TECHNICAL GUIDE TO
Forest Wildlife Habitat Management
IN NEW ENGLAND

Richard M. DeGraaf
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TO JOHN W. LANIER,

former forest biologist, White Mountain National Forest, and habitat biologist, New Hampshire Fish and Game Department, who first expressed the need for a comprehensive forest wildlife habitat management guide for New England, and who encouraged us toward that end.

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PREFACE

Forest wildlife populations and their habitats in New England are products of the land — its condition after centuries of human use and natural processes. Conditions are never static; they are changing continually in response to disturbance and succession. Habitats for all species once were provided continuously by wind, fire, and other disturbances. Native prairies, shrublands, forests opened by burns and blowdowns, and subsequent forest regrowth provided habitats for a diverse New England fauna in a shifting mosaic across the landscape. This is no longer the case. Development of historically open habitats, fire control, and the decline of agriculture have changed the landscape dramatically. Today in much of New England, forests are mature and largely unmanaged. Wildlife species associated with mature forests — fisher and pileated woodpecker, for example — have become common. Species associated with old fields, brushlands, and young forests — field sparrows, eastern towhees, and New England cottontails, among many others — have declined precipitously as their habitats have been developed or have reverted to forest. This volume is a compilation of forest management practices that are now necessary for creating a range of forest habitat conditions to maintain or enhance forest wildlife diversity in the region.

This book is a complete revision of R. M. DeGraaf, M. Yamasaki, W. B. Leak, and J. W. Lanier's *New England Wildlife: Management of Forested Habitats* (Radnor, Pa.: USDA Forest Service, Northeastern Forest Experiment Station, 1992). That volume was the first reference to provide foresters and habitat biologists a compilation of forestry practices to manage forests — primarily on public lands — for wildlife diversity. It was based on the habitat associations of the 338 inland New England wildlife species as presented in R. M. DeGraaf and D. D. Rudis's *New England Wildlife: Habitat, Natural History, and Distribution* (Broomall, Pa: USDA Forest Service, 1986), which was used widely by foresters and other land managers. This book was necessitated by a complete revision of DeGraaf and Rudis's 1986 work by R. M. DeGraaf and M. Yamasaki in 2001 (*New England Wildlife: Habitat, Natural History, and Distribution*. Hanover, N.H.: University Press of New England), which reflected the most recent published research on the habitat relationships of the amphibians, reptiles, birds, and mammals of New England. This volume presents silvicultural options for six forest cover-type groups to provide the forest conditions that will enhance wildlife diversity in the region, if implemented. It also will help address the recent, alarming declines of early-successional species, many of

which would benefit from forest management. It is written for professional foresters and other natural resource managers concerned with wildlife habitat management. Traditionally, forest wildlife habitat management on private land is the responsibility of the landowner; on public lands, it resides with the administering agency. More than 90 percent of the forestland in New England is privately owned; the fate of forest wildlife habitat conditions lies with approximately a half-million landowners using a variety of public and private consulting services. Fortunately, most landowners have a high regard for and interest in wildlife on their land and will do what they perceive is the "right thing." Too often this perception has led them to refrain from management, to preserve the forest and "let nature take its course," with the result that wildlife diversity declines. This book is intended to help professional foresters meet landowner goals to enhance wildlife habitat quality and diversity through the application of silviculture.

The supporting matrix of species/habitat relationship uses the forest cover-type classification based upon *Forest Cover Types of the United States and Canada* (F. H. Eyre, editor, Washington, D.C.: Society of American Foresters, 1980). The matrix of upland and nonforest habitat relationships contains the full range of such habitats in New England. The upland habitat types are based on descriptions in *Land Resources in New Hampshire* (Durham, N.H.: U.S. Department of Agriculture, Soil Conservation Service, 1982). The wetland habitat types are based on *Classification of Wetlands and Deepwater Habitats of the United States* (L. M. Cowardin, V. Carter, F. C. Golet, and E. T. LaRoe, Washington, D.C.: U.S. Dept. of the Interior, 1979).

We describe the potential responses of amphibians, reptiles, birds, and mammals to silviculture in New England. We emphasize the word *potential*, for there is great variety in species abundances and local occurrences. This publication lists the amphibians, reptiles, birds, and mammals potentially occurring in a given habitat. More species are listed than likely will occur—the smaller the area of concern, the fewer the species that actually will occur of those potentially able to occur. Factors other than habitat features affect a given species occurrence on a given area. This effect diminishes with increasing area of consideration. Species occurrence can be predicted more accurately with larger units of land. Larger areas contain more special habitat features, more habitat interspersion and successional stages of forest growth, and hence more species diversity than do smaller areas. We have provided a local occurrence column in the Appendixes for users to check species that apply to their area of concern. Scientific names of extant vertebrate species are provided in the matrices; those extirpated or extinct species are in the text, as are those of the plant species, and those vertebrate species not found in the New England region.

Forests and woodlots dominate the New England landscape; they have been important cultural and economic resources since colonial times. Most New England woodlands are privately owned—only 6 percent of the forest is in public ownership (Irland 1982). Public lands generally are managed more intensively than are most private holdings, except for the industrial forest lands in Maine. In the rest of the region, the fate of New England's wildlife lies

with private landowners. A companion book, *Landowner's Guide to Wildlife Habitat: Forest Management for the New England Region* by R. M. DeGraaf, M. Yamasaki, W. B. Leak, and A. M. Lester (Hanover, NH: University Press of New England, 2005), provides forest landowners with the basics of forest management and wildlife habitat needs. Those who read it should be fully prepared to talk with professional foresters as they manage their lands with wildlife habitats in mind.

No modern landscape condition is intrinsically ideal or "natural"; we shape the land and our actions or inactions determine which species thrive and which decline. Once abundant in New England, early successional species are now in decline, victims of benign neglect as their habitats revert to forest. Acceptance of such change as "natural" will eliminate many such species from the region. Active vegetation management, of which silviculture is a major part, is needed more than ever to maintain New England's wildlife diversity.

We hope that the habitat management options provided here encourage landowners and professionals alike to think about the opportunities to improve wildlife habitat conditions in the increasingly human-influenced New England landscape. Providing a broad range of habitats for New England's wildlife requires active land management, not further reductions in vegetation management across the landscape.

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Technical Guide to Forest Wildlife Habitat Management in New England

Introduction

Historical Perspective

NOW MOSTLY FORESTED, the New England landscape has changed dramatically over the last 350 years. Once substantially covered by forests, especially in the interior, the land was cleared for agriculture, slowly until the mid-eighteenth century, then at an increased pace until, between 1820 and 1840, 75 percent or more of the arable land in southern and central New England was in crops and pasture (Raup 1966). Even at the peak of clearing, forests still covered about 58 percent of New England as a whole (Irland 1982, 2). Individual states varied considerably: 27 percent of Connecticut, 35 percent of Vermont, 40 percent of Massachusetts, 50 percent of New Hampshire, and 79 percent of Maine remained forested (Harper 1918). Woodlots were maintained for fuel, albeit with small-diameter trees. Large, old trees, especially oaks (*Quercus* spp.) and hickories (*Carya* spp.), were removed selectively; the sprouting of these trees after cutting perpetuated the farm "sprout lot" in which trees rarely grew older than thirty years (Irland 1982, 59). For example, 95 percent of the hardwood forest in Litchfield County, Connecticut, was less than forty-one years old by 1909 (Irland 1982, 59). Mast crops for wildlife surely were meager. One hundred years later, New England was again mostly forested— the result of an era of farm abandonment that began in 1825 with the opening of the Erie Canal and the growth of industrial cities. With few takers for the abandoned farms, the land reverted to forest, now gridded by thousands of miles of stone walls.

From about 1880 to the 1940s, farming in New England continued its slow but steady decline. Just after the turn of the twentieth century, the cutting of white pine (*Pinus strobus*) that had seeded into the abandoned fields and dry pastures constituted the last major land clearing in southern and central New England. Once cut, most sites grew up to hardwoods that, variously used, abused, picked over, or ignored, now constitute the mature forests we see today. In northern New England, clearing for agriculture was less prevalent

than in the southern New England states; about one-half of New Hampshire was cleared for farming by the mid-1800s. The major forest disturbance in northern New England was intensive logging followed by extensive slash fires. Softwood stands containing spruce (*Picea* spp.), pine (*Pinus* spp.), and fir (*Abies* spp.) generally were clearcut; the subsequent stands commonly supported a high proportion of hardwoods such as aspen (*Populus* spp.), and paper and yellow birch (*Betula papyrifera* and *B. alleghaniensis*). Hardwood stands, on the other hand, often were partially cut, removing small groups of softwoods and the best hardwood stems, although some stands were cut more heavily to provide fuelwood for steam engines or to make removal of softwoods easier. In the mountainous areas of New Hampshire, railroad logging of hardwoods was the rule, while river drives were the common form of softwood transport in Maine. The most intensive logging activity was during the mid-1800s up through the early 1900s; the last logging railroad in New Hampshire closed in the 1940s. The result has been a mosaic of hardwood/mixedwood stands about one hundred years old, patches of old, uneven-aged hardwoods, and a lower proportion of softwoods than was present in pre-colonial times.

Since about 1950, agriculture, especially dairy farming, has declined dramatically, supplanted by suburban development in southern New England (figure 1). Forests and woodlands have come to be viewed by many New Englanders as a "green backdrop" rather than a source of wood products (Irland 1982). Recreational development and the second-home market beginning in the 1960s and 1970s brought many suburban New Englanders — commonly unfamiliar with forest management — into more rural areas where timber harvesting and hunting were accepted and regarded as economically important activities. Land posting increased and timber harvesting decreased in many areas.

Patterns of wood use have changed over the centuries in New England. Fuelwood was the dominant use from colonial times. The replacement of fireplaces by cast-iron stoves in the early nineteenth century and the introduction of coal in southern New England cities by mid-century dramatically decreased the use of wood for heating and cooking fuel. A typical house in colonial southern New England used thirty or more cords per year; by 1846 use declined to thirteen or fourteen cords (Emerson 1846, 15), and was less than seven cords by 1888 (Blake 1888, 77). Population growth offset fuelwood use but total consumption declined by half from the 1870s to 1910 (Reynolds and Pierson 1942). Charcoal was an important forest product throughout southern New England in the nineteenth century and continued on a small scale through the 1940s. Wood use for paper pulp did not exceed fuelwood use until 1880; timber and pulpwood cutting traditionally have been important in northern New England, although timber output has risen and fallen since its peak in 1909 (Irland 1982).

Currently, there are markets in New England and adjacent states for a very wide range of tree species and qualities: pulpwood, fuelwood, and biomass chips at the lower price range to softwood sawlogs and hardwood sawtimber and veneer at the mid- to upper range. Although markets and prices vary

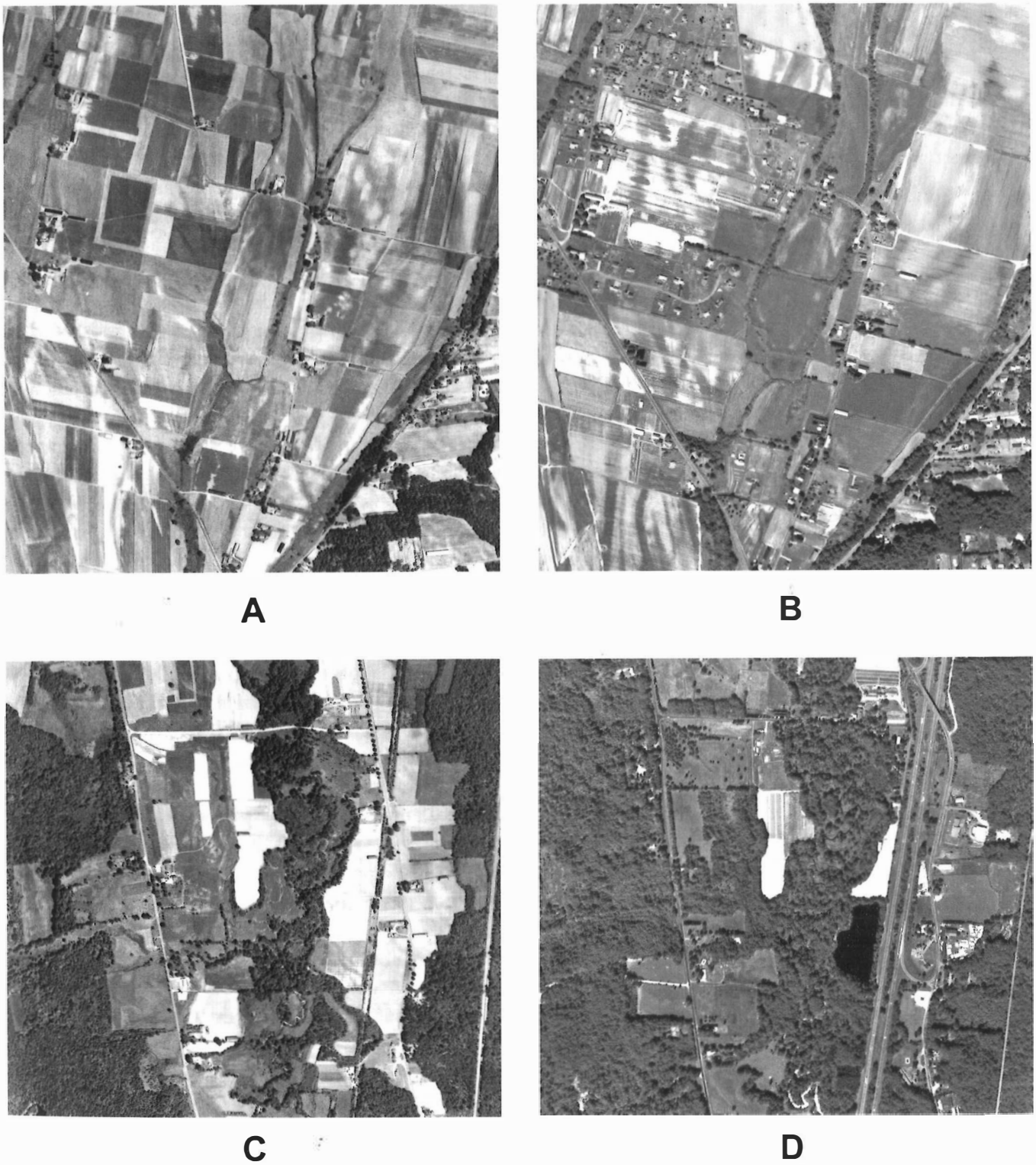


Fig. 1. Land use change in Sunderland, Massachusetts, 1952 to 1999. Photos A and B show residential development of agricultural land; C and D show forest reclaiming abandoned agricultural land. The 1952 photos are from the U.S. Dept. of Agriculture, Soil Conservation Service (now Natural Resource Conservation Service); the 1999 photos are courtesy of the Department of Natural Resources Conservation, University of Massachusetts.

markedly, there are better opportunities than ever before to make commercial timber sales on even small forest properties. On the other hand, careful attention needs to be given to retaining adequate numbers of trees with wildlife habitat potential: cavity trees, snags, and softwood or hardwood inclusions.

Fuelwood cutting in the mid-1970s caused an increase in wood harvesting, especially in southern New England, and exposed many New Englanders to the value of forest products and the need for forest management. For many, it marked a change in attitude toward forests from one of protection or neglect to one of use and management. Recent increases in fuelwood use in the form of chips to generate electricity in northern New England may play an even larger part in forest product use in the near future. Biomass harvesting to produce chips entails complete utilization of all tree species and sizes. The utilization of wood chips to generate electricity in northern New England provides markets for even the smallest, lowest-quality trees of almost any species. The future of this market outlet is somewhat uncertain, but there is a decided sentiment for utilizing wood in addition to oil and coal for power generation.

Changes in wildlife populations have accompanied changes in land use as habitat conditions changed over time. Some species were extirpated for a time, others have extended their ranges into New England, and several others are still extirpated or extinct. Predators of livestock—wolves and mountain lions—were hunted and trapped intensively since earliest settlement. Other species retreated as the forest was cleared for agriculture; black bear, white-tailed deer, and wild turkey had disappeared from much of their former range by the mid-nineteenth century. The heath hen (*Tympanuchus c. cupido*)—the eastern race of the greater prairie chicken (Gross 1932)—and the passenger pigeon (*Ectopistes migratorius*) (Ellsworth and McComb 2003) became extinct largely through habitat alteration, though both were hunted heavily for food. Shortly after the peak of agriculture, vesper sparrows were the most abundant sparrow and chestnut-sided warblers the most abundant warbler in southern New Hampshire (Goodhue 1877). Today, the vesper sparrow is one of the rarest sparrows in New Hampshire. Wood thrushes, now common, were not reported in summer in New Hampshire until 1894 (Elkins 1957). Perhaps no species better reflects forest maturity than the pileated woodpecker: virtually absent from New England in the 1920s, it is now common throughout the region (figure 2).

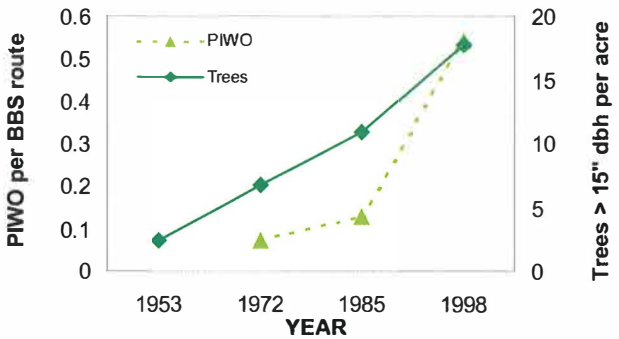


Fig. 2. Mean number of pileated woodpeckers (PIWO) detected per Breeding Bird Survey (BBS) route (n = 47 routes) in Massachusetts (Sauer et al. 2004) and number of trees per acre greater than 15 inches dbh in Massachusetts timberland in the last half-century (Alerich 2000b; Dickson and McAfee 1988; Peters and Bowers 1977; and U.S. Department of Agriculture 1956).

Most populations of woodland wildlife such as deer, ruffed grouse, and snowshoe hare returned with the reversion of the land to forest in the late nineteenth century. Wild turkeys were reintroduced using wild-trapped birds in the 1970s and are now thriving in all New England states, and fishers and eastern coyotes have become common in the last three decades.

Other dramatic changes are the range extensions of more southerly birds into New England and the declines of early-successional species. Cardinals, tufted titmice, mockingbirds, and recently, red-bellied woodpeckers—species that thrive in suburban habitats—have extended their ranges northward.

Most early-successional species, however, especially those that do not tolerate suburbanization — smooth green snakes, brown thrashers, towhees, and field sparrows, among many others — are declining dramatically as the remaining old fields revert to forest or undergo development.

Game, of course, had been long important as food; upland hunting in New England probably reached its zenith from the turn of the twentieth century to about 1940, during which time the young hardwood forest succeeded the cutover old-field pine, and supported populations of ruffed grouse that scarcely can be imagined now.

Today, in southern New England (Massachusetts, Connecticut, and Rhode Island), forest management usually involves uneven-aged practices — selection or group selection, though small clearcuts are common when white pine is harvested. In general, roughly 60 percent of southern New England is in hardwood and pine types, most in small, private holdings (Alerich 2000a, 2000b, and 2000c). Fuelwood and sawlogs are the major products. Habitat management for ruffed grouse and woodcock is practiced locally, primarily on private lands. In southern New England, public land management commonly includes maintenance of open habitats for stocked pheasants and for grassland and old-field species.

In northern New England, even-aged silvicultural practices are fairly common. A long history of local public acceptance of even-aged management prevails. About 80 percent of northern New England is in hardwood and conifer forests, much in small holdings. Sawlogs and pulpwood are major products; maple syrup is produced locally. Deer hunting is extensive, and the maintenance of deer yards is a major forest habitat concern.

The effects of landscape change have exerted longer-lasting effects on more species than did direct exploitation. Almost two centuries after the peak of agricultural clearing, the effects of forest regrowth are still occurring, as revealed by the decline of open-country species and the increase of forest species (figure 3). Population increases are more obvious than decreases; perhaps none are more obvious than those of moose and black bear. In the past thirty years, moose have extended their range from northern Maine southward to Massachusetts, with stragglers occurring in Connecticut, as they did at the time of European settlement (Morton 1637, Adams 1896). In the past twenty years, black bear have been increasing their range in much of New England and are now seen commonly in suburban areas.

New England's forests and woodlands, taken together, provide a wide array of habitats that still support virtually all the species present before European settlement. In much of the region, however, habitat diversity has declined in recent decades as forests have matured. Young forest and old-field habitats are disappearing. The net result is a change in the region's wildlife populations favoring mature forest species while early-successional ones are

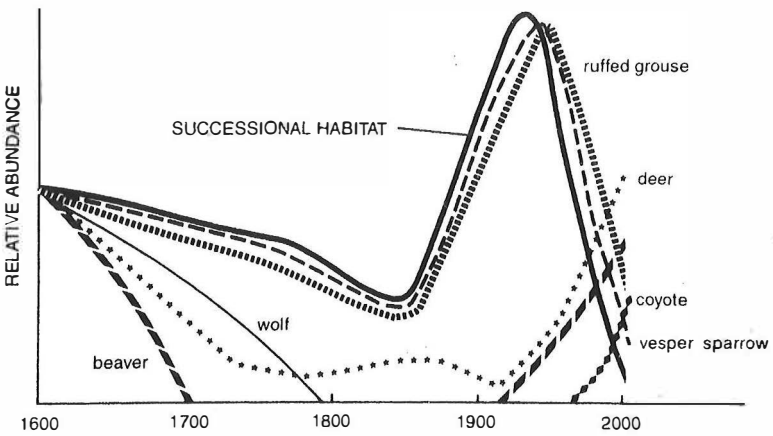


Fig. 3. Schematic depiction of historical changes in representative wildlife species and successional habitat in New England. Several factors are involved in the changes indicated. Wolf, beaver, and deer were persecuted from earliest settlement. Vesper sparrow and ruffed grouse responded to vegetation change with settlement and subsequent land abandonment. Deer and beaver recovered because of protection and reintroduction in the early twentieth century, while coyotes colonized the region independently. Note that the abundance of early-successional habitat gradually declined as Native American populations declined shortly after European contact. European settlers, penetrating interior southern New England a century or more later, encountered a more mature forest, once partly cleared by Native Americans and subsequently regrown. Modified from Bickford and Dymon (1990).

declining. Declines in wildlife diversity still can be reversed but active habitat management, starting now, is required.

Forest Disturbance

Four major types of disturbance have altered the New England landscape: fire, windthrow, agriculture, and logging. In addition, ice storms, insects, disease, drought, flood, landslide, and avalanche have caused minor disturbances.

Catastrophes from fire and windthrow occur at intervals of about 800 and 1,150 years, respectively, in northern New England (Lorimer 1977). However, localized disturbances—sometimes severe—occur at much shorter intervals. Major hurricanes are most common on the southern New England coast (Foster 1988a, 1988b). A severe hurricane in 1938 caused extensive damage from Rhode Island to central New Hampshire (figure 4). Several billion board feet of timber were blown down (Curtis 1943). Past human land use and the consequent widespread invasion of white pine on agricultural sites enhanced the forest change caused by the storm. White pine and other conifers are particularly susceptible to wind damage and the high proportion of these species on the landscape at that time was a major factor in the extensive damage to the central New England landscape (Rowlands 1941). The effect of the 1938 hurricane was influenced greatly by the structure, composition, and spatial distribution of forest vegetation that existed after two hundred years of agriculture and land abandonment (Foster and Boose 1992). Storms of similar magnitude occurred in 1635 and 1815 (Channing 1939) and occur, generally, at 150-year intervals. However, significant windthrow events—some approaching hurricane intensity—may occur at shorter intervals of perhaps every fifteen to thirty years (Curtis 1943). Although wind has a dramatic effect on forest overstories, it has little impact upon successional trends and overall species composition because of the presence of a tolerant understory and the

Fig. 4. In 1938, a massive hurricane swept through New England, blowing down trees on thousands of acres. Here is an example of the blowdown damage on the Bartlett Experimental Forest, in central New Hampshire. Photograph by USDA Forest Service.

aggressive nature of New England pioneer species. Wind has minimal effects upon soils except for some churning and mounding from uprooted trees.

Intense forest fires generally occur on dry sites: outwash sands and gravels, fractured or loose rock, or shallow-to-bedrock at high or low elevations. Generally, these sites support mixedwood or softwood types such as white pine, oak–pine, pitch pine (*Pinus rigida*), or spruce–fir. The impact of fire on forest conditions is more severe than that of wind. Pitch pine barrens occur on repeatedly burned areas that often were in white pine or oak–pine. Most bare-rock mountaintops in New England are the result of fire. Productivity of outwash and shallow-bedrock sites seems to be reduced by fire because of the destruction of organic matter. However, even very large, intense burns revegetate with surprising rapidity; the 7,600-acre Beddington Burn in Maine was 97 percent stocked with tree species and other vegetation five years after the 1952 burn (Mills 1961).

In addition to natural fire disasters, fire was used by Native Americans in New England to drive game for hunting, clear fields for planting, and open the forest for traveling (Cronon 1983; Spurr and Barnes 1973). There is no strong evidence, however, that Native Americans intentionally burned large forested areas frequently (Russell 1983). Most of the burning was done in the local vicinity of villages. Accidental fires resulted from signal fires or campfires that escaped control (Russell 1983). The use and frequency of fire varied throughout New England. Native Americans in southern New England used fire to cultivate the land and open the forest more than those in northern New England. They planted corn after burning around the bases of standing trees; fire destroyed the bark and eventually the trees died (Cronon 1983).

Only a few tracts in New England remain unlogged. Much of the logging (as opposed to land clearing in the 1700s) took place in the mid- to late 1800s when the best softwoods in mixedwood stands were high-graded and the softwood stands were clearcut. Until recently, the only hardwood stands that were cut heavily were those along railroads and those cleared for agriculture in the past. Logging was similar to windthrow in that it did not have an impact on successional pathways or soils. However, intense fires fueled by slash sometimes followed, especially in softwood stands on dry sites.

More than half of New England was cultivated or grazed in the past, though much of the area has reverted to forest. The effects of agriculture have been described: loss of nutrients, changes in soil profiles, and major cover-type conversions from hardwoods to spruce–fir in the north and from hardwoods to old-field white pine farther south (Bormann 1982). Old-field conditions will revert to natural forest vegetation in one or two rotations (Goodlett 1960).

In summary, agriculture had the greatest impact on the forested landscape in New England because it caused major changes in cover types and soils over a wide range of sites. Although fire lowered productivity of dry-site softwood stands, which reverted to earlier successional stages, fires did not cause major shifts from hardwood to softwood successional paths. Windthrow and logging maintained diversity by initiating earlier successional stages, but had little impact on the forest ecosystem.

Forest Fragmentation

The term "forest fragmentation" has been used to describe various removals of forest, or the forest overstory, in large or small patches, temporarily or permanently. We use the term in this book to mean permanent removal of forest due to development, roads, and other elements of urbanization, not temporary changes in stand ages due to forest management.

Forest fragmentation became a conservation concern in recent decades in response to the cutting of old-growth forests in the Pacific Northwest, which provided habitat for the endangered northern spotted owl (*Strix occidentalis*). Forest fragmentation concerns regarding migratory birds arose in the Midwest, where true forest fragments exist like oceanic "islands" in an agricultural "sea." Such small (50 acres or less), isolated patches were found to contain few breeding migratory bird species, especially those that winter in the Neotropics.

In rural New England, however, forests have reclaimed the landscape to a remarkable extent; millions of acres of former farmland are now covered by forest. The widespread increase of forest species such as fisher and moose exemplify the greatly improved habitat conditions for forest wildlife species in recent decades. Except for the urbanizing parts of several states, the region's forests have increased in extent and age yearly for over a century.

To what extent is forest fragmentation a wildlife habitat issue in New England today? New England contains no old-growth specialist species — it never did. Even-aged hardwood forests eighty to one hundred years old and uneven-aged mature forests have the same breeding bird compositions as forests 175 years old (DeGraaf 1991). Actually, forest wildlife species in New England and northeastern North America are remarkably tolerant of a wide range of forest overstory conditions. Forest birds are unaffected whether none, half, or all trees greater than 14 inches in diameter at breast height (dbh) are removed (Webb et al. 1977). Small mammals occur throughout New England forests regardless of cover type or size-class (DeGraaf et al. 1991). Among amphibians, terrestrial redback salamanders, common in mature forests, occur in sapling stands soon after timber harvest (DeGraaf and Yamasaki 2002). New England's forest species are adapted to a wide range of forest conditions; such adaptations have allowed them to persist in the landscape that has long been dynamic in response to wind and fire.

Permanent losses of forest to development and of early-successional habitats to both development and succession are far more serious wildlife habitat concerns than is ephemeral forest "fragmentation" due to management. Landscape conditions differ considerably in the region: most of northern New England is extensively forested, and much of southern New England is a suburban agricultural/forest landscape. Habitat management varies accordingly. Even-aged methods are more appropriate in extensively forested areas and uneven-aged methods more appropriate in more open landscapes. In either case, forest management is necessary to maintain or enhance wildlife diversity. Still, the effects of landscape fragmentation on wildlife are not linear; they vary greatly among species. As habitat patch size declines below certain

thresholds, forest birds such as ovenbirds and hairy woodpeckers and open country birds such as bobolinks cease to occur, even though their individual territories are small. At the same time, species with large home ranges such as black bear, moose, and fisher have been increasing in the face of increasing fragmentation. The factors that constitute barriers to species occurrence are species-specific and poorly known in some cases.

Invasive Plants

In many parts of southern New England, invasive exotic woody plants such as glossy buckthorn (*Frangula alnus*), Japanese barberry (*Berberis thunbergii*), multiflora rose (*Rosa multiflora),* and oriental bittersweet (*Celastrus orbiculatus*) are common, especially in field–forest ecotones and woodlots near former agricultural land. These plants are often well established and difficult to control. Some, such as multiflora rose and autumn olive (*Elaeagnus umbellata*), have high wildlife food and cover values. Their presence is not an obstacle to forest management. They rarely achieve densities that affect tree regeneration and they cannot be kept out of the forest by avoiding forest management. Where practiced or required, logging equipment can be washed thoroughly to prevent transporting roots to managed sites. In most forest management situations, invasive plants can be treated the same as native species—hay-scented fern (*Dennstaedtia punctilobula*), beech (*Fagus grandifolia*), and black birch (*Betula lenta*)—that in some cases are dense enough to prevent regeneration of desired tree species. Such cases commonly result from overbrowsing by overly abundant deer populations. Where deer are overabundant for extended periods, profound changes in forest structure and composition result. Mature stands subjected to intense browsing do not undergo normal succession; they do not pass from the stem exclusion phase to the understory re-initiation phase and so do not have adequate numbers of seedlings and saplings. This lack of understory development precludes the use of silviculture to regenerate new stands or age-classes within existing stands (Healy 1997). Such stands will develop into park-like or savanna conditions with herbaceous cover and shrubs that are both unpalatable to deer if deer numbers are not reduced. Last, such stands will be prevented from maturing into an old-growth condition if such were desired (Oliver and Larson 1990, 153). Where deer levels reach overabundance, they produce forest changes that affect many other wildlife species, for example, shrub-nesting birds and thicket-dwellers such as New England cottontails, and so pose more severe forest and wildlife concerns than do most invasive plant species.

In most cases, the proportion of both exotic and native invasive species can be controlled silviculturally to regenerate desired species. In some cases herbicides may need to be applied. Invasive plants should not be planted or maintained, rather they should be removed where possible. We do need to keep them in perspective if we are to maintain productive working forests and a diverse array of wildlife habitats on the landscape. Treating forests as

somehow at risk of being degraded by invasive plants if managed will only lead to development or land conversion and then all habitat values are lost.

Forest Regions

There are more than 30.6 million acres of commercial forestland in New England today (Smith et al. 2004), and forests cover more than 80 percent of the landscape. The percentages of forestland in New England by state range from 59 to 89; the lower percentages occur in southern New England (Massachusetts, Connecticut, and Rhode Island); while timberland dominates the northern New England landscapes of Maine (86%; Griffith and Alerich 1996), New Hampshire (79%; Frieswyk and Widmann 2000a), and Vermont (76%; Frieswyk and Widmann 2000b).

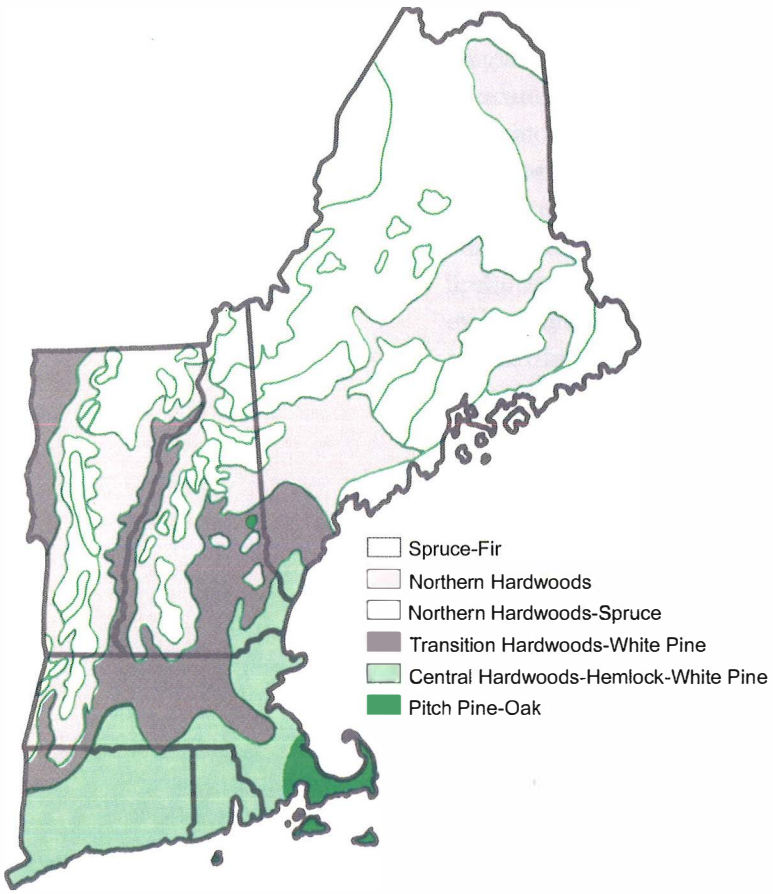


Fig. 5. Forest regions of New England.

The ever-changing forests of New England have been classified into regions by various authors (Braun 1950; Hawley and Hawes 1912; Küchler 1964; Shantz and Zon 1924; Westveld et al. 1956) on the basis of presettlement forest conditions, original forest vegetation, or potential natural vegetation. Gradual transitions and distinct boundaries exist between these regions depending on physiography, climate, bedrock mineralogy, topography, and soils.

Six forest regions based on the work of Küchler (1964) and Braun (1950) are described in this book (figure 5). Characteristic tree species in each region form the basis for the regional names. Physiographic features and climatic conditions characteristic of these forest regions are described (figure 6). Many of the eleven major forest cover types found in New England forests and woodlands consistently occur throughout these forest regions and are mentioned briefly (DeGraaf and Yamasaki 2001). (**Note:** The chapter on silvicultural methods discusses the ecological site associations and silvicultural systems used to regenerate and maintain selected cover-type groups and wildlife communities in northern New England).

