LOWLAND HARDWOOD BIRD COMMUNITIES[1/]

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Abstract.--Lowland hardwood forests have declined in area since settlement, and precipitous decreases are reported in some states. Suitable silvicultural options for maintaining lowland hardwoods are selection and shelterwood cutting, but clearcutting should be avoided because of soil characteristics. The species-area concept may also be used in acquisition and in management of lowland hardwoods. Resource needs in the breeding or the non-breeding season for birds in the lowland hardwoods are little known nor investigated. Recommendations include preventing further loss of these forests, maintaining a diversity of tree species and stand ages by appropriate silvicultural option, and research to determine bird resource needs particularly during the non-breeding season.

INTRODUCTION

Nearly 50 years ago, Aldo Leopold wrote "The public is (and the sportsman ought to be) just as interested in conserving non-game species, forests, fish and other wildlife as in conserving game." He continued, "In the long run lop-sided programs dealing with game only, songbirds only, forests only, or fish only, will fail because they cost too much, use up too much energy in friction, and lack sufficient volume of support" (Leopold 1930: 287). However, only recently has the awareness and need for integrated management for all wildlife received its due attention. Legislation, including the Environmental Protection Policy Act of 1973, the Endangered Species Act of 1973, Forest and Rangeland Renewable Resource Planning Act of 1976, Land and Waters Resource Act of 1977 and other federal legislative or judicial acts point to the recent increase in professional and public awareness of nongame wildlife. Concurrent with the federal activity has been the passage of legislation or regulations by states supportive of nongame wildlife. Examples include legislation to protect endangered or threatened species (including at least 8 north central or northeast states), "nongame" stamps providing revenues to support research and management of nongame wildlife, and a constitutional amendment passed in Missouri which provides one-eighth of one percent of general sales tax revenues to game and nongame wildlife research and habitat management programs. Finally, as Allen (1973:21) pointed out in the Report to the Committee on National American Wildlife Policy, programs should "recognize that all peoples have a common concern for the survival of plants and animals still existing on earth. We regard this as a feature of the right-to-live concept already advanced. In a utilitarian sense, the preservation of species leaves options open for generations to come, who may find unpredictable uses for many organisms."

Among all terrestrial vertebrates, birds have been particularly successful in exploiting a wide array of aquatic and terrestrial habitats (Dorst 1974). Of these, lowland hardwoods, whether in tropical or temperate latitudes, are particularly important (Ferguson et al. 1975, Pearson 1977, Johnson and Jones 1977, Dickson 1978 and others). The high net productivity of lowland forest trees are influenced by many factors including light, temperature, and the high availability of soil moisture and nutrients (Ricklefs 1973, Whittaker 1975).

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These factors, particularly the availability of nutrients and moisture, have in part contributed to the vast conversion of lowland hardwoods to agricultural crops (Graber and Graber 1976, Korte and Fredrickson 1977, Giulio 1978 and others). Additionally, stream or river channelization for flood control by the Army Corps of Engineers and the Soil Conservation Service and authorized under Public Law 566 has reduced overall acreages of lowland hardwoods. The Soil Conservation Service (1975) has recently reported that over 15,540 km of streams or rivers have been affected, with an additional 18,440 km scheduled for alteration for flood protection. Additionally, applications have been filed for channel modification work involving approximately 91.4 million hectares with planning authorizations issued for approximately 51.8 million of these hectares.

Estimates of presettlement (about 1650) areas of lowland hardwoods are difficult to obtain, but unquestionably these acreages in several northeast and north central states have decreased since settlement (Table 1). Examples of very serious losses include Missouri, wherein about 4% of the presettlement southeastern lowland hardwoods remains today, with only 5860 (0.6%) hectares of the original 971,260 hectares in public ownership (Korte and Fredrickson 1977). In Ohio, less than 5% of an estimated original 80,938 hectares of lowland hardwood remains (Gebhart pers. comm.). Unfortunately, estimates of losses of lowland hardwoods are not available for all states, nor can the overall impact of their loss for wildlife ever be clearly determined. However, studies by Bonnema (1972) in Minnesota, New (1972) in Indiana, and Passordt and Dodge (1975) in Vermont provide examples of the damaging effect of stream modification on wildlife including many nongame avian species.

Currently, there are about 14.3 million hectares of lowland hardwoods in the northeast and north central states (Table 1). Some recent increases in lowland hardwood acreages are evident in New York and Rhode Island, where small farms, no longer economically profitable, are reverting to natural habitats.

