Shoreline features include sandstone cliffs, clay bluffs, sand beach, and a short spit that encloses a bog. On the southwest shore is an historic lighthouse. The area around the lighthouse has been cleared so as not to obstruct the beacon. The remainder of the island's interior is virtually undisturbed forest, and includes an apparently virgin stand of white cedar and yellow birch with a tall, lush shrub layer of yew and mountain maple. The forest around the island's edge is dominated by balsam fir, white cedar, and paper birch. A high spot in the interior supports a small stand of mesic hardwoods dominated by sugar maple and basswood. In total, the island consists of approximately 56% boreal and mixed hardwood-coniferous forest, 32% aspen-birch, 8% open areas, and 4% lowland conifers.

Birds.—Bird life is less boreal here than on Devil's Island, but it illustrates the influence of understory on boreal and mixed forest avifaunas. Temple and Harris (1985) recorded 61 breeding species, 6 of which are not true forest breeders. The most frequently observed were Red-eyed Vireo, Black-throated Green Warbler, Ovenbird, Black-and-White Warbler, Black-capped Chickadee, American Redstart, and Veery. Bird species of the lush understory and brushy edges include Veery, Black-throated Blue Warbler, Magnolia Warbler, Canada Warbler, Mourning Warbler, Chestnut-sided Warbler, Golden-winged Warbler, and Wilson's Warbler.

Port Wing Boreal Forest

Size.—188 acres, consisting of 2 distinct units of approximately equal size.

Location.—Northern Bayfield County, along Lake Superior.

Access.—The eastern unit is one mile northeast of the Village of Port Wing, on the northwest side of State Highway 13, bisected by Big Pete Road. The western unit is reached by taking Quarry Road from the village of Port Wing, west one mile to the southwestern corner of the tract.

Description.—The Port Wing project encompasses 2 forested tracts on sand spits inland from present Lake Superior beaches. Both units have dry-mesic, boreal-like forest that is separated by wetlands from the sandy lake beach. The total area of boreal forest on the Natural Area is 100 acres. White and red pines dominate, forming a canopy over white spruce and balsam fir. Also present are red maple, white birch, mountain maple, yellow birch, and white cedar. Many mosses and lichens are found on twigs, downed trunks, and the forest floor. North of the forest is an open water and sedge bog complex with many typical bog species such as pitcher plant (*Sarracenia purpurea*), sundews (*Drosera* spp.), bladderworts (*Utricularia* spp.), and sedges (*Carex* spp.). The beach is dominated by native grasses, beach pea (*Lathyrus maritimus*) and sand cherry (*Prunus pumila*).

Birds.—Birds (Table 1) were counted throughout the Natural Area, but primarily in boreal forest. The most common species are, in order of decreasing abundance: Nashville Warbler, Blackburnian Warbler, Red-winged Blackbird, Northern Parula, Black-and-White Warbler, Cedar Waxwing and Black-throated Green Warbler. There are intriguing summer observations for Bay-breasted and Blackpoll Warblers, which suggest that at least the Bay-breasted may breed here.

Ridges Sanctuary

Size.—860 acres.

Location.—The Natural Area is within the Ridges Sanctuary, just north of Bailey's Harbor, Door County.

Access.—From Hwy. 57 north of Bailey's Harbor, turn east on County Hwy. Q. Follow the signs to the nature center, and then hike the marked trails through the tract; or, enter the site from the south via a parking area near the range light on Harbor Drive.

Description.—The Ridges Sanctuary consists of a series of Lake Michigan beach ridges forested with black spruce, white spruce, balsam fir, and white pine, with wet swales between the ridges. Swamp conifers occupy some of the swales; others are filled with marsh and bog flora. Portions of the ridges are open, wet, and calcareous and support an outstanding assemblage of rare and endangered plants. Eighty acres of the forest is classified as boreal, far disjunct from the main areas of Wisconsin boreal forest near Lake Superior. However, the 700 acres of northern wet and wet-mesic forest on the tract also have boreal components, which are favored by the climatic influence of Lake Michigan.

Birds.—Breeding-bird surveys here covered the entire Natural Area, including open and semi-open swales. In order of decreasing abundance, the most common species (Table 1) are Black-capped Chickadee, Blue Jay, Song Sparrow, White-throated Sparrow, American Crow, American Robin, and Black-and-White Warbler. The Ridges supports many species that are typically associated with the conifers of mixed forest, but none of those species that characterize true boreal forest.

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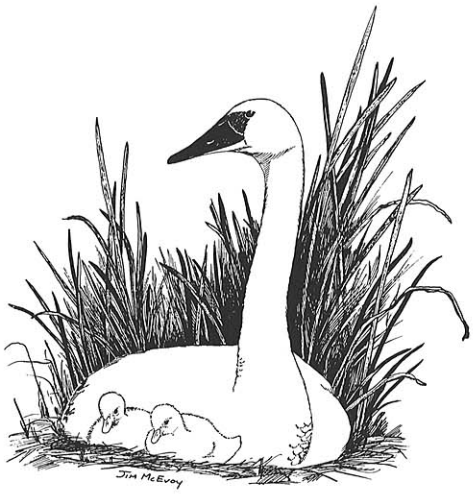

Trumpeter Swan *by Jim McEvoy*