SPRUCE–FIR FOREST REGION. Red spruce (*Picea rubens*) and balsam fir (*Abies balsamea*) are the major tree species in the spruce–fir forest region. Black spruce (*Picea mariana*) can be found in the colder, poorly drained to very poorly drained uplands, in addition to swamps and bogs. White spruce (*Picea glauca*) occurs frequently on abandoned agricultural fields. Other conifer associates of the spruce–fir forest region include tamarack or larch

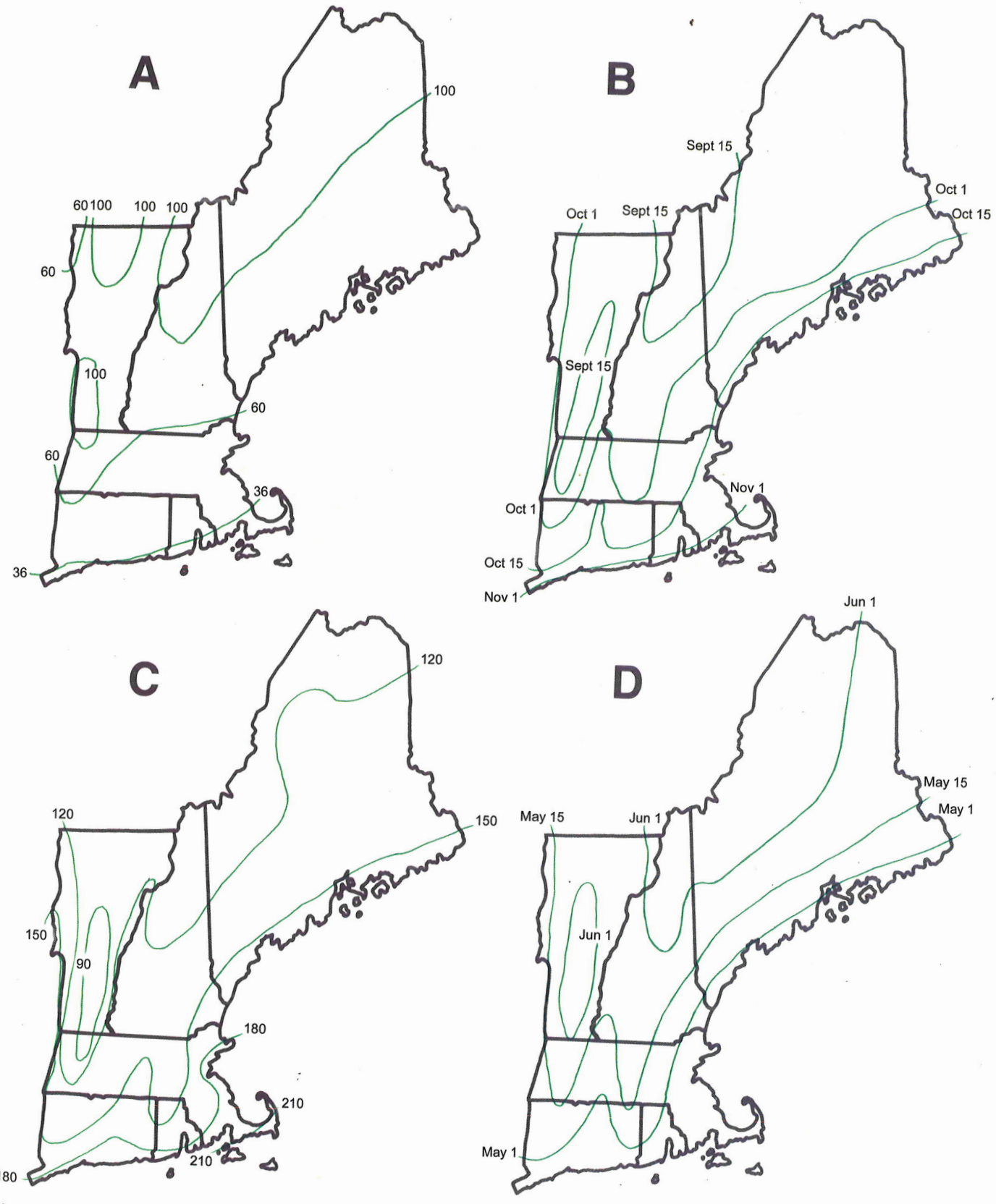


Fig. 6. Climatic variables important to New England forests: (A) average annual snowfall (inches); (B) average date of first frost; (C) average number of frost-free days; and (D) average date of last frost.

(*Larix laricina*), northern white cedar (*Thuja occidentalis*), and hemlock (*Tsuga canadensis*). Most characteristic of the hardwood component in the spruce–fir forest region are red maple (*Acer rubrum*), paper birch, quaking and bigtooth aspen (*Populus tremuloides* and *P. grandidentata*), and mountain-ash (*Sorbus americana*).

The spruce–fir forest region occurs in the coolest sections of New England. It is predominant above elevations of 500 feet in the central, northern, and easterly coastal counties of Maine (Bormann et al. 1970), and above elevations of 2,600 feet in the White and Green Mountains of New Hampshire and Vermont (Leak and Graber 1974). Krummholz is characteristic at high elevations. Average date of last frost is June 1; average date of first frost is September 15; with an average of 90 to 120 frost-free days. Mean annual total snowfall ranges from 96 to more than 160 inches (Kingsley 1985; Lull 1968).

NORTHERN HARDWOODS–SPRUCE FOREST REGION. The major tree species in the northern hardwoods–spruce forest region are beech (*Fagus grandifolia*), white and yellow birches, sugar maple (*Acer saccharum*), and associated conifers on the better-drained soils. Hemlock is found at lower elevations in northern New England; red spruce and balsam fir replace hemlock at higher elevations. Imperfectly to poorly drained soils, mountaintops, and northerly exposures are characterized by spruce and fir stands. Hardwood stands with a component of hemlock and white pine characterize southerly exposures and the southern portion of this forest region. White pine is an early-successional species that can be found on abandoned agricultural areas in river valleys and outwash plains.

Characteristic of lower elevations, this forest region occurs below 2,800 feet in the White and Green Mountains in northern and central New Hampshire (Leak and Graber 1974), and southern Vermont. Average date of last frost is June 1; average date of first frost is September 15; with an average of 90 to 120 frost-free days. Mean annual total snowfall ranges from 80 to 120 inches (Kingsley 1985; Lull 1968).

NORTHERN HARDWOODS FOREST REGION. The northern hardwoods forest region includes beech, sugar maple, and yellow birch. Hemlock, American elm (*Ulmus americana*), basswood (*Tilia americana*), black cherry (*Prunus serotina*), and white ash (*Fraxinus americana*) are also components to a lesser extent. Quaking and bigtooth aspen and paper birch are early-successional species across the range of sites in this forest region. Red maple, American elm, black ash (*Fraxius nigra*), hemlock, northern white cedar, and red spruce are characteristic of wetter site conditions.

The northern hardwoods forest region occurs across the higher elevations of the New England upland, particularly in the Aroostook area and upper Penobscot, Kennebec, and Androscoggin river basins in Maine, portions of the Berkshires in western Massachusetts, and throughout the Champlain Valley in western Vermont. Elevations range from 500 to 2,600 feet. Average date of last frost is May 15; average date of first frost is October 1; with an average of 120 to 150 frost-free days. Mean annual total snowfall ranges from 80 to 96 inches (Kingsley 1985; Lull 1968).

TRANSITION HARDWOODS–WHITE PINE FOREST REGION. This is a transition region. Northern hardwoods (yellow and paper birches, beech, and sugar and red maple) are the major species, with the oaks and hickories found on the warmer and drier site conditions of this region. Hemlock occurs on the cooler sites in this region. White pine is characteristic of the well-drained sandy sites. Red maple, black ash, and American elm can be found on the imperfectly drained to very poorly drained sites of this region.

The transition hardwoods–white pine forest region occurs to 1,500 feet throughout the lower elevations of the New England upland in northern central Massachusetts and southern New Hampshire, reaching northward through the Champlain and Connecticut river valleys (Bormann et al. 1970). It also occurs in southwestern Maine and the lower reaches of the Androscoggin, Kennebec, and Penobscot river basins. Average date of last frost is May 15; average date of first frost is October 1; with an average of 120 to 150 frost-free days. Mean annual total snowfall ranges from 48 to 80 inches (Kingsley 1985; Lull 1968).

CENTRAL HARDWOODS–HEMLOCK–WHITE PINE FOREST REGION. This region is a mixture of northern and central hardwoods. Formerly, American chestnut was the dominant tree species of this region. Now, however, red, black, and white oaks (*Quercus rubra*, *Q. velutina*, and *Q. alba*); the hickories; gray, yellow, and black birches (*Betula populifolia*, *B. alleghaniensis*, and *B. lenta*); and beech are the major species. The primary conifers in the region are white pine and hemlock. Red maple occurs on the wetter sites. Pitch and red pine (*Pinus rigida* and *P. resinosa*) can be found on the sandy outwash sites.

The central hardwoods–hemlock–white pine forest region occurs across the southern portions of the New England upland and seaboard; throughout Massachusetts, Connecticut, and Rhode Island, and along the southwestern Maine and New Hampshire coast. Elevations range from sea level to 1,000 feet. Average date of last frost is May 1; average date of first frost is October 15; with an average of 150 to 180 frost-free days. Mean annual total snowfall ranges from 32 to 64 inches (Kingsley 1985; Lull 1968).

PITCH PINE–OAK FOREST REGION. The pitch pine–oak forest region is composed of pitch pine, scrub or bear oak (*Quercus ilicifolia*), and scarlet (*Q. coccinea*) and black oaks. Repeated burning has created favorable conditions for pitch pine and scrub oak, occurring almost exclusively in places. Lowbush blueberry (*Vaccinium angustifolium*) and other ericaceous shrubs abound on these burned areas.

The pitch pine–oak forest region of New England essentially lies on the northeastern extension of the coastal plain formation, represented by Cape Cod, and ranges in elevation from sea level to 150 feet. Much of the Cape is underlain with poorly stratified sheets of sand, gravel, and clay. The Montague Plain in Massachusetts is an inland example of this region. Average date of last frost is May 1; average date of first frost is November 1; with an average of 180 to 210 frost-free days. Mean annual total snowfall is less than 32 inches (Kingsley 1985; Lull 1968).

1

Understanding Wildlife Habitats

Wildlife Habitat

WILDLIFE HABITAT is the sum of the environmental factors—food, water, cover, and their spatial distribution—that a given species needs to survive and reproduce in a given area (Schemnitz 1980). Wildlife species have specific habitat requirements, such that the distribution and abundance of each species are limited by the quality and quantity of available habitat in any given area.

Wildlife populations change in response to several factors, such as diseases, predation, extremes of weather, exploitation, and habitat conditions. These factors are not mutually exclusive; several may act in concert or compensate for one another. When habitat conditions for a prolific prey species improve, its population will increase, other factors being unchanged, but opportunistic predators likely will respond to that increase. Populations of all species are always in flux, responding to sets of factors that enhance survival and those that reduce survival. For migratory species, conditions on the wintering grounds or severe weather or accidents during migration are important factors. But by far, the most important factor is habitat condition. Habitat changes, whether relatively slow as in succession or forest development or rapid due to fire, logging, or hurricane, can produce changes in species composition that are dramatic compared to effects of other factors affecting wildlife populations.

Habitats typically are named for wildlife species; for example, "grouse covert" or "deer yard." Such terms imply that, within the overall forest, habitat conditions exist that meet the habitat needs for that species. Wildlife biologists use "habitat" to mean a set of conditions required or used by a given species or group of species with similar requirements, or a group of species whose

various requirements are met in a given, visually identifiable environment. For example, sapling stands of northern hardwoods or aspen, well known as the drumming habitat of ruffed grouse, support a diverse community of other species such as redstarts, veeries, rose-breasted grosbeaks, red efts, and red-backed voles. A general overview of the factors that affect each member species is basic to understanding the nature of species/habitat relationships.

Each species has unique habitat requirements. To be resident in an area, each species must find its needs met within the daily activity zones of individual breeding adults. Otherwise, species occurrence is likely to be transitory, temporary, or seasonal. The factors affecting wildlife habitat—food, water, cover, and spatial relationships—are discussed separately and then collectively on a community basis.

FOOD. A source of energy for growth, maintenance, and reproduction is essential to each species. The plants eaten by grazing or browsing herbivores, such as white-tailed deer, commonly are categorized as preferred, staple, or emergency. Fruits taken by birds can be categorized similarly by how readily they are taken. The foods consumed depend on presence and seasonal availability, and the physiological needs, morphology, and behavior of the consumer. There are also regional and seasonal differences in food preferences within species. For example, dark-eyed juncos feed in trees in the western United States, but are strictly ground gleaners in the East; ruffed grouse are fairly dependent on aspen buds—especially male flower buds—in the Lake States, but consume a wide variety of winter foods in New England where aspen is much less common.

In New England, deep snows and ice storms commonly render food unavailable. Many woodlands at higher elevations in New England are unoccupied by wild turkeys because of severe winter conditions and deep snows. Not all factors affecting food availability can be manipulated by the habitat manager, but to the extent possible or practical, wildlife food needs, especially of herbivores, should be considered in wildlife habitat management plans. Basic references on food preferences are *American Wildlife and Plants: A Guide to Wildlife Food Habits* (Martin et al. 1951) and *Trees, Shrubs, and Vines for Attracting Birds* (DeGraaf 2002).

WATER. Most wildlife species must consume water daily. Water is readily available in most New England woodlands and is rarely a limiting factor for terrestrial species. Aquatic habitats, however, have species compositions that are restricted in their distributions because the species involved depend on water for breeding, feeding, or overwintering. Factors that affect the quality and availability of aquatic habitats are periodic droughts and managed drawdowns of impoundments and reservoirs.

COVER. Cover provides protection from the weather or predators; it also provides temporary specialized places for reproduction, escape, roosting, sleeping, travel, or resting. The forest manager must be aware of the variety of wildlife cover needs, because forest management can provide the sites

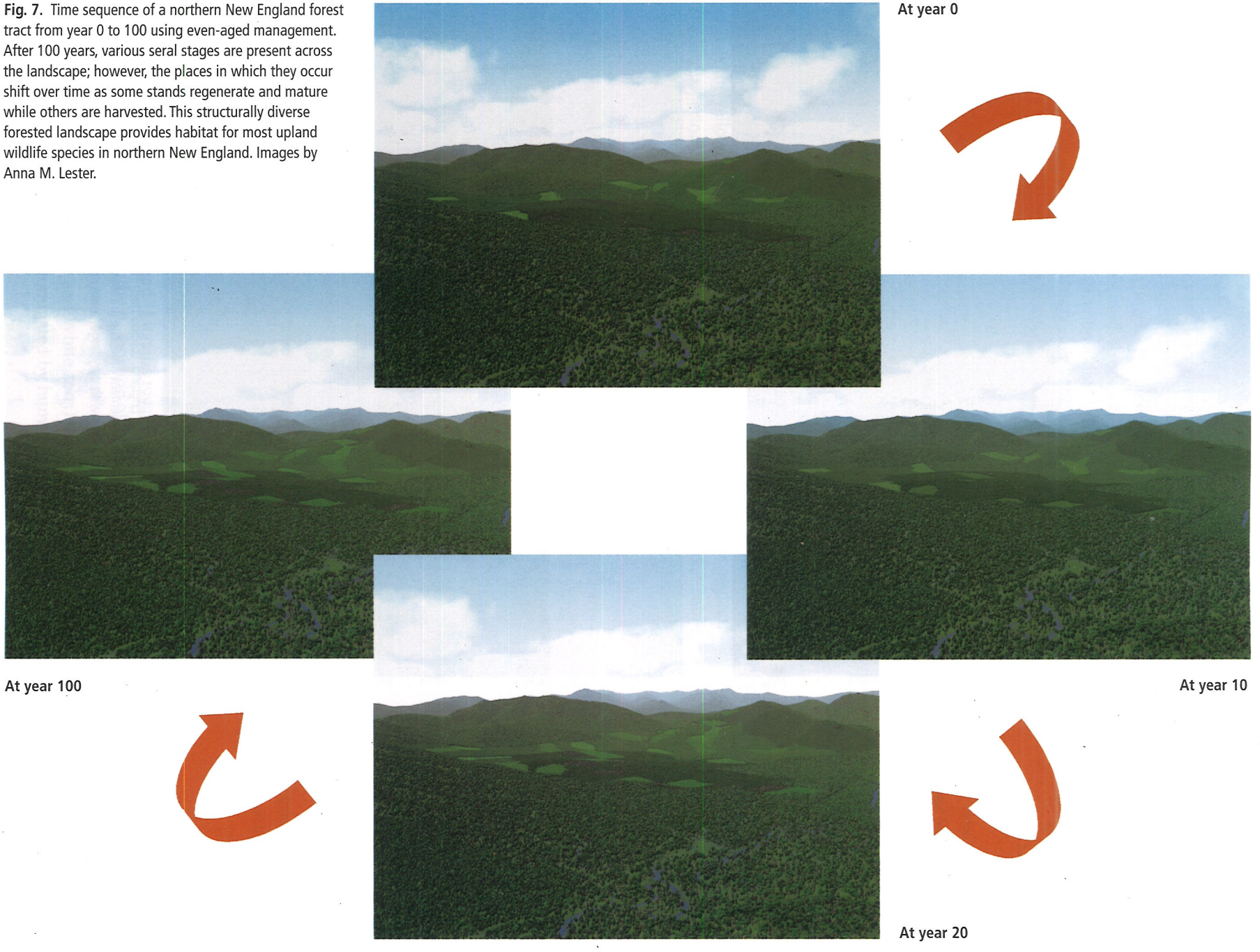
needed. Cavity trees are used by a succession of species as they decline and die. Roughly a third of New England forest wildlife species are associated with cavity trees, snags, and down logs. Use of cavity trees ranges from perches, nest and roost holes, and dens to foraging sites, and continues until the snag falls and rots away. See *Guide to Wildlife Tree Management in New England Northern Hardwoods* (Tubbs et al. 1986) for detailed information on cavity-tree management.

Dense brush or seedling stands are uncommon in many New England woodlands unless even-aged management has been practiced recently. Uneven-aged management — single-tree selection or small-group cuts — does not produce stands of regeneration that are large enough to provide significant wildlife food or cover. Unmanaged stands lack patches of regeneration until they are very old, when large trees begin to fall. In many woodlands, brushy cover is virtually absent, and such absence probably limits populations of species such as the New England cottontail, which uses it for escape and resting cover. Many other species are associated with woodland thickets, such as ruffed grouse, cuckoos, whip-poor-will, chestnut-sided warbler, and red-backed vole. See the next section, on critically needed habitats (pages 19–21), for more information on this particular cover condition.

Cover for wildlife includes nonforest features, such as fields and other grassy areas and bodies of water, which provide foraging, escape, protection from weather, and breeding habitat for many species. The cover requirements of all New England forest wildlife are too numerous to mention here. Many are known and readily identifiable, and also are provided routinely in normal silvicultural practices. Awareness of the values of wildlife cover in forest management planning will help the forest manager meet wildlife needs.

SPATIAL RELATIONSHIPS. The spatial relationships of these factors and their relative abundance and availability largely determine the wildlife species composition — the community — that can occur in a given woodland. The availability of food, cover, and water is reflected to a large degree by the successional stages of various forest types and other cover types, both terrestrial and aquatic. There is a greater likelihood of meeting more species' requirements when more varied habitat conditions are present, and thus a higher degree of wildlife diversity can be expected. A forest landscape that is managed to provide all successional stages of the forest types present, using silvicultural methods appropriate to the site, provides habitat for the most species over time. Habitat conditions needed by various species are present continuously in a shifting mosaic as some stands are regenerated and others mature (figure 7). Certainly, the size of a habitat management unit can affect the potential wildlife species that will occupy the site relative to the conditions surrounding the area. It is a matter of scale. Species with small home ranges or territories generally can be managed on smaller units. Portions of the year-round habitat conditions needed by species with large home ranges also can be managed on smaller units depending on the surrounding conditions. A 40-acre clearcut, two to three years old, in a northern hardwood forest typically provides breeding habitat for twenty to thirty pairs of willow flycatchers,

Fig. 7. Time sequence of a northern New England forest tract from year 0 to 100 using even-aged management. After 100 years, various seral stages are present across the landscape; however, the places in which they occur shift over time as some stands regenerate and mature while others are harvested. This structurally diverse forested landscape provides habitat for most upland wildlife species in northern New England. Images by Anna M. Lester.



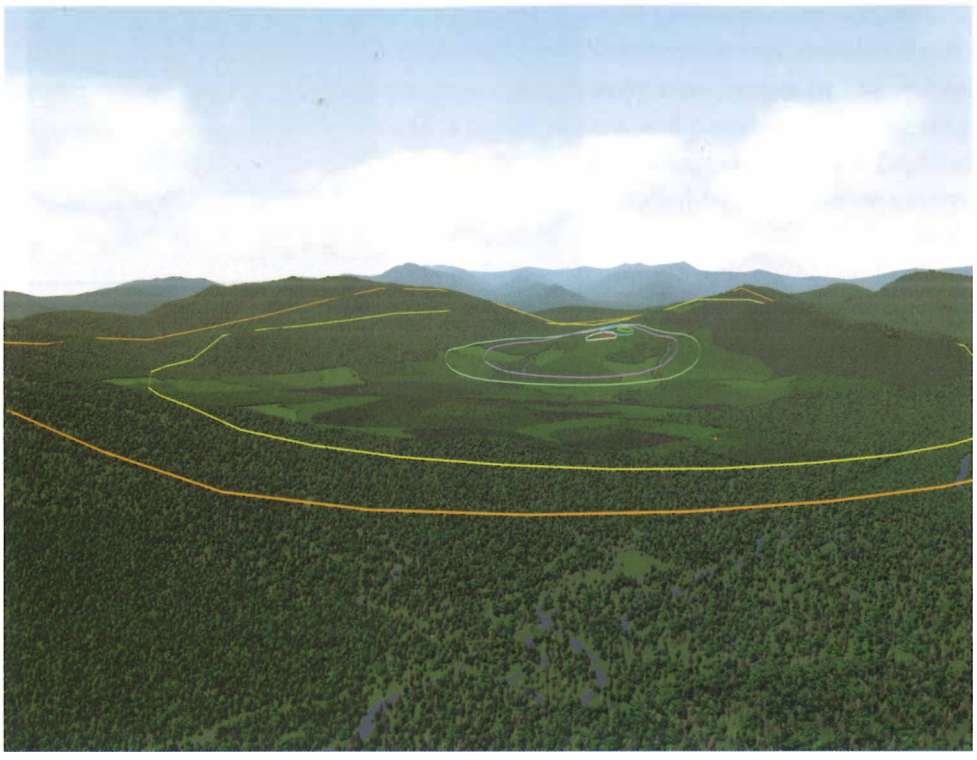
Home Range Legend

Range: 1-2 acres
- Chestnut-sided warbler
- Mourning warbler

Range: 8-10 acres
- Ruffed grouse
- Snowshoe hare

Range: 300-500 acres
- Sharp-shinned hawk
- Barred owl

Range: 4000-6000
- Fisher
- Moose



Home Range Legend

Range: 1-2 acres
- Yellow warbler
- Ovenbird

Range: 5-7 acres
- Red-bellied woodpecker
- Hairy woodpecker

Range: 200-600 acres
- Pileated woodpecker
- White-tailed deer

Range: 2000-8000 acres
- Great horned owl
- Black bear

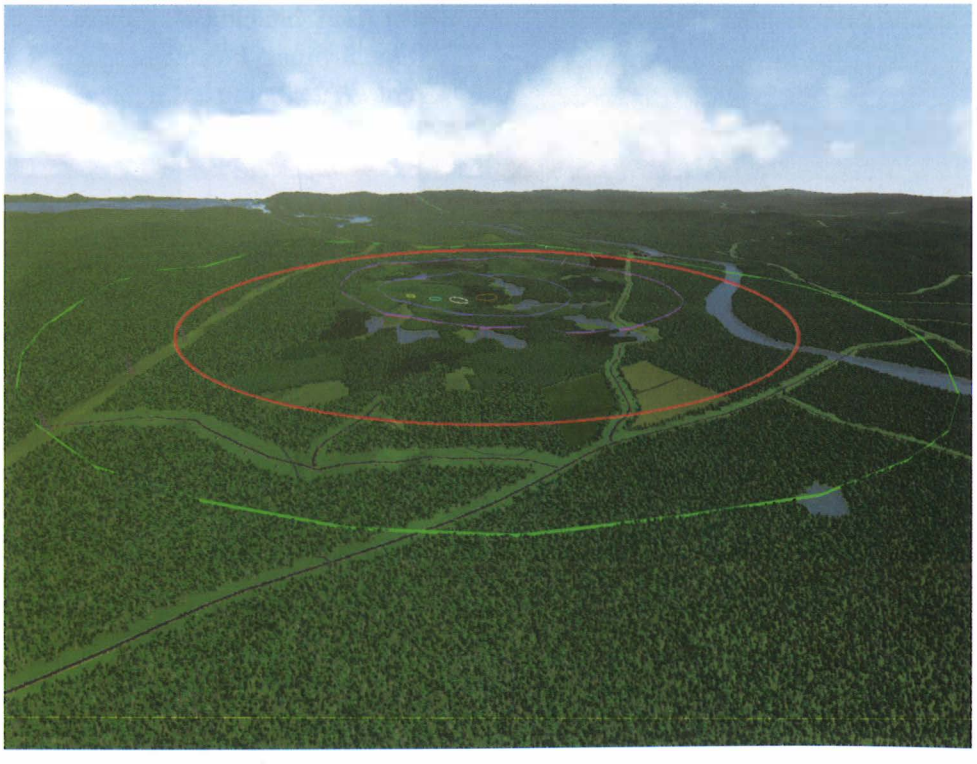


Fig. 8a and 8b. (a) Northern New England. (b) Southern New England. In both northern and southern New England, the larger the management area, the greater is the number of species whose habitat needs can be met within it. Species with very large home ranges likely also use adjacent forestlands. Image by Anna M. Lester.

two or three pairs of Swainson's thrushes, one pair of olive-sided flycatchers, and many white-footed mice, but only a small part of the home range of a pair of red-tailed hawks that hunt over it and a very small part — about 1 percent — of a moose's home range, which is approximately 4,000 acres (figure 8).

Species occurrence and utilization by forested habitat, nonforested habitat, habitat breadth and size-class, and structural habitat features listed in Appendixes A to D, respectively, provide a detailed description of the cover requirements of New England's wildlife species.

Critically Needed Habitats

One of the most important wildlife habitat issues today in New England is the decline of early-successional habitats and the species associated with them. For the first time since European settlement, early-successional species are declining across eastern North America, and especially in New England. Species that thrive in mature forest, such as squirrels and fishers, are abundant, but most early-successional ones such as field sparrows, whip-poor-wills, eastern towhees, and New England cottontails are disappearing quietly as the remaining patches of young forest mature. All brushland species are in decline; some, such as the yellow-breasted chat, are gone already, victims of benign neglect. The key is periodically to create patches of shrubland and young-forest habitat of sufficient size and proximity to others so that the needed habitats are available continually on the landscape.

Forest disturbance by fire, wind, beaver, flooding, and Native American agriculture and burning once continuously produced a wide array of early-successional habitats and young forest. In much of the region, many fire-prone areas were soon settled by Europeans and are now largely developed. Beaver, once extirpated but now increasing, cannot modify the landscape to the extent they did in pre-settlement times. Many drainages are confined or channelized now and beaver generally are not tolerated where key woods roads, suburban development, or agriculture occur. Wind still creates small openings in softwood stands, but mid-successional hardwoods, now predominant across much of southern New England, are fairly resistant to wind, even hurricanes (Leak et al. 1994). The net result is that natural disturbances are much reduced compared to pre-settlement times and cannot be relied upon to produce early-successional habitats where and when they are needed. Management is required to provide habitats for disturbance-dependent species.

Abandonment of agricultural lands reached a peak in New England in the late 1800s to mid-1900s (Litvaitis 1993), and a wave of early-successional habitats followed. Today, such habitats are less common than they were in pre-settlement times in much of the northeastern United States, especially southern and south-coastal New England (Litvaitis 1993; DeGraaf and Miller 1996; Brooks 2003). On the other hand, the proportion of early-successional habitat in northern industrial forests is currently several times that which occurred in pre-settlement times (Lorimer and White 2003). Most of the northeastern United States landscape is now dominated by human uses, and maintaining

early-successional habitats throughout in proportion to pre-settlement levels is not possible. If the concern is for conservation (that is, maintenance of viable populations) of early-successional species, management ideally should be representative of the historical range of variability where feasible. The historic patterns in living resources and hence the expected variability in ecological conditions have been shaped over time by climate fluctuations and natural disturbance regimes. The historical range of variability concept assumes that the more proposed conditions differ from those during the historic period, the greater risk to native species, their habitats, and their long-term ecological productivity (Committee of Scientists 1999). It also requires selection of a historic time period and consideration of what is natural. Adherence to pre-settlement levels is not possible in much of the northeastern United States, especially southern New England, and proposing management that does not create adequate patches of early-successional habitats, while within the historic range of variability locally, will tend eventually to eliminate such habitats and the species associated with them throughout the region.

Because they were so abundant in the recent past, most wildlife associated with native shrublands and early-successional habitats once were considered generalist "edge" species that needed no specific management actions. Many early-successional species, however, are now either extirpated, threatened, or species of management concern in the region, largely because of habitat loss (Litvaitis 1993; Witham and Hunter 1992). Most early-successional species are not generalist species at all; rather, they are specialists in vegetation structure or area requirements, to a remarkable degree. For example, New England cottontails are obligate users of young stands; occupying habitats when secondary succession has progressed ten to twenty-five years, after which time they decline rapidly when understories thin as trees mature (Litvaitis 2001; Barbour and Litvaitis 1993). Chestnut-sided warblers generally occupy patches of regenerating hardwoods of at least 0.5 acre in New England managed forests (King et al. 2001), and then only for three to ten years after harvest. Chestnut-sided warblers build well-concealed nests 1 to 4 feet above ground in low bushes or seedlings, and decline steadily in a patch as stand development reduces the availability of nesting habitat (DeGraaf and Yamasaki 2001, 221).

The decline of agriculture and reversion to forest essentially have eliminated grassland birds from the New England landscape, although many were common a half-century ago (Askins 1993; Bagg and Eliot 1937). Shrubland birds that are not adapted to suburbia, such as brown thrashers, eastern towhees, and field sparrows, are now declining across the region (DeGraaf and Yamasaki 2001; Veit and Petersen 1993). Mature forest birds, whose habitats have been increasing in northeastern North America, are as a group quite tolerant of dramatic changes in stand structure (Webb et al. 1977) or patchy disturbance within areas of extensive forest (Maurer et al. 1981; DeGraaf 1991). Shrubland and young-forest birds, however, are specialists that quickly disappear from a site as stand development proceeds. While some early-successional species depend on agriculture or frequent burning or mowing (Oehler 2003), the greatest opportunity to provide habitat for most species lies in even-age forest management.

Two points need to be considered when managing early-successional habitats silviculturally.

- **Size of opening matters.** The number of breeding bird species present in regenerating spruce–fir stands and clearcuts increased with opening size up to 50 acres in Maine (Rudnicky and Hunter 1993). Breeding bird species diversity was also higher in clearcuts 20 to 30 acres than in group cuts 0.25 to 1.5 acres in central New Hampshire (Costello et al. 2000). Large regeneration cuts enhance diversity more effectively than small ones.
- **Frequency of disturbance matters.** Breeding bird composition changes rapidly in the first ten to fifteen years after clearcutting in northern hardwoods. For example, white-throated sparrows, winter wrens, and willow flycatchers generally are abundant in the first growing season after clearcutting. Winter wrens are associated with dense slash. If stubs with old woodpecker holes are left, eastern bluebirds commonly are present. Two years after clearcutting, the number of species doubles. Common yellowthroats, chestnut-sided warblers, cedar waxwings, American goldfinches, and mourning warblers invade, along with Swainson's thrushes, eastern towhees, and American redstarts. Northern flickers and white-throated sparrows remain, but eastern bluebirds and sometimes winter wrens are gone. In the third growing season after clearcutting, bird species numbers again double, with about a dozen new species added, including black-and-white warbler and rose-breasted grosbeak, mostly in low numbers. During the next twelve years, bird species composition changes substantially, as ruffed grouse, red-eyed vireos, wood thrushes, and ovenbirds, among others, arrive but the number of species usually does not change appreciably (DeGraaf 1991).

The time between periodic regeneration cuts needs to be short enough to maintain the presence of early-successional bird species in a management area. Silvicultural practices that minimize the size of regeneration cuts and the total harvest area or lengthen rotation age and re-entry periods inhibit the creation and maintenance of young forest habitats. See DeGraaf and Yamasaki (2003) for a detailed discussion of young-forest and early-successional nonforest habitats. Both are needed to ensure wildlife diversity in New England.

Habitat Structure

The distribution or mixing of vegetative types, size classes, and an assortment of features to a large extent determines the wildlife communities that occur within forest vegetation (Smith 1962). Horizontal and vertical diversity are two components of habitat structure. A key to the following illustrations is provided in figure 9.

Fig. 9. Key to the figure illustrations that follow.

HORIZONTAL DIVERSITY. Horizontal diversity or "patchiness" refers to the complexity of the arrangement of plant communities and other habitats (figure 10). Different forest types have different wildlife communities. The greater the range of size classes present, the greater the potential that more wildlife species will be present. Still, many wildlife species occur in several forest types and size classes. The horizontal diversity provided by open and wetland habitats contributes greatly to the overall forest wildlife community because these nonforested habitats contain species not normally associated with forest vegetation and provide food, water, and cover opportunities not available in only forested areas.

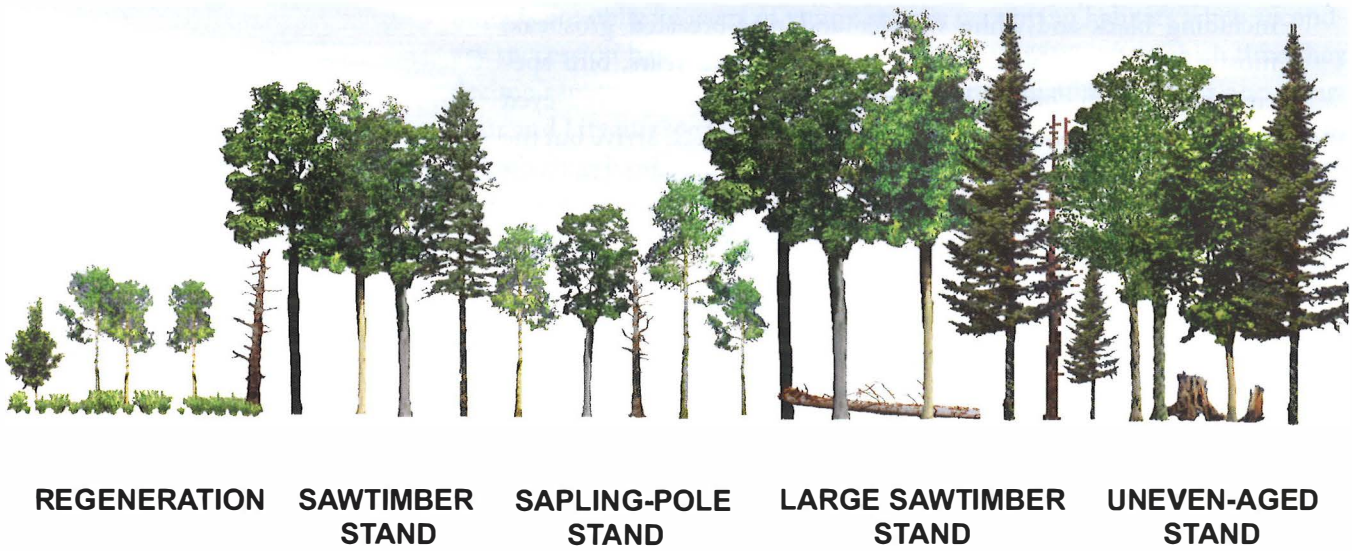


Fig. 10. Horizontal diversity depends on the type of area and size-class management used on the property.

VERTICAL DIVERSITY. Vertical diversity refers to the extent to which plants are layered within a stand. The degree of layering is determined by the arrangement of growth forms (trees, vines, shrubs, herbs, and thallophytes [mosses and lichens]), by the distribution of different tree species having different heights and crown characteristics, and by trees of different ages of the same species. The extent to which vertical structure varies within the stand determines the degree of vertical diversity (figure 11). Stands with a high

Fig. 11. Vertical diversity depends on the number of vegetative layers present in a stand.

degree of vertical diversity characteristically develop multiple vegetative layers — overstories with a rich species composition and well-developed herbaceous, shrub understory, and woody midstory layers.