FOREST SUCCESSION AND MANAGEMENT

Lowland forests contrast with upland forests in number of tree species present (generally more) and their often patchy distribution (Solomon 1977). These differences reflect the effects of periodic flooding, floods of varying duration, structural damage from ice or debris, and shifts in soil texture and layering as the result of flood activity (Lindsey et al. 1961, Johnson and Bell 1976, Huffman 1977). Of these, Bendinger (1971) described flood frequency and duration as most important in determining distribution of plant species on a flood plain. The irregular horizontal and vertical distribution of the alluvial soils and the dynamic nature of the ecotype influence the relatively high plant species diversity. Tesky and Hinckley (1978), however, have pointed out that these micro-habitat characteristics lessen or preclude the opportunity to place lowland hardwoods in the ecoregions or macro-vegetation groupings suggested by the USDA (1949), Kuchler (1964), Braun (1972), and recently by Bailey (1978). The characteristics influence a pattern in lowland hardwood forest succession which is generally similar through most of the northeast and north central states.

Forest succession and composition reflect the interaction of a moisture-nutrient-soil gradient and the shade tolerance of the species forming a plant community (fig. 1). Early successional stages are often characterized by species intolerant of shade yet requiring a moist soil for seed germination. On a flood plain, "new ground" is regularly added through silt deposits. The new soils are often a diverse array of sand of different particle sizes and soil of varying textures. Pioneer tree species, cottonwoods and willows, require a moist mineral soil for seed germination. Because they often are prolific seed producers, they frequently develop into dense stands, competitively eliminating other species. Although tolerant to flooding (Table 2), neither species, particularly the willows, tends to succeed itself due to their shade intolerance. Thus, species more tolerant to shade and flooding including maples (silver and red), boxelder, sycamore, hackberry, ash (green, white, black), and elms form a second stage in succession. Late stages of succession are formed by species intolerant to flooding but shade tolerant including beech, basswood, sugar maple, yellow poplar, white oak in the northeast and north central states and in more southern states hickories, pecans, and several oaks. The time required to evolve to a stable or climax stage for a mesic or lowland stand of shade-tolerant species may exceed that for an upland more xeric stand (Peet and Louks 1977), an important consideration for forest management or modeling. However, soils supporting these late successional stands may be lost to erosion during floods. Thus, the lowland hardwood ecotype is dynamic, with

Table 1.--Estimated area of lowland hardwoods (elm-ash-cottonwood or maple-beech-birch) in north central and northeast states

Locality	Current area (ha)	Percent change during interval	Source
Connecticut	290,290		Dickson and Bowers (1976)
Delaware	32,900		Ferguson and Mayer (1973)
Illinois	335,460	-25 to 28.6, 1962-1973	Graber and Graber (1976)
Indiana	510,600		Spencer (1969)
Iowa 1/	168,500		Ostrom (1974)
Kentucky 1/	926,830		Kingsley and Powell (1978)
Maine 2/	693,650		Ferguson and Kingsley (1972)
Maryland	211,500		Powell and Bowers (1978)
Massachusetts	479,400		Peters and Bowers (1977)
Michigan	769,000	-20.8 presettlement to date	Chase et al. (1970); W. B. Bottie (pers. comm.)
Minnesota 3/	515,980	-5 to 10, 1968-1978	W. Hanson (pers. comm.)
Missouri	435,530	-25.5, 1959-1972	Spencer and Essex (1972)
New Hampshire	827,960	-9.5, 1948-1973	Kingsley (1975)
New Jersey	152,570		Ferguson and Mayer (1974)
New York	3,692,000	+10 to 30, 1950-1968	Ferguson and Mayer (1970)
Ohio	4,040	-95, presettlement to date	E. J. Gebhart (pers. Comm.)
Pennsylvania	2,281,260		USDA (1975), J. D. Hassinger (pers. comm.)
Rhode Island	1,200	+25, 1953-1972	D. C. Holt (pers. comm.)
Vermont	1,047,000		Kingsley (1977)
West Virginia	1,389,360		Barnard and Bowers (1977)
Wisconsin	468,600	-56.4 presettlement to 1968	M. E. Reinke (pers. comm.)

1/ Data for only commercial forest lands.

2/ Data for elm-ash-red maple.

3/ Data for two of four management units.

erosion altering late successional stages and with early stages created by the same flood activity.

FOREST MANAGEMENT PRACTICES

Lowland hardwoods can be managed for lumber, water, wildlife, recreation or any combination of these. The management goal(s), species-site relationships, and stand composition determine the approach to regeneration (Dickson 1978).

Selection, shelterwood, and clearcutting are employed (Table 2) in the north central states on well-drained sites where sugar maple-basswood or yellow birch dominate. Selection results in many aged stands and a predominance of shade-tolerant species; whereas, shelterwood with removal of advanced regeneration leads to a moderately tolerant or tolerant species composition (Tubbs 1977). Although clearcutting creates overstory openings, the sand, silt, and clay soils characteristic of floodplains are vulnerable to invasion of grass, herbaceous, or bushy species that may prevent regeneration of desired tree species. On wet sites where red maple, black ash, yellow birch, and elm predominate, individual tree selection is used when timber harvest is the objective (Tubbs 1977).

Suitable silvicultural options in the northeastern states also are influenced by site productivity, species composition, age distribution, and management objectives (USDA 1973). Trees harvested singly or in groups meet recreational or esthetic goals. Even-aged management, primarily clearcutting, results in a mixture of species and is used where light-demanding species are a management objective (Leak and Wilson 1958).