The number of species that occupy a given forest habitat is, in a large part, a function of vegetative composition and distribution — the combination of its horizontal and vertical diversities. Vertical diversity is probably of greatest importance to most forest birds (Anderson and Shugart 1974; Balda 1975; James 1971; MacArthur et al. 1966); horizontal diversity is probably more important to open-country birds and mammals. Some species require both types of diversity (for example, ruffed grouse, wild turkey, black bear, white-tailed deer, and others).

Niche separation by specific habitat selection seems to be the most common mechanism of achieving competitive coexistence in temperate forest bird communities (Noon and Able 1978; Noon et al. 1979; Whitmore 1977). The variety of bird species present in such communities is directly related to habitat structure, especially in the breeding season.

Area

The area used by a given wildlife species can fluctuate greatly, depending on a number of different physical and biological factors. These factors range from the variety of habitat conditions present, food and cover resources in the area, and a species' relative abundance in the area, to the season of the year. Exercise care when interpreting wildlife area estimates for any type of vegetative management strategy. For example, home ranges commonly vary greatly between male and female, or juvenile and adult mammals. Furthermore, individuals do not "pack" their ranges to fill a given area in a non-overlapping arrangement. Home range size is only a general guide to area needs.

Two concepts also apply to area considerations: area sensitivity and habitat connectivity. Area sensitivity, the concept that species, normally bird species, that have relatively small individual territories nevertheless only occur in

much larger patches of habitat. Area sensitivity applies to both mature forest species and early-successional species. Bobolinks, grassland birds, have territories a few acres in size but do not nest in fields smaller than 30–40 acres. Similarly, hairy woodpeckers have territories about 10 acres in size but only nest in extensive forests. Area sensitivity is a factor in determining whether a species will occupy a patch of otherwise suitable habitat. Individuals are parts of populations that exist in the surrounding landscape; the larger landscape needs to support populations in order for individuals to occupy the managed patch under consideration. This consideration of the population points up the importance of habitat connectivity, which facilitates movement among suitable habitat patches and dispersal of individuals throughout the population. Habitat connectivity is not normally a concern for forest species in forested landscapes, but may be for early-successional species in small patches of early-successional habitat in otherwise extensive mature forest.

Estimates of areas used in New England by taxonomic class are summarized in table 1. Approximately two-thirds of the 338 forest wildlife species potentially occurring in New England have average home ranges or territories that are less than 10 acres. Most amphibians, reptiles, many migratory birds, and most small mammals are in this category. About a sixth of the region's forest wildlife species have average home ranges greater than 50 acres. Most raptors and larger-bodied woodpeckers, and most medium and large-sized mammals are in this category. Table 2 lists wildlife species occurrence by estimated home range area size in New England.

Thus, several concepts need to be considered when managing forested properties. In general, large forested tracts present more opportunities than small forested properties to manage more year-round habitats for permanent resident species with large home range areas because all necessary habitats for such species are likely to be found on larger, more diverse properties. Also, for the same reason, large forested properties present more opportunities to manage more seasonal habitats for migratory species and species with smaller home range areas.

Small forested properties present fewer opportunities to manage year-round habitats for permanent resident species with large home ranges, because it is difficult to find all the necessary habitats for such species on small, less diverse properties. However, small forested properties present many opportunities to manage a portion of the year-round habitat needs of permanent resident species with larger home ranges if they are coordinated with management activities in the surrounding area or complement conditions on adjacent properties. Small forested properties still present opportunities to manage seasonal habitats for migratory species and species with smaller home range areas, although the range of available habitats will be considerably narrower and perhaps less diverse.

In sum, tract size is an important consideration but much depends on the character of the surrounding landscape. For example, a small forest tract embedded in extensive forest provides a wider range of forest management opportunities than one abutting residential or agricultural land.

Table 1
Number of Species by Taxonomic Class and Estimated Home Range Area Category in New England

	Average home range area estimates (acres)				
Taxonomic class	None reported/ not applicable	1–10	11–50	>50	Total
Amphibians	—	22	1	—	23
Reptiles	—	19	5	2	26
Birds	24	121	47	33	225
Mammals	9	32	6	17	64
Total	33	194	59	52	338

Table 2
Wildlife Species, by Estimated Home Range Area Category

	Home range area (acres)			
Taxonomic class	None reported/ not applicable	1–10	11–50	>50
Amphibians		Mudpuppy, marbled salamander, Jefferson salamander, blue-spotted salamander, red-spotted newt, northern dusky salamander, northern redback salamander, northern slimy salamander, four-toed salamander, northern spring salamander, northern two-lined salamander, eastern spadefoot, eastern American toad, Fowler's toad, northern spring peeper, gray treefrog, bullfrog, green frog, mink frog, wood frog, northern leopard frog, pickerel frog	Spotted salamander	
Totals	—	22	1	—
Reptiles		Spotted turtle, bog turtle, wood turtle, eastern box turtle, painted turtle, Blanding's turtle, common musk turtle, eastern spiny softshell, five-lined skink, northern water snake, northern brown snake, northern redbelly snake, common garter snake, ribbon snake, eastern hognose snake, northern ringneck snake, eastern worm snake, northern black racer, eastern smooth green snake	Common snapping turtle, map turtle, northern red-bellied cooter, northern copperhead, timber rattlesnake	Black rat snake, eastern milk snake
Totals	—	19	5	2

(continued)

Table 2 (continued)

	Home range area (acres)			
Taxonomic class	None reported/ not applicable	1–10	11–50	>50
Birds	Double-crested cormorant, great egret, snowy egret, little blue heron, cattle egret, buffle-head, rough-legged hawk, willet, ring-billed gull, herring gull, great black-backed gull, common tern, snowy owl, northern hawk-owl, great gray owl, boreal owl, northern shrike, American pipit, Bohe-mian waxwing, American tree sparrow, Lapland longspur, snow bunting, com-mon redpoll, hoary redpoll	Pied-billed grebe, American bittern, least bittern, great blue heron, green heron, black-crowned night heron, yellow-crowned night heron, glossy ibis, wood duck, gadwall, American wigeon, American black duck, mallard, blue-winged teal, northern shoveler, northern pintail, green-winged teal, canvasback, ring-necked duck, common goldeneye, hooded merganser, common merganser, red-breasted merganser, northern bobwhite, Virginia rail, sora, killdeer, spotted sandpiper, common snipe, black tern, rock dove, mourning dove, ruby-throated hummingbird, red-headed woodpecker, red-bellied woodpecker, yellow-bellied sapsucker, downy wood-pecker, hairy woodpecker, northern flicker, olive-sided flycatcher, yellow-bellied flycatcher, Acadian flycatcher, alder flycatcher, willow flycatcher, least flycatcher, eastern phoebe, great crested flycatcher, white-eyed vireo, warbling vireo, Philadelphia vireo, red-eyed vireo, house wren, winter wren, sedge wren, marsh wren, golden-crowned kinglet, ruby-crowned kinglet, blue-gray gnatcatcher, tree swallow, veery, hermit thrush, wood thrush, American robin, gray catbird, northern mockingbird, brown thrasher, European starling, blue-winged warbler, golden-winged warbler, Tennessee warbler, Nashville warbler, northern parula, yellow warbler, chestnut-sided warbler, magnolia warbler, Cape May warbler, black-throated blue warbler, yellow-rumped warbler, black-throated green warbler, Blackburnian warbler, pine warbler, prairie warbler, palm warbler, bay-breasted warbler, blackpoll warbler, cerulean warbler, black-and-white warbler, American redstart, worm-eating warbler, ovenbird, northern water-thrush, Louisiana waterthrush, mourning warbler, common yellowthroat, hooded warbler, Wilson's warbler, Canada warbler, yellow-breasted chat, scarlet tanager, eastern towhee, chipping sparrow, field sparrow, vesper sparrow, savannah sparrow, grasshopper sparrow, fox sparrow, song sparrow, Lincoln's sparrow, swamp sparrow, white-throated sparrow, rose-breasted grosbeak, indigo bunting, bobolink, red-winged blackbird, common grackle, orchard oriole, house finch, pine siskin, American goldfinch, evening grosbeak, house sparrow	Canada goose, mute swan, ring-necked pheas-ant, ruffed grouse, king rail, common moorhen, American coot, upland sandpiper, American woodcock, black-billed cuckoo, yellow-billed cuckoo, eastern screech-owl, common nighthawk, whip-poor-will, eastern wood-pewee, eastern kingbird, loggerhead shrike, yellow-throated vireo, blue-headed vireo, blue jay, horned lark, purple martin, northern rough-winged swal-low, bank swallow, cliff sparrow, barn sparrow, black-capped chickadee, boreal chickadee, tufted titmouse, red-breasted nuthatch, white-breasted nuthatch, brown creeper, Carolina wren, eastern bluebird, Bicknell's thrush, Swainson's thrush, cedar waxwing, dark-eyed junco, northern cardinal, eastern meadowlark, rusty blackbird, brown-headed cowbird, Baltimore oriole, pine grosbeak, purple finch, red crossbill, white-winged crossbill	Common loon, turkey vulture, osprey, bald eagle, northern harrier, sharp-shinned hawk, Cooper's hawk, northern goshawk, red-shouldered hawk, broad-winged hawk, red-tailed hawk, golden eagle, American kestrel, merlin, peregrine falcon, gray partridge, spruce grouse, wild turkey, barn owl, great horned owl, barred owl, long-eared owl, short-eared owl, northern saw-whet owl, chim-ney swift, belted kingfisher, three-toed woodpecker, black-backed woodpecker, pile-ated woodpecker, gray jay, American crow, fish crow, common raven
Totals	24	121	47	33

	Home range area (acres)			
	None reported/not applicable	1–10	11–50	>50
Mammals	Little brown myotis, northern long-eared bat, Indiana myotis, eastern small-footed myotis, silver-haired bat, eastern pipistrelle, big brown bat, red bat, hoary bat	Masked shrew, water shrew, smoky shrew, long-tailed shrew, pygmy shrew, northern short-tailed shrew, least shrew, hairy-tailed mole, eastern mole, star-nosed mole, eastern cottontail, New England cottontail, snowshoe hare, eastern chipmunk, gray squirrel, red squirrel, southern flying squirrel, northern flying squirrel, beaver, deer mouse, white-footed mouse, southern red-backed vole, meadow vole, rock vole, woodland vole, muskrat, southern bog lemming, northern bog lemming, Norway rat, house mouse, meadow jumping mouse, woodland jumping mouse	Virginia opossum, European hare, black-tailed jackrabbit, porcupine, ermine, long-tailed weasel	Woodchuck, coyote, gray wolf, red fox, gray fox, black bear, raccoon, marten, fisher, mink, striped skunk, river otter, mountain lion, lynx, bobcat, white-tailed deer, moose
Totals	9	32	6	17

Other Factors Affecting Wildlife Distribution

Other factors that permit many bird species to coexist in the same forest include separation of feeding times (for example, hawks feeding during the day and owls feeding at night), separation of breeding times (for example, American goldfinches nest in late summer, after other finches), and separation of feeding and nesting height. Many insectivores, frugivores, and herbivores forage within certain vegetative layers (for example, on the forest floor, in shrub understories and midstory layers, in tree holes, or in the upper canopy) and nest and raise young within other vegetative layers.

Factors that commonly influence amphibian and reptile occurrence are soil and moisture regimes, drainage (factors that influence forest type), and cover such as that provided by logs and debris (DeGraaf and Rudis 1983). Factors that occur independently of forest type, such as cliffs, talus and boulders areas, and those habitats produced by human activities (for example, logging roads, debris piles, agricultural fields, and old dwellings) also commonly influence reptile occurrence.

Small mammals (for example, moles, shrews, bats, mice, and voles), many of which are seasonally herbivorous, insectivorous, or omnivorous, tend to be habitat generalists, and are not as responsive as birds to changes in forest structure (DeGraaf et al. 1991; Gore 1986). Squirrels and other mammals that den in tree cavities are very much affected by the distribution and structural features of stands that contain both cavity trees and a variety of food sources.

Carnivores and omnivores such as skunks, raccoons, coyotes, and foxes need a larger area for feeding than do more localized amphibians, reptiles, and small mammals. Large herbivores and omnivores such as white-tailed deer, moose, and black bear can cover large areas, feeding on mixtures of herbaceous, aquatic, and woody vegetation depending on availability and time of year. Additionally, black bears consume variable amounts of larval insects and carrion. Carnivores such as bobcat, lynx, eagles, and other large hawks and owls also cover large areas throughout the year, feeding on various prey depending on availability. Some species avoid human activity; freedom from human disturbance during the breeding season is a requirement for great blue herons, goshawks, peregrine falcons, bald eagles, and martens, among others. The mountain lion and wolf (which now occur as individuals, not as populations) have been replaced in New England by human hunters and coyotes at the top of an intricately intertwined food web.

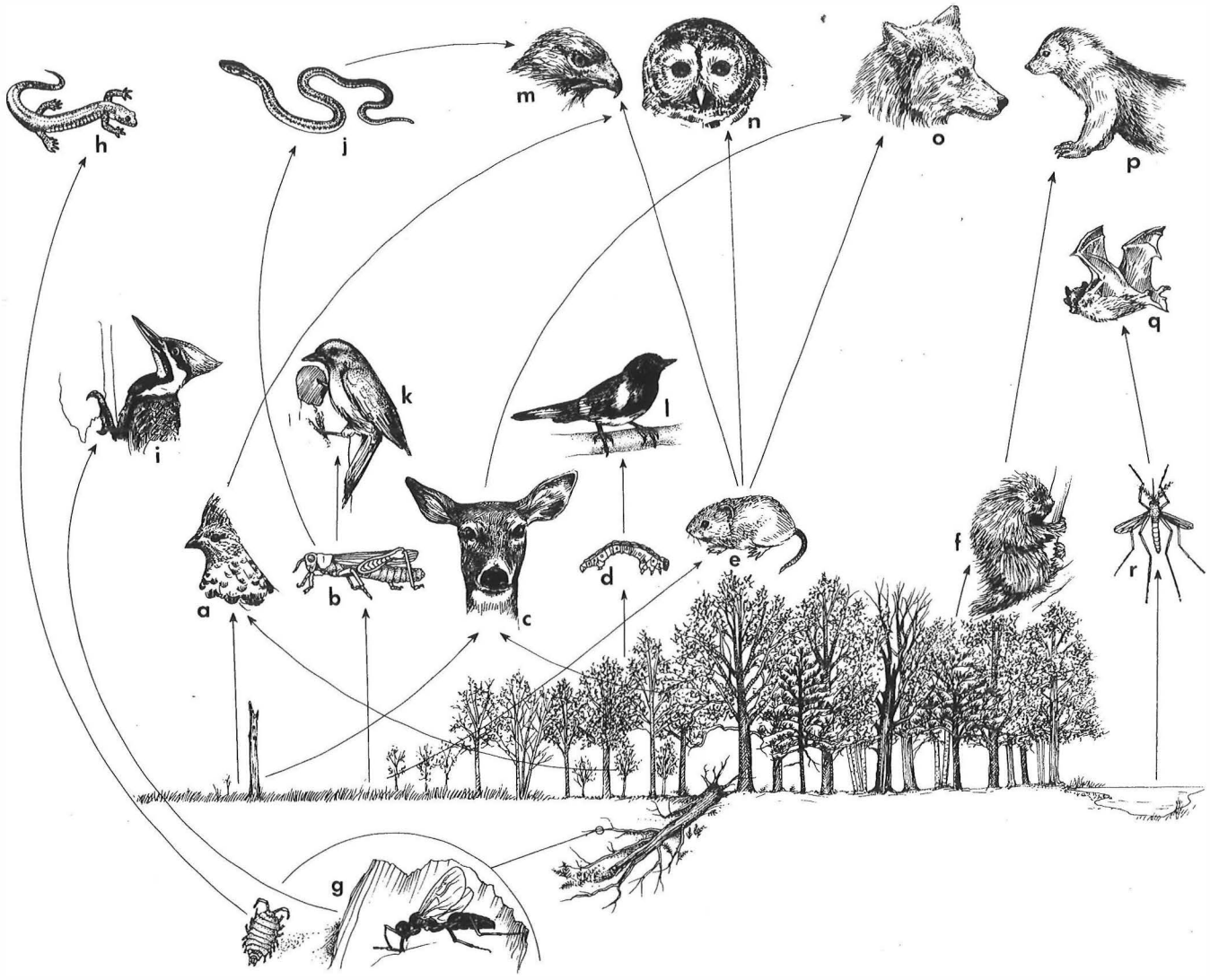
Community Organization and Structure

Plant communities each support more or less distinct wildlife communities. Here the term "community" includes size classes of forest cover types and various upland and aquatic nonforested habitats.

The assemblages of plants, animals, and other organisms occupying the same area comprise a biotic community. These assemblages are to some extent mutually sustaining and interdependent; constantly fixing, utilizing, and dissipating energy (Smith 1966). The interacting populations of plants and animals are characterized by continual replacement of individuals, and fluctuate with seasonal and environmental changes.

Food webs, whether simple or complex, link assemblages of herbivores and carnivores to their ultimate plant food through the process of eating and being eaten (Colinvaux 1986). Food webs integrate multiple food chains to describe the relationships and interactions among plants (producers), herbivores, insectivores, primary and secondary carnivores, and omnivores (all consumers), and decomposers. Within a food web, many plant species normally occur together, and most herbivores and browsers can eat several species. Food webs are systems in quasi-equilibrium; each species in the food web affects the fluctuations of all other species in some manner (figure 12). In this way, species in a community are determined not only by interactions among themselves but also by adaptation of each species to different environmental conditions (Poole 1974).

These food web combinations provide some definition of the problem of understanding assemblages of unrelated species and where they are likely to occur. Habitat managers require methods that predictably relate the major aspects of wildlife species' natural histories (for example, food, water, cover, and spatial requirements) to recognized managed habitats (for example, the various successional stages of forest plant communities). These stages are thought to contain a unique set of habitat niches — specific arrangements of food, cover, and water — that meet the requirements of particular species (Hanson 1962).



Habitat niches, therefore, are presumed to be occupied by a set of wildlife species unique to that habitat; species may be either seasonal or year-long habitat occupants (Meslow and Wight 1975; Thomas et al. 1975). For example, northern hardwood stands can be distinguished by their breeding bird composition into four habitats: (1) regenerating; (2) seedling/sapling; (3) poles; and (4) sawlogs, large sawlogs, and silviculturally uneven-aged stands (DeGraaf 1987).

The classification of vegetation into forest cover types and size classes, upland and wetland nonforest types, and various types of permanent aquatic habitats provides a partial basis for determining the habitat niche opportunities or habitat potential available on the site over time. A word of caution: similar cover types may occur across forest region boundaries. The combination of physiography, soils, climatic factors, successional patterns, and past management practices can produce very different habitat niches or potential within these vegetative classifications over time. It is important to examine these habitat potentials within a regional ecosystem context.

Fig. 12. A representative food web in a typical New England northern hardwood forest sere. Plant parts such as leaves, twigs, buds, and seeds are consumed by herbivores such as ruffed grouse (a), grasshoppers (b), white-tailed deer (c), Bruce spanworm (d), red-backed voles (e), and porcupines (f). Decomposers of plants include sowbugs and carpenter ants (g), which are preyed upon by redback salamanders (h) and pileated woodpeckers (i). Herbivorous insects are consumed by garter snakes (j), eastern bluebirds (k), and redstarts (l), among others. Vertebrate herbivores are consumed by carnivores such as broad-winged hawks (m), barred owls (n), coyotes (o), and fishers (p). Bats (q) consume mosquitoes (r) and other flying insects. Illustration by Nancy Haver.

Management Objectives

An understanding of the nature and structure of habitats and biotic communities provides a basis for defining wildlife habitat management objectives. Each species' habitat needs for food, cover, water, and spatial distribution within a limited space are provided by a characteristic set of physical and biological environmental conditions. Also, there are many interrelationships among the plants, insects, and wildlife species that comprise a biotic community. This means that wildlife habitat management (1) consists of providing the essential habitat features—some that are manipulated easily, some difficult to change, some relatively permanent, and some that change rapidly over time; and (2) involves entire communities, even if the primary interest is a certain group of animal species.

Wildlife habitat management is the art of applying ecological principles and manipulating vegetative conditions in a scientific manner to achieve a set of species and habitat goals (Bailey 1982). To practice wildlife habitat management on a given ownership or unit of forestland, a manager must:

- know the habitat requirements of the concerned species;
- know the forest cover types involved and their silvicultural characteristics;
- inventory associated habitats;
- develop a forest management plan with specific objectives for species and habitats, and management prescriptions for their accomplishments;
- implement the management plan; and
- evaluate results and adjust management prescriptions as required to meet objectives.

Traditional approaches in wildlife habitat management usually have emphasized single-species management, combinations of several species management strategies, or a species-diversity management strategy. Sometimes single-species habitat management goals and objectives are identified and treatments implemented on the ground to produce suitable habitat conditions, particularly for game species such as ruffed grouse, woodcock, and white-tailed deer. Specific rare, threatened, and endangered species habitat management strategies (for example, bald eagle and osprey nesting and various habitat protection zones for sensitive or state-endangered species) are examples of single-species management approaches that often are achieved cooperatively on private lands but may be required on public lands. Sometimes the term indicator or focal species is used to denote management for a species whose habitat needs closely represent those of a set of others. For example, managing for bats or woodpeckers also would provide habitat for many other cavity-using species such as the flying squirrels. On a larger scale,

managing for ruffed grouse provides habitat for other brushland and young forest species.

The species-diversity approach consists of providing a range of forest wildlife habitats by managing both vertical forest structure and horizontal patchiness. This approach has many applications on both large and small management units. It is based on site conditions and the application of disturbance regimes that historically occurred in the region. Large patch disturbance regimes largely occurred historically on coastal and riparian sites that are now industrial, urban, and suburban areas. Therefore, to achieve wildlife diversity goals, management for larger patch disturbances now need to be incorporated on forest sites that rarely or at very long intervals experienced such disturbances historically.

Habitat manipulation becomes a major tool when the management objective is to increase the variety of wildlife species that potentially can occupy an area. Regardless of the approach, use of standard forest management and silvicultural practices, with some modifications, can be the most efficient way to manage forest wildlife habitats.

Our objective is to provide information in order to manage New England forests for the greatest variety of wildlife that is practical using various types of silvicultural practices. We want to provide either breeding or wintering habitat conditions for all wildlife species that potentially can occupy a given habitat. Individual species can be managed by emphasizing their habitat requirements.

An array of wildlife habitat improvement practices is available to benefit individual species or groups of species. Habitat improvement practices — erecting nest boxes or platforms, planting food patches, creating impoundments, and improving wetland conditions — while useful in certain situations, are beyond the scope of this publication. We refer the reader to the *Techniques for Wildlife Investigations and Management* (Braun 2005), and the *Forestry Handbook* (Wenger 1984) for details on these and other intensive practices.

2

Inventory and Prescription

THIS CHAPTER outlines an inventory procedure to assess current wildlife habitat features for large or small parcels of land. A prescription key is provided to help users determine wildlife habitat needs and establish priorities for wildlife habitat management activities.

Assessment of Habitat Management Opportunities

Before conducting the actual inventory, it is necessary to recognize the types and distribution of forested and nonforested landscapes.

We use four landscape classes with different wildlife habitat opportunities to describe major forested sections of New England (Alerich 2000a, 2000b, 2000c; Frieswyk and Widmann 2000a, 2000b; Griffith and Alerich 1996):

1. *Habitat Opportunity Class I.* Landscapes that are approximately 90 percent forested.
2. *Habitat Opportunity Class II.* Landscapes that are approximately 90 percent forested with more than 5 percent in deep-water and freshwater wetland nonforest types.
3. *Habitat Opportunity Class III.* Landscapes that are approximately 70 percent forested with less than 5 percent in deep-water and freshwater wetland nonforest types.
4. *Habitat Opportunity Class IV.* Landscapes that are approximately 70 percent forested with more than 5 percent in deep-water and freshwater wetland nonforest types.

Identification of such large-scale habitat opportunity classes helps managers to assess the capability of these predominantly forested New England landscapes to provide a range of vegetative compositions (table 3). Smaller

area surveys of vegetative compositions and size-class distributions provide managers with an assessment of a specific piece of landscape in relation to its potential for providing a varied range of habitat opportunities. Because this publication is directed toward maintaining and improving habitat diversity, the resource capability data are crucial to determining what types of vegetative management prescriptions can improve the habitat potential for the

Table 3
Habitat Opportunity Classes and Composition Goals for New England Forested Landscapes, by Percentage of Area

	Habitat opportunity class			
Composition	I	II	III	IV
Habitat breadth				
Forest	>90	>90	70–90	70–90
Nonforest	0–10	<5	5–30	5–30
Water	<5	>5	<5	>5
Krummholz	p/a[a]	p/a	p/a	p/a
Size-class distribution				
Regeneration	5–15	5–15	5–10	5–15
Sapling-pole	30–40	30–40	25–30	30–40
Sawtimber	40–50	40–50	55–65	40–50
Large sawtimber	<10	<10	<10	<10
Cover-type distribution				
Deciduous (not oak)				
Short rotation[b]	5–15	10–25	5–10	5–20
Long rotation[c]	20–35	15–30	20–40	10–20
Hard mast—oak[d]				
Northern New England	1–5	1–5	5–25	1–15
Southern New England	30–50	30–50	5–25	1–15
Coniferous[e]				
Northern New England	35–50	35–60	10–35	25–50
Southern New England	10–40	10–40	10–35	25–50
Nonforest				
Upland openings	3–5	3–5	15–30	5–10
Wetlands	1–3	1–3	1–3	3–5

[a]Presence/absence.
[b]Short-rotation deciduous type includes the aspen–birch group.
[c]Long-rotation deciduous types include northern and swamp hardwoods groups.
[d]Hard mast includes oak–pine and oak–hickory groups.
[e]Coniferous type includes mixes of white/red pine–hemlock and spruce–fir groups.

broadest possible array of wildlife species, while maintaining habitat conditions of those species currently present.

We suggest ranges of mixtures of habitat components for these four habitat opportunity classes as optimal goals for areas of 250 to 2,500 acres that can be used in the prescription development process. The estimates of these ranges can be used for developing prescriptions on both large and small properties (see table 3).

We urge caution when using the prescription process on predominantly upland and wetland nonforested landscapes, where forested stands are the less common features, that is, compose less than 70 percent of the landscape. These broadly defined habitat opportunity classes are based on county-level summaries in New England — areas of at least 235,000 acres.

Inventory

The presence of a wildlife species or community in a specific location often depends on the surrounding habitat conditions. Ownerships smaller than 250 acres need to be examined within a larger context to determine the habitat management opportunities that may be effective and reasonable to pursue within the smaller tract. On very large properties (tens of thousands of acres), the habitat needs of all species, even those with very large home ranges, can be accommodated. On smaller units, typical of southern New England, an extensive survey of the surrounding area to determine the relative cover-type composition should cover up to about ten times the area of the single ownership because, based on a hundred-year rotation and a treatment cycle of ten years, a small ownership represents a single stand within a larger management unit ten times its size. In other words, even on a larger ownership under sustained production, only one-tenth of the area is harvest cut within a ten-year period. Second, consideration of large-scale interdependent relationships is crucial to holistic management of habitats and vegetative landscapes. Finally, parcel size is an effective screen for what realistically can be done with wildlife habitat in the identified area during a ten-year planning period. An extensive survey can be estimated quickly and effectively from aerial photos. For example, for a 10-acre tract, survey 100 acres; for a 50-acre tract, survey approximately 500 acres, and so on. The ten-times extensive survey is an approximate guide; the smaller the managed tract, the more important the larger survey. The concept is not linearly applicable: 2,500 acres around a 250-acre tract is a very large area, and it likely contains a wide array of habitats or even other land uses, especially in southern New England. For large management units, consideration of the surrounding area up to 1,000 acres is probably sufficient. It may be possible with some small ownerships to develop multi-owner management plans if landowners have common interests and are willing to cooperate on a joint land-management venture.

Small ownerships (<250 acres) present very limited opportunities to manage habitat conditions of resident wildlife species with large home ranges such as black bear, deer, and moose, and their diverse habitat requirements on a

year-round basis. However, small ownerships are quite capable of supplying needed habitat components for these species, if the other required habitat components are supplied predictably elsewhere within the surrounding area. Also, smaller ownerships often are capable of fully providing the diversity of habitat features needed by rare resident wildlife species such as the eastern spadefoot or those species with smaller home ranges such as cottontails. Managers of small ownerships need to know something about the diversity of the surrounding area, how it is managed, and the likelihood of those conditions changing in order to exploit the habitat management opportunities presented on a given small property.

Early-successional species, including various migratory species, have habitat needs that are unmet in areas totally removed from active vegetation management. Not even the ten-factor expansion of habitat survey can address adequately the full life-cycle or year-round habitat requirements of species such as chestnut-sided warblers, American redstarts, New England cottontails, among many others, in extensive mature forest conditions in the absence of natural large-scale disturbances. Nevertheless, specific seasonal habitat requirements for such species may be identified and provided for in the subject tract. The position of the subject tract in relation to horizontal and vertical vegetative diversity throughout the larger survey unit is especially relevant in this perspective.

To complete this step of the process, the landscape surrounding the survey tract is described in terms of the features that functionally define or limit access to habitat opportunities, without consideration of political division or current ownership. Natural boundaries such as watershed perimeters, large rivers, and major highways are suitable as approximate boundaries of the inventory unit, while property or county lines are not.

This extensive part of the inventory should provide information on several levels of habitat features for the area surrounding the subject tract. Important general features of the surrounding area that need to be determined include: (1) the relative proportion of available habitats — forest, nonforest, krummholz, and water — to determine the habitat opportunity class; (2) the relative composition of forest cover types; and (3) the relative proportion of upland/wetland nonforest and water types. These general features can be surveyed using an ocular estimation method and aerial photos. Estimates of acreage are sufficient.

The next step of the inventory deals with the subject tract itself. Divide the tract into recognizable stands, identify cover types, and conduct ground inventories, especially of tree data and other within-stand vegetative features, and nonforest habitats. Recording the presence or absence of these features gives some indication of the habitat opportunities available in the subject tract. It also rounds out the vegetative survey in places that a standard timber inventory does not cover. Listing of specific natural or artificial features on the subject tract can be very useful. We have designed a small ownership habitat evaluation form and stand tally sheet to assist a resource manager in this type of integrated vegetation/habitat evaluation (figure 13). A list of the major habitat inventory features and a description of each is included.

Small ownership habitat evaluation form

General Features:

Owner Name:_____ **Location:**_____

Ownership acres:_____ **Description:**_____

Assessment Unit: Forest____% : Nonforest____% : Water____% : Krummholz____%

Forest Composition: Softwood____% : Hardwood____% : Mixed____%

Forest Size Composition: Regeneration____% Sawtimber +_____%

Nonforest Composition: Upland_____% : Wetland_____%

Forest Cover Type Distribution of Ownership (acres):

Cover Type	Regeneration	Sapling-pole	Sawtimber	Large Sawtimber	Uneven-aged	Cover Type Acres	% Forest Type	% Total Acreage
Total							100%	

Nonforest Type Distribution of Ownership (acres): **Water** (acres):

Upland	Wetland	Water
Type | Acres	Type | Acres	Type | Acres
Total ____ _____%	Total ____ _____%	Total ____ _____%

Ownership Summary:

Stand No.	Type Size Density	Acres	Ownership Objectives	Management Opportunities	Prescription Activities

Fig. 13. Small-ownership habitat evaluation form.

Ownership:_____ **Stand No.:**_____ **Acres:**_____ **Prescriber:**_____

Tree Data

Plot___	Plot___	Plot___	Plot___
No. Spec. DBH Qual	No. Spec. DBH Qual	No. Spec. DBH Qual	No. Spec. DBH Qual

Plot___	Plot___	Plot___	Plot___
No. Spec. DBH Qual	No. Spec. DBH Qual	No. Spec. DBH Qual	No. Spec. DBH Qual
Total:BA__ AGS__ UGS__ DGS__ Cull__ Mat__ X__	Total:BA__ AGS__ UGS__ DGS__ Cull__ Mat__ X__	Total:BA__ AGS__ UGS__ DGS__ Cull__ Mat__ X__	Total:BA__ AGS__ UGS__ DGS__ Cull__ Mat__ X__

Within-Stand Features (note presence = very apparent / absence = minimal):

Plot No.	Canopy	Exposed Perches	Inclusions	Large Cavity Tree Boles	Vegetation Layer	Dead / Down
	<30|30-70|>70	High| Low		Dead|Live	Midstory|Shrub| Herb	

Special Habitat, Human-made and/or Visual Features: _____

Stand Summary:

Plot No.	Type Size Density	Basal Area	Key Within Stand Features	Management Possibilities
Stand Presc.				

List and description of habitat inventory features used

General Features:

1. **Forested Cover Types:** Descriptions can be found in *Forest Cover Types of the United States and Canada* (Eyre 1980).
   (a) **Softwoods:** Includes the following types: balsam fir, spruce/fir; spruce; pine; and eastern hemlock. Size classes of particular interest include: 0–10 year/regeneration through seedling class; and mature/small and large sawtimber classes.
   (b) **Hardwoods:** Includes the following types: aspen; paper birch; northern hardwoods; swamp hardwoods; and northern red oak. Size classes of particular interest include: 0–10 year/regeneration through seedling class; and mature/small and large sawtimber classes.
   (c) **Mixed:** Includes the oak-pine type. Size classes of particular interest are the same as hardwoods and softwoods.
2. **Nonforested Cover Types:**
   (a) **Upland:** See descriptions in DeGraaf and Rudis (1986).
   - Grass openings—hayfields, etc.
   - Forb openings—broad-leaved herbaceous cover like goldenrod (*Solidago*), sensitive fern (*Onoclea*), etc.
   - Shrub openings or old fields—abandoned agricultural fields reverting to forest, characterized by grasses, shrubs, and small trees.
   - Pastures—usually too wet or rocky for cultivation.
   - Savanna—grasslands with shrubs and widely scattered trees, resulting from disturbances like fire or grazing.
   - Orchard—fruit trees with a grassy ground cover.

   (b) **Wetland:** Palustrine descriptions can be found in *Classification of Wetlands and Deepwater Habitats of the United States* (Cowardin et al. 1979).
   - Sedge meadow—dominated by sedges (*Carex*) and cattails (*Typha*); surface water depths to 6 inches in winter and spring; soil surface saturated in summer.
   - Shallow marsh—characterized by persistent emergent and floating-leaved aquatic vegetation and water depths to 1.5 feet.
   - Deep marsh—characterized by persistent emergent and floating-leaved aquatic vegetation and water depths to 6 feet.
   - Shrub swamp—dominated by woody vegetation less than 20 feet tall; seasonally or permanently flooded to a depth of 1 foot.
   - Bog—characterized by peat (*Sphagnum*) accumulation; usually a floating mat of vegetation with pitcher plants (*Sarracenia*) and sundew (*Drosera*) common.
   - Pond—permanent water body less than 10 acres, characterized by emergent and floating-leaved aquatic vegetation.
3. **Water:** See lacustrine and riverine descriptions in Cowardin et al. (1979). Deepwater habitats situated in topographic depressions or dammed channels; lacking trees, shrubs, persistent emergents, emergent mosses or lichens with greater than 30 percent areal coverage; and total area exceeds 10 acres. A channeled water flow characterizes riverine habitats.
   (a) Lakes—characterized by water depths greater than 6.5 feet.
   (b) Streams—intermittent or permanent up to 30 cubic feet per second at high flow.
   (c) Rivers—at least 30 cubic feet per second at low flow.
4. **Krummholz:** Subalpine forest and alpine zones usually above 3500 feet characterized by smaller, windsheared trees below timberline; above timberline, characterized by low, shrubby, slow-growing woody plants and ground cover of boreal lichens, sedges and grasses (DeGraaf and Rudis 1986).

Within-Stand Features:

1. **Overstory Canopy Closure:**
   (a) Less than 30%—characteristic of clearcuts, open shelterwood cuts, poorly stocked stands, and nonforested types with scattered trees present.
   (b) 30–70%—characteristic of shelterwood and partial cuts.
   (c) Greater than 70%—characteristic of individual selection cuts and dense first stage shelterwood cuts.
2. **Exposed Perches:** Dead/live woody perches of variable heights above the surrounding forest canopy or herbaceous ground vegetation.
   (a) High—supracanopy and pasture trees characterize hunting perches or nesting sites.
   (b) Low—shrubs, fence posts, and dead stubs less than 10 feet high.
3. **Inclusions:**
   (a) Overstory—coniferous/deciduous inclusions in predominantly hardwood/softwood stands.
   (b) Other—any habitat features too small to be mapped or tallied.
4. **Large Cavity Tree Boles:** Dead/live stems larger than 18 inches dbh with at least two major defects such as large holes, large, broken tops and limbs, and butt rot.
5. **Midstory Layer:** Deciduous/coniferous saplings and poles that occur within the 10–30 feet zone in forested stands; usually beneath an overstory canopy.
6. **Shrub Layer:** Deciduous/coniferous/ericaceous shrubs and seedlings that occur within the 2–10 feet zone in forested and nonforested stands.
7. **Herbaceous Vegetation Layer:** Forbs, grasses, and woody seedlings that occur in the 0–2 foot zone in forested and nonforested stands; usually with a ground coverage range greater than 50%
8. **Dead and Down Material:** Results from stand mortality and harvesting activities; ranging from minimal amounts on biomass harvested stands to maximum amounts on some of the natural areas in New England.

Other Special Habitat Features:

1. Agricultural Fields
2. Cliff/Ledges/Talus/Outcrops
3. Caves
4. Seeps
5. Gravel Pits/Bare Ground/Cut Bank
6. Slash Piles
7. Hard/Soft Mast

Human-made Features:

1. Buildings/Bridges
2. Junk Piles

General features, such as vegetative composition of both forested and nonforested components, should be considered in terms of their percentage of the surrounding area and subject tract. Aerial photos, type maps, and area cover types and size-class inventories are useful tools to complete this procedure. Acreage of brooks, streams, and rivers is hard to estimate. To do so, use a rough width figure that includes the brook, stream, or river and the adjacent riparian area; then multiply by the approximate length.

To develop stand prescriptions, a resource manager needs to: (1) understand the goals of the landowners, (2) inventory and evaluate the resource capability of the subject tract and surrounding area, (3) make some judgment on the likelihood and type of vegetative change in the surrounding area over the next ten- to twenty-year planning period, (4) develop a set of working objectives that addresses the goals of the landowner, and (5) decide on the stand prescriptions that best meet the landowner objectives, realizing that several prescriptions usually are possible for any set of landowner goals and objectives.

PRESCRIPTION KEY

A range of predictable wildlife habitat components around the overall survey area is described for each habitat opportunity class. The user then can find an approximation of the existing condition of these habitat components for a particular survey area. The key recommendations suggest a range of prescriptions and activities to consider in order to manage the subject ownership, given the user's knowledge of land capability of the overall survey area, in addition to the ownership goals, objectives, and limitations (see pages 43–44).

Use the following key to identify the wildlife habitat opportunity class of the overall survey area:

1	Forestland in survey area >90 percent	
	2 Water and wetland nonforest <5 percent	Class I
	2′ Water and wetland nonforest >5 percent	Class II
1′	Forestland in management unit/area approximately 70 percent	
	2 Water and wetland nonforest <5 percent	Class III
	2′ Water and wetland nonforest >5 percent	Class IV

Habitat Opportunity Class I

Ownership size is large (>250 acres); ownership and surrounding survey area (approximately ten times ownership area) is more than 90 percent forested	Prescription key recommendations
1 Upland nonforested and age/size class distribution meet composition objectives; cover types balanced between hardwood and softwood types.	a

Ownership size is large (continued)		Prescription key recommendations
1′	Upland nonforest does not meet composition objectives.	2
2	Age/size-class distribution meets composition objectives; cover types balance hardwood and softwood types.	b
2′	Age/size-class distribution does not meet composition objectives; cover types not balanced between hardwood and softwood types.	b, c

Ownership size is small (<250 acres); ownership and surrounding survey area (approximately ten times ownership area) may be less than 90 percent forested		Prescription key recommendations
1	Ownership and surrounding survey area meets composition objectives; more than 90 percent of survey area is forested; cover types balanced between hardwood and softwood types.	d
1′	Ownership and surrounding survey area does not meet composition objectives.	2
2	Upland and wetland nonforest and water components comprise more than 10 percent of the survey area; cover type composition may or may not be balanced between hardwood and softwood types.	d, e
2′	Upland and wetland nonforest and water components comprise no more than 10 percent of the survey area; cover type composition unbalanced.	f

Habitat Opportunity Class II

Ownership size is large (>250 acres); ownership and surrounding survey area (approximately ten times ownership area) is more than 90 percent forested; wetland nonforest and water components are greater than 5 percent of the area		Prescription key recommendations
1	Upland nonforest and age/size-class distribution meet composition objectives; cover-type composition is heavier to softwoods than hardwoods; water-influenced components present.	g
1′	Upland nonforest distribution does not meet composition objectives; water-influenced components may or may not be present.	2
2	Upland and wetland nonforest and water components comprise more than 10 percent of the surrounding survey area; cover-type composition may or may not be heavier to softwoods than hardwoods; water-influenced components present.	c, g
2′	Upland and wetland nonforest and water components comprise less than 5 percent of the surrounding survey area; cover-type composition may or may not be heavier to softwoods than hardwoods; water-influenced components not present.	b, c

Ownership size is small (>250 acres); ownership and surrounding survey area (approximately ten times ownership area) may be less than 90 percent forested with a wetland nonforest and water component greater than 5 percent of the area		Prescription key recommendations
1	Ownership and surrounding survey area meets composition objectives; more than 90 percent forested; cover-type composition is heavier to softwoods than hardwoods; water-influenced components present.	d, g
1′	Ownership and surrounding survey area does not meet composition objectives.	2
2	Upland and wetland nonforest and water components comprise more than 10 percent of the survey area; cover-type composition may or may not be heavier to softwoods than hardwoods; water-influenced components present.	d, e, g
2′	Upland and wetland nonforest and water components comprise no more than 10 percent of the survey area; cover-type composition far from the desired composition; water-influenced components not present.	f

Habitat Opportunity Class III

Ownership is large (>250 acres); ownership and surrounding survey area (approximately ten times ownership area) is approximately 70 percent forested with a wetland nonforest and water component less than 5 percent of the area		Prescription key recommendations
1	Upland and wetland nonforest and water components meet composition objectives; cover types balanced between hardwood and softwood types.	h
1′	Upland and wetland nonforest and water components do not meet composition objectives.	2
2	Upland and wetland nonforest and water components comprise more than 40 percent of the area; age/size-class distributions and cover-type compositions may or may not meet composition objectives.	c, i
2′	Upland and wetland nonforest and water components comprise less than 15 percent of the area; age/size-class distributions and cover-type compositions may or may not meet composition objectives.	b, c

Ownership is small (<250 acres); ownership and surrounding survey area (approximately ten times ownership area) may be less than 70 percent forested with wetland nonforest and water components less than 5 percent of the area		Prescription key recommendations
1	Ownership and surrounding survey area meets composition objectives; approximately 70 percent of the area is forested; cover-type composition may or may not meet composition objectives.	d, h

Ownership is small (continued)		Prescription key recommendations
1′	Ownership and surrounding survey area is less than 70 percent forested; composition of the survey area may not meet objectives.	2
2	Upland and wetland nonforest and water components of the survey area comprise more than 30 percent of the area.	d, e
2′	Upland and wetland nonforest and water components of the survey area comprise less than 10 percent of the area.	d, f

Habitat Opportunity Class IV

Ownership size is large (>250 acres); ownership and surrounding survey area (approximately ten times ownership area) is approximately 70 percent forested; wetland nonforest and water components greater than 5 percent of the area		Prescription key recommendations
1	Upland and wetland nonforest and water components; and age/size-class distribution meet composition and age/size-class objectives; cover-type compositions heavier to softwoods than hardwoods; water-influenced components present.	g, h
1′	Upland and wetland nonforest and water components may or may not meet composition objectives; cover-type composition may be heavier to softwoods than hardwoods; water-influenced components may or may not be present.	2
2	Upland and wetland nonforest and water components comprise more than 30 percent of the surrounding area; cover-type composition may or may not be heavier to softwoods than hardwoods; water-influenced components present.	c, g, i
2′	Upland and wetland nonforest and water components comprise less than 10 percent of the surrounding area; cover-type composition may or may not be heavier to softwoods than hardwoods; water-influenced components not present.	b, c

Ownership size is small (<250 acres); ownership and surrounding area (approximately ten times ownership) may be less than 70 percent forested; wetland nonforest and water components greater than 5 percent of the area		Prescription key recommendations
1	Ownership and surrounding survey area meets composition objectives; approximately 70 percent of the area is forested; cover-type composition is heavier to softwoods than hardwoods; water-influenced components present.	d, g
1′	Ownership and surrounding survey area does not meet composition objectives.	2
2	Upland and wetland nonforest and water components comprise more than 30 percent of the survey area; cover-type composition may or may not be heavier to softwoods than hardwoods; water-influenced components present.	d, e, g

2'	Upland and wetland nonforest and water components comprise no more than 10 percent of the survey area: cover-type composition far from the desired composition; water-influenced components not present.	d, f

PRESCRIPTION KEY RECOMMENDATIONS

a. Within balanced cover-type composition, consider the following small-scale manipulations:
   (1) maintain aspen–birch short rotation component;
   (2) maintain quantity and juxtaposition of regenerating acreage in the surrounding area;
   (3) increase the hard mast component (oak and beech primarily);
   (4) improve quality and juxtaposition of dense conifer thermal cover;
   (5) continue upland nonforest opening maintenance;
   (6) recognize, protect, maintain, and develop within-stand features throughout the area where possible (for example, high exposed perches, raptor nesting sites, heron rookeries, large-diameter cavity/den trees, shrub layers, herbaceous vegetation, dead and down material, water influence zones, wet swales, and so on), and where needed;
   (7) recognize, protect, maintain, and develop special habitat (for example, cliffs and ledges, talus, outcrops, and caves) and human-made features (for example, agricultural fields, gravel pits, old buildings, bridge supports, and so on) where necessary.

b. Consider developing the upland nonforest opening component as a part of the logging operation using cleared and seeded log landings (>1/3 acre in size) and skid trails and roads to provide soft mast, shrub production, and an herbaceous and grassy ground cover and forage. Continue with recommendation a.

c. Evaluate the ownership area for opportunities to convert or maintain stand composition and structure according the following priority considerations: (1) site capability; (2) gradual attainment of the composition objectives; (3) current markets; and (4) within-stand features diversity. Look for opportunities to place key cover-type conditions where they can contribute needed habitat components to the surrounding area and still be re-entered for future treatment (for example, multiple size classes of aspen–birch and mixed hardwoods nearby in smaller sized stands for species such as ruffed grouse; herbaceous and grassy openings adjacent to aspen and conifer cover; distribution of dense conifer thermal cover, hard mast, regenerating hardwood opportunities throughout the area). Continue with recommendation a.

d. Consider maintaining and developing as broad a range of growing stock conditions and sizes as possible, given the broad diversity of ownership goals and objectives present in populations of small landowners, site capability, and current market conditions. There is an opportunity to capitalize on the high levels of horizontal and vertical diversity that can occur when many small ownerships form these larger habitat management units. Conversion or maintenance of cover types depend on landowners' goals, management intensity, and aesthetic considerations. Within-stand feature manipulation and development probably will be emphasized to a greater extent in these situations. Continue with recommendation a.

e. Maintain upland and wetland nonforest and aquatic habitat diversity.

f. Look for opportunities to provide increased vertical diversity through intermediate treatments of existing stands that have limited conversion opportunities due to levels of management intensity, aesthetic considerations, or other landowner concerns. Look for regeneration and conversion opportunities at a smaller scale whenever possible. Consider developing the upland nonforest opening component as part of the aesthetic development of the ownership through vegetative manipulation. Continue with recommendation a.

g. Consider the management of water-influenced components or riparian zones carefully. These zones present more habitat management opportunities for increased vertical structural diversity than most upland stands. Transition zones such as these can be very important to wildlife species with significantly different habitat requirements for forested/nonforested nesting and denning, and aquatic feeding locations (for example, ducks, bald eagle, osprey, various herons, and furbearers such as mink and otter). Consider protecting, developing, and maintaining different types of water-influenced components for a broad range of species through appropriate vegetative manipulation practices. Protect and develop special within-stand features such as high exposed perches and nest trees for herons, eagles and ospreys; large-diameter cavity and den trees; a dead and down woody component for various moist-ground dwelling species such as redback salamanders and ringneck snakes; and dense conifer stands where necessary and desired, primarily for deer winter cover. Consider developing an aspen–birch component adjacent to these transition zones especially if it will be maintained by beaver. Continue with recommendation a.

h. Maintain the diversity of upland nonforest cover types (for example, pastures, orchards, cultivated fields, old fields, and grass and forb openings) periodically. Maintain and develop the hard mast (primarily oak, beech, and hickories) component where possible. Maintain and develop a density of large-diameter cavity trees sufficient to provide adequate denning and nesting opportunities. Continue with recommendation a.

i. Maintain or enhance the diversity of upland nonforest cover types (for example, pastures, orchards, cultivated fields, old fields, and grass and forb openings) periodically.

Working with Private Landowners

Most forest landowners enjoy seeing wildlife or signs of wildlife use on their land. Many would like to improve habitat conditions but are unsure of what to do; often they do nothing or make only small investments in planting shrubs or placing nest boxes. Such practices, while enjoyable, do not enhance wildlife populations. Sometimes the first step in working with private landowners is realizing that many of them value privacy, tranquility, and wildlife more than wood products. Enhancing wildlife diversity depends upon creating and maintaining a mix of age-classes, so it is important to help landowners translate their desires into specific goals. A recent publication, *Landowner's Guide to Wildlife Habitat: Forest Management for the New England Region*, (R. M. DeGraaf, M. Yamasaki, W. B. Leak, and A. M. Lester, Hanover, N.H.: University Press of New England, 2005) is designed to help landowners manage their lands as wildlife habitat through a basic understanding of species habitat requirements, silvicultural options, and developing goals. The best way to accomplish those goals is through the services of a professional forester.

Successfully meeting private landowners' wildlife habitat management goals requires clear articulation of several realities. These include an honest description of temporary unsightliness, a discussion of expectations of wildlife use of treated areas, the need for even-aged methods and frequent treatments for effective wildlife habitat management, and a clear statement of why letting nature take its course will not enhance wildlife diversity.

Often landowners will ask why we can't just let nature take its course to provide for wildlife. It's useful to recall that before European settlement,

when nature *was* free to take its course, habitats for all native wildlife species were being created continuously in a shifting mosaic as natural disturbances occurred and the forest regrew. Now, those natural agents of forest disturbance that created grasslands, shrublands, and young forest—to which so many New England species are adapted—are, for the most part, no longer at work. Native prairies were developed soon after settlement, wildfire is no longer tolerated or practical, Native American agriculture and burning are no more, and beaver, once again abundant, are greatly restricted in their range and activities by stream channel controls. So we can't just "leave it alone and let nature take its course" and expect all wildlife species to thrive. Doing so would start with the false premise that we're dealing with a natural forest situation. We're not—350 years of land use, abuse, and control or elimination of most sources of natural disturbance have resulted in soil changes in most former agricultural areas and an extensive, even-aged mature forest, broken not by burns or beaver flowages but by cities, suburbs, and highways. In order to keep early-successional habitats on the landscape for the wildlife species that need them, we need to create them intentionally and continuously. Leaving the forest alone—letting nature take its course—will allow the forest to become ever-more homogeneous, and as it ages and becomes similar to the rest of the forests in the region, wildlife diversity will continue to decline.

New England forests are not tending toward some ideal pre-colonial condition—there is none. Many different vegetative conditions have existed over the past twelve thousand years in post-glacial New England: steppe, spruce, parkland, grasslands, and open forest maintained by large browsing ungulates and mastodonts (Askins 2000, 17). Hunter-gatherers occupied mixed forest, and then Native Americans began agriculture about fifteen hundred years ago. Native American retreats and declines after the earliest European settlement resulted in the densely forested interior that was cleared for agriculture a century later (DeGraaf and Miller 1996). The New England landscape always has been in a state of change. Now the extent of homogeneous mature forest probably exceeds that which existed at any time previously. Managing for conditions that existed at any particular time is arbitrary and no more "natural" than any of the previous ones. We need to accept reality and manage the forests that exist now as a result of past human uses of the land, and enhance wildlife habitats in that context. No landscape condition is intrinsically ideal or "natural"; we shape the land, and our actions—whether use, abuse, or neglect—dictate which species will thrive and which will decline. In that sense, nature is what we make it. All species will not survive if we do nothing. Active vegetation management is now critically required to maintain the diversity of New England's wildlife for future generations.

Once a landowner is committed to improve forest wildlife habitat, the need for treatments of sufficient size and frequency can be addressed. The character of the surrounding landscape is an important guide. In extensively forested areas, periodic creation of large silvicultural openings will have dramatic effects on wildlife populations. In areas where extensive wetlands and agriculture are present, there is less need for such treatment. The initial, temporary unsightliness of slash is a real concern for some landowners, but a

Fig. 14a and 14b. Some consider logging slash unsightly; however, in New England it is quite temporary. Smaller pieces decompose within a few years and large pieces provide coarse woody debris used by several species. Shown here (a) is a winter-logged Massachusetts oak–pine stand in the following early summer and (b) the adjacent stand logged five years earlier. Photos by Richard M. DeGraaf.

demonstration of how rapidly a typical New England site greens over is often well received (figure 14).

Most forestland in New England and in the northeastern United States and adjacent Canada is privately owned. On large ownerships, the whole range of habitat conditions needed for the region's wildlife can be provided through forest management. On smaller ownerships, the most effective habitat management practices will take into account the character of the surrounding landscape and will result from the cooperative management of several adjoining ownerships.

3

Habitat Relationships

Habitat-Breadth Combinations

WILDLIFE USE of various habitat combinations on a year-round basis should be examined before making forest management decisions. Examining habitat combinations provides some sense of the species diversity that results from landscape diversity; and these combinations serve to place management in a landscape context. Landscapes with significant proportions of nonforested and aquatic habitats will be inherently more diverse than landscapes that are totally forested. Maintaining or increasing habitat diversity on totally forested landscapes will of course increase wildlife species diversity but it will be lower than that found on more diverse landscapes — those that include a range of nonforest and aquatic habitats, high elevation forests, and the like. Species occurrences and utilization of forested and nonforested habitats are provided in Appendixes A and B, respectively. Habitat-breadth combinations are provided in Appendix C. By taking the four seasonal/functional use combinations and finding the least common denominator for each species, we can identify groups of species that use similar combinations of habitats on a year-round basis.

For example, if we take four general habitat categories such as forest, nonforest, krummholz (including subalpine forest), and water, there are fifteen possible combinations of these categories. **Note:** There is no implication that these species occur together in time or space. They do not in any sense constitute a community or necessarily respond to forest management in similar ways. These lists are useful, however, to show how wide or narrow a range of general habitat categories species utilize in the annual cycle. For example, most New England species can be found in the region's forests, but a fairly small subset is found *only* in forests. Be aware of species ranges when using these habitat-breadth combinations; see DeGraaf and Yamasaki (2001).

Habitat-breadth combinations contain several important management implications. Obviously, the forest–nonforest combination is the most important category; it describes most of the New England landscape and benefits

most species. If a land manager is dealing with a forested condition such as an extensive, homogeneous, unbroken forest tract that benefits several dozen species, and the management objective is to increase habitat diversity, an obvious decision would be to establish a variety of nonforest components that would attract many more species. If enough large (>100 acres) nonforest habitats are added, potentially several dozen more species are added.

We list species groups for ten of these habitat-breadth categories (not all possible combinations have species that utilize them in New England; see table 4). The following section lists wildlife species' occurrence within habitat-breadth categories and indicates parenthetically their coniferous (C)

Table 4
Number of Species That Use Various Habitat-breadth Combinations for 338 Wildlife Species in New England, by Taxonomic Class

Habitat-breadth combination	No. of species	Percent of total	A[a]	R	B	M
One habitat						
Forest	24	7	2	3	17	2
Nonforest	42	12			39	3
Water	8	2		1	7	
Krummholz[b]						
Two habitats						
Forest–Krummholz	9	3			6	3
Forest–Nonforest	144	43	6	9	106	23
Forest–Water	3	1	2		1	
Nonforest–Water	29	9	2	7	19	1
Krummholz–Water[b]						
Nonforest–Krummholz[b]						
Three habitats						
Forest–Krummholz–Nonforest	30	9	1		13	16
Forest–Nonforest–Water	44	13	10	5	14	15
Nonforest–Krummholz–Water[b]						
Forest–Krummholz–Water[b]						
Four habitats						
Forest–Krummholz–Nonforest–Water	5	1		1	3	1
Total	338	100	23	26	225	64

[a]A = Amphibians, R = Reptiles, B = Birds, and M = Mammals (includes wolf and mountain lion).
[b]These habitat-breadth combinations are utilized by no species in New England.

and deciduous (D) or upland (U) and wetland (W) type preferences, if any.
Note: Species that are regionally uncommon are noted with an asterisk.

Wildlife Species That Use Forested Habitats Exclusively, No Matter What Type or Size-Class

Amphibians

Northern redback salamander, northern slimy salamander

Reptiles

Five-lined skink (D), *northern copperhead (D), *timber rattlesnake (D)

Birds

Pileated woodpecker, Acadian flycatcher (D), yellow-throated vireo (D), blue-headed vireo, veery, Swainson's thrush, wood thrush, magnolia warbler (C), Cape May warbler (C), black-throated blue warbler, black-throated green warbler, Blackburnian warbler, pine warbler (C), cerulean warbler (D), worm-eating warbler (D), ovenbird, scarlet tanager

Mammals

Gray squirrel, northern flying squirrel

Wildlife Species That Use Forest and Krummholz Habitats during the Year

Birds

Gray jay (C), golden-crowned kinglet, Bicknell's thrush (C), blackpoll warbler (C), red crossbill (C), white-winged crossbill

Mammals

Long-tailed shrew, red squirrel, American marten

Wildlife Species That Use Forest, Krummholz, and Nonforest Habitats during the Year

Amphibians

Wood frog

Birds

Spruce grouse (CW), great horned owl, yellow-bellied flycatcher (CW), black-capped chickadee (U), boreal chickadee (CW), red-breasted nuthatch, ruby-crowned kinglet (CW), American robin, yellow-rumped warbler, fox sparrow (U), white-throated sparrow (U), dark-eyed junco (U), pine grosbeak (U)

Mammals

Pygmy shrew, northern short-tailed shrew, snowshoe hare, eastern chipmunk (U), deer mouse (U), white-footed mouse, southern red-backed vole, rock vole (U), southern bog lemming, *northern bog lemming (C), porcupine, fisher, ermine, long-tailed weasel, lynx (W), bobcat

Wildlife Species That Use Forest, Krummholz, Nonforest, and Water Habitats during the Year

Reptiles

Common garter snake

Birds

*Golden eagle, peregrine falcon, common raven (W)

Mammals

Moose

Wildlife Species That Use Forest and Nonforest Habitats during the Year

Amphibians

Marbled salamander (W), Jefferson salamander (W), blue-spotted salamander (W), spotted salamander (W), eastern spadefoot (CU), northern spring peeper (W)

Reptiles

Northern brown snake, northern redbelly snake, eastern hognose snake, northern ringneck snake (U), eastern worm snake (U), northern black racer, eastern smooth green snake, black rat snake (DU), eastern milk snake (U)

Birds

Turkey vulture (U), sharp-shinned hawk (U), Cooper's hawk (U), northern goshawk (U), red-shouldered hawk (W), broad-winged hawk (U), red-tailed hawk (U), American kestrel, merlin (CW), ruffed grouse (U), wild turkey (U), northern bobwhite (CU), American woodcock, mourning dove (U), black-billed cuckoo, yellow-billed cuckoo (DU), eastern screech-owl, *northern hawk-owl (CW), barred owl (U), great gray owl, *long-eared owl, *boreal owl (CW), northern saw-whet owl (U), common nighthawk, whip-poor-will (U), ruby-throated hummingbird (U), *red-headed woodpecker (DU), red-bellied woodpecker (U), yellow-bellied sapsucker (U), downy woodpecker (U), hairy woodpecker (U), three-toed woodpecker (CW), black-backed woodpecker (CW), northern flicker (U), olive-sided flycatcher (W), eastern wood-pewee (U), alder flycatcher (W), willow flycatcher (DU), least flycatcher (U), eastern phoebe (U), great crested flycatcher (U), eastern kingbird (D), *loggerhead shrike (C), *northern shrike, white-eyed vireo (D), warbling vireo (DU), Philadelphia vireo (U), red-eyed vireo (U), blue jay (U), American crow (U), cliff swallow, tufted titmouse (U), white-breasted nuthatch (U), brown creeper, Carolina wren (DU), house wren (DU), winter wren (W), blue-gray gnatcatcher (D), eastern bluebird (U), hermit thrush, gray catbird, northern mockingbird (DU), brown thrasher (U), Bohemian waxwing (U), cedar waxwing, blue-winged warbler (D), golden-winged warbler (DU), Tennessee warbler, Nashville warbler, northern parula (W), yellow warbler, chestnut-sided warbler (D), prairie warbler (U), palm warbler (CW), bay-breasted warbler (CU), black-and-white warbler, American redstart (U), northern waterthrush (W), mourning warbler, common yellowthroat, hooded warbler (D), Wilson's warbler (CW), Canada warbler (W), *yellow-breasted chat (DU), eastern towhee (U), American tree sparrow, chipping sparrow (U), field sparrow (U), song sparrow, Lincoln's sparrow, swamp sparrow (DW), northern cardinal, rose-breasted grosbeak (U), indigo bunting (U), red-winged blackbird (D), rusty blackbird, brown-headed cowbird, orchard oriole (DU), Baltimore oriole (DU), purple finch (U), house finch (U), common redpoll, hoary redpoll, pine siskin, American goldfinch, evening grosbeak (U)

Mammals

Virginia opossum (D), masked shrew, smoky shrew (W), least shrew (D), hairy-tailed mole (U), eastern mole (DU), eastern cottontail, New England cottontail, *European hare (DU), woodchuck (U), southern flying squirrel (DU), meadow vole, woodland vole (DU), meadow jumping mouse, woodland jumping mouse, coyote, red fox, gray fox, raccoon, striped skunk, white-tailed deer

Wildlife Species That Use Forest, Nonforest, and Water Habitats during the Year

Amphibians

Red-spotted newt (W), northern dusky salamander (W), four-toed salamander (W), eastern American toad, Fowler's toad, gray treefrog (DW), green frog (DW), mink frog (DW), northern leopard frog (D), pickerel frog (D)

Reptiles

Spotted turtle, wood turtle, eastern box turtle, Blanding's turtle, ribbon snake (W)

Birds

Great blue heron, green heron (DW), wood duck (DW), American black duck (D), common goldeneye (W), hooded merganser (W), common merganser (W), purple martin, tree swallow, northern rough-winged swallow, bank swallow, barn swallow, Louisiana waterthrush (DW), common grackle

Mammals

Water shrew (W), star-nosed mole (W), little brown myotis, northern long-eared bat, Indiana myotis, eastern small-footed myotis, silver-haired bat, eastern pipistrelle, big brown bat, red bat, hoary bat, beaver (W), black bear, mink (W), river otter (W)

Wildlife Species That Use Forest and Water Habitats during the Year

Amphibians

Northern spring salamander, northern two-lined salamander

Birds

Bald eagle

Wildlife Species That Use Nonforest Habitats Exclusively during the Year

Birds

Least bittern, snowy egret (W), cattle egret (U), black-crowned night-heron (W), yellow-crowned night-heron (W), glossy ibis (W), American wigeon (W), blue-winged teal (W), northern shoveler (W), northern pintail (W), green-winged teal (W), northern harrier, rough-legged hawk, *gray partridge (U), ring-necked pheasant (U), king rail (W), Virginia rail (W), sora (W), killdeer, upland sandpiper (U), common snipe, rock dove (U), *barn owl (U), snowy owl, short-eared owl, chimney swift, horned lark (U), sedge wren (W), marsh wren (W), European starling (U), American pipit (U), vesper sparrow, savannah sparrow, grasshopper sparrow (U), Lapland longspur (U), snow bunting, bobolink, eastern meadowlark (U), house sparrow (U)

Mammals

Black-tailed jackrabbit (U), Norway rat (U), house mouse (U)

Wildlife Species That Use Nonforest and Water Habitats Exclusively during the Year

Amphibians

Common mudpuppy (W), bullfrog (W)

Reptiles

Common snapping turtle, bog turtle (W), map turtle (U), *northern red-bellied cooter, painted turtle, common musk turtle, northern water snake (W)

Birds

Pied-billed grebe (W), American bittern (W), great egret (W), little blue heron (W), Canada goose, mute swan, gadwall (W), mallard, canvasback (W), ring-necked duck (W), red-breasted merganser (W), common moorhen (W), American coot (W), willet (W), spotted sandpiper, ring-billed gull, black tern (W), belted kingfisher (W), fish crow (W)

Mammals

Muskrat (W)

Wildlife Species That Use Water Habitats Exclusively during the Year

Reptiles

Eastern spiny softshell

Birds

Common loon, double-crested cormorant, bufflehead, osprey, herring gull, great black-backed gull, common tern

Size-Class Combinations

The use of different size-class combinations by wildlife species on a year-round basis, or when they are present, can be examined in the same manner as habitat-breadth combinations (see Appendix C). There are fifteen possible forested combinations of four general size-class categories (for example, regeneration through seedlings, sapling through poletimber, sawtimber, large sawtimber). We need to include a category for those species that do not occur in forested habitats. Thus there are a total of sixteen possible size-class combinations. **Note:** As with the habitat-breadth combinations, the listed species do not necessarily occur together. Some, especially the disturbance-dependent ones, are generally quite restricted to early-successional habitat conditions. Be aware of the species' ranges when using these size-class combinations; see DeGraaf and Yamasaki (2001).

We report species groups for eight of these size-class combinations (not all combinations are utilized by species in New England; see table 5). The following section lists wildlife occurrence within the size-class combinations.

In the list that follows, habitat-breadth occurrence is indicated parenthetically: C = Coniferous forest cover types, K = Krummholz type, D = Deciduous forest cover types, U = Upland nonforest types, W = Wetland nonforest types, and Wa = Water (lakes, streams, and rivers). **Note:** Species that are regionally uncommon are noted with an asterisk.

Wildlife species that use regeneration, sapling-pole, sawtimber, and large sawtimber size-classes constitute a large group that either uses distinct vegetative features found in the four different size-class conditions throughout the year, uses habitat features found in all conditions, or disregards size-class conditions, as resource managers may perceive them.

Wildlife Species That Use Regeneration, Sapling-pole, Sawtimber, and Large Sawtimber Size-classes during the Year

Amphibians

Marbled salamander (DCW), Jefferson salamander (DCW), blue-spotted salamander (DCW), spotted salamander (DCW), red-spotted newt (DCW-Wa), northern dusky salamander (DCW-Wa), northern redback salamander (DC), northern slimy salamander (DC), four-toed salamander (DCW-Wa), northern spring salamander (DC-Wa), northern two-lined salamander (DC-Wa), eastern American toad (DCUW-Wa), Fowler's toad (DCUW-Wa), gray treefrog (DW-Wa), green frog (DW-Wa), mink frog (DW-Wa), wood frog (DCKUW), pickerel frog (DUW-Wa)

Table 5
Number of Wildlife Species That Use Various Size-class Combinations in New England, by Habitat-breadth Combinations and Taxonomic Class

			Habitat-breadth combinations										Taxonomic class			
Size-class combinations	No. of species	Percent of total	F[a]	FK	FKN	FKNW	FN	FNW	FW	N	NW	W	A[b]	R	B	M
No size-class affinity	79	23								42	29	8	2	8	65	4
One size class																
Regeneration only	40	12			1	1	34	4						1	35	4
Sapling-pole only[c]																
Sawtimber only[c]																
Large sawtimber only[c]																
Two size classes																
Regeneration–Sapling-pole	7	2	1		1		5								4	3
Regeneration–Sawtimber[c]																
Regeneration–Large sawtimber[c]																
Sapling-pole–Sawtimber[c]																
Sapling-pole–Large sawtimber[c]																
Sawtimber–Large sawtimber	20	6	7				8	4	1						17	3
Three size classes																
Regeneration–Sapling-pole–Sawtimber[c]																
Regeneration-Sapling-pole-Large Sawtimber[c]																
Regeneration–Sawtimber–Large sawtimber	18	5					10	8							8	10
Sapling-pole–Sawtimber–Large sawtimber	32	10	8	2	3		16	3					3	6	22	1
Four size classes																
Regeneration–Sapling-pole–Sawtimber–Large sawtimber	142	42	8	7	25	4	71	25	2				18	11	74	39
Total	338	100	24	9	30	5	144	44	3	42	29	8	23	26	225	64

[a]F = Forest, FK = Forest–Krummholz, FN = Forest–Nonforest, FKN = Forest–Krummholz–Nonforest, FKNW = Forest–Krummholz–Nonforest–Water, FNW=Forest-Nonforest-Water, FW = Forest–Water, N = Nonforest, NW = Nonforest–Water, and W = Water.

[b]A = Amphibians, R = Reptiles, B = Birds, and M = Mammals (includes wolf and mountain lion).

[c]These size-class combinations are utilized by no species in New England.