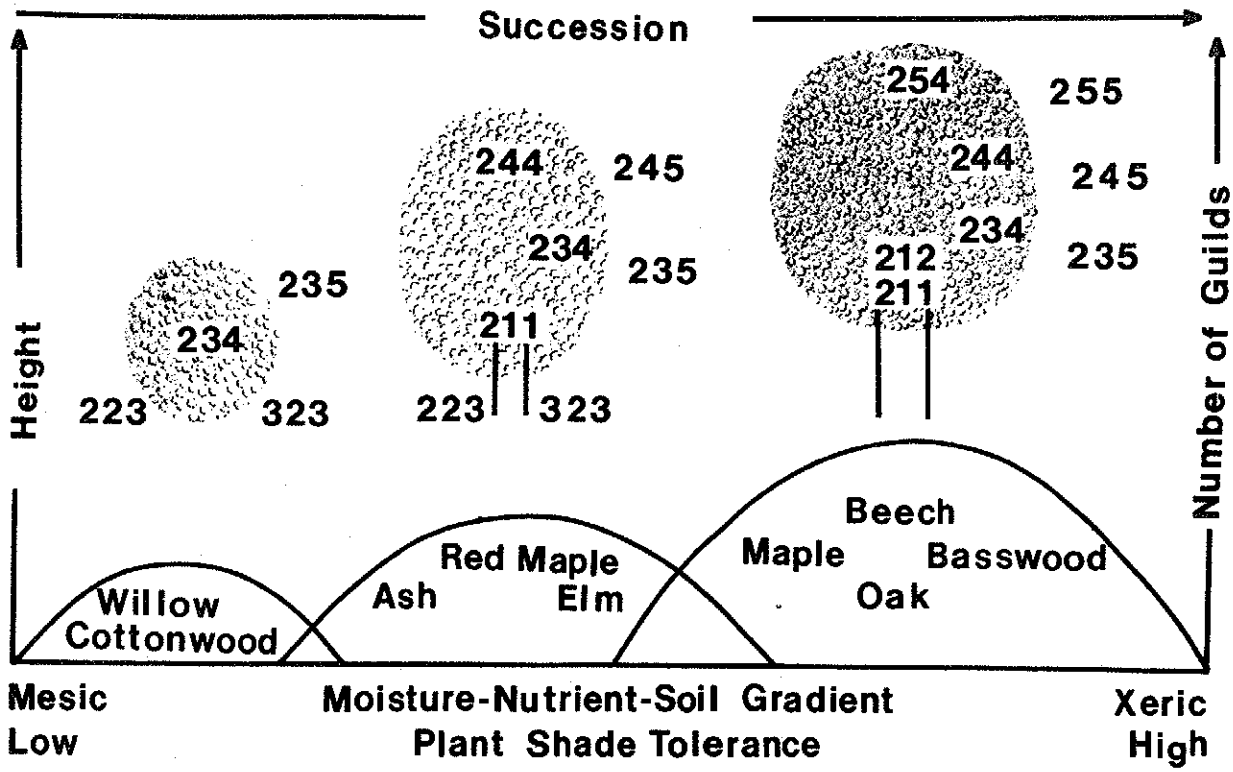

Figure 1.--Relationship of avian guild and forest succession in the lowland hardwoods in the northeast and north central states. Guild membership is listed in Table 3.

Information on shelterwood cutting in the northeast is lacking and its use is therefore limited (Filip and Leak 1973). Management guidelines for lowland hardwoods in the Appalachian oak area have recently been reported in detail by Hooper (1978).

Shade-intolerant species, particularly cottonwoods, but including sycamore and sweet gum, are being managed through clearcutting in Missouri and other southern states. The impact of these monocultures on wildlife is not clearly known, although their value appears less than that of natural diverse stands of lowland hardwoods.

BIRD POPULATIONS IN THE BREEDING SEASON

Species-area Relationships

Plant ecologists for many years have asserted that habitat size is a significant factor in determining numbers of plant species present (Gleason 1922, Cain and Castor 1959, Preston 1960, Greg-Smith 1969, and others). Numerous studies of terrestrial vertebrates on archipelagos or islands (Koopman 1958, MacArthur and Wilson 1967, Diamond 1969, Terborgh 1973, McNeil and Cody 1978, and others) have empirically verified that the number of species can be predicted by area and, in some instances, have discussed the area required for long-term survival of populations. A number of authors also have recently pointed out the usefulness of this concept in the design of wildlife or natural areas (Terborgh 1974, Diamond 1975, May 1975, Slayter 1975, Wilson and Willis 1975, Miller and Harris 1977, and others). Additionally, a number of investigators have provided evidence that size of an inland forest fragment or "island" can be used to predict the number of avian species present (Moore and Hooper 1975, Graber and Graber 1976, Galli et al. 1976, Gavareski 1976, Howe and Jones 1977, Tilghman 1977). Although this concept will be covered in detail elsewhere in these proceedings, two land-use implications are important in considering avian use of lowland hardwoods.