Reptiles

Spotted turtle (DCUW-Wa), wood turtle (DCUW-Wa), eastern box turtle (DCUW-Wa), Blanding's turtle (DCUW-Wa), five-lined skink (D), northern brown snake (DCUW), common garter snake (DCKUW-Wa), ribbon snake (DCW-Wa), northern black racer (DCUW), black rat snake (DU), eastern milk snake (DCU)

Birds

Green heron (DW-Wa), American black duck (DUW-Wa), sharp-shinned hawk (DCU), Cooper's hawk (DCU), northern goshawk (DCU), peregrine falcon (DCKUW-Wa), ruffed grouse (DCU), spruce grouse (CKW), wild turkey (DCU), mourning dove (DCU), black-billed cuckoo (DCUW), yellow-billed cuckoo (DU), eastern screech-owl (DCUW), great horned owl (DCKUW), *northern hawk-owl (CW), barred owl (DCU), *great gray owl (DCUW), *long-eared owl (DCUW), *boreal owl (CW), northern saw-whet owl (DCU), common nighthawk (DCUW), whip-poor-will (DCU), ruby-throated hummingbird (DCU), *red-headed woodpecker (DU), downy woodpecker (DCU), black-backed woodpecker (CW), northern flicker (DCU), yellow-bellied flycatcher (CKW), *northern shrike (DCUW), red-eyed vireo (DCU), gray jay (CK), blue jay (DCU), common raven (DCKW-Wa), tree swallow (DCUW-Wa), black-capped chickadee (DCKU), Carolina wren (DU), house wren (DU), winter wren (DCW), golden-crowned kinglet (DCK), ruby-crowned kinglet (CKW), veery (DC), Bicknell's thrush (CK), Swainson's thrush (DC), hermit thrush (DCUW), wood thrush (DC), American robin (DCKUW), gray catbird (DCUW), cedar waxwing (DCUW), Nashville warbler (DCUW), black-throated blue warbler (DC), pine warbler (C), bay-breasted warbler (CU), blackpoll warbler (CK), black-and-white warbler (DCUW), American redstart (DCU), northern waterthrush (DCW), Louisiana waterthrush (DW-Wa), common yellowthroat (DCUW), Canada warbler (DCW), eastern towhee (DCU), chipping sparrow (DCU), white-throated sparrow (DCKU), dark-eyed junco (DCKU), northern cardinal (DCUW), rose-breasted grosbeak (DCU), rusty blackbird (DCUW), common grackle (DCUW-Wa), brown-headed cowbird (DCUW), orchard oriole (DU), pine grosbeak (DCKU), purple finch (DCU), house finch (DCU), pine siskin (DCUW), American goldfinch (DCUW)

Mammals

Virginia opossum (DUW), masked shrew (DCUW), water shrew (DCW-Wa), smoky shrew (DCW), long-tailed shrew (DCK), pygmy shrew (DCKUW), northern short-tailed shrew (DCKUW), hairy-tailed mole (DCU), red bat (DCUW-Wa), hoary bat (DCUW-Wa), snowshoe hare (DCKUW), eastern chipmunk (DCKU), red squirrel (DCK), beaver (DCW-Wa), deer mouse (DCKU), white-footed mouse (DCKUW), southern red-backed vole (DCKUW), rock vole (DCKU), woodland vole (DU), southern bog lemming (DCKUW), *northern bog lemming (CKUW), woodland jumping mouse (DCUW), porcupine (DCKUW), coyote (DCUW), red fox (DCUW), gray fox (DCUW), black bear (DCUW-Wa), raccoon (DCUW), American marten (DCK), fisher (DCKUW), ermine (DCKUW), mink (DCW-Wa), striped skunk (DCUW), lynx (DCKW), bobcat (DCKUW), white-tailed deer (DCUW), moose (DCKUW-Wa)

Wildlife Species That Use Sapling-pole, Sawtimber, and Large Sawtimber Size-classes during the Year

Amphibians

Eastern spadefoot (CU), northern spring peeper (DCW), northern leopard frog (DUW-Wa)

Reptiles

Northern redbelly snake (DCUW), eastern hognose snake (DCUW), northern ringneck snake (DCU), eastern worm snake (DCU), *northern copperhead (D), *timber rattlesnake (D)

Birds

Wood duck (DW-Wa), yellow-bellied sapsucker (DCU), eastern wood-pewee (DCU), least flycatcher (DCU), blue-headed vireo (DC), boreal chickadee (CKW), tufted titmouse (DCU), red-breasted nuthatch (DCKUW), white-breasted nuthatch (DCU), brown creeper (DCUW), blue-gray gnatcatcher (DUW), northern parula (DCW), Cape May warbler (C), yellow-rumped warbler (DCKUW), black-throated green warbler (DC), Blackburnian warbler (DC), ovenbird (DC), scarlet tanager (DC), Baltimore oriole (DU), red crossbill (CK), white-winged crossbill (DCK), evening grosbeak (DCU)

Mammals

River otter (DCW-Wa)

Wildlife Species That Use Regeneration, Sawtimber, and Large Sawtimber Size-classes during the Year Tend to Use the Regenerating Forest Habitat Condition for Foraging Activities and the Mature and Overmature Forest Habitat Conditions for Suitable Nesting and Roosting Activities

Birds

Turkey vulture (DCU), red-shouldered hawk (DCW), broad-winged hawk (DCU), red-tailed hawk (DCU), northern bobwhite (CU), olive-sided flycatcher (DCW), American crow (DCU), hooded warbler (DUW)

Mammals

Eastern mole (DU), star-nosed mole (DCW-Wa), little brown myotis (DCUW-Wa), northern long-eared bat (DCUW-Wa), Indiana myotis (DCUW-Wa), eastern small-footed myotis (DCUW-Wa), silver-haired bat (DCUW-Wa), eastern pipistrelle (DCUW-Wa), big brown bat (DCUW-Wa), woodchuck (DCU)

Wildlife Species That Use Only Regeneration and Sapling-pole Size-classes during the Year

Birds

American woodcock (DCUW), Philadelphia vireo (DCU), chestnut-sided warbler (DUW), Magnolia warbler (C)

Mammals

New England cottontail (DCUW), meadow jumping mouse (DCUW), long-tailed weasel (DCKUW)

Wildlife Species That Use Only Sawtimber and Large Sawtimber Size-classes during the Year

Birds

Great blue heron (DCUW-Wa), common goldeneye (DCW-Wa), hooded merganser (DCW-Wa), common merganser (DCW-Wa), bald eagle (DC-Wa), merlin (CW), red-bellied woodpecker (DCU), hairy woodpecker (DCU), three-toed woodpecker (CW), pileated woodpecker (DC), eastern phoebe (DCU), Acadian flycatcher (D), great crested flycatcher (DCU), yellow-throated vireo (D), warbling vireo (DU), cerulean warbler (D), worm-eating warbler (D)

Mammals

Gray squirrel (DC), southern flying squirrel (DU), northern flying squirrel (DC)

Wildlife Species That Use Regenerating Stands Only during the Year

Reptiles

Eastern smooth green snake (DCUW)

Birds

*Golden eagle (DCKUW-Wa), American kestrel (DCUW), alder flycatcher (DCW), willow flycatcher (DU), eastern kingbird (DUW), *loggerhead shrike (CUW), white-eyed vireo (DUW), purple martin (DCUW-Wa), northern rough-winged swallow (DCUW-Wa), bank swallow (DCUW-Wa), cliff swallow (DCUW), barn swallow (DCUW-Wa), eastern bluebird (DCU), northern mockingbird (DU), brown thrasher (DCU), Bohemian waxwing (DCU), blue-winged warbler (DUW), golden-winged warbler (DU), Tennessee warbler (DCUW), yellow warbler (DCUW), prairie warbler (DCU), palm warbler (CW), mourning warbler (DCUW), Wilson's warbler (CW), *yellow-breasted chat (DU), American tree sparrow (DCUW), field sparrow (DCU), fox sparrow (DCKU), song sparrow (DCUW), Lincoln's sparrow (DCUW), swamp sparrow (DCW), indigo bunting (DCU), red-winged blackbird (DUW), common redpoll (DCUW), hoary redpoll (DCUW)

Mammals

Least shrew (DUW), eastern cottontail (DCUW), *European hare (DU), meadow vole (DCUW)

Wildlife Species That Use Nonforest or Water Habitats but Not Forest Habitats during the Year[a]

Amphibians

Common mudpuppy (W-Wa), bullfrog (W-Wa)

Reptiles

Common snapping turtle (UW-Wa), bog turtle (W-Wa), map turtle (U-Wa), *northern red-bellied cooter (UW-Wa), painted turtle (UW-Wa), common musk turtle (UW-Wa), eastern spiny softshell (Wa), northern water snake (W-Wa)

Birds

Common loon (Wa), pied-billed grebe (W-Wa), double-crested cormorant (Wa), American bittern (W-Wa), least bittern (UW), great egret (W-Wa), snowy egret (W), little blue heron (W-Wa), cattle egret (U), black-crowned night-heron (W), yellow-crowned night-heron (W), glossy ibis (W), Canada goose (UW-Wa), mute swan (UW-Wa), gadwall (W-Wa), American wigeon (W), mallard (UW-Wa), blue-winged teal (W), northern shoveler (W), northern pintail (W), green-winged teal (W), canvasback (W-Wa), ring-necked duck (W-Wa), bufflehead (Wa), red-breasted merganser (W-Wa), osprey (Wa), northern harrier (UW), rough-legged hawk (UW), *gray partridge (U), ring-necked pheasant (U), king rail (W), Virginia rail (W), sora (W), common moorhen (W-Wa), American coot (W-Wa), killdeer (UW), willet (W-Wa), spotted sandpiper (UW-Wa), upland sandpiper (U), common snipe (UW), ring-billed gull (UW-Wa), herring gull (Wa), great black-backed gull (Wa), common tern (Wa), black tern (W-Wa), rock dove (U), *barn owl (U), snowy owl (UW), short-eared owl (UW), chimney swift (UW), belted kingfisher (W-Wa), fish crow (W-Wa), horned lark (U), sedge wren (W), marsh wren (W), European starling (U), American pipit (U), vesper sparrow (UW), savannah sparrow (UW), grasshopper sparrow (U), Lapland longspur (U), snow bunting (UW), bobolink (UW), eastern meadowlark (U), house sparrow (U)

Mammals

Black-tailed jackrabbit (U), muskrat (W-Wa), Norway rat (U), house mouse (U)

[a]Forest habitat conditions are not habitat factors for wildlife species that use nonforest or aquatic habitats but not forest habitats. However, the presence of upland and wetland nonforest and aquatic habitat conditions within largely forested areas increases the potential habitats for an even larger number of species.

Structural Habitat Features

The occurrence and distribution of many wildlife species are related to key structural habitat features within the various forest cover types in New England. The following section highlights some of the more important habitat (stand) features and species associated with them (see Appendix D). Also, check species' distributions when using these lists (DeGraaf and Yamasaki 2001). Habitat-breadth categories associated with each species are also listed. Management prescriptions can be written to accommodate any combination of these features. The number of wildlife species that use different structural habitat features is given in table 6.

Table 6
Number of Wildlife Species That Use Different Structural Habitat Features, by Taxonomic Class, Habitat Breadth, and Forest Size-Class Condition

		Forest species (by size class)[a]			
Taxonomic class	Nonforest and aquatic species[a]	Regeneration	Sapling-pole	Sawtimber	Large sawtimber
High exposed perches					
Amphibians					
Reptiles					
Birds	6	7	3	8	8
Mammals					
Low exposed perches					
Amphibians					
Reptiles					
Birds	10	14	7	10	10
Mammals					
Open overstory canopy conditions					
Amphibians		10	13	13	13
Reptiles		12	17	17	17
Birds	7	116	86	100	97
Mammals	2	53	39	48	48
Partial overstory canopy conditions					
Amphibians		18	20	20	20
Reptiles		8	12	12	12
Birds		55	67	81	78
Mammals		45	40	50	50

(continued)

Table 6 (continued)

Taxonomic class	Nonforest and aquatic species[a]	Forest species (by size class)[a]			
		Regeneration	Sapling-pole	Sawtimber	Large sawtimber
Closed overstory canopy conditions					
Amphibians		18	19	19	19
Reptiles		8	12	12	12
Birds		45	61	73	71
Mammals		37	32	40	40
Overstory inclusions					
Amphibians					
Reptiles					
Birds		39	48	55	54
Mammals		7	7	8	8
Tree boles					
Amphibians					
Reptiles					
Birds	3	18	21	31	31
Mammals		20	14	22	22
Midstory layer					
Amphibians					
Reptiles					
Birds		19	25	26	24
Mammals					
Shrub layer					
Amphibians		1	2	2	2
Reptiles	1				
Birds	4	91	59	66	63
Mammals		33	24	28	28
Wetland shrub layer					
Amphibians	1	13	15	15	15
Reptiles	3	7	8	8	8
Birds	21	43	25	33	31
Mammals		28	20	24	24
Minimal to partial ground cover layer					
Amphibians		2	3	3	3

Taxonomic class	Nonforest and aquatic species[a]	Forest species (by size class)[a]			
		Regeneration	Sapling-pole	Sawtimber	Large sawtimber
Reptiles		6	6	6	6
Birds	21	44	22	26	25
Mammals	3	14	12	13	13
Dense ground cover layer					
Amphibians		3	5	5	5
Reptiles		12	14	14	14
Birds	29	67	35	42	41
Mammals	1	35	21	29	29
Wetland ground cover layer					
Amphibians	1	15	18	18	18
Reptiles	7	7	7	7	7
Birds	36	20	12	15	15
Mammals	1	24	16	22	22
Waterside logs					
Amphibians					
Reptiles	6	2	2	2	2
Birds	3		1	2	2
Mammals		1	2	2	2
Dead and down material					
Amphibians		10	10	10	10
Reptiles		7	12	12	12
Birds		8	9	10	9
Mammals		25	23	22	22
Forest litter and moss					
Amphibians		12	13	13	13
Reptiles		3	7	7	7
Birds		17	15	15	14
Mammals		9	9	9	9
Subterranean habitats					
Amphibians		14	16	16	16
Reptiles	8	11	17	17	17
Birds	1	2			
Mammals	3	40	29	35	35

(continued)

Table 6 (continued)

Taxonomic class	Nonforest and aquatic species[a]	Forest species (by size class)[a] Regeneration	Sapling-pole	Sawtimber	Large sawtimber
Slashpiles					
Amphibians		3	3	3	3
Reptiles		7	10	10	10
Birds		7	6	6	6
Mammals		9	7	7	7
Hard mast					
Amphibians					
Reptiles					
Birds	2	10	12	16	16
Mammals	2	19	19	21	21
Soft mast or fruit					
Amphibians					
Reptiles	1	3	3	3	3
Birds	5	52	49	58	57
Mammals	2	19	18	20	20

[a]Nonforest and aquatic species utilize those habitats exclusively; forest species partly or wholly utilize forest habitats.

Habitat breadth is indicated parenthetically: F = Forest, K = Krummholz, N = Nonforest, W = Water. Species that are regionally uncommon are noted with an asterisk.

HIGH EXPOSED PERCHES. High exposed perching sites often are found in old fields, pastures, new clearcuts, roadsides with grassy rights-of-way, riparian corridors, and stands where an overstory tree clearly stands above the other forest vegetation or where a single tree or group of trees stands considerably above the surrounding herbaceous ground vegetation. Bull pines, supracanopy white pines and hemlock, lone elms in a pasture, leave trees such as red oak (*Quercus rubra*) seed trees, and large roadside sugar maples are examples of high exposed perching sites. The exposed nature of these high perches makes them excellent hunting sites for various raptors such as osprey, bald eagle, red-tailed hawk, and kestrel that forage in nonforested cover types and open forests, and small perching birds such as the olive-sided flycatcher that hawk flying insects (figure 15). These perches also provide nest sites for the red-tailed hawk and great blue heron, and for osprey and bald eagle when near water (within ½ mile). Also, high perches are excellent sites for turkey vultures and ravens, scavengers that often look for carrion from these perches.

Wildlife use of high exposed perches is lowest in the sapling-pole classes (see table 6) and remains fairly constant in the other size classes. Pole-size stands are fairly uniform in tree distribution and lack the distinct contrast among vegetative layers that can be found in sawtimber size classes and some nonforest types. Clearcut prescriptions for aspen–birch; open shelterwood prescriptions for northern hardwoods and oak–pine; and group selection prescriptions for northern hardwoods and spruce–fir, especially close to water and other nonforested cover types, can provide such perching sites for immediate use by hunting hawks by retaining suitable wildlife trees. Note in table 6 that use by these species declines dramatically as regenerating stands develop into sapling-pole stands. Long-term management of these habitat features would assure suitable nesting and perching sites for these types of wildlife species. If cowbirds, which parasitize nests of many small forest passerines, are a problem, no effort to provide high exposed perches should be made within 3 to 4 miles of active farmland.

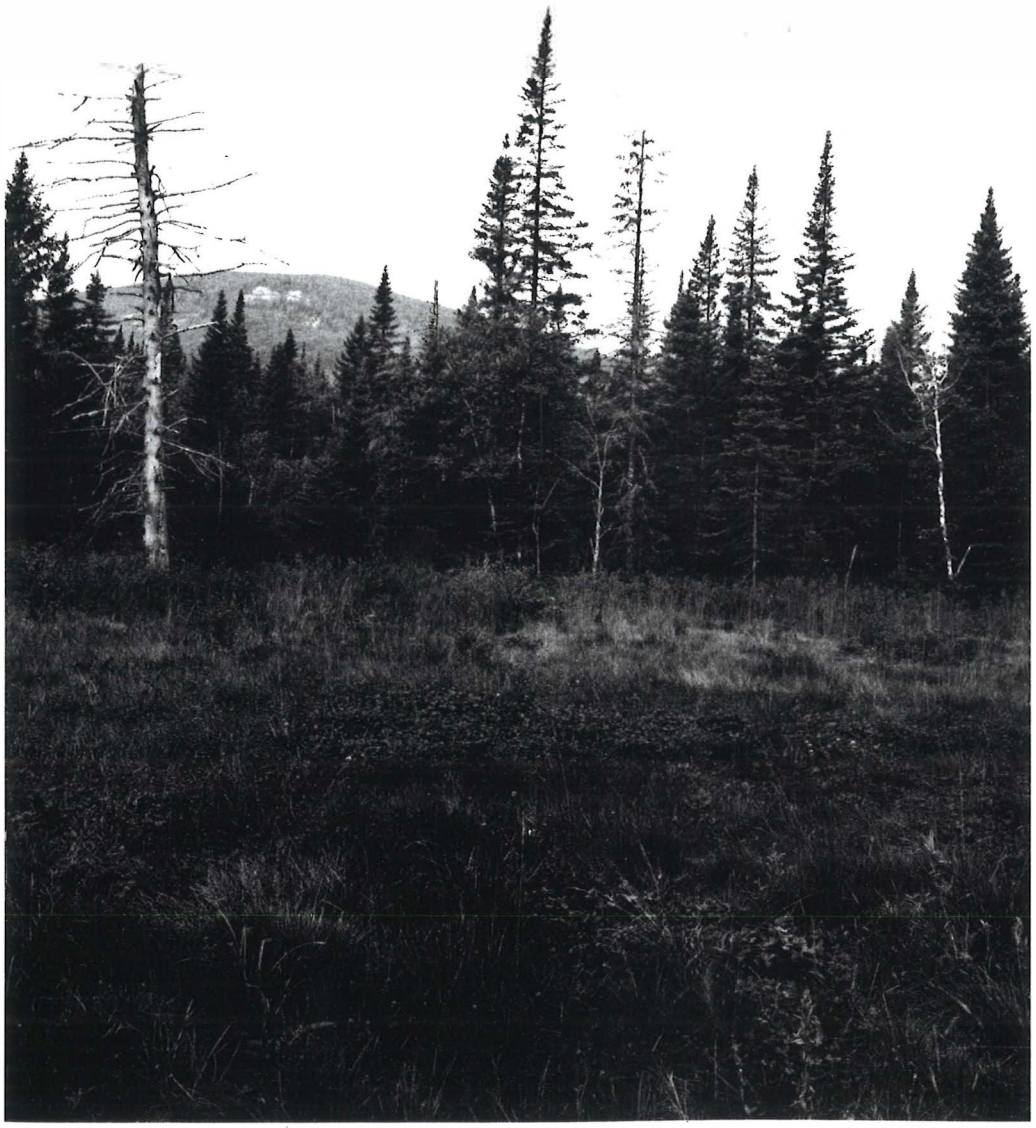


Fig. 15. High perches are important for olive-sided flycatcher, red-tailed and red-shouldered hawks. Berlin, New Hampshire, 1985. Photo by Richard M. DeGraaf.

Wildlife Species That Use High Exposed Perches

Birds

Double-crested cormorant (W), great blue heron (FNW), great egret (NW), black-crowned night-heron (N), yellow-crowned night-heron (N), turkey vulture (FN), osprey (W), bald eagle (FW), red-tailed hawk (FN), rough-legged hawk (N), American kestrel (FN), *northern hawk-owl (FN), olive-sided flycatcher (FN), common raven (FKNW), brown-headed cowbird (FN)

LOW EXPOSED PERCHES. Exposed perches relatively close to the ground yet still standing considerably above the rest of the surrounding vegetation can be found in old fields, pastures, wetland nonforest cover types, water-influenced areas, roadside right-of-ways, landscaped backyards, and recent clearcuts. Fences, utility lines, isolated deciduous shrubs, woody sprout clumps, dead stubs, or clearcutting residuals can serve as exposed perches. Wildlife use of low exposed perches is highest in the regeneration size class (see table 6). Again note that use declines as stands develop beyond the regeneration stage.

Wildlife Species for Which Low Perches Are Suitable Singing and Insect-hawking Perches

Birds

Double-crested cormorant (W), little blue heron (NW), black-crowned night-heron (N), glossy ibis (N), upland sandpiper (N), common snipe (N), belted kingfisher (NW), olive-sided flycatcher (FN), eastern wood-pewee (FN), yellow-bellied flycatcher (FKN), Acadian flycatcher (F), eastern phoebe (FN), eastern kingbird (FN), *loggerhead shrike (FN), *northern shrike (FN), eastern bluebird (FN), northern mockingbird (FN), chipping sparrow (FN), field sparrow (FN), vesper sparrow (N), grasshopper sparrow (N), song sparrow (FN), northern cardinal (FN), rose-breasted grosbeak (FN), indigo bunting (FN), eastern meadowlark (N), brown-headed cowbird (FN)

OPEN OVERSTORY CANOPY CONDITIONS. Open overstory canopy conditions are defined as those forested stands or nonforested cover types with overstory crown closures less than 30 percent. Most New England wildlife species use such habitat conditions at some time in the annual cycle. These conditions can be found in abandoned fields and old pastures, sedge meadows, savannas, open bogs, stands defined as commercially nonstocked, recently clearcut stands, and some shelterwood or seed tree cuts. Open overstory canopy conditions permit high insolation with a resulting response in the shrub and ground cover layers. Species such as nighthawks and bats are listed here because they forage on insects flying above these cover layers; they do not use these cover layers per se, but they would not be present without the open habitat condition. The open nature of these stands provides foraging and nesting habitats for a diverse range of wildlife species during the annual cycle. Some habitats are used briefly but are critical, for example temporary pools for amphibian breeding, open grassy areas for woodcock courtship displays, etc.

Wildlife use of open overstory canopy conditions is highest in the regen-

eration size class, where the overstory canopy usually is minimal and where clearcutting is a standard practice (see table 6). In older, larger size-class stands, open overstory canopy conditions usually exist in poorly stocked and commercially nonstocked forest stands, or where a low stocking level is desired for aesthetic reasons.

Wildlife Species That Use Open Overstory Canopy Conditions

Amphibians

Spotted salamander (FN), northern redback salamander (F), northern slimy salamander (F), eastern spadefoot (FN), eastern American toad (FNW), Fowler's toad (FNW), northern spring peeper (FN), gray treefrog (FNW), green frog (FNW), mink frog (FNW), wood frog (FKN), northern leopard frog (FNW), pickerel frog (FNW)

Reptiles

Spotted turtle (FNW), wood turtle (FNW), eastern box turtle (FNW), Blanding's turtle (FNW), five-lined skink (F), northern brown snake (FN), northern redbelly snake (FN), common garter snake (FKNW), ribbon snake (FNW), eastern hognose snake (FN), northern ringneck snake (FN), eastern worm snake (FN), northern black racer (FN), eastern smooth green snake (FN), black rat snake (FN), eastern milk snake (FN), *northern copperhead (F), *timber rattlesnake (F)

Birds

Green heron (FNW), turkey vulture (FN), wood duck (FNW), American black duck (FNW), common goldeneye (FNW), hooded merganser (FNW), osprey (W), bald eagle (FW), northern harrier (N), sharp-shinned hawk (FN), Cooper's hawk (FN), northern goshawk (FN), red-shouldered hawk (FN), broad-winged hawk (FN), red-tailed hawk (FN), rough-legged hawk (N), *golden eagle (FKNW), American kestrel (FN), merlin (FN), ruffed grouse (FN), wild turkey (FN), northern bobwhite (FN), killdeer (N), American woodcock (FN), mourning dove (FN), black-billed cuckoo (FN), yellow-billed cuckoo (FN), eastern screech-owl (FN), great horned owl (FKN), snowy owl (N), *northern hawk-owl (FN), barred owl (FN), *great gray owl (FN), *long-eared owl (FN), *boreal owl (FN), northern saw-whet owl (FN), common nighthawk (FN), whip-poor-will (FN), ruby-throated hummingbird (FN), *red-headed woodpecker (FN), yellow-bellied sapsucker (FN), downy woodpecker (FN), hairy woodpecker (FN), black-backed woodpecker (FN), northern flicker (FN), pileated woodpecker (F), olive-sided flycatcher (FN), yellow-bellied flycatcher (FKN), alder flycatcher (FN), willow fly-catcher (FN), eastern phoebe (FN), eastern kingbird (FN), *loggerhead shrike (FN), *northern shrike (FN), white-eyed vireo (FN), warbling vireo (FN), Philadelphia vireo (FN), gray jay (FK), blue jay (FN), American crow (FN), fish crow (NW), common raven (FKNW), purple martin (FNW), tree swallow (FNW), northern rough-winged swallow (FNW), bank swallow (FNW), cliff swallow (FN), barn swallow (FNW), black-capped chickadee (FKN), boreal chickadee (FKN), tufted titmouse (FN), red-breasted nuthatch (FKN), white-breasted nuthatch (FN), brown creeper (FN), Carolina wren (FN), house wren (FN), winter wren (FN), golden-crowned kinglet (FK), ruby-crowned kinglet (FKN), blue-gray gnatcatcher (FN), eastern bluebird (FN), veery (F), Bicknell's thrush (FK), Swainson's thrush (F), hermit thrush (FN), wood thrush (F), American robin (FKN), gray catbird (FN), northern mockingbird (FN), brown thrasher (FN), European starling (N), Bohemian waxwing (FN), cedar waxwing (FN), blue-winged warbler (FN), golden-winged warbler (FN), Tennessee warbler (FN), Nashville warbler (FN), yellow warbler (FN), chestnut-sided warbler (FN), magnolia warbler (F), black-throated blue warbler (F), pine warbler (F), prairie warbler (FN), palm warbler (FN), black-and-white warbler (FN), American redstart (FN), worm-eating warbler (F), northern waterthrush (FN), mourning warbler (FN), common yellowthroat (FN), hooded warbler (FN), Wilson's warbler (FN), Canada warbler (FN), *yellow-breasted chat (FN), scarlet tanager (F), eastern towhee (FN), American tree sparrow (FN), chipping sparrow (FN), field sparrow (FN), fox sparrow (FKN), song sparrow (FN),

Lincoln's sparrow (FN), swamp sparrow (FN), white-throated sparrow (FKN), dark-eyed junco (FKN), northern cardinal (FN), rose-breasted grosbeak (FN), indigo bunting (FN), red-winged blackbird (FN), rusty blackbird (FN), common grackle (FNW), brown-headed cowbird (FN), orchard oriole (FN), Baltimore oriole (FN), pine grosbeak (FKN), purple finch (FN), house finch (FN), red crossbill (FK), white-winged crossbill (FK), common redpoll (FN), hoary redpoll (FN), pine siskin (FN), American goldfinch (FN), evening grosbeak (FN)

Mammals

Virginia opossum (FN), masked shrew (FN), water shrew (FNW), smoky shrew (FN), long-tailed shrew (FK), pygmy shrew (FKN), northern short-tailed shrew (FKN), least shrew (FN), hairy-tailed mole (FN), eastern mole (FN), star-nosed mole (FNW), little brown myotis (FNW), northern long-eared bat (FNW), Indiana myotis (FNW), eastern small-footed myotis (FNW), silver-haired bat (FNW), eastern pipistrelle (FNW), big brown bat (FNW), red bat (FNW), hoary bat (FNW), eastern cottontail (FN), New England cottontail (FN), snowshoe hare (FKN), *European hare (FN), eastern chipmunk (FKN), woodchuck (FN), red squirrel (FK), southern flying squirrel (FN), beaver (FNW), deer mouse (FKN), white-footed mouse (FKN), southern red-backed vole (FKN), meadow vole (FN), rock vole (FKN), woodland vole (FN), southern bog lemming (FKN), *northern bog lemming (FKN), Norway rat (N), house mouse (N), meadow jumping mouse (FN), woodland jumping mouse (FN), porcupine (FKN), coyote (FN), red fox (FN), black bear (FNW), raccoon (FN), American marten (FK), ermine (FKN), mink (FNW), striped skunk (FN), lynx (FKN), bobcat (FKN), white-tailed deer (FN), moose (FKNW)

PARTIAL OVERSTORY CANOPY CONDITIONS. Partial overstory canopy conditions are defined as forested stands with overstory crown closures between 30 and 70 percent (figure 16). These conditions can occur in a number of forest cover types and size-class situations and are used by many New England wildlife species. Examples of more-open canopy conditions include clearcuts, open shelterwoods, sugarbush stands, and low-density pine stands. Intermediate thinnings and dense shelterwoods are examples of high canopy closure conditions approaching 70 percent closure. Partial overstory canopy conditions are often temporary—the overstory commonly fills in over several growing seasons. Other structural habitat features associated with partial overstory canopy conditions include developing shrub and mid-story vegetation layers.

Wildlife use of partial overstory canopy conditions increases with size class but does not seem to vary among the various forest cover-type groups (see table 6). Note that a partial overstory provides habitat for more amphibian species than does an open overstory.

Wildlife Species That Use Partial Overstory Canopy Conditions

Amphibians

Marbled salamander (FN), Jefferson salamander (FN), blue-spotted salamander (FN), spotted salamander (FN), red-spotted newt (FNW), northern dusky salamander (FNW), northern redback salamander (F), northern slimy salamander (F), four-toed salamander (FNW), northern spring salamander (FW), northern two-lined salamander (FW), eastern spadefoot (FN), eastern American toad (FNW), Fowler's toad (FNW), northern spring peeper (FN), gray treefrog (FNW), green frog (FNW), mink frog (FNW), wood frog (FKN), pickerel frog (FNW)

Reptiles

Spotted turtle (FNW), wood turtle (FNW), Blanding's turtle (FNW), northern brown snake (FN),

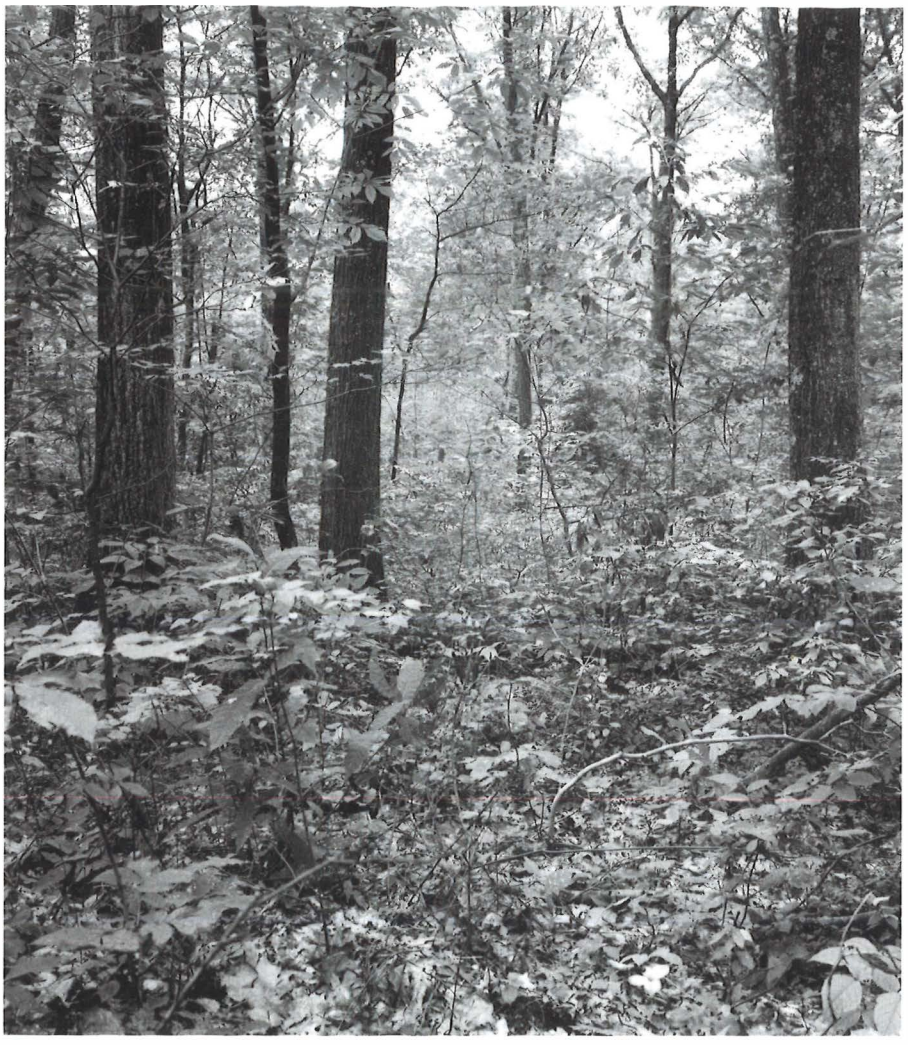


Fig. 16. Partial overstory canopy provides brushland habitat for some species such as eastern towhee, white-throated sparrow, and New England cottontail, among others. Ware, Massachusetts, 1990. Photo by Richard M. DeGraaf.

northern redbelly snake (FN), common garter snake (FKNW), ribbon snake (FNW), northern ringneck snake (FN), eastern worm snake (FN), black rat snake (FN), eastern milk snake (FN), *timber rattlesnake (F)

Birds

Green heron (FNW), turkey vulture (FN), wood duck (FNW), American black duck (FNW), common merganser (FNW), bald eagle (FW), sharp-shinned hawk (FN), Cooper's hawk (FN), northern goshawk (FN), red-shouldered hawk (FN), broad-winged hawk (FN), ruffed grouse (FN), spruce grouse (FKN), wild turkey (FN), American woodcock (FN), great horned owl (FKN), *northern hawk-owl (FN), barred owl (FN), *long-eared owl (FN), *boreal owl (FN), northern saw-whet owl (FN), whip-poor-will (FN), ruby-throated hummingbird (FN), red-bellied woodpecker (FN), yellow-bellied sapsucker (FN), downy woodpecker (FN), hairy woodpecker (FN), three-toed woodpecker (FN), black-backed woodpecker (FN), pileated woodpecker (F), least flycatcher (FN), eastern phoebe (FN), great crested flycatcher (FN), yellow-throated vireo (F), gray jay (FK), blue jay (FN), American crow (FN), common raven (FKNW), black-capped chickadee (FKN), boreal chickadee (FKN), tufted titmouse (FN), red-breasted nuthatch (FKN), white-breasted nuthatch (FN), brown creeper (FN), winter wren (FN), golden-crowned kinglet (FK), ruby-crowned kinglet (FKN), blue-gray gnatcatcher (FN), veery (F), Bicknell's thrush (FK), Swainson's thrush (F), hermit thrush (FN), wood thrush (F), American robin (FKN), Nashville warbler (FN), northern parula (FN), magnolia warbler (F), Cape May warbler (F), black-throated blue warbler (F), pine warbler (F), blackpoll warbler (FK),

cerulean warbler (F), black-and-white warbler (FN), American redstart (FN), worm-eating warbler (F), ovenbird (F), northern waterthrush (FN), Louisiana waterthrush (FNW), common yellowthroat (FN), Canada warbler (FN), scarlet tanager (F), white-throated sparrow (FKN), dark-eyed junco (FKN), rose-breasted grosbeak (FN), pine grosbeak (FKN), purple finch (FN), red crossbill (FK), white-winged crossbill (FK), pine siskin (FN), American goldfinch (FN), evening grosbeak (FN)

Mammals

Virginia opossum (FN), masked shrew (FN), water shrew (FNW), smoky shrew (FN), long-tailed shrew (FK), pygmy shrew (FKN), northern short-tailed shrew (FKN), hairy-tailed mole (FN), eastern mole (FN), star-nosed mole (FNW), little brown myotis (FNW), northern long-eared bat (FNW), Indiana myotis (FNW), eastern small-footed myotis (FNW), silver-haired bat (FNW), eastern pipistrelle (FNW), big brown bat (FNW), red bat (FNW), hoary bat (FNW), eastern cottontail (FN), New England cottontail (FN), snowshoe hare (FKN), eastern chipmunk (FKN), gray squirrel (F), red squirrel (FK), southern flying squirrel (FN), northern flying squirrel (F), beaver (FNW), deer mouse (FKN), white-footed mouse (FKN), southern red-backed vole (FKN), rock vole (FKN), woodland vole (FN), *northern bog lemming (FKN), woodland jumping mouse (FN), porcupine (FKN), coyote (FN), red fox (FN), gray fox (FN), black bear (FNW), raccoon (FN), American marten (FK), fisher (FKN), ermine (FKN), long-tailed weasel (FKN), mink (FNW), river otter (FNW), lynx (FKN), bobcat (FKN), white-tailed deer (FN), moose (FKNW)

CLOSED OVERSTORY CANOPY CONDITIONS. Closed overstory canopy conditions are defined as those forested stands with overstory crown closures greater than 70 percent (figure 17). These conditions can occur in any number of forest cover-type and size-class situations, such as in uneven-aged management systems where stocking levels are maintained at these levels for maximum form, quality, and growth. Other structural habitat features associated with closed overstory canopy conditions include minimal development of shrub, midstory, and ground vegetation layers.

Wildlife use of closed overstory canopy conditions increases with size class, whereas wildlife use of open overstory canopy conditions is greatest in the regeneration size class (see table 6). The wildlife species assemblages that

Fig. 17. Closed overstory canopy, Bartlett, New Hampshire, 1989. Photo by William B. Leak.

use closed canopy situations are very different from the assemblages that use more-open canopy conditions. Species are very apt to use several canopy conditions, due to changes in seasonal feeding and shelter requirements.

Wildlife Species That Use Closed Overstory Canopy Conditions

Amphibians

Marbled salamander (FN), Jefferson salamander (FN), blue-spotted salamander (FN), spotted salamander (FN), red-spotted newt (FNW), northern dusky salamander (FNW), northern redback salamander (F), northern slimy salamander (F), four-toed salamander (FNW), northern spring salamander (FW), northern two-lined salamander (FW), eastern American toad (FNW), Fowler's toad (FNW), northern spring peeper (FN), gray treefrog (FNW), green frog (FNW), mink frog (FNW), wood frog (FKN), pickerel frog (FNW)

Reptiles

Spotted turtle (FNW), wood turtle (FNW), Blanding's turtle (FNW), northern brown snake (FN), northern redbelly snake (FN), common garter snake (FKNW), ribbon snake (FNW), northern ringneck snake (FN), eastern worm snake (FN), black rat snake (FN), eastern milk snake (FN), *timber rattlesnake (F)

Birds

Green heron (FNW), turkey vulture (FN), wood duck (FNW), American black duck (FNW), common merganser (FNW), bald eagle (FW), sharp-shinned hawk (FN), Cooper's hawk (FN), northern goshawk (FN), red-shouldered hawk (FN), broad-winged hawk (FN), red-tailed hawk (FN), ruffed grouse (FN), spruce grouse (FKN), great horned owl (FKN), *northern hawk-owl (FN), barred owl (FN), *long-eared owl (FN), *boreal owl (FN), northern saw-whet owl (FN), ruby-throated hummingbird (FN), red-bellied woodpecker (FN), yellow-bellied sapsucker (FN), hairy woodpecker (FN), three-toed woodpecker (FN), black-backed woodpecker (FN), pileated woodpecker (F), eastern wood-pewee (FN), Acadian flycatcher (F), least flycatcher (FN), blue-headed vireo (F), red-eyed vireo (FN), gray jay (FK), blue jay (FN), black-capped chickadee (FKN), boreal chickadee (FKN), tufted titmouse (FN), red-breasted nuthatch (FKN), white-breasted nuthatch (FN), brown creeper (FN), golden-crowned kinglet (FK), ruby-crowned kinglet (FKN), Bicknell's thrush (FK), Swainson's thrush (F), hermit thrush (FN), wood thrush (F), American robin (FKN), northern parula (FN), magnolia warbler (F), Cape May warbler (F), black-throated blue warbler (F), yellow-rumped warbler (FKN), black-throated green warbler (F), Blackburnian warbler (F), pine warbler (F), bay-breasted warbler (FN), blackpoll warbler (FK), cerulean warbler (F), black-and-white warbler (FN), American redstart (FN), worm-eating warbler (F), ovenbird (F), northern waterthrush (FN), Louisiana waterthrush (FNW), Canada warbler (FN), scarlet tanager (F), white-throated sparrow (FKN), dark-eyed junco (FKN), pine grosbeak (FKN), purple finch (FN), red crossbill (FK), white-winged crossbill (FK), evening grosbeak (FN)

Mammals

Virginia opossum (FN), masked shrew (FN), water shrew (FNW), smoky shrew (FN), long-tailed shrew (FK), pygmy shrew (FKN), northern short-tailed shrew (FKN), little brown myotis (FNW), northern long-eared bat (FNW), Indiana myotis (FNW), eastern small-footed myotis (FNW), silver-haired bat (FNW), big brown bat (FNW), red bat (FNW), hoary bat (FNW), snowshoe hare (FKN), eastern chipmunk (FKN), gray squirrel (F), red squirrel (FK), southern flying squirrel (FN), northern flying squirrel (F), deer mouse (FKN), white-footed mouse (FKN), southern red-backed vole (FKN), woodland vole (FN), *northern bog lemming (FKN), woodland jumping mouse (FN), porcupine (FKN), coyote (FN), gray fox (FN), black bear (FNW), American marten (FK), fisher (FKN), long-tailed weasel (FKN), river otter (FNW), lynx (FKN), bobcat (FKN), white-tailed deer (FN), moose (FKNW)

Fig. 18. Overstory softwood inclusions. Belchertown, Massachusetts, 1990. Photo by Richard M. DeGraaf.

OVERSTORY INCLUSIONS. Overstory inclusions in forested stands depend on several factors: a minimum stand size and the level of detail in forest cover-type mapping and inventory. Large stands (larger than 10 acres) tend to obscure the isolated patches of conifer stems in hardwood stands or hardwood stems in conifer stands, especially where the cover types change as rapidly as they do across New England landscapes (every 5 to 10 acres). Mixed-stand cover types such as in aspen–fir–spruce, oak–pine, and northern hardwoods–hemlock help identify large acreages where these conditions are present. Coniferous overstory inclusions of hemlock, spruce, fir, or pine can provide feeding, nesting, and winter shelter opportunities in deciduous stands that pure hardwood stands cannot provide (figure 18). Likewise, deciduous overstory inclusions of oak, beech, and other hardwoods can provide mast and other foraging and nesting sites that pure conifer stands cannot provide.

Wildlife use of overstory coniferous or deciduous inclusions increases with size class (see table 6). The nonforest cover types, krummholz, and water groups are also used by species that have a seasonal use for coniferous and deciduous overstory inclusions. However, more species, primarily birds, use the larger size classes than the regeneration size class.

Birds and Mammals That Use Overstory Inclusions, Sometimes Just a Group of Several Trees or Patches of ¼ to 2 Acres in Size

Birds

Sharp-shinned hawk (FN), Cooper's hawk (FN), northern goshawk (FN), red-shouldered hawk (FN), broad-winged hawk (FN), red-tailed hawk (FN), ruffed grouse (FN), wild turkey (FN), eastern

screech-owl (FN), great horned owl (FKN), barred owl (FN), *long-eared owl (FN), northern saw-whet owl (FN), whip-poor-will (FN), yellow-bellied sapsucker (FN), eastern wood-pewee (FN), least flycatcher (FN), eastern phoebe (FN), great crested flycatcher (FN), yellow-throated vereo (F), blue-headed vireo (F), red-eyed vireo (FN), blue jay (FN), American crow (FN), tufted titmouse (FN), red-breasted nuthatch (FKN), white-breasted nuthatch (FN), brown creeper (FN), golden-crowned kinglet (FK), ruby-crowned kinglet (FKN), blue-gray gnatcatcher (FN), veery (F), hermit thrush (FN), wood thrush (F), American robin (FKN), Nashville warbler (FN), northern parula (FN), yellow warbler (FN), magnolia warbler (F), black-throated blue warbler (F), yellow-rumped warbler (FKN), black-throated green warbler (F), Blackburnian warbler (F), pine warbler (F), American redstart (FN), mourning warbler (FN), Canada warbler (FN), scarlet tanager (F), chipping sparrow (FN), dark-eyed junco (FKN), rusty blackbird (FN), common grackle (FNW), purple finch (FN), house finch (FN), pine siskin (FN), American goldfinch (FN), evening grosbeak (FN)

Mammals

Smoky shrew (FN), northern short-tailed shrew (FKN), gray squirrel (F), red squirrel (FK), deer mouse (FKN), southern red-backed vole (FKN), porcupine (FKN), white-tailed deer (FN)

TREE BOLES. Trees with cavities can be found in upland openings and old pastures, riparian corridors, sedge meadows and open bogs, and in all forest cover types and size classes (figures 19a and 19b). Cavities in stems less

a

b

Fig. 19a and 19b. Retain trees like these whenever possible. (a) Den trees in large hardwoods are important habitat elements for a variety of mammals and birds. (b) Standing dead trees provide important nesting and roosting areas for cavity-nesting birds and bats. Photos by Mariko Yamasaki.

than 6 inches dbh are used by black-capped and boreal chickadees and eastern bluebirds. Cavities in stems 12 to 18 inches dbh are used by gray squirrels, screech-owls, and various woodpeckers such as northern flickers. Larger birds and mammals such as pileated woodpecker, fisher, and raccoon require larger cavities in stems usually greater than 18 inches dbh. Hollow stems larger than 18 inches dbh provide sites for porcupine and gray fox, and good roosting areas for little brown myotis, northern long-eared bat, and big brown bat. Cavities also occur in dead limbs of live trees, as well as dead and dying stems. Feeding sites abound on tree boles. For example, pileated woodpeckers excavate carpenter ant galleries and yellow-bellied sapsuckers drill sap holes in yellow birch and glean the insects that visit the sap holes. The rough bark of mature trees is probed for insects by species such as tufted titmouse, brown creeper, nuthatches, and woodpeckers, among others. Note that large trees are not to be confused here with sawtimber or large sawtimber stands.

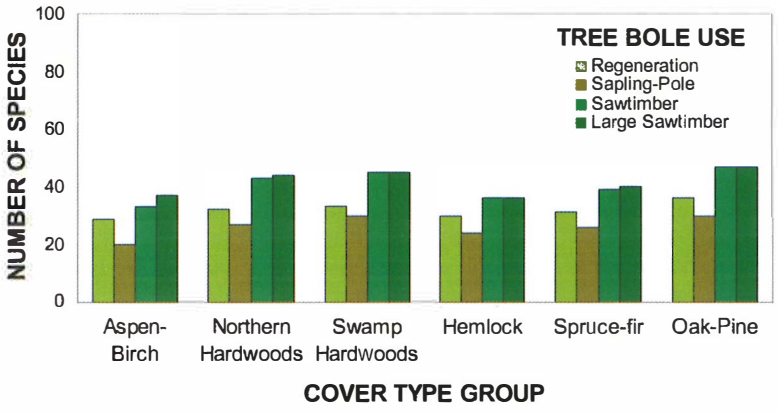


Fig. 20. Number of species using tree boles, by cover type and size class. Note: Bole use in regeneration reflects use of leave trees, dead trees, snags, and stubs.

Wildlife use of all sizes and conditions of tree boles increases with size class (see table 6). The number of wildlife species that use tree boles tends to be higher in northern hardwood, swamp hardwood, and oak–pine cover-type groups; and tends to be lower in the hemlock cover-type group (figure 20). It seems that stands with large average stand diameters, a variety of tree conditions (including large-diameter dead stems, live trees with hollow stems and dead limbs, and small diameter suppressed and dying stems), and nearby water have a high habitat potential for cavity-dwelling wildlife species in New England.

Birds and Mammals That Use Large or Small Tree Boles for Shelter or Feeding Sites

Birds

Turkey vulture (FN), wood duck (FNW), common goldeneye (FNW), hooded merganser (FNW), common merganser (FNW), American kestrel (FN), merlin (FN), *barn owl (N), eastern screech-owl (FN), great horned owl (FKN), barred owl (FN), *boreal owl (FN), northern saw-whet owl (FN), chimney swift (N), *red-headed woodpecker (FN), red-bellied woodpecker (FN), yellow-bellied sapsucker (FN), downy woodpecker (FN), hairy woodpecker (FN), three-toed woodpecker (FN), black-backed woodpecker (FN), northern flicker (FN), pileated woodpecker (F), great crested flycatcher (FN), purple martin (FNW), tree swallow (FNW), black-capped chickadee (FKN), boreal chickadee (FKN), tufted titmouse (FN), red-breasted nuthatch (FKN), white-breasted nuthatch (FN), brown creeper (FN), Carolina wren (FN), house wren (FN), winter wren (FN), eastern bluebird (FN), European starling (N)

Mammals

Virginia opossum (FN), little brown myotis (FNW), northern long-eared bat (FNW), Indiana myotis (FNW), silver-haired bat (FNW), eastern pipistrelle (FNW), big brown bat (FNW), red bat (FNW), hoary bat (FNW), gray squirrel (F), red squirrel (FK), southern flying squirrel (FN), northern flying squirrel (F), deer mouse (FKN), white-footed mouse (FKN), porcupine (FKN), gray fox (FN), black bear (FNW), raccoon (FN), American marten (FK), fisher (FKN), ermine (FKN), long-tailed weasel (FKN)

Fig. 21. Midstory layer. Photo by USDA Forest Service.

MIDSTORY LAYER. The midstory layer can be described as the deciduous and coniferous saplings and poles that occur within the 10- to 30-foot zone beneath the overstory canopy (figure 21). Wildlife species that use a deciduous, coniferous, or mixed midstory layer in which to nest or forage, or that use the forest floor because of conditions provided by the midstory, also can find suitable conditions in certain krummholz and nonforest habitats. Wildlife use of a midstory layer increases slightly from the regeneration stage and then remains fairly even in the older size classes (see table 6).

Birds That Are Associated with a Midstory Layer

Birds

Mourning dove (FN), ruby-throated hummingbird (FN), eastern wood-pewee (FN), Acadian flycatcher (F), white-eyed vireo (FN), blue-headed vireo (F), warbling vireo (FN), Philadelphia vireo (FN),

red-eyed vireo (FN), gray jay (FK), blue jay (FN), veery (F), Swainson's thrush (F), wood thrush (F), American robin (FKN), northern parula (FN), magnolia warbler (F), yellow-rumped warbler (FKN), black-throated green warbler (F), blackpoll warbler (FK), American redstart (FN), worm-eating warbler (F), Wilson's warbler (FN), scarlet tanager (F), rose-breasted grosbeak (FN), pine grosbeak (FKN), red crossbill (FK), white-winged crossbill (FK), pine siskin (FN)

SHRUB LAYER. A shrub layer is defined as the deciduous, coniferous, and ericaceous shrubs and seedlings that occur within the 2- to 10-foot zone in forested and nonforested cover types, usually but not always with an overstory canopy present. Wildlife use of shrub layer whether for foraging, nesting, or cover is highest in the regeneration size class (figure 22). The shrub layer continues to be an important habitat element though often much less dense in the larger size classes (see table 6). Wetland shrub layers are described separately in the next section.

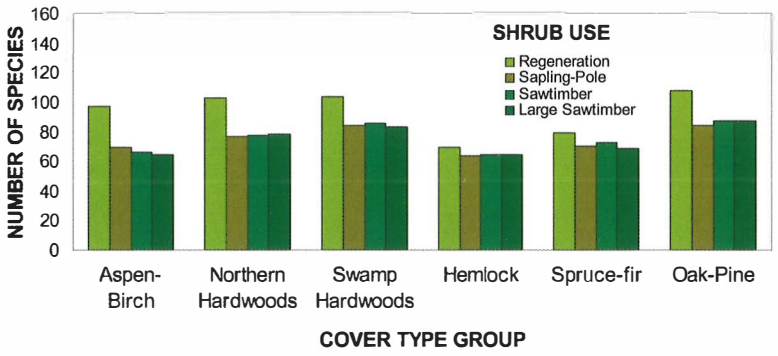


Fig. 22. Number of species using shrub layers, by cover type and size class.

Wildlife Species That Use Shrub Layers, Whether in Forested or Nonforested Cover Types

Amphibians

Four-toed salamander (FNW), northern spring peeper (FN)

Reptiles

Bog turtle (NW)

Birds

Turkey vulture (FN), sharp-shinned hawk (FN), Cooper's hawk (FN), northern goshawk (FN), red-shouldered hawk (FN), broad-winged hawk (FN), red-tailed hawk (FN), *golden eagle (FKNW), American kestrel (FN), merlin (FN), ring-necked pheasant (N), ruffed grouse (FN), spruce grouse (FKN), wild turkey (FN), northern bobwhite (FN), common snipe (N), American woodcock (FN), mourning dove (FN), black-billed cuckoo (FN), yellow-billed cuckoo (FN), *northern hawk-owl (FN), *great gray owl (FN), *long-eared owl (FN), short-eared owl (N), northern saw-whet owl (FN), whip-poor-will (FN), ruby-throated hummingbird (FN), olive-sided flycatcher (FN), yellow-bellied flycatcher (FKN), Acadian flycatcher (FN), alder flycatcher (FN), willow flycatcher (FN), least flycatcher (FN), eastern kingbird (FN), *loggerhead shrike (FN), *northern shrike (FN), white-eyed vireo (FN), blue-headed vireo (F), Philadelphia vireo (FN), Carolina wren (FN), house wren (FN), winter wren (FN), ruby-crowned kinglet (FKN), blue-gray gnatcatcher (FN), eastern bluebird (FN), veery (F), Bicknell's thrush (FK), Swainson's thrush (F), hermit thrush (FN), wood thrush (F), gray catbird (FN), northern mockingbird (FN), brown thrasher (FN), American pipit (N), Bohemian waxwing (FN), cedar waxwing (FN), blue-winged warbler (FN), golden-winged warbler (FN), Tennessee warbler (FN), Nashville warbler (FN), yellow warbler (FN), chestnut-sided warbler (FN), magnolia warbler (F), black-throated blue warbler (F), yellow-rumped warbler (FKN), prairie warbler (FN), palm warbler (FN), blackpoll warbler (FK), black-and-white warbler (FN), American redstart (FN), worm-eating warbler (F), northern waterthrush (FN), Louisiana waterthrush (FNW), mourning warbler (FN), common yellowthroat (FN), hooded warbler (FN), Wilson's warbler (FN), Canada warbler (FN), *yellow-breasted chat (FN), eastern towhee (FN), American tree sparrow (FN), chipping sparrow (FN), field sparrow (FN), fox sparrow (FKN), song sparrow (FN), Lincoln's sparrow (FN), swamp sparrow (FN), white-throated sparrow (FKN), dark-eyed junco (FKN), northern cardinal (FN), rose-

breasted grosbeak (FN), indigo bunting (FN), red-winged blackbird (FN), rusty blackbird (FN), common grackle (FNW), pine grosbeak (FN), purple finch (FN), common redpoll (FN), hoary redpoll (FN), pine siskin (FN), American goldfinch (FN), evening grosbeak (FN)

Mammals

Little brown myotis (FNW), northern long-eared bat (FNW), Indiana myotis (FNW), eastern small-footed myotis (FNW), silver-haired bat (FNW), eastern pipistrelle (FNW), big brown bat (FNW), red bat (FNW), hoary bat (FNW), eastern cottontail (FN), New England cottontail (FN), snowshoe hare (FKN), eastern chipmunk (FKN), beaver (FNW), white-footed mouse (FKN), southern red-backed vole (FKN), meadow vole (FN), rock vole (FKN), woodland vole (FN), southern bog lemming (FKN), *northern bog lemming (FKN), meadow jumping mouse (FN), woodland jumping mouse (FN), coyote (FN), red fox (FN), gray fox (FN), black bear (FNW), fisher (FKN), ermine (FKN), long-tailed weasel (FKN), lynx (FKN), bobcat (FKN), white-tailed deer (FN), moose (FKNW)

WETLAND SHRUB LAYER. A wetland shrub layer is defined as the deciduous and ericaceous shrubs that occur within the 2- to 10-foot zone in forested and wetland nonforest cover types; it is usually, but not always, beneath open overstory canopy conditions. Willows (*Salix* spp.), dogwoods (*Cornus* spp.), alders (*Alnus* spp.), bog laurel (*Kalmia polifolia*), and Labrador tea (*Ledum groenlandicum*) are examples of wetland shrubs. Wildlife use of wetland shrubs is similar in all size classes but is more diverse than that of upland shrubs (see table 6).

Wildlife Species That Use Wetland Shrub Layers

Amphibians

Marbled salamander (FN), Jefferson salamander (FN), blue-spotted salamander (FN), spotted salamander (FN), northern dusky salamander (FNW), four-toed salamander (FNW), northern two-lined salamander (FW), eastern American toad (FNW), Fowler's toad (FNW), northern spring peeper (FN), gray treefrog (FNW), bullfrog (NW), green frog (FNW), wood frog (FKN), northern leopard frog (FNW), pickerel frog (FNW)

Reptiles

Spotted turtle (FNW), bog turtle (NW), wood turtle (FNW), eastern box turtle (FNW), map turtle (NW), painted turtle (NW), Blanding's turtle (FNW), common garter snake (FKNW), ribbon snake (FNW), northern black racer (FN), *timber rattlesnake (F)

Birds

Pied-billed grebe (NW), American bittern (NW), least bittern (N), great blue heron (FNW), great egret (NW), snowy egret (N), little blue heron (NW), cattle egret (N), green heron (FNW), black-crowned night-heron (N), yellow-crowned night-heron (N), glossy ibis (N), wood duck (FNW), gadwall (NW), American wigeon (N), American black duck (FNW), mallard (NW), blue-winged teal (N), northern pintail (N), ring-necked duck (NW), common goldeneye (FNW), hooded merganser (FNW), common merganser (FNW), red-breasted merganser (NW), red-shouldered hawk (FN), broad-winged hawk (FN), red-tailed hawk (FN), *golden eagle (FKNW), American kestrel (FN), merlin (FN), spruce grouse (FKN), common snipe (N), American woodcock (FN), *great gray owl (FN), *long-eared owl (FN), northern saw-whet owl (FN), chimney swift (N), alder flycatcher (FN), willow flycatcher (FN), least flycatcher (FN), eastern kingbird (FN), fish crow (NW), tree swallow (FNW), northern rough-winged swallow (FNW), winter wren (FN), sedge wren (N), veery (F), blue-winged warbler (FN), Tennessee warbler (FN), Nashville warbler (FN), yellow warbler (FN), yellow-rumped warbler (FKN), palm warbler (FN), worm-eating warbler (F), northern waterthrush (FN), Louisiana

waterthrush (FNW), common yellowthroat (FN), Wilson's warbler (FN), Canada warbler (FN), American tree sparrow (FN), song sparrow (FN), Lincoln's sparrow (FN), swamp sparrow (FN), white-throated sparrow (FKN), northern cardinal (FN), red-winged blackbird (FN), rusty blackbird (FN), common grackle (FNW), pine grosbeak (FKN), common redpoll (FN), hoary redpoll (FN), American goldfinch (FN)

Mammals

Water shrew (FNW), pygmy shrew (FKN), northern short-tailed shrew (FKN), northern long-eared bat (FNW), Indiana myotis (FNW), eastern small-footed myotis (FNW), silver-haired bat (FNW), eastern pipistrelle (FNW), big brown bat (FNW), red bat (FNW), hoary bat (FNW), eastern cottontail (FN), New England cottontail (FN), beaver (FNW), meadow vole (FN), southern bog lemming (FKN), *northern bog lemming (FKN), meadow jumping mouse (FN), gray fox (FN), black bear (FNW), raccoon (FN), fisher (FKN), ermine (FKN), long-tailed weasel (FKN), mink (FNW), river otter (FNW), lynx (FKN), moose (FKNW)

MINIMAL TO PARTIAL GROUND COVER. A minimal to partial ground cover layer is defined as the forbs, grasses, and woody seedlings that occur in the 0- and 2-foot zone in forest and nonforest cover types, and provides less than 75 percent ground cover.

Relatively few species—notably the killdeer, horned lark, vesper sparrow, and black-tailed jackrabbit—use habitats with minimal to partial ground cover exclusively. These four species are specialists that occur in sparse ground cover conditions. The species listed also can be found using more dense ground cover conditions at certain times of the year.

Wildlife Species That Use Minimal to Partial Ground Cover, Whether to Seasonally Forage, Seek Cover, or Nest

Amphibians

Eastern American toad (FNW), Fowler's toad (FNW), northern spring peeper (FN)

Reptiles

Spotted turtle (FNW), wood turtle (FNW), eastern box turtle (FNW), Blanding's turtle (FNW), five-lined skink (F), black rat snake (FN)

Birds

Cattle egret (N), turkey vulture (FN), rough-legged hawk (N), American kestrel (FN), ring-necked pheasant (N), ruffed grouse (FN), wild turkey (FN), northern bobwhite (FN), killdeer (N), upland sandpiper (N), common snipe (N), American woodcock (FN), herring gull (W), common tern (W), rock dove (N), mourning dove (FN), barn owl (N), eastern screech-owl (FN), great horned owl (FKN), snowy owl (N), short-eared owl (N), common nighthawk (FN), whip-poor-will (FN), eastern phoebe (FN), *loggerhead shrike (FN), *northern shrike (FN), American crow (FN), common raven (FKNW), horned lark (N), purple martin (FNW), tree swallow (FNW), northern rough-winged swallow (FNW), bank swallow (FNW), cliff swallow (FN), barn swallow (FNW), eastern bluebird (FN), American robin (FKN), northern mockingbird (FN), brown thrasher (FN), European starling (N), American pipit (N), cedar waxwing (FN), Nashville warbler (FN), yellow warbler (FN), prairie warbler (FN), mourning warbler (FN), common yellowthroat (FN), American tree sparrow (FN), chipping sparrow (FN), field sparrow (FN), vesper sparrow (N), savannah sparrow (N), grasshopper sparrow (N), song sparrow (FN), white-throated sparrow (FKN), Lapland longspur (N), snow bunting (N), indigo bunting (FN), common grackle (FNW), brown-headed cowbird (FN), purple finch (FN), house finch (FN), common redpoll (FN), hoary redpoll (FN), American goldfinch (FN), house sparrow (N)

Mammals

Pygmy shrew (FKN), northern short-tailed shrew (FKN), least shrew (FN), hairy-tailed mole (FN), eastern mole (FN), black-tailed jackrabbit (N), deer mouse (FKN), white-footed mouse (FKN), woodland vole (FN), Norway rat (N), house mouse (N), coyote (FN), red fox (FN), gray fox (FN), black bear (FNW), ermine (FKN), striped skunk (FN)

DENSE GROUND COVER. A dense ground cover is defined as the forbs, grasses, and woody seedlings that occur in the 0- and 2-foot zone in forest and nonforest cover types, and provides more than 75 percent ground coverage. Wildlife use of a dense ground cover is high in the regeneration size class; and also in the nonforest and aquatic habitat types (see table 6). The older size classes are used less by these species, often because of a more sparse herbaceous cover condition (figure 23). Species such as the bats are listed here principally because they forage for insects flying above this substrate; they do not use dense ground cover per se, but they would not be present without the open habitat condition.

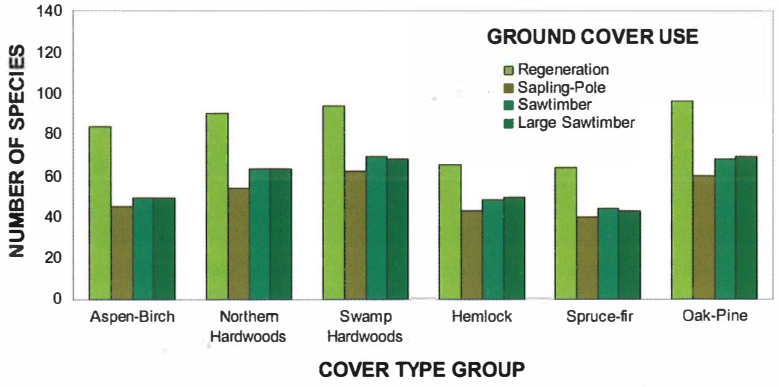


Fig. 23. Number of species using upland ground cover, by cover type and size class.

Wildlife Species That Use a Dense Ground Cover Condition, Whether to Seasonally Forage, Seek Cover, or Nest

Amphibians

Eastern American toad (FNW), Fowler's toad (FNW), northern spring peeper (FN), northern leopard frog (FNW), pickerel frog (FNW)

Reptiles

Spotted turtle (FNW), wood turtle (FNW), eastern box turtle (FNW), Blanding's turtle (FNW), five-lined skink (F), northern brown snake (FN), northern redbelly snake (FN), common garter snake (FKNW), ribbon snake (FNW), eastern hognose snake (FN), eastern worm snake (FN), northern black racer (FN), eastern smooth green snake (FN), eastern milk snake (FN), black rat snake (FN)

Birds

American bittern (NW), cattle egret (N), turkey vulture (FN), Canada goose (NW), gadwall (NW), mallard (NW), northern shoveler (N), northern pintail (N), green-winged teal (N), northern harrier (N), sharp-shinned hawk (FN), Cooper's hawk (FN), red-shouldered hawk (FN), broad-winged hawk (FN), red-tailed hawk (FN), rough-legged hawk (N), *golden eagle (FKNW), American kestrel (FN), merlin (FN), *gray partridge (N), ring-necked pheasant (N), ruffed grouse (FN), spruce grouse (FKN), wild turkey (FN), northern bobwhite (FN), sora (N), willet (NW), spotted sandpiper (NW), upland sandpiper (N), common snipe (N), American woodcock (FN), ring-billed gull (NW), herring gull (W), mourning dove (FN), *barn owl (N), eastern screech-owl (FN), great horned owl (FKN), snowy owl (N), *northern hawk-owl (FN), barred owl (FN), *great gray owl (FN), *long-eared owl (FN), short-eared owl (N), common nighthawk (FN), chimney swift (N), *red-headed woodpecker (FN), northern flicker (FN), willow flycatcher (FN), eastern phoebe (FN), eastern kingbird (FN), *loggerhead shrike (FN), *northern shrike (FN), American crow (FN), common raven (FKNW), purple martin (FNW), tree swallow (FNW), northern rough-winged swallow (FNW), bank swallow (FNW), cliff swallow (FN), barn swallow (FNW), eastern bluebird (FN), American robin (FKN), northern mockingbird (FN), brown thrasher (FN), European starling (N), cedar

waxwing (FN), blue-winged warbler (FN), golden-winged warbler (FN), Tennessee warbler (FN), Nashville warbler (FN), yellow warbler (FN), chestnut-sided warbler (FN), prairie warbler (FN), palm warbler (FN), mourning warbler (FN), common yellowthroat (FN), American tree sparrow (FN), chipping sparrow (FN), field sparrow (FN), savannah sparrow (N), grasshopper sparrow (N), song sparrow (FN), Lincoln's sparrow (FN), white-throated sparrow (FKN), dark-eyed junco (FKN), indigo bunting (FN), bobolink (N), eastern meadowlark (N), rusty blackbird (FN), common grackle (FNW), brown-headed cowbird (FN), orchard oriole (FN), Baltimore oriole (FN), purple finch (FN), house finch (FN), common redpoll (FN), hoary redpoll (FN), American goldfinch (FN), house sparrow (N)

Mammals

Pygmy shrew (FKN), northern short-tailed shrew (FKN), least shrew (FN), hairy-tailed mole (FN), eastern mole (FN), star-nosed mole (FNW), little brown myotis (FNW), northern long-eared bat (FNW), Indiana myotis (FNW), eastern small-footed myotis (FNW), silver-haired bat (FNW), eastern pipistrelle (FNW), big brown bat (FNW), red bat (FNW), hoary bat (FNW), eastern cottontail (FN), New England cottontail (FN), *European hare (FN), woodchuck (FN), white-footed mouse (FKN), meadow vole (FN), rock vole (FKN), woodland vole (FN), southern bog lemming (FKN), *northern bog lemming (FKN), house mouse (N), meadow jumping mouse (FN), woodland jumping mouse (FN), coyote (FN), red fox (FN), gray fox (FN), black bear (FNW), raccoon (FN), ermine (FKN), striped skunk (FN), white-tailed deer (FN)

WETLAND GROUND COVER AND TEMPORARY POOLS. Sedges (*Carex* spp.), cattails (*Typha* spp.), sphagnum (*Sphagnum* spp.), and other typical wetland plants can be found in small and large inclusions of somewhat poorly to very poorly drained soils in closed drainages of upland landscapes.

Fig. 24. Vernal pools. Central Massachusetts, April 1994. Photo by Robert T. Brooks.

Earthmoving activities can rearrange drainage patterns to create ponds and pools that remain full of water on a year-round basis. Ephemeral pools can be found in the early spring because of soil drainage type or litter accumulation; these pools provide egg-laying habitat for various woodland salamanders, frogs, and toads (figure 24).

Wildlife use of wetland ground cover conditions is highest in the wetland nonforest types, riparian areas (lakes, streams, and rivers), and forest regeneration (see table 6). Wildlife species that utilize nonforest cover types and water exclusively infrequently will use small inclusions that commonly occur in various forest cover types and size-class groups. However, such small wetland inclusions and temporary pools provide habitat components for up to twenty-five forest-dwelling species. The number of wildlife species that use wetland ground vegetation conditions is consistently higher in the swamp hardwood cover type group (figure 25).

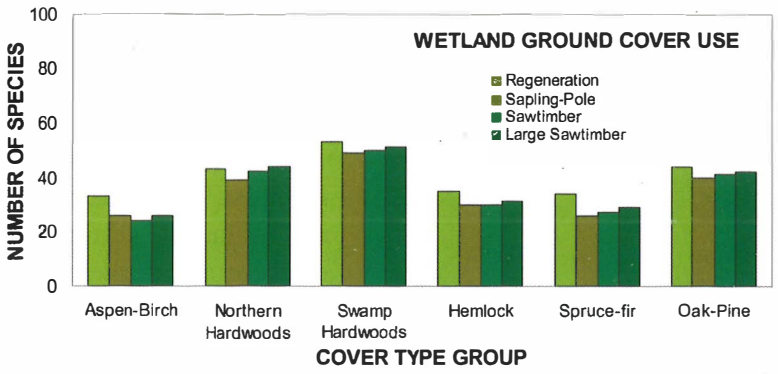


Fig. 25. Number of species using wetland ground cover, by cover type and size class.

Wildlife Species That Use Large and Small Wetlands with Emergent Herbaceous Ground Cover Vegetation

Amphibians

Marbled salamander (FN), Jefferson salamander (FN), blue-spotted salamander (FN), spotted salamander (FN), red-spotted newt (FNW), northern dusky salamander (FNW), four-toed salamander (FNW), northern two-lined salamander (FW), eastern spadefoot (FN), eastern American toad (FNW), Fowler's toad (FNW), northern spring peeper (FN), gray treefrog (FNW), bullfrog (NW), green frog (FNW), mink frog (FNW), wood frog (FKN), northern leopard frog (FNW), pickerel frog (FNW)

Reptiles

Spotted turtle (FNW), bog turtle (NW), wood turtle (FNW), eastern box turtle (FNW), map turtle (NW), *northern red-bellied cooter (NW), painted turtle (NW), Blanding's turtle (FNW), common musk turtle (NW), eastern spiny softshell (W), northern water snake (NW), common garter snake (FKNW), ribbon snake (FNW), northern black racer (FN)

Birds

Pied-billed grebe (NW), American bittern (NW), least bittern (N), great blue heron (FNW), great egret (NW), snowy egret (N), little blue heron (NW), green heron (FNW), black-crowned night-heron (N), yellow-crowned night-heron (N), glossy ibis (N), Canada goose (NW), mute swan (NW), gadwall (NW), American wigeon (N), American black duck (FNW), mallard (NW), blue-winged teal (N), northern shoveler (N), northern pintail (N), green-winged teal (N), ring-necked duck (NW), common goldeneye (FNW), hooded merganser (FNW), northern harrier (N), king rail (N), Virginia rail (N), sora (N), common moorhen (NW), American coot (NW), willet (NW), spotted sandpiper (NW), common snipe (N), black tern (NW), eastern screech-owl (FN), great horned owl (FKN), snowy owl (N), barred owl (FN), *great gray owl (FN), short-eared owl (N), fish crow (NW), purple martin (FNW), tree swallow (FNW), northern rough-winged swallow (FNW), sedge wren (N), marsh wren (N), northern waterthrush (FN), Louisiana waterthrush (FNW), common yellowthroat (FN), Wilson's warbler (FN), American tree sparrow (FN), savannah sparrow (N), song sparrow (FN), Lincoln's

sparrow (FN), swamp sparrow (FN), bobolink (N), red-winged blackbird (FN), rusty blackbird (FN), American goldfinch (FN)

Mammals

Water shrew (FNW), pygmy shrew (FKN), northern short-tailed shrew (FKN), star-nosed mole (FNW), little brown myotis (FNW), northern long-eared bat (FNW), Indiana myotis (FNW), eastern small-footed myotis (FNW), silver-haired bat (FNW), eastern pipistrelle (FNW), big brown bat (FNW), red bat (FNW), hoary bat (FNW), New England cottontail (FN), beaver (FNW), meadow vole (FN), muskrat (NW), southern bog lemming (FKN), *northern bog lemming (FKN), meadow jumping mouse (FN), gray fox (FN), black bear (FNW), raccoon (FN), mink (FNW), river otter (FNW), moose (FKNW)

WATERSIDE LOGS. Waterside logs are fallen logs in water and riparian areas. These structures provide basking locations for turtles and snakes and resting and nesting areas for ring-necked ducks. Log jams and piles often can become den sites for river otters. Wildlife use of waterside logs is highest in the wetland nonforest cover types and riparian (lake, stream, and river) areas (see table 6). Wildlife use of forest cover types and size-class groups is minimal, depending totally on the presence of permanent water within these stands.