Figure 2 depicts a curvilinear relationship between size of a deciduous

Table 2. Response to flooding or shade and silvical options for major lowland hardwood species. (Response to flooding after: McDermott 1954, Hall and Smith 1955, Wistendahl 1958, Curtis 1959, Lindsey et al. 1961, Dickson et al. 1965, Rochow 1974, Brunk et al. 1975, Solomon 1977, Tesky and Hinckley 1978; silvical options after: USDA Forest Service 1973.)

Species	Response to flooding/shade	Silvical options
Boxelder (*Acer negundo*)	Tolerant/intermediate	
Red maple (*A. rubrum*)	Tolerant/intermediate	Selective, shelterwood
Silver maple (*A. saccharinum*	Tolerant/intermediate	Selective, shelterwood
Sugar maple (*A. saccharum*)	Intermediate/intermediate	Selective
Yellow birch (*Betula alleghaniensis*)	Intermediate/intermediate	Selective, shelterwood
River birch (*B. nigra*)	Intermediate/intermediate	Clearcut
Bitternut hickory (*Carya cordiformis*)	Intermediate/intermediate	Group selection
Pecan (*C. illinoensis*)	Intermediate/intermediate	Selection cutting
Shagbark hickories (*C.* spp.)	Intolerant/tolerant	Group selection
American beech (*Fagus grandifolia*)	Intolerant/tolerant	Selection cutting
White oak (*Quercus alba*)	Tolerant/intolerant	Group selection
Green ash (*Fraxinus pennsylvanica*)	Tolerant/intolerant	Selection cutting
Black ash (*F. nigra*)	Tolerant/intolerant	Selective, shelterwood
Black walnut (*Juglans nigra*)	Intolerant/tolerant	Selection cutting
Yellow poplar (*Liriodendron tulipifera*)	Intolerant/tolerant	Selection cutting
American sycamore (*Platanus occidentalis*)	Tolerant/intolerant	Clearcut
Eastern cottonwood (*Populus deltoides*)	Tolerant/intolerant	Clearcut
Swamp cottonwood (*P. heterophylla*)	Tolerant/intolerant	Clearcut
American elm (*Ulmus americana*)	Tolerant/intermediate	Selective,shelterwood
Basswood (*Tilia americana*)	Tolerant/intermediate	Selective
Sandbar willow (*Salix interior*)	Tolerant/intolerant	
Black willow (*S. nigra*)	Tolerant/intolerant	
Swamp white oak (*Quercus bicolor*)	Tolerant/intolerant	Group selection
White oak (*Q. alba*)	Intolerant/tolerant	Group selection
Northern red oak (*Q. rubra*)	Intolerant/tolerant	Group selection

forest fragment and number of avian species present in four different forest types. Thus, in order to maintain maximum regional avian diversity (as indicated by each curve in figure 2), top priority should emphasize identification and protection of large forests rather than an equal area of small forests (Forman *et al*. 1976). Second, there is a minimum point (similar to that defined by Goodall 1952, Cain and Castor 1959, and Greg-Smith 1969) on a species-area curve where a 5% increase in number of avian species would require a doubling in size of the forest fragments. Forman *et al*. (1976) suggested that this minimum point may be useful in size-related land-use decisions unless specific requirements for species that require even larger forest fragments must be met. Additionally, the configuration of the woodlot may be important; Stauffer (1978) reported a significant relationship between bird species richness and width of stream-side habitat.

Breeding Bird Populations--Precautions

The number of singing males either mapped or incorporated into an index is often the basis for estimating number of territorial males (Williams 1936, Enemar 1959, Robbins 1970) or as the focal point for evaluation of breeding habitat (James 1971, Shugart and James 1973, and others). Yet controversy in use of this technique remains. The interpretation of singing male data relative to the actual number of breeding males or to territorial function is complicated. In some species, song does not have a site-specific territory-related function (Thorpe 1958, Thompson 1960, Baptista 1972, Catchpole 1973, 1977, Marler and Mundinger 1975, Samson 1978, and others). Nor, has the role or function of song in a behavioral-ecological context been examined in detail for many avian species.

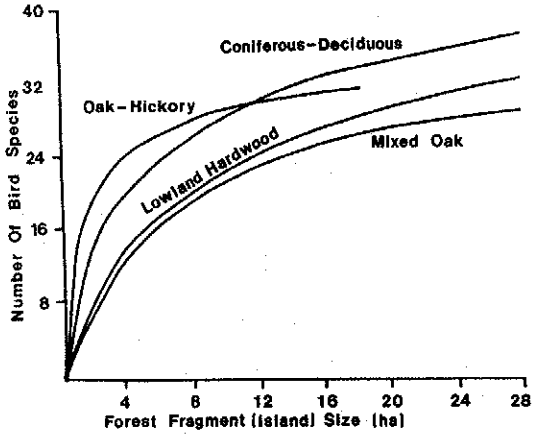

Figure 2.--Avian species--area relationships in four different continental forest habitats at mid-latitudes. Coniferous-deciduous after Moore and Hooper (1975), lowland hardwoods after Graber and Graber (1976), mixed oak after Galli et al. (1976), and oak-hickory after Tilghman (1977).