Wildlife Species That Use the Structural Habitat Features of Waterside Logs

Reptiles

Spotted turtle (FNW), map turtle (NW), *northern red-bellied cooter (NW), painted turtle (NW), Blanding's turtle (FNW), common musk turtle (NW), eastern spiny softshell (W), northern water snake (NW)

Birds

Wood duck (FNW), green-winged teal (N), ring-necked duck (NW), hooded merganser (FNW), black tern (NW)

Mammals

Mink (FNW), river otter (FNW)

ROCKY FOREST FLOOR.

Wildlife Species for which Rocky Forest Floor, Especially in Moist Woodlands, Provides Foraging and Shelter Sites

Amphibians

Northern redback salamander (F), northern slimy salamander (F), northern spring salamander (FW), northern two-lined salamander (FW)

Reptiles

Five-lined skink (F), *northern copperhead (F), *timber rattlesnake (F)

Birds

American pipit (N)

Mammals

Long-tailed shrew (FK), rock vole (FKN), lynx (FKN), bobcat (FKN)

DEAD AND DOWN MATERIAL. Dead and down woody material (figure 26) also is called coarse woody debris. Wildlife use of dead and down woody material is similar throughout the sawtimber size-class groups; use in the regeneration size-class group is slightly less (see table 6).

Wildlife Species for which Dead and Down Material Provides Foraging and Shelter Sites in the Forest

Amphibians

Marbled salamander (FN), Jefferson salamander (FN), blue-spotted salamander (FN), spotted salamander (FN), red-spotted newt (FNW), northern dusky salamander (FNW), northern redback salamander (F), northern slimy salamander (F), four-toed salamander (FNW), gray treefrog (FNW)

Reptiles

Eastern box turtle (FNW), five-lined skink (F), northern brown snake (FN), northern redbelly snake (FN), common garter snake (FKNW), eastern hognose snake (FN), northern ringneck snake (FN), eastern worm snake (FN), northern black racer (FN), black rat snake (FN), eastern milk snake (FN), *northern copperhead (F)

Birds

Ruffed grouse (FN), great crested flycatcher (FN), winter wren (FN), black-and-white warbler (FN), worm-eating warbler (F), ovenbird (F), northern waterthrush (FN), Louisiana waterthrush (FNW), Canada warbler (FN), dark-eyed junco (FKN)

Mammals

Virginia opossum (FN), masked shrew (FN), smoky shrew (FN), long-tailed shrew (FK), pygmy shrew (FKN), least shrew (FN), eastern chipmunk (FKN), deer mouse (FKN), white-footed mouse (FKN), southern red-backed vole (FKN), meadow vole (FN), woodland vole (FN), woodland jumping mouse (FN), porcupine (FKN), gray fox (FN), black bear (FNW), raccoon (FN), American marten (FK), fisher (FKN), ermine (FKN), long-tailed weasel (FKN), mink (FNW), striped skunk (FN), lynx (FKN), bobcat (FKN)

Fig. 26. Dead and down woody debris. Photo by USDA Forest Service.

FOREST LITTER AND MOSS. Wildlife use of forest litter, duff, and mossy ground surfaces does not vary by size class (see table 6).

Wildlife Species for which Forest Litter, Duff, and Mossy Ground Surfaces Provide Foraging and Shelter Sites

Amphibians

Marbled salamander (FN), Jefferson salamander (FN), blue-spotted salamander (FN), spotted salamander (FN), red-spotted newt (FNW), northern dusky salamander (FNW), northern redback salamander (F), northern slimy salamander (F), four-toed salamander (FNW), northern two-lined salamander (FW), northern spring peeper (FN), gray treefrog (FNW), wood frog (FKN)

Reptiles

Eastern box turtle (FNW), five-lined skink (F), northern brown snake (FN), northern redbelly snake (FN), eastern hognose snake (FN), eastern worm snake (FN), *northern copperhead (F)

Birds

Carolina wren (FN), veery (F), Swainson's thrush (F), hermit thrush (FN), wood thrush (F), gray catbird (FN), northern mockingbird (FN), Tennessee warbler (FN), Nashville warbler (FN), black-and-white warbler (FN), worm-eating warbler (F), ovenbird (F), northern waterthrush (FN), Louisiana

waterthrush (FNW), Wilson's warbler (FN), Canada warbler (FN), eastern towhee (FN), northern cardinal (FN)

Mammals

Masked shrew (FN), smoky shrew (FN), pygmy shrew (FKN), northern short-tailed shrew (FKN), hairy-tailed mole (FN), rock vole (FKN), woodland vole (FN), southern bog lemming (FKN), *northern bog lemming (FKN)

SUBTERRANEAN HABITATS. Wildlife species with fossorial (underground burrowing) habits that dwell in caves or cache food in the soil abound in both moist and well-drained forested and nonforested environments. The mole salamanders use old root channels and moist conditions under rotten logs and in somewhat poorly drained soils; eastern spadefoot and Fowler's toad burrow in sandy well-drained soils. Muddy streambanks and shorelines are ideal burrowing sites for muskrats. Rocky crevices, boulder piles, and talus slopes, especially near water, are ideal hibernacula for water snakes, black rat snake, northern copperhead, and timber rattlesnake. Dry sand and gravel banks that are stabilized by vegetation at the top are excellent nesting sites for belted kingfishers, northern rough-winged swallows, and bank swallows. Open nonforested areas on sandy loams such as grassy openings, abandoned fields, and pastures are ideal burrowing spots for hairy-tailed and eastern moles, woodchuck, and meadow and woodland voles. Forest-dwelling fossorial mammals include the southern red-backed vole, northern and southern bog lemmings, and woodland jumping mouse. Bat hibernacula are often found in subterranean mine shafts and caves. Wildlife use of the subterranean habitats is similar in all size classes (see table 6).

Wildlife Species That Use Subterranean Habitats

Amphibians

Marbled salamander (FN), Jefferson salamander (FN), blue-spotted salamander (FN), spotted salamander (FN), northern dusky salamander (FNW), northern redback salamander (F), northern slimy salamander (F), four-toed salamander (FNW), northern spring salamander (FW), northern two-lined salamander (FW), eastern spadefoot (FN), eastern American toad (FNW), Fowler's toad (FNW), northern spring peeper (FN), green frog (FNW), pickerel frog (FNW)

Reptiles

Common snapping turtle (NW), spotted turtle (FNW), bog turtle (NW), wood turtle (FNW), eastern box turtle (FNW), map turtle (NW), *northern red-bellied cooter (NW), painted turtle (NW), Blanding's turtle (FNW), common musk turtle (NW), eastern spiny softshell (W), five-lined skink (F), northern water snake (NW), northern brown snake (FN), northern redbelly snake (FN), common garter snake (FKNW), ribbon snake (FNW), eastern hognose snake (FN), northern ringneck snake (FN), eastern worm snake (FN), northern black racer (FN), black rat snake (FN), eastern milk snake (FN), *northern copperhead (F), *timber rattlesnake (F)

Birds

Belted kingfisher (NW), northern rough-winged swallow (FNW), bank swallow (FNW)

Mammals

Virginia opossum (FN), water shrew (FNW), long-tailed shrew (FK), northern short-tailed shrew (FKN), least shrew (FN), hairy-tailed mole (FN), eastern mole (FN), star-nosed mole (FNW),

little brown myotis (FNW), northern long-eared bat (FNW), Indiana myotis (FNW), eastern small-footed myotis (FNW), eastern pipistrelle (FNW), big brown bat (FNW), eastern cottontail (FN), New England cottontail (FN), eastern chipmunk (FKN), woodchuck (FN), red squirrel (FK), beaver (FNW), deer mouse (FKN), southern red-backed vole (FKN), meadow vole (FN), woodland vole (FN), muskrat (NW), southern bog lemming (FKN), *northern bog lemming (FKN), Norway rat (N), house mouse (N), meadow jumping mouse (FN), woodland jumping mouse (FN), porcupine (FKN), coyote (FN), red fox (FN), gray fox (FN), raccoon (FN), American marten (FK), fisher (FKN), ermine (FKN), long-tailed weasel (FKN), mink (FNW), striped skunk (FN), river otter (FNW)

SEEPS. Seeps occur across the New England landscape on lower slopes of glacial till hills and bedrock. The usually lush ground vegetation associated with seeps and the moist cool environment provides feeding and shelter sites.

Wildlife Species That Use Seeps

Amphibians

Northern dusky salamander (FNW), northern spring salamander (FW), northern two-lined salamander (FW), gray treefrog (FNW), pickerel frog (FNW)

Reptiles

Bog turtle (NW), ribbon snake (FNW)

Birds

Wild turkey (FN)

Mammals

Southern red-backed vole (FKN), black bear (FNW)

GRAVEL PITS AND BARE GROUND. Gravel pits, sand banks, and patches of well-drained bare ground can be found where upland landscapes have been created. Roadside edges, log decking areas, and recently plowed and bare fields are examples of similar habitat conditions where there is sparse ground cover vegetation, much grit, and waste grass and forb seeds.

Wildlife Species for which Gravel Pits and Bare Ground Are Favorable for Either Nesting or Foraging

Reptiles

Common snapping turtle (NW), wood turtle (FNW), eastern box turtle (FNW), map turtle (NW), *northern red-bellied cooter (NW), painted turtle (NW), Blanding's turtle (FNW), eastern spiny softshell (W)

Birds

Killdeer (N), spotted sandpiper (NW), ring-billed gull (NW), herring gull (W), common tern (W), rock dove (N), common nighthawk (FN), horned lark (N), northern rough-winged swallow (FNW), bank swallow (FNW), American pipit (N), vesper sparrow (N), Lapland longspur (N), snow bunting (N)

WOODS ROADS. Grass-covered or weedy woods roads provide herbs and insects, especially for ruffed grouse and wild turkey broods, when

nonforest habitats are not present. Broad-winged hawks hunt snakes and other prey along these roads; and bats utilize woods roads as flight corridors. Large yellow and paper birches along woods roads provide nesting sites for broad-winged hawks.

SLASHPILES. Slashpiles usually result from land clearing or silvicultural activities (figure 27). Piling brush, slash, or other logging residual in loose rows or piles creates denning, hiding, and other shelter areas for different types of wildlife species.

Slashpiles most often are found in regeneration size-class stands or stands where some type of intermediate treatment has been completed. Piles of woody debris are fairly temporary in New England but provide hiding cover and denning sites for amphibians, reptiles, small mammals, and even several of the larger mammals such as bear, regardless of size class of the surrounding stand. House wrens and winter wrens are the birds most likely to use slashpiles.

Wildlife Species That Use Slashpiles

Amphibians

Red-spotted newt (FNW), northern redback salamander (F), wood frog (FKN)

Reptiles

Eastern box turtle (FNW), five-lined skink (F), northern brown snake (FN), northern redbelly snake (FN), common garter snake (FKNW), eastern hognose snake (FN), northern ringneck snake (FN), northern black racer (FN), black rat snake (FN), eastern milk snake (FN)

Birds

Carolina wren (FN), house wren (FN), winter wren (FN), veery (F), song sparrow (FN), white-throated sparrow (FKN), dark-eyed junco (FKN)

Fig. 27. Slashpiles. Berlin, New Hampshire, 1990. Photo by Richard M. DeGraaf.

Mammals

Virginia opossum (FN), northern short-tailed shrew (FKN), eastern cottontail (FN), southern red-backed vole (FKN), meadow vole (FN), black bear (FNW), American marten (FK), ermine (FKN), bobcat (FKN)

HARD MAST. Hard mast refers to the nuts produced by trees and shrubs in New England, especially hickories, oaks, beech, butternut (*Juglans cinerea*), and hazel-nut (*Corylus* spp.). Hard mast provides a variable but high-caloric source of digestible lipids and carbohydrates needed by most resident and migratory wildlife species. Wildlife use of hard mast is fairly even across the size-class groups because of the sometimes scattered nature of mast trees throughout stands of all size classes (see table 6). Also, shrubs such as hazel-nut commonly provide hard mast in regeneration stands.

Predictable Seasonal and Long-term Availability of Hard Mast Increases the Frequency of Occurrence and Survivability of the Following Wildlife Species

Birds

Wood duck (FNW), American black duck (FNW), mallard (NW), ruffed grouse (FN), wild turkey (FN), *red-headed woodpecker (FN), red-bellied woodpecker (FN), hairy woodpecker (FN), pileated woodpecker (F), blue jay (FN), American crow (FN), common raven (FKNW), tufted titmouse (FN), white-breasted nuthatch (FN), brown creeper (FN), brown thrasher (FN), European starling (N), eastern towhee (FN), common grackle (FNW)

Mammals

Virginia opossum (FN), eastern chipmunk (FKN), gray squirrel (F), red squirrel (FK), southern flying squirrel (FN), northern flying squirrel (F), deer mouse (FKN), white-footed mouse (FKN), southern red-backed vole (FKN), woodland vole (FN), Norway rat (N), house mouse (N), meadow jumping mouse (FN), woodland jumping mouse (FN), porcupine (FKN), coyote (FN), red fox (FN), gray fox (FN), black bear (FNW), raccoon (FN), American marten (FK), fisher (FKN), striped skunk (FN), white-tailed deer (FN)

SOFT MAST OR FRUIT. Fleshy fruits include those of trees and shrubs such as mountain-ash, pin cherry (*Prunus pensylvanica*) the various *Vaccinium*, *Rubus*, and *Amelanchier* species, and fruits of herbs such as wild strawberry (*Fragaria* spp.). Note that apples are considered in the orchard section of nonforest habitats.

Predictable Seasonal and Long-term Availability of Fleshy Fruits Increases the Frequency of Occurrence and Survivability of the Following Wildlife Species

Reptiles

Bog turtle (NW), wood turtle (FNW), eastern box turtle (FNW), Blanding's turtle (FNW)

Birds

Wood duck (FNW), American black duck (FNW), ring-necked pheasant (N), ruffed grouse (FN), spruce grouse (FKN), wild turkey (FN), northern bobwhite (FN), American woodcock (FN), rock dove (N), black-billed cuckoo (FN), yellow-billed cuckoo (FN), *red-headed woodpecker (FN), red-bellied woodpecker (FN), yellow-bellied sapsucker (FN), hairy woodpecker (FN), northern flicker (FN),

pileated woodpecker (F), yellow-bellied flycatcher (FKN), Acadian flycatcher (F), alder flycatcher (FN), eastern phoebe (FN), great crested flycatcher (FN), eastern kingbird (FN), white-eyed vireo (FN), yellow-throated vireo (F), blue-headed vireo (F), warbling vireo (FN), Philadelphia vireo (FN), gray jay (FK), blue jay (FN), American crow (FN), tree swallow (FNW), barn swallow (FNW), black-capped chickadee (FKN), tufted titmouse (FN), white-breasted nuthatch (FN), Carolina wren (FN), ruby-crowned kinglet (FKN), eastern bluebird (FN), veery (F), Bicknell's thrush (FK), Swainson's thrush (F), hermit thrush (FN), wood thrush (F), American robin (FKN), gray catbird (FN), northern mocking-bird (FN), brown thrasher (FN), European starling (N), American pipit (N), Bohemian waxwing (FN), cedar waxwing (FN), yellow-rumped warbler (FKN), black-throated green warbler (F), palm warbler (FN), blackpoll warbler (FK), American redstart (FN), scarlet tanager (F), eastern towhee (FN), fox sparrow (FKN), song sparrow (FN), white-throated sparrow (FKN), dark-eyed junco (FKN), north-ern cardinal (FN), rose-breasted grosbeak (FN), indigo bunting (FN), rusty blackbird (FN), common grackle (FNW), orchard oriole (FN), Baltimore oriole (FN), purple finch (FN), house finch (FN), red crossbill (FK), white-winged crossbill (FK), American goldfinch (FN), house sparrow (N)

Mammals

Virginia opossum (FN), *European hare (FN), gray squirrel (F), red squirrel (FK), southern flying squir-rel (FN), northern flying squirrel (F), deer mouse (FKN), white-footed mouse (FKN), southern red-backed vole (FKN), woodland vole (FN), southern bog lemming (FKN), Norway rat (N), house mouse (N), meadow jumping mouse (FN), woodland jumping mouse (FN), porcupine (FKN), coyote (FN), red fox (FN), gray fox (FN), black bear (FNW), raccoon (FN), American marten (FK), fisher (FKN), striped skunk (FN), white-tailed deer (FN)

In managed forests, some soft mast is usually present in all size classes, but it is much more abundant in regenerating and sapling stands than in sawtimber stands. Larger openings in older stands due to large tree-fall gaps, blowdown, or group selection openings can increase the abundance of soft mast.

SPECIAL REQUIREMENTS. Six wildlife species in our database do not fit the categorization of vertically distributed forest structure. They either require aquatic habitats exclusively (mudpuppy, common loon), are found essentially on coastal bays or the ocean (canvasback, great black-backed gull), are winter visitors to New England's estuarine habitats, open rivers, and lakes (bufflehead), or nest on cliffs, tall buildings, or bridges (peregrine falcon).

4

Silvicultural Methods

SILVICULTURE deals with the cutting and cultural treatments applied to stands of trees. The objective usually is to produce stands of commercially valuable trees. In this book, silviculture includes the application of cutting and cultural treatments to produce wildlife habitats. Forests are managed on a stand-by-stand basis, but management is planned in a larger context. The larger landscape context periodically takes into account the habitat conditions that exist in adjacent stands, so that successive stand treatments enhance habitat diversity, and therefore potential wildlife diversity over time.

In this section, we use the following definitions:

Stand: A stand is an area of trees of a certain species composition (cover type), age-class, or size-class distribution and condition (quality, vigor, risk), usually growing on a fairly homogeneous site. Stands of 5 acres and larger commonly are recognized, though minimum stand size depends upon size of ownership and intensity of management.

Even-aged: An even-aged stand contains trees in the main canopy that are within twenty years of being the same age. Even-aged stands sometimes are designated by age-class (ten-year-old stand, forty-year-old stand) or broad size class: seedling stand (most trees are <1 inch dbh); sapling stand (trees 1–4 inches dbh); poletimber stand (trees 5–10 inches dbh); and sawtimber and large sawtimber stands (trees ≥11 inches dbh).

Uneven-aged: An uneven-aged stand contains trees of several twenty-year age classes. These stands generally contain trees of many sizes (seedlings through sawtimber) due to the range in age as well as differences in growth rate among species.

Site: The site conditions representative of a stand sometimes are designated by soil factors (parent material, texture, drainage, or soil

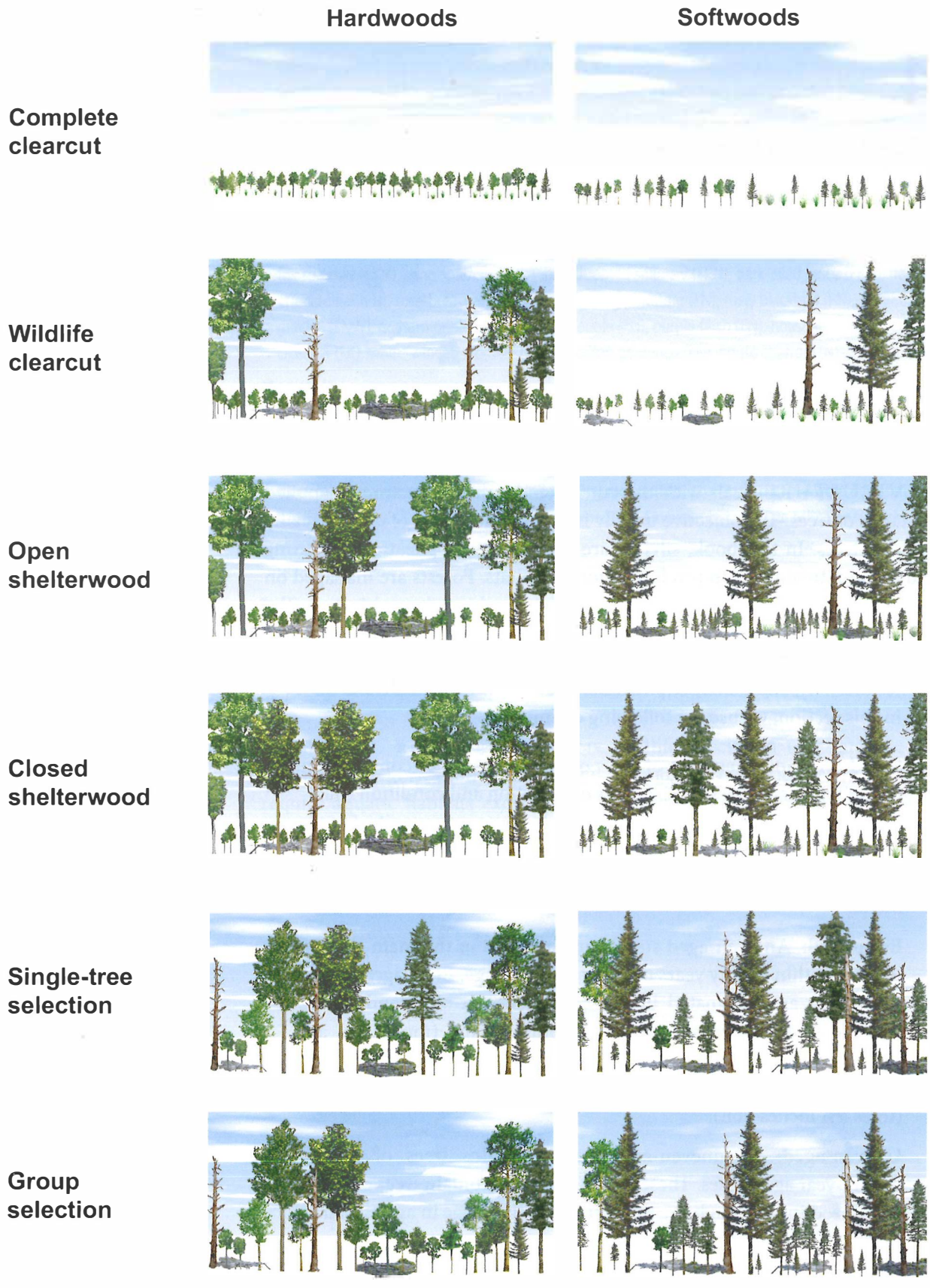


Fig. 28. Comparison of wildlife habitat conditions under several regeneration cutting practices.

series), or by direct measurements such as site index—the height of the dominant/co-dominant trees at a base age, usually fifty years.

Forest: A group of stands under one ownership or manager is a forest. Forest management includes silviculture, and also involves activities such as road construction, fire protection, pest management, regulating the cut of timber products, maintenance of wildlife habitat conditions, inventory, boundary maintenance, and recreational and aesthetic planning, and so on.

Regeneration cuttings: Silvicultural cuttings commonly are classified as regeneration cuttings or intermediate cuttings (figure 28). Regeneration cuttings are designed to regenerate the stand naturally by providing for seedling (or vegetative stem) establishment or development, or both. Four techniques are mentioned in this book: two for producing even-aged stands and two for maintaining uneven-aged stands:

- **Even-aged:** (1) **Clearcutting** is the removal of all stems in the stand. Strip cutting is a form of clearcutting. (2) **Shelterwood** cutting is the removal of the understory and lower crown canopy trees to allow the new stand to regenerate under shade. Subsequent removal of the overstory occurs in one or several cuts within a few years or sometimes up to several decades later (deferred shelterwood).
- **Uneven-aged:** (1) **Single-tree selection** is the removal of trees singly or in groups of two or three, which maintains a continuous cover and an uneven-aged or uneven-sized mixture. (2) **Group selection** is the removal of trees in groups usually 1/10 to 2/3 acre in size, but sometimes up to 1 to 2 acres on large properties. Group selection can be applied in combination with single-tree selection between the groups.

Intermediate cuttings: Intermediate cuttings are applied in the culture of even-aged stands and are normally noncommercial (no products sold) or commercial thinnings (timber sold) designed to favor certain species, sizes, and qualities of trees by removal of competitors (figure 29). Thinnings designed to grow quality timber commonly maintain a closed canopy; however, low-density thinning (50 to 70 percent residual crown cover) can be used to hasten diameter growth and stimulate understory development for wildlife purposes. At rotation age, the stand is considered to be mature, and a regeneration cutting is applied to produce a new stand.

Single-tree selection and group selection methods culture an uneven-aged stand, as well as regenerate it, so specific intermediate cuts are not used. However, the term improvement cut is sometimes used to describe a cut in an uneven-aged stand, designed especially to upgrade the quality or species composition. No rotation age is specified for uneven-aged stands. Instead, a

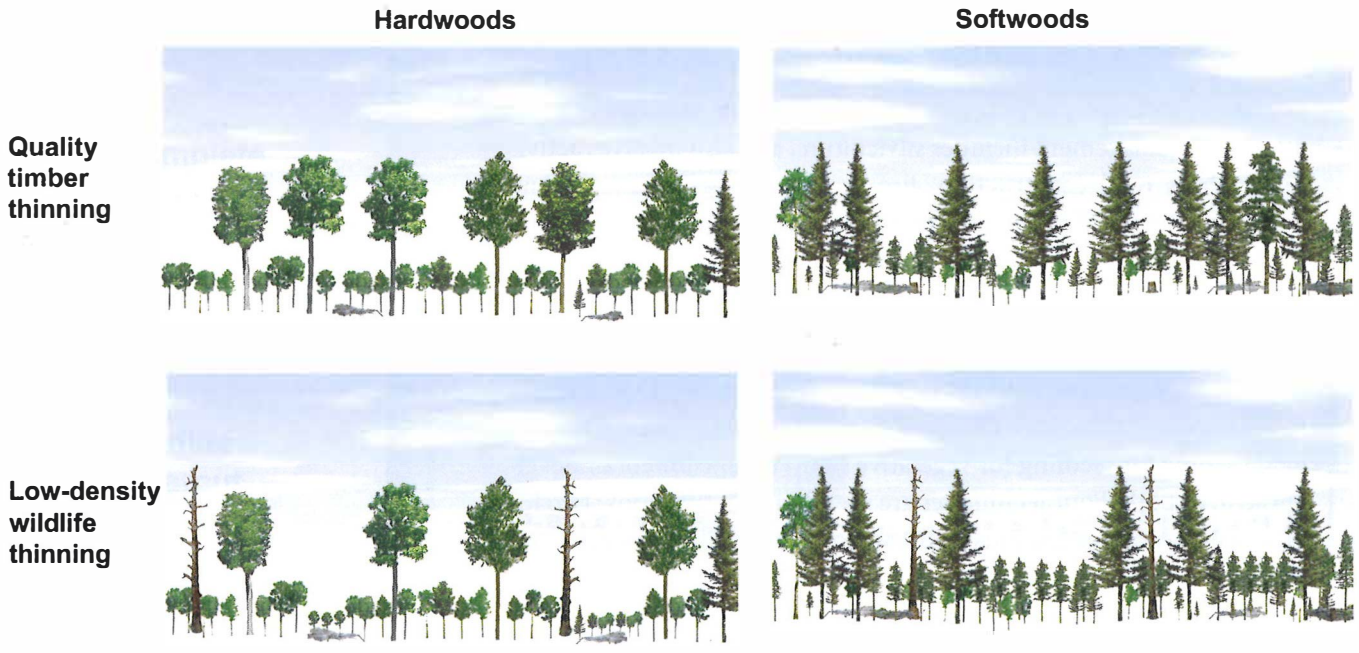


Fig. 29. General comparison of wildlife habitat conditions following quality timber thinning and low-density thinning with reserved wildlife trees.

very general maximum tree size is chosen, and residual stands after cutting are defined by maximum tree size, stand density, and stand structure — diameter distribution, proportion of sawtimber, and so on.

The responses of vegetation to treatments vary considerably across the New England region because of differences in past land-use history, climate, geology, and so on. Therefore, it is difficult to predict vegetative responses exactly, especially for certain structural features such as the herbaceous and shrub layers. Furthermore, overbrowsing by deer and moose is a problem in some areas. Overabundant deer consume regeneration and promote the abundance of invasive plants (e.g., de la Cretaz and Kelty 1999), dramatically changing forest composition, both of woody plants (Horsley et al. 2003) and herbs (Augustine and Frelich 1998). The changes in forest understories have significant effects on the abundance and diversity of forest birds, especially ground/shrub and intermediate canopy species (McShea and Rappole 2000). Deer density has a greater effect than silvicultural practices on the small mammal community (Brooks and Healy 1988) but has minimal effects on terrestrial salamanders (Brooks 1999) in New England.

Management in the face of continued deer overabundance results in permanent reductions in plant diversity and selective removal of species preferred by deer (Horsley et al. 2003). Securing adequate regeneration is difficult when using even-aged methods and impossible using uneven-aged methods. If deer numbers are reduced, effects of overbrowsing on stand structure (e.g., Rooney and Waller 2003) and wildlife (McShea and Rappole 2000) are reduced. Some methods to reduce deer damage to regenerating stands include fencing, which is expensive and requires continuous maintenance (Kees 2004) or using slash and opening size to reduce browsing effects. Leaving untreated slash in place or piling it around the edges of small cuts can reduce deer access. Making large (>30 acres) cuts reduces overall damage; browsing on most species declines

with distance from the edge of the cut (Williamson and Hirth 1985). Leaving slash untreated may be unsightly, even disallowed in some areas, but it is temporary compared to the effects of overbrowsing. Probably the most effective method is to use clearcutting in areas of deer abundance to overwhelm them with more browse than they can eat. Of course, reducing numbers of deer where they are overly abundant is basic to sound forest management. Uncertainty about vegetative responses may be resolved by on-site examination using the inventory procedures described earlier.

Timber and wildlife silvicultural options are described below for six size-type groups: aspen–birch, northern hardwoods, swamp hardwoods, spruce–fir, hemlock, and oak–pine. These type groups are composites of eleven distinct community types described in DeGraaf and Yamasaki (2001). For each type group, we describe: (1) the component types and subtypes, including site relationships (table 7); (2) treatment options including natural succession,

Table 7
Cover-Type Occurrence and Range of Environmental Sites in New England

	Imperfectly drained				Excessively drained	
Cover type	Soggy wet	Moist	Mesic	Dry–mesic	Dry	Dry–ledge
Aspen–birch						
Aspen	✓	✓	✓	✓	✓	✓
Paper birch	✓	✓	✓	✓	✓	✓
Northern hardwoods						
Northern hardwoods			✓	✓		
Northern hardwoods–conifer	✓	✓		✓		
Swamp hardwoods						
Swamp hardwoods	✓					
Spruce–fir						
Balsam fir	✓	✓			✓	
Red spruce	✓[a]	✓		✓[b]	✓	✓
Spruce–fir	✓	✓			✓	✓
Hemlock						
Eastern hemlock	✓		✓		✓	✓
Oak–pine						
Northern red oak			✓[c]	✓		✓
Oak–pine				✓	✓	
White pine			✓[d]	✓	✓	

[a]Primarily black spruce.
[b]Occurs in northern New England.
[c]Occurs in southern New England.
[d]Occurs in old fields.

intermediate thinnings (even-aged management) directed toward timber or wildlife objectives, and regeneration cuttings; and (3) type conversion possibilities. Overall, we describe the effects of treatment options on the stand structural features that determine wildlife habitat values.

The descriptions of each of the six type groups, their general successional patterns, silvicultural options, and wildlife responses, include figures showing the general patterns of stand development and wildlife use over time. These figures represent approximate responses over the range of sites existing in the region and the range of silvicultural methods used to regenerate stands. Detailed wildlife responses to stand structural features (pp. 57–84) can be summarized fairly well by grouping species as shrub users, tree-bole users, ground cover users, and wetland ground cover users.

These four species groups are used in the following section to describe general wildlife responses to stand development. Note that:

- **Shrub users** refer to species occurring in regenerating stands, not in scattered shrubs in the forest understory.
- **Tree-bole users** are species using pole-sized and larger trees. Use is inclusive: bark probing, cavity nesting, denning or roosting, nesting in the crown. Some tree user's occurrence is shown in young stands; these are generalized patterns, and include situations where residual trees, seed trees, or snags are left, shelterwood cuts are made, and so on.
- **Ground cover users** refer to species associated with herbaceous and very low woody vegetation wherever it occurs: in newly regenerated stands or small openings in mature stands.
- **Wetland ground cover users** are species using herbaceous vegetation associated with wetland or other poorly drained sites wherever they occur in the forest.

Aspen–Birch Types

The aspen–birch type is an early-successional type found throughout New England. As such, frequent disturbance is required to maintain its presence or it is replaced rapidly by late-successional or climax types that contain very little birch or aspen (figure 30).

Quaking aspen is the typical aspen species, though bigtooth aspen becomes fairly common, especially on good hardwood sites, and balsam poplar (*Populus balsamifera*) becomes an associate in northern New England. The typical birch species is paper birch (*Betula papyrifera*; figure 31). Toward northern New England and at high elevations, mountain paper birch (var. *cordifolia*) — a longer-lived species (approximately two hundred years) than typical paper birch — is common. From mid-New England south, gray birch (*B. populifolia*) becomes more common. Common early- to mid-successional associates of aspen–birch include pin cherry, yellow and black birches, and red maple.

Both aspen and birch occur on a very wide range of sites. The proportion of aspen to birch varies widely depending mostly on stand history, origin, and treatment rather than site; nearly pure stands of each species sometimes occur, especially in small stands. The type occurs on three broad types of sites, reflecting soil and drainage conditions: (1) dry-site, (2) wet-site, and (3) mesic aspen–birch.

Fig. 30. Aspen stand. Twin Mountain, New Hampshire, August 1985. Photo by Richard M. DeGraaf.

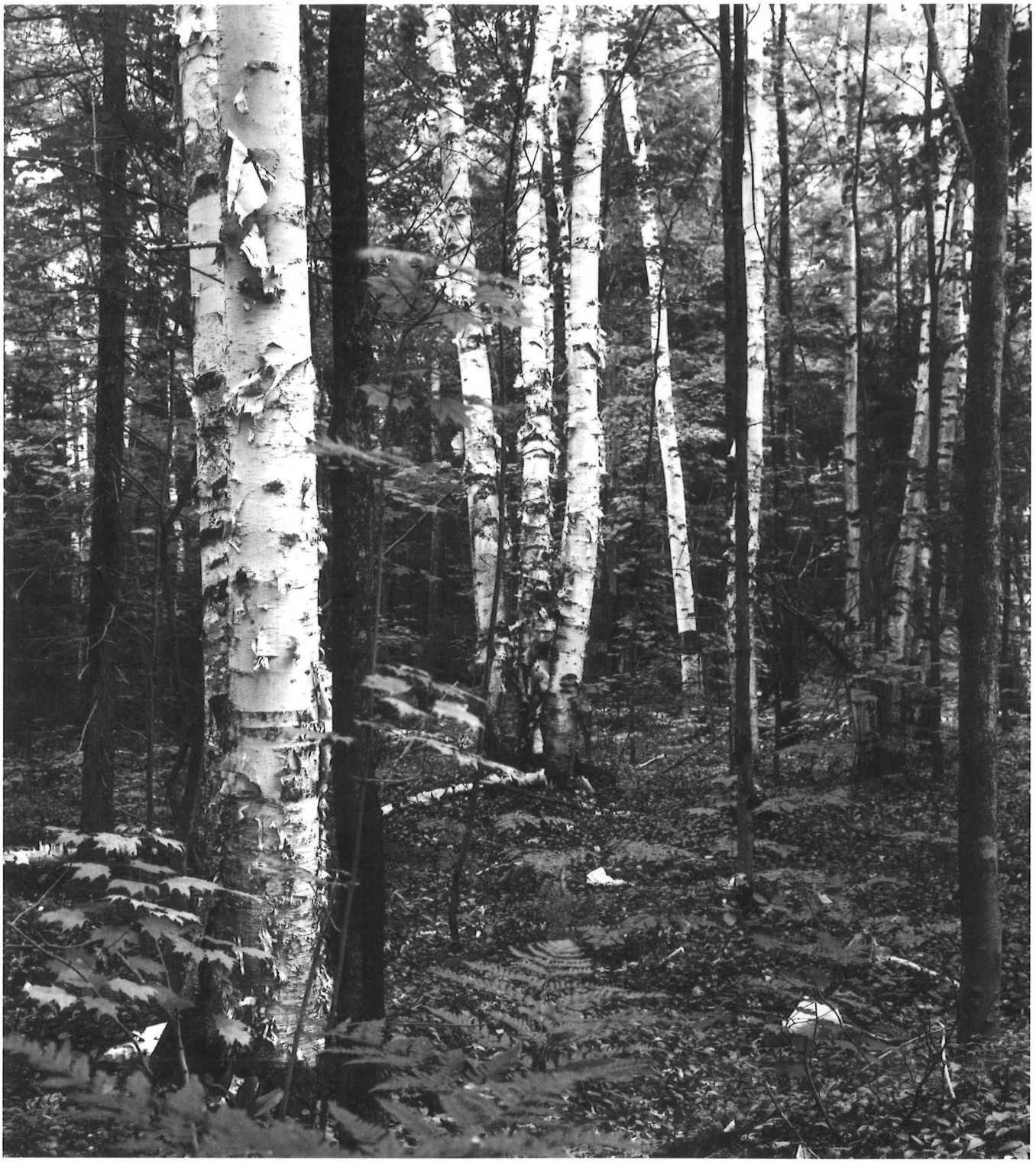


Fig. 31. Paper birch stand. Gorham, New Hampshire, August 1985. Photo by Richard M. DeGraaf.