Additionally, as early as 1961, Thorpe, in an initial important review of avian vocalizations, pointed out that non-breeding males sing more often than breeding males. Studies of a diverse array of species including bobwhite, Colinus virginianus (Stoddard 1931), English robin, Erithacus rubecula (Lack 1946), song sparrow (Nice 1943), snow bunting, Plectrophenax nivalis (Tinbergen 1939), white-throated sparrow (Falls 1969), field sparrow (Best 1977), mourning dove (Baskett et al. 1978), fox sparrow (Martin 1978), prairie warbler, Dendroica discolor (Nolan 1978), and Cassin's finch, Carpodacus cassinii (Samson 1978) support Thorpe's contention. The potential bias of higher singing rates by non-breeding birds on estimates of breeding numbers is not precisely known, but it cannot be disregarded. Recent experimental studies of Orians (1961), Carrick (1963), Jenkins et al. (1963), Nolan (1963), Knapton and Krebs (1974), Power (1975), Samson (1976), and Thompson (1977) as well as "natural experiments" reported by Meunier (1960), Dixon (1963), Delieus (1965), Smith (1978), and others have all reported the existence of non-breeding birds, representing in one study upward to 67% of males present (Best 1975). Thus, considerable caution must be exercised when relating number of singing males to the concept of territory, to number of breeding birds, and to the analysis of breeding habitat.

A final consideration is the effect of events of the non-breeding season on subsequent densities of a breeding population. Lack (1966) argued that annual changes in breeding numbers of birds, both annual residents and migrants, reflected food-related mortality from early fall through winter. Supporting data for parids provided by Lack correlated breeding numbers which changed from year to year to fall mast production, particularly of beech. Subsequent studies by Newton (1964), Fretwell (1969, 1972), Pulliam and Enders (1971), Krebs (1971), Davis (1973), Samson (1976, 1978), Slagsvold (1975), Jones and Ward (1976), and others all support the contention that size of a breeding population reflects or is influenced by the events of the non-breeding season.

Guild-habitat Associations

The analysis of avian communities in different localities has provided insight into concepts of ecological equivalence as well as the association with habitat parameters including the vertical foliage structure (MacArthur and MacArthur 1961), successional stage (Karr 1968, Shugart and James 1973), foliage volume (Willson 1974), horizontal heterogeneity (Roth 1976), and a moisture gradient (Smith 1977). These studies have used a diversity index approach to relate the structure of an avian community to habitat or a multivariate statistical approach to describe avian species or family habitat needs. However, Maguire (1973) and Willson (1974) suggest a detailed analysis of guilds and resource availability may be necessary to clarify the impact of vegetational complexity on avian diversity.

A guild may be defined as "a group of species that exploit the same class of environmental resources in a similar way... without regard to taxonomic position" (Root 1967:335). Advantages of the use of guilds include directing attention toward all species regardless of taxonomic similarity, defining which set of conditions are necessary for a species or group of species to exist in a habitat type, and comparing communities where it is impractical to consider all species using an ecotype. This last advantage of the use of a guild approach is particularly important in

Table 3. Feeding guild and territorial males per 20 ha (raptors and wading birds excluded). Guilds are characterized by a 3-digit (ABC) number where: A = primary food habits (1) seedeater, (2) insectivore, or (3) omnivore; B = stratum most often used for foraging (1) bark, (2) ground, (3) low, (4) middle, or (5) high canopy; and C = common foraging behavior (1) bark drill, (2) bark glean, (3) ground glean, (4) foliage glean, (5) sally, or (6) fruit or buds (after Willson 1974). Number of territorial males are from the thirty-ninth and fortieth breeding bird census (Van Velzen 1975, 1977).

Species	Guild	Number of territorial males per 20 ha habitat, and state
Mourning dove (Zenaida macroura)	123	0.6, mixed mesophytic, OH
Yellow-billed cuckoo (Coccyzus americanus)	244	1.4, beech-oak, OH
Black-billed cuckoo (C. erythrophthalmus)	244	0.2, mixed mesophytic, OH
Common flicker (Colaptes auratus)	323	2.4, ash-basswood, NY
Pileated woodpecker (Dryocopus pileatus)	211	2.4, ash-basswood, NY
Red-bellied woodpecker (Centurus carolinus)	211	7.7, hickory-ash, oak, MO
Red-headed woodpecker (Melanerpes erythrocephalus)	211	4.2, mixed hardwood, MI
Yellow-bellied sapsucker (Sphyrapicus varius)	211	2.8, oak-hickory, OH
Hairy woodpecker (Picoides villosus)	211	1.8, birch-basswood, PA
Downy woodpecker (P. pubescens)	211	1.8, birch-basswood, PA
Great crested flycatcher (Myiarchus crinitus)	255	9.8, red maple-birch, NY
Eastern phoebe (Sayornis phoebe)	235	2.9, birch-maple, CT
Acadian flycatcher (Empidonax virescens)	235	10.9, birch-basswood, PA
Alder flycatcher (E. alnorum)	235	2.3, shrub, NY
Least flycatcher (E. minimus)	235	4.9, ash-basswood, NY
Eastern wood pewee (Contopus virens)	245	27.1, ash basswood, NY
Tree swallow (Iridoprocne bicolor)	234	1.9, maple-pine, ME
Blue jay (Cyanocitta cristata)	334	2.5, ash-maple, NY
Common crow (Corvus brachyrhynchos)	323	2.0, second growth hardwoods, CT
Black-capped chickadee (Parus atricapillus)	244	12.3, ash-basswood, NY
Carolina chickadee (P. carolinensis)	244	7.3, hickory-ash-oak, MD
Tufted titmouse (P. bicolor)	244	5.4, birch-basswood, PA
White-breasted nuthatch (Sitta carolinensis)	212	1.8, birch-basswood, PA
Red-breasted nuthatch (S. canadensis)	212	0.2, mixed mesophytic, PA
Brown creeper (Certhia familiaris)	212	1.8, birch-basswood, PA
House wren (Troglodytes aedon)	234	22.2, ash-basswood, NY
Winter wren (T. troglodytes)	234	0.1, mixed upland, NY
Carolina wren (Thryothorus ludovicianus)	234	3.6, birch-basswood, PA
Gray catbird (Dumetella carolinensis)	234	2.5, ash-basswood, NY
Brown thrasher (Toxostoma rufum)	323	0.7, upland-swamp, MA
American robin (Turdus migratorius)	323	20.0, ash-basswood, NY
Wood thrush (Hylocichla mustelina)	323	20.0, ash-basswood, NY
Hermit thrush (Catharus guttata)	323	3.8, maple-pine, ME
Veery (C. fuscescens)	323	20.0, ash-basswood, NY
Eastern bluebird (Sialia sialis)	335	4.6, red maple, NY
Blue-gray gnatcatcher (Polioptila caerulea)	235	4.8, birch-basswood, PA
Cedar waxwing (Bombycilla cedrorum)	146	2.4, ash-basswood, NY
White-eyed vireo (Vireo griseus)	234	5.0 birch-oak, WV
Yellow-throated vireo (V. flavifrons)	254	6.6, birch-oak, WV
Red-eyed vireo (V. olivaceaus)	254	12.3, ash-basswood, NY
Warbling vireo (V. gilvus)	244	14.8, ash-basswood, NY
Prothonotary warbler (Protonotaria citrea)	234	2.6, flood plain forest, MD
Swainson's warbler (Limnothlypis swainsonii)	234	
Northern parula warbler (Parula americana)	244	1.2, birch-basswood, PA
Yellow warbler (Dendroica petechia)	234	29.6, red maple-birch, NY
Black-throated blue warbler (D. caerulescens)	234	1.3, deciduous-coniferous, VT
Cerulean warbler (D. cerulea)	254	4.8, birch-basswood, PA
Chestnut-sided warbler (D. pensylvanica)	234	4.0, second growth hardwood, CT
Ovenbird (Seiurus aurocapillus)	323	4.9, red maple-birch, NY
Northern waterthrush (S. noveboracensis)	323	3.1, red maple-pine, NY
Louisiana waterthrush (S. motacilla)	223	2.4, birch-basswood, PA
Kentucky warbler (Oporornis formosus)	234	3.6, streamside, PA
Common yellowthroat (Geothlypis trichas)	234	17.3, red maple-birch, NY

Table 3.--Continued

Species	Guild	Number of territorial males per 20 ha habitat, and state
Yellow-breasted chat (Icteria virens)	244	26.6, brushy hillside, WV
Mourning warbler (O. philadelphia)	234	25.9, ash-basswood, NY
Hooded warbler (Wilsonia citrina)	234	0.5, hickory-oak, MD
Wilson's warbler (W. pusilla)	233	
American redstart (Setophaga ruticilla)	245	19.7, ash-basswood, NY
Common grackle (Quiscalus quiscula)	323	17.3, red maple-birch, NY
Brown-headed cowbird (Molothrus ater)	323	5.3, hickory-ash-oak, MO
Northern oriole (Icterus galbula)	344	22.2, ash-basswood, NY
Scarlet tanager (Piranga olivacea)	254	0.6, mixed mesophytic, OH
Cardinal (Cardinalis cardinalis)	334	4.9, ash-basswood, NY
Rose-breasted grosbeak (Pheucticus ludovicianus)	346	2.5, red maple-birch, NY
Indigo bunting (Passerina cyanea)	344	4.9, ash-basswood, NY
Rufous-sided towhee (Pipilo erythtophthalmus)	344	12.3, ash-basswood, NY
Chipping sparrow (Spizella passerina)	334	7.4, ash-basswood, NY
Field sparrow (S. pusilla)	334	1.3, upland forest, NY
White-throated sparrow (Zonotrichia albicollis)	334	14.8, red maple-birch, NY
Lincoln sparrow (Melospiza lincolnii)	334	
Swamp sparrow (M. georgiana)	334	4.1, swamp forest, IN
Song sparrow (M. melodia)	334	14.8, red maple-birch, NY

Nesting densities in lowland forests also may exceed other habitats. Examples include 211 singing males per 40.4 ha in a Maryland hickory-oak-ash flood plain forest and 488 per 40.4 ha in a mature deciduous flood plain forest versus 162 per 40.4 ha and 108 per 40.4 ha in an upland oak-hickory forest and upland tulip tree-oak forest respectively in northern Virginia (Van Velzen 1975, 1977). In Pennsylvania, 255 singing males per 40.4 ha were reported in a stream valley-mixed mesophytic forest compared to 163 males per 40.4 ha on a mountain oak-maple forest (Van Velzen 1975, 1977). Carter (1967), Tramer (1969), Blem and Blem (1975), Whitcomb (1977) and Stauffer (1978) also have reported increases in density of breeding birds from herbaceous habitats, to upland, to flood plain habitats.

Nesting Habitat

Although habitat selection by singing males has been examined in several habitats, few published reports describe nest site selection or habitat factors that affect success of open nesters in lowland hardwoods (Stauffer 1978). It also is difficult to characterize habitat in detail for some ubiquitous species (cardinal, American redstart, common crow, and Carolina wren). Additionally, reported habitat use of a species varies from locale to locale. For example, the blue-gray gnatcatcher may prefer a close-canopy forest with little understory (Anderson and Shugart 1974) or may be a habitat generalist (Root 1967, James 1971) rose-breasted grosbeaks may nest in flood plain habitats (Stauffer 1978) or in xeric upland forests (Bond 1957).

For many species, however, the foraging guild encompasses the preferred nesting habitat. The yellow warbler (234), common yellowthroat (234), alder flycatcher (235), Louisiana waterthrush (223), fox sparrow (334), Lincoln sparrow (334), and rufous-sided towhee (334) nest in low shrub willow-bushy areas (Graber et al. 1974, Shugart and James 1974). As a tree layer-edge develops, the kingbird (243), black-billed cuckoo (244), parula warbler (244), gray catbird (234), and indigo bunting (344) nest in areas with a variety of life forms including a shrub-stratum, areas of dense saplings, but a poorly-developed canopy. As the forest becomes more xeric or upland in character, nests are found of the bluejay (334), eastern wood pewee (245), brown thrasher (323), yellow-billed cuckoo (244), warbling vireo (244), and northern oriole (344) (Johnston 1947, Johnston and Odum 1956 and others). In tall mature forests, the yellow-throated vireo (254), red-eyed vireo (254), cerulean warbler (254), and yellow-throated warbler (254) nest. Table 3 lists examples of the number of singing males adjusted to individuals per 20 ha for most nesting species found in lowland hardwoods.

BIRD POPULATIONS IN WINTER

Annual residents in lowland hardwoods include the pileated woodpecker, red-bellied woodpecker, yellow-bellied sapsucker, hairy woodpecker, downy woodpecker, white-breasted nuthatch, common flicker, common crow, black-capped chickadee, Carolina chickadee, tufted titmouse, cardinal, and blue jay. Winter woodland residents exclusive of raptors and wading birds, include large flocks of red-winged blackbirds and common grackles which roost in lowland hardwoods, brown creeper, white-throated sparrow, fox sparrow, song sparrow, golden-crowned kinglets, and ruby-crowned kinglets. Some flocks of the pine siskin, purple finch, evening grosbeak, and pine grosbeak also may use lowland forests.

Very little is known of the habitat or energetic requirements of nongame birds in winter. Willson (1970) and Grubb (1975, 1977) have reported the foraging behavior of the white-breasted nuthatch, tufted titmouse, and Carolina chickadee and other species to be influenced by decreased solar radiation, wind velocity, and low temperatures. A pronounced example is the movement of foraging tufted titmice and Carolina chickadees from wooded areas to an old field when temperatures dropped to -20.0 to -29.9 C. The importance of thermal "refuges" such as grape vine thickets or blackberry-hawthorne thickets for these and other species cannot be overemphasized, and additional research on their use is needed. Although some evidence does show that winter movement of song birds, particularly some finches, is influenced by food supply (Bock and Lepthien 1976, Middleton 1977), further research is needed. It is known that artificial feeding (i.e., at winter feeders) can accelerate the onset of breeding (Kallander 1974) to the possible detriment of the species, and the overall effect of food supply and habitat condition in winter-early spring on the density and distribution of breeding songbirds is not clearly known (Knapton and Krebs 1974, Slagsvold 1975).

MANAGEMENT RECOMMENDATIONS AND RESEARCH NEEDS

As in the southeast (Dickson 1978) and west (Johnson and Jones 1977), a major threat to avian species is loss of lowland or stream-riverside habitat through conversion to agriculture, stream channelization, and reservoirs. For example, George (1971) pointed out that 8 of 16 birds that no longer breed in Illinois were residents of the Mississippi River flood plain. The passenger pigeon (Ectopistes migratrius) and Carolina parakeet (Conuropsis carolinensis) are extinct species whose decline in part reflects forest clearing (George 1911, McKinney 1960, Walley 1966). The ivory-billed woodpecker (Compephilus principalis), most certainly extinct in the midwest, and the Bachman's warbler (Vernivora bachmanii), an endangered species, may also have declined as lowland forests and swamps disappeared (Chapman 1932, Tanner 1942). On state endangered species lists, 8 birds in Illinois, 3 in Indiana, 7 in Iowa, 9 in Missouri and New York, 6 in Wisconsin, and 3 in Vermont are associated with lowland hardwoods.

In the management of lowland hardwoods, management or compartment unit size decisions should consider the species-area relationship. As Graber and Graber (1976) point out, this concept may be used in the decision-making process for land acquisition and has been useful in Great Britain (Moore and Hooper 1975) in making recommendations for lands under private ownership. However, this concept assumes a large area will include numerous microhabitats (accounting for more species being represented), but this may not be true. Specific requirements, e.g., cane for Swainson's warbler, mud banks for the kingfisher and bank swallow, bluffs (road-cuts) for the rough-winged swallow, and snags for primary excavators (woodpeckers) and secondary holes (titmouse and others) need to be considered. Conner (1978) has pointed out that many trees selected by primary cavity-nesters are infected by a fungal heart rot or other species of fungi. These trees as well as dead trees or snags should be maintained for both potential nest sites and as a foraging stratum for many species as discussed elsewhere in these proceedings. Additionally, area alone does not predict number of avian species present in some habitats or locales (Johnson 1975, Power 1976, Abbott and Grant 1976) and, although promising in management of lowland hardwoods, future empirical evidence is needed.

Under natural conditions, flood activity and soil erosion will create a natural diversity of the species and age classes. Management of lowland hardwoods characteristic of middle and late successional stage by individual or group selection will result in an interspersion of the species and age classes. Clearcutting should be avoided for these successional stages where limited blocks of clearcuts may be beneficial. In contrast to walnut, basswood, and some other species characteristic of mature forests, the commercial value of willow is negligible. Thus, mechanical treatment, or other approaches may be necessary to regenerate brushy thickets characteristic of early successional stages where natural flooding or erosion are ineffective. However, the

conversion of large, uneven-aged stands of hardwoods to plantation plantings of cottonwood, sweetgum or sycamore has at least in the southeast reduced avian use and diversity (Wesley et al. 1976) and therefore should be avoided.

Few published reports describe avian habitat needs in north central and northeast lowland hardwoods in contrast to upland or grassland areas (Wiens 1969, Shugart and James 1973, and others). Studies involving both the breeding and non-breeding season similar to Dickson and Noble (1978) would provide a useful basis to approach other information including habitat characteristics important to nest site selection and nest success. Census techniques employed in these studies should clearly recognize behavioral and ecological problems associated with the interpretation of singing of non-breeding and breeding males. There also is a clear need to establish a mathematical framework for these techniques. For example, of available current techniques, Burnham and Anderson (1976:334, 335) point out "Emlen's approach is not mathematical" (Emlen 1971), but improvements in this and other techniques are becoming available (Kovner and Patil 1974, Burnham and Anderson 1976, and others). Additionally, most studies on the effect of forest management practices have emphasized clearcutting rather than individual or group selection cutting (Adams and Barrett 1976, Whitcomb et al. 1977). Because of the importance of those silvicultural practices in management of lowland hardwoods, their effects on breeding and wintering avian populations should be investigated in depth.

Fretwell (1978:3) has recently commented that "the embarrassing thing about being an avian population ecologist in America today is the distance that separates us from our European counterparts." Fretwell's criticism is directed toward the frequent use of the assumption that birds compete for food during the breeding season to support niche diversification and breeding bird diversity studies. As he emphasizes, this assumption is largely untested, and long term studies to support or refute the assumption are lacking in America. Nor do forthcoming long term studies in Europe provide support. Many European workers, however, have long contended that fall-winter food is the factor limiting population size. Yet, in America, few studies have emphasized resource needs (food or habitat) of forest-dwelling birds overwintering in middle or low latitudes. Considering these important information needs, research on resource needs of nongame birds in the non-breeding season should be emphasized in forthcoming years.

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