DRY-SITE ASPEN–BIRCH. These stands occur on sands, gravel, sandy tills, and shallow-to-bedrock soils. Aspen–birch tends to be common on these soils, probably because of a past fire history rather than any competitive ability on dry sites.

On sands, gravel, and shallow bedrock, the climax type is red spruce, balsam fir, or hemlock in the north, oak–pine or hemlock in the south. On sandy tills, beech with some softwood component may be climax with red maple as a common associate.

Quaking aspen grows to only moderate size on dry sites—8 to 12 inches in forty to fifty years before cankers, rot, and mortality denote overmaturity.

When the stands are opened up through decadence, cutting, or windthrow, dry-site shrubs and herbs are quite abundant. Blueberry, beaked hazel (*Corylus cornuta*), wintergreen (*Gaultheria procumbens*), Canada Mayflower or false lily of the valley (*Maianthemum canadense*), dry-site clubmosses (*Lycopodium* spp.), and starflower (*Trientalis borealis*) are typical.

WET-SITE ASPEN–BIRCH. These sites have shallow pans or layers of fine-textured sediments so that drainage is moderate to somewhat poor. However, aspen–birch as a distinct type generally is not found in poorly drained swamps such as those occupied by red maple swamps or wetland shrub swamps.

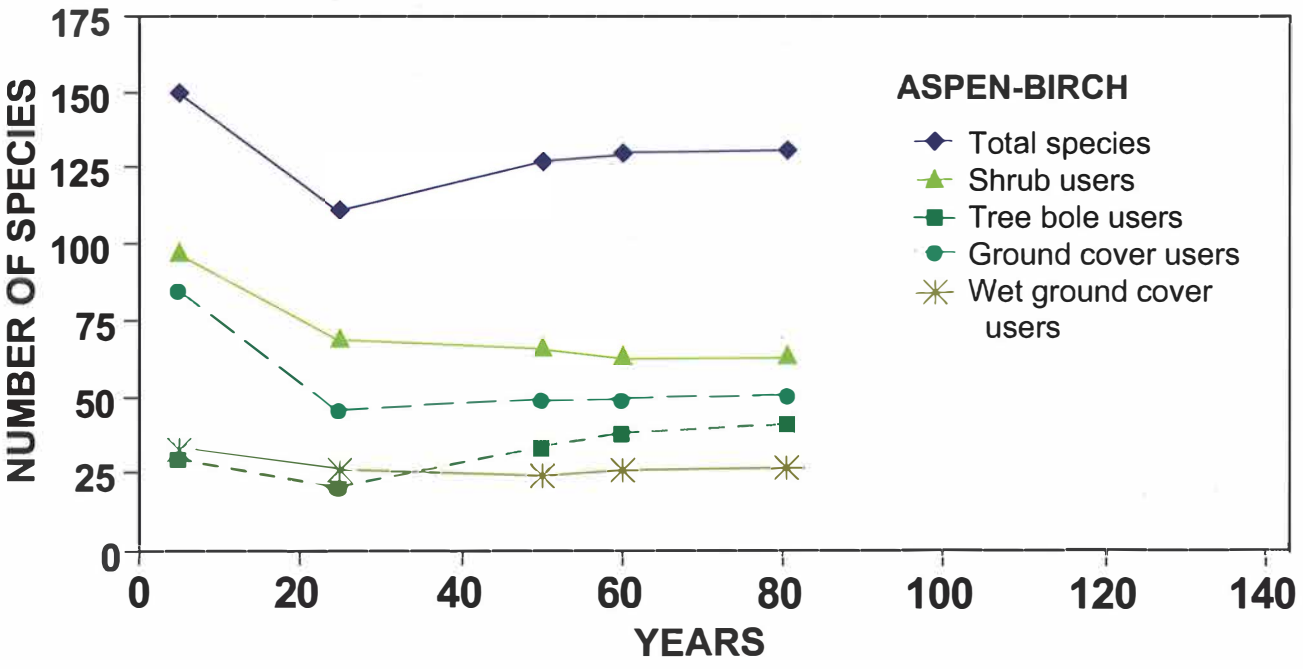
The climax type on wet sites usually is softwoods, spruce–fir in the far north, and hemlock farther south. The tendency toward the climax is strong, and a softwood understory usually is present under the aspen–birch overstory. Quaking aspen grows to fairly large size on these wet sites in mid- to southern New England—up to 14 to 16 inches dbh in fifty years. Maximum sizes of 10 to 14 inches dbh are more common in northern New England.

Wet-site shrubs and herbs include highbush blueberry (*Vaccinium corymbosum*), mountain holly (*Nemopanthus mucronata*), common winterberry (*Ilex verticillata*), *Rubus* species, alders (*Alnus* spp.), several viburnums (*Viburnum* spp.), wood sorrel (*Oxalis* spp.), and goldthread (*Coptis groenlandica*).

In central and southern New England, wet-site shrubs and herbs tend to be more common and higher density than on dry sites. In northern New England, these differences between dry and wet sites are not as distinct.

MESIC ASPEN–BIRCH. These sites have fine-textured soils, sometimes with fairly deep pans, that normally support northern hardwood stands. The climax type is either sugar maple, beech, or a combination of the two; softwoods are not common. Aspen is not abundant on these sites, but it can be regenerated by appropriate procedures.

Quaking aspen easily attains 14 to 16 inches dbh on these soils, and bigtooth aspen may grow to 20 to 24 inches dbh. However, some experience indicates that aspen mortality is high after fifty to sixty years on good hardwood sites. Paper birch attains comparable diameters to trembling aspen, but occasionally reaches 18 to 20 inches dbh.



Mean d.b.h. (in)	2-4	4-6	6-10	10-12
Basal area (ft^2)	60-80	90-120	100-140	100-140
No. stems per acre	2000-3000	700-1300	300-600	150-200
Maximum height (ft)	20-40	45-65	55-85	60-90
Maximum d.b.h. (in)	6-8	8-12	12-16	16-18

Hardwood Site

Softwood Site

Fig. 32. Aspen–birch stand development and wildlife species occurrence.

Herbs and shrubs are not abundant. Herbs include woodfern (*Dryopteris* spp.), shining clubmoss (*Lycopodium lucidulum*), violets (*Viola* spp.), and partridgeberry (*Mitchella repens*). Hobblebush (*Viburnum alnifolium*) is found but not in great numbers. Understories under cutover or decadent aspen–birch are mostly deciduous.

SUCCESSION. Aspen–birch stands develop rapidly. The herb/shrub stage lasts only a year or two (figure 32). The seedling-sapling stage is characterized by high stem densities; at 1-inch average stand diameter (trees at least 0.6 inches dbh), numbers of stems may be 4,000 to 6,000 per acre. These high stem densities provide ideal protection for ruffed grouse, especially drumming males, from avian predators such as the northern goshawk. As succession proceeds, aspen–birch stands are characterized by (1) closed canopies up through the poletimber (approximately twenty-five to forty-five years old) and small sawtimber (approximately forty-five to seventy years old) stages; (2) increasing proportions of the fast-growing aspen over birch; and (3) small dead tree boles, which stand for only a few years during the pole and sawtimber stages. Aspen generally is dead by age seventy-five and birch by age one hundred in New England. Male aspen flower buds and catkins of mature birch and aspen are important winter foods for ruffed grouse. Yellow-bellied sapsuckers commonly excavate nest holes in pole-sized or larger aspens.

On mesic sites, a tolerant northern hardwood understory begins to develop early, and can dominate the stand in forty to fifty years. On wet or dry aspen sites, a tolerant softwood understory develops and gradually predominates. In southern New England, mixed oak–pine may develop on certain dry sites.

Total numbers of wildlife species (amphibians, reptiles, birds, and mammals) in aspen–birch are highest in the early regeneration stage. Numbers of species using the shrub layer and herb/ground layer decline as stand development proceeds, and numbers using tree boles for bark gleaning, hole nesting, or denning increase (see figure 32 and table 8).

Numbers of species indicated in figure 32 include the total range of site and stand conditions that characterize each habitat component. For example, species using the shrub layer include all those that are found using deciduous, coniferous, ericaceous, and wetland shrubs. The wet and dry sites would tend to support a coniferous shrub layer used by Swainson's thrush, olive-sided flycatcher, Wilson's warbler, Lincoln's sparrow, dark-eyed junco, snowshoe hare, and bobcat; and coniferous overstory inclusions used by northern goshawk, red-breasted nuthatch, hermit thrush, Nashville warbler, red squirrel, porcupine, and white-tailed deer. Mesic aspen–birch supports species that frequently produce a deciduous shrub layer that is used by black-billed cuckoo, yellow-billed cuckoo, gray catbird, and eastern towhee, and midstory layers used by wood thrush, white-eyed and Philadelphia vireos, and American redstart. The climax types will differ by site: northern hardwoods on mesic sites, and either spruce–fir or hemlock on wet and dry sites.

As in all forest types, birds comprise the majority of species with mammals second (see table 8). Numbers tend to be a little higher in aspen than in

birch stands. A stand with 30 percent or more aspen probably qualifies as an aspen stand.

SILVICULTURAL TREATMENTS. Clearcutting is the standard method for regenerating aspen–birch using openings of 3 to 5 acres or larger in small sawtimber or large poletimber stands (see table 8). Aspen regeneration is primarily from root suckers with some supplementary seedlings, while paper birch develops from seed. The typical rotation age is fifty to sixty years or even earlier if rapid increases in the aspen component are desired. Longer rotations may result in high aspen mortality, less vigorous suckering, and the development of a dense understory of competing late-successional species. The best time of year to regenerate aspen is the dormant season—late fall or winter. Snow-free harvesting provides the maximum level of disturbance to any existing advance regeneration and prepares a mixed or mineral seedbed for birch seed. The harvest would provide for reserved areas, perhaps with a softwood component, as well as a few individual reserved wildlife trees (high perches, large cavity and mast trees, and coniferous overstory inclusions). Successful aspen suckering is reduced by partial overstories. The primary structural features resulting from clearcutting include: a dense layer of shrubs and tree species, mostly deciduous on hardwood sites but with a coniferous component on softwood sites; soft mast including *Rubus* species and pin cherry; an

Table 8
Characteristic Structural Habitat Features of and Potential Number of Species Associated with Silvicultural Options in the Aspen–Birch Group in a Ten-Year Window

Size class	Treatment options	Site	Overstory	Structural habitat features	A[a]	R	B	M	Total
Regeneration	None	All	Open	Dense shrub and herbaceous ground cover layers; soft mast	5	7	83	47	142
		Wet	Softwood inclusions						
Sapling-pole	No treatment	All	Closed	Small dead trees	8	6	32	29	75
		Wet		Softwood inclusions					
	Crop-tree	All	Closed	Deciduous shrub layer; small dead trees					
		Wet	Coniferous shrub layer; softwood inclusions		8	6	32	29	75
Sawtimber	No treatment	All	Closed	Small/medium dead aspen/birch trees					
		Mesic	Deciduous midstory		8	6	39	37	90
		Dry/Wet	Coniferous midstory						
	Clearcut	All	Open	Exposed perches and cavity trees (few without reserved wildlife trees); dense shrub and herbaceous ground cover layers; soft mast; slash	5	7	83	47	142

[a]A = Amphibians; R = Reptiles; B = Birds; and M = Mammals.

herbaceous ground cover including ferns and grasses; dense slash; and both low and high exposed perches (see table 8). The wildlife response is dramatic in terms of species numbers, especially birds, including red-tailed hawk, Cooper's hawk, turkey vulture, olive-sided flycatcher (on wet sites), common raven, and chipping sparrow — all species that require exposed perches; northern flicker, saw-whet owl, bluebird, tree swallow, house wren, and black-capped chickadee — species that use cavities; nesting Swainson's thrush and purple finch, which are associated with coniferous overstory inclusions; and black bear, which feed on soft mast and commonly den under slash.

Thinning in aspen–birch is not a common practice in New England. However, noncommercial thinning to favor birch is a possibility in sapling or small-pole stands, especially since aspen may outcompete and almost eliminate the birch in unmanaged stands. Choose perhaps fifty or fewer crop trees per acre and free them on all sides. This treatment will slightly hasten the development of a woody shrub layer composed mostly of late-successional tree species, including a coniferous component on softwood sites. We suggest only a small number of crop trees, since ruffed grouse habitat can be compromised by significant reductions in stem density. Following crop-tree thinning, numbers of species will be similar to those under no treatment.

Note: See the *Manager's Handbook for Aspen in the North-Central States* by Perala (1977) and the *Silvicultural Guide for Paper Birch in the Northeast* by Safford (1983) for further information on the management of aspen and birch.

Fig. 33. Northern hardwoods stand. Bowl Research Natural Area, Wonalancet, New Hampshire, 1980. Photo by Raymond Graber.

Northern Hardwood Types

The northern hardwood type is the basic hardwood type in northern New England and occurs at elevations up to 2,500 feet (figure 33). Details follow of the three subtypes: sugar maple–white ash, beech–birch–maple (typical northern hardwoods), and beech–red maple. These subtypes tend to occupy distinct sites with different soil and vegetative features, though mixed subtypes do occur. Collectively, the subtypes are characterized by the presence of maple (sugar or red), the presence of beech (abundant or occasional), and a low proportion of softwoods (<20%). All are late-successional subtypes, approaching the climax, and are persistent under light to moderate disturbance or heavy disturbance (clearcutting) at long intervals (rotations) of one hundred years or more.

These subtypes generally occur on well-drained to moderately well-drained upland

soils between 500 and 2,500 feet elevations (Leak and Graber 1974). Stands representing a given subtype vary from small to moderate in size from a few to 100 acres or so. The subtypes occur throughout New England, though regional shifts in the abundance of certain species occur. For example, black birch (instead of yellow birch) and red oak (with less birch) become more common south of southern New Hampshire, while the softwood component contains more hemlock and white pine, and less red spruce.

SUGAR MAPLE–ASH. This subtype occurs on the best soils in New England: well-drained, fine-textured tills derived from limestone and certain metamorphics, as well as moderately drained areas enriched by moving water and organic materials.

Although beech may be present, we will restrict our definition of this subtype to stands where sugar maple is far more abundant and aggressive. Yellow birch and white ash are common associates of intermediate tolerance. The sites supporting this subtype have the capacity to grow large trees. In overmature stands, sugar maple, yellow birch, and ash commonly attain diameters of 30 to 40 inches. Trees larger than 22 to 24 inches dbh commonly have seams and cavities (Leak 1985).

The shrub layer (2 to 10 feet tall), including true shrubs, small-tree, and large-tree species, is primarily deciduous, though occasional enriched sites contain colonies of Canada yew (*Taxus canadensis*). The midstory canopy (10 to 30 feet tall) is almost completely deciduous. In a mature undisturbed stand, numbers of stems per acre in the shrub layer range around 2,000, and 300 stems per acre in the midstory layers (Bormann et al. 1970; Leak 1959); a fairly sparse understory is typical.

A hundred or more plant species can be found in the herbaceous layer (<2 feet) including herbs, shrubs, and tree seedlings. In mature stands of hardwood, ground cover occupies about 40 percent of the forest floor, but may attain higher percentages under sugar maple–ash because of the richer soils (Siccama et al. 1970).

BEECH–BIRCH–MAPLE. This most common subtype occurs on well-drained sandy loams (occasionally moderately well-drained) in New England. Beech commonly is as abundant or more abundant than sugar maple, especially in the understory. Yellow birch is a common intermediate, while in successional stands, paper birch is more common here than in the sugar maple–ash subtype. Ash is not abundant. Sugar maple and yellow birch in overmature stands reach 30 to 36 inches dbh, but defect is common in trees larger than 20 inches dbh. Because of the abundance of beech, dead and defective trees are more common — at an earlier age — in northern hardwood stands than in sugar maple–ash. In New England, the majority of beech have cavities and holes at 16 to 18 inches dbh and few live trees are found larger than 22 inches dbh (Leak 1985).

The shrub and midstory layers are primarily deciduous, and are similar in general character to those under sugar maple–ash. However, in undisturbed mature stands, the shrub and midstory layers are less dense than in many

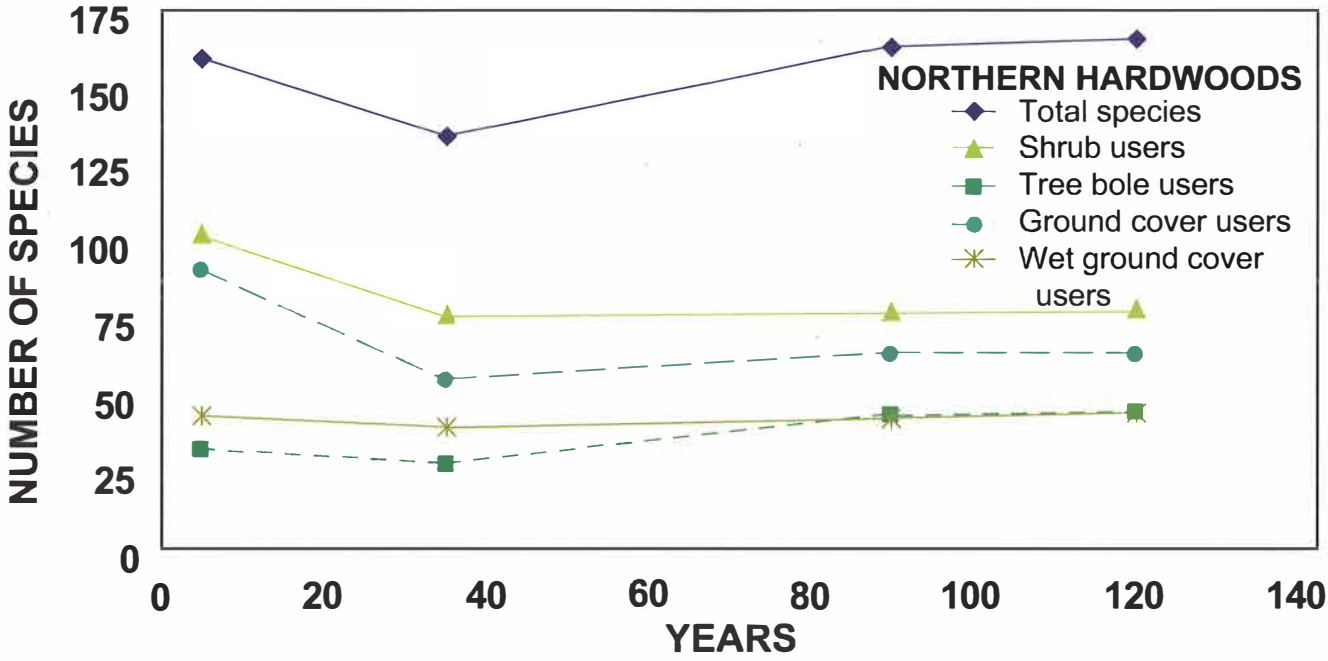
other forest types—for example, fewer than 200 stems per acre in the midstory layer. Herbaceous layers in mature stands typically reach about 40 percent ground coverage, with lower plant diversity than under sugar maple–ash. Beech–birch–maple stands on acidic soils, such as those derived from granite, have sparse ground covers—probably less than 30 percent coverage in mature stands (Siccama et al. 1970).

BEECH–RED MAPLE. In the beech–red maple subtype, beech is a predominant component and probably the climax species; red maple is more abundant and aggressive than sugar maple. Northern red oak is an associate from mid–New Hampshire south; the subtype often contains softwood components (spruce, hemlock, or white pine—up to 10 to 15 percent of the basal area). The soils generally are sandy, somewhat washed tills. In old stands, maximum tree sizes seldom exceed 20 to 22 inches dbh, and cavities are common in trees over 14 to 16 inches dbh (Leak 1985).

The shrub and midstory layers frequently contain some mixture of softwoods, though hardwoods are predominant. Midstory layers are more dense than those under beech–birch–maple, containing twice the number of stems. This is probably due to the tendency of beech to form dense understory thickets. Herbaceous layers are sparse under undisturbed stands, less than 30 percent ground cover.

SUCCESSION. Succession in the northern hardwood type group consists of a short (two to four years) herbaceous/shrub stage followed by a predominance of hardwood species in the seedling/sapling (to ten years), pole (ten to fifty-nine years), and sawtimber stages (figure 34). Seedling-sapling stands in this type are less dense than in aspen–birch, and contain about 3,000 to 3,500 stems per acre at 1-inch mean stand diameter (stems >0.6 inches dbh). During succession, canopies are closed, a range of dbh classes is represented, and the herbaceous/shrub layer is sparse. One basic distinction is that beech–red maple stands (and beech–birch–maple with a high proportion of beech) develop an abundance of cavity trees earlier in the life of the stand. This subtype also develops small inclusions of softwoods. In old stands (>150 years), the few cavity trees in stands where sugar maple is abundant will be much larger (≤30 inches dbh) than in beech–red maple (≤20 to 22 inches dbh).

Numbers of wildlife species are high in regenerating stands and then drop off in pole stands because rapid tree growth and crown closure shade out the herbaceous/shrub layer (used by species such as alder and willow flycatchers, brown thrasher, cedar waxwing, yellow warbler, chestnut-sided warbler, common yellowthroat, song sparrow, and American goldfinch; see figure 34). Eastern bluebirds have an extremely short tenure, being present only one or two years after clearcutting when stubs or snags with old woodpecker holes are retained (table 9). Numbers are lowest in the pole stage, and then increase to the maximum in mature stands. Silviculturally mature, overmature, and all-aged stands generally have the same breeding bird composition. The species that respond most dramatically to forest maturation are the tree-bole users—those that glean bark insects or use cavities (see figure 34 and table 10). Beech–red



Mean d.b.h. (in)	2-4	4-6	6-8	8-10	10-12	11-13	12-14
Basal area (ft^2)	50-70	90-100	100-110	100-120	90-100	100-120	100-120
No. stems per acre	1000-2000	500-1000	300-500	200-300	125-165	125-150	110-125
Maximum height (ft)	30-40	40-60	50-70	60-80	70-80	70-80	70-80
Maximum d.b.h. (in)	8-10	10-12	12-14	16-18	16-18	16-18	16-18

Fig. 34. Northern hardwoods stand development and wildlife species occurrence.

maple stands tend to have the highest number of such species, though large boles for certain species such as the pileated woodpecker, porcupine, black bear, fisher, and ermine are especially likely in overmature sugar maple stands. Beech–red maple also contains small coniferous overstory inclusions, which are utilized by forty to sixty species including northern goshawk, great horned owl, red-breasted nuthatch, hermit thrush, Nashville warbler, northern parula, black-throated green warbler, blackburnian warbler, pine siskin, red squirrel, porcupine, and white-tailed deer (see table 10).

SILVICULTURAL TREATMENTS. Several harvesting systems are used to regenerate northern hardwood sawtimber stands: clearcutting, shel-

Table 9
Year in which Breeding Bird Species First Appear, Become Common, and Decline in Seedling and Sapling Stands of Northern Hardwoods in New England After Clearcutting

Bird species	First appear	Become common	Decline
Eastern bluebird	1	1	2
Northern flicker	1	1	7–10
Willow flycatcher	1	4	7–10
Winter wren	1		2
Swainson's thrush	2	4	15[a]
Chestnut-sided warbler	2	4	10
Mourning warbler	2	5	7–10
Common yellowthroat	2	6	10
American goldfinch	2	6	7–10
Cedar waxwing	2	4	7–10
Veery	3	6	[a]
Black-and-white warbler	3	4	15[a]
Rose-breasted grosbeak	3	15	[a]
Canada warbler	5	15	[a]
Ruffed grouse	10	15	[a]
Wood thrush	10	15	[a]
Ovenbird	10	15	[a]
Black-throated blue warbler	15	[a]	[a]
Black-throated green warbler	15	[a]	[a]

Source: DeGraaf, 1987.
[a]Present throughout the remainder of the developing stand.

terwoods, and selection (see table 10). Each produces appreciably different regeneration species as well as wildlife habitat conditions.

Clearcutting maximizes intolerant/intermediate species including paper and yellow birches, white ash (on appropriate sites), red maple, aspen, and pin cherry; and there always is a component of the shade-tolerant beech and sugar maple. Wildlife habitat features include dense shrub and herbaceous ground cover layers, soft mast (*Rubus* spp. and pin cherry), slash, and low exposed perches—provided that there are reserved patches and wildlife trees (high exposed perches, cavity trees, and coniferous overstory inclusions). Eliminating reserved wildlife trees affects the necessary habitat features for at least three dozen wildlife species, including red-tailed hawk, olive-sided flycatcher, northern flicker, house wren, eastern bluebird, black bear, porcupine, ermine, and long-tailed weasel. On beech–red maple sites, the reserved areas could include a softwood component, which is commonly used by nesting Swainson's thrushes. In comparison with untreated sawtimber stands, the clearcuts

support many more wildlife species (see table 10). More open canopies and a vigorous herb/shrub layer combine to provide accessible raptor hunting areas the first few years post-harvest, especially where openings and wetlands are uncommon. Rapid changes in bird species occur during the first few years after clearcutting, reflecting the ephemeral nature of this habitat condition and its relative importance in providing important brushy habitat and soft mast component in largely forested landscapes (see table 9).

Shelterwood harvests in northern hardwoods usually are deferred or delayed shelterwoods where 20 to 40 square feet of basal area in vigorous 10- to 14-inch trees are retained for decades, along with a component of wildlife trees (high exposed perches, cavity trees, and coniferous overstory inclusions). On good northern hardwood sites, where there is an understory of sugar maple, the residual density can be on the high end. Where there is

Table 10
Characteristic Structural Habitat Features of and Potential Number of Species Associated with Silvicultural Options in Northern Hardwoods in a Ten-Year Window

Size class	Treatment options	Subtype	Overstory	Structural habitat features	A[a]	R	B	M	Total
Regeneration	None	All	Open	Dense shrub and herbaceous ground cover layers; soft mast	7	9	87	46	149
Sapling-pole	No treatment	All	Closed	Small dead trees	16	9	43	31	99
	Thinning[b]	All	Partial	Deciduous shrubs; small dead trees	16	11	50	39	116
Sawtimber	No treatment	Be/YB/SM[c]	Closed	Large cavity trees; midstory; beech mast; dead and down material	17	9	54	38	118
		Be/RM[c]		Same as above; softwood inclusions; small/ medium cavity trees					
	Clearcut	All	Open	Exposed perches and cavity trees (few without reserved wildlife trees); dense shrub layer and herbaceous ground cover; soft mast; slash	7	9	87	46	149
	Shelterwood	All	Partial	Midstory; beech mast; slash	17	11	66	47	141
		Be/RM		Softwood inclusions					
	Selection[d]	All	Closed	Reserved cavity trees; midstory; beech mast; slash	17	9	54	38	118
		Be/RM[c]		Softwood inclusions					
	Thinning	Be/YB/SM and Be/RM	Closed	Midstory; beech mast	17	9	54	38	118
		Be/RM[c]		Softwood inclusions					
	Thinning	All	Partial	Midstory; slight shrub layer; beech mast; slash	17	11	66	47	141
		Be/RM[c]		Softwood inclusions					

[a]A = Amphibians; R = Reptiles; B = Birds; and M = Mammals.
[b]Commercial or noncommercial thinning.
[c]Be = Beech, YB = Yellow birch, SM = Sugar maple, RM = Red maple.
[d]Includes both single-tree and group/patch selection. The latter creates somewhat greater species diversity and small areas of early successional habitat.

an understory of less-desirable species — on the beech–red maples sites for example — the residual overstory should be lower, and the ground disturbance more intensive, to encourage birch regeneration. On such sites, there may be opportunities to reserve some softwood inclusions. Shelterwood harvests result in a partial overstory, a dense woody shrub layer, beech mast (from reserved wildlife trees), and slash. However, the earliest successional benefits — soft mast from *Rubus* species and pin cherry and herbaceous ground cover — are generally less abundant than in clearcuts. These habitat factors combine to provide suitable hunting and feeding areas for species such as Cooper's hawk, red-tailed hawk, American kestrel, phoebe, and olive-sided flycatcher. These are important considerations, especially where upland openings and wetlands that provide dense ground cover are scattered infrequently throughout an area.

The selection system in northern hardwoods can be either single-tree or group/patch. On the best northern hardwood sites, single-tree selection will regenerate an acceptable component of sugar maple. On lower sites, and especially in beech–red maple stands, single-tree selection will result in a dense beech understory. Group/patch selection using openings 0.25 to 0.67 acre or even up to a couple acres in size will provide for a component of birch and small areas of early-successional habitat; however the wildlife habitat potential is not greatly different between single-tree and group/patch selection (unless the groups are large). The habitat features include a mostly closed canopy, large cavity trees, a midstory, moderate amounts of slash, and beech mast and softwood inclusions on beech-red maple sites. Wildlife species that utilize these forest conditions are not greatly different from those that are found in unmanaged sawtimber stands (see table 10), and include sharp-shinned hawk, northern goshawk, barred owl, veery, Philadelphia vireo, American redstart, scarlet tanager, red bat, and hoary bat, among others.

Intermediate treatments in northern hardwoods consist of precommercial and commercial thinning in poletimber and small sawtimber stands. Commercial thinning is the more common alternative. This often consists of the removal of early-maturing species such as paper birch and aspen together with some cultural improvement in other species. It is important at this point to provide additional aspen–paper birch acreage in overall management strategies if commercial thinning is practiced extensively. Thinning produces only a moderate alteration of wildlife habitat features when a partial overstory canopy results (slight shrub layer; see table 10). Where a closed canopy results from thinning, minimal alteration of wildlife habitat features results and the potential wildlife species response differs little from untreated sawtimber stands, as long as larger cavity trees and softwood inclusions are distributed throughout the stand.

Where the presence of early-successional forest types such as aspen and paper birch are desired, the beech–red maple subtype is probably one of the easier places to convert to aspen–birch. This is accomplished by a series of short-rotation complete clearcuttings. Cuttings at rotations of twenty-five to thirty years will result in the most rapid conversion, if costs or markets or both permit. Conversion is most feasible if some aspen component is available

for root-sucker regeneration. Otherwise, consider scarification (and perhaps liming) to encourage aspen and birch seedling regeneration.

Note: See the *Silvicultural Guide for Northern Hardwoods Types in the Northeast* (Leak et al. 1987) for further information on the management of these types.

Swamp Hardwoods Type

In New England, the usual swamp hardwood type is referred to as elm–ash–red maple. However, these areas are essentially red maple swamps (figure 35). The elm mostly has been eliminated by the Dutch elm disease, and black ash (*Fraxinus nigra*) is rarely abundant. The swamp hardwood type is most common in riparian zones and freshwater wetlands in southern New England. The sites are very poorly drained—inundated part of the year—and commonly associated with slow-moving streams and beaver flowages.

Common associates of the type are black spruce and northern white cedar (*Thuja occidentalis*) to the north, and Atlantic white cedar (*Chamaecyparis thyoides*) and black gum (*Nyssa sylvatica*) in southern New England. Wetland understory shrubs are common, including alders, *Ilex* species, mountain holly, blueberries, and others. Herbaceous vegetation is abundant, including sedges, ferns, false hellebore (*Veratrum viride*), and skunk cabbage (*Symplocarpus foetidus*).

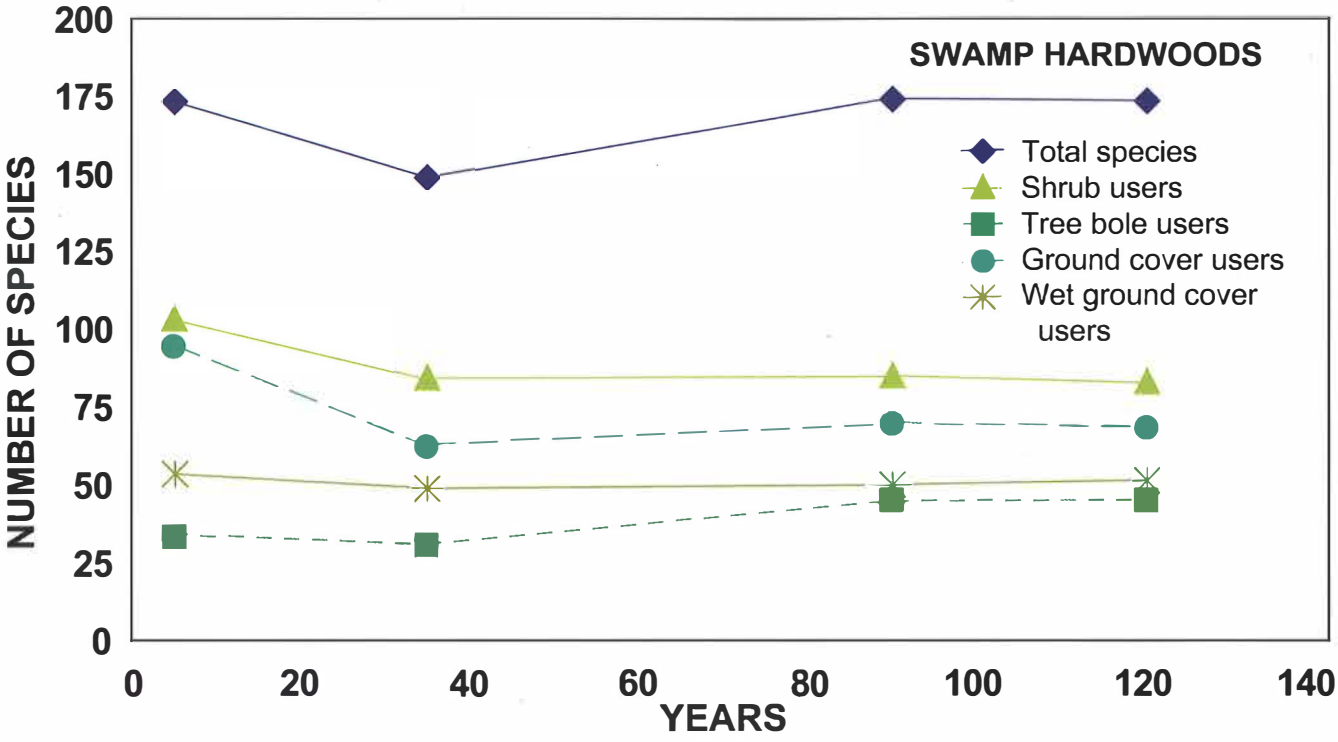
Successional trends in red maple swamps are not well understood. One possibility is that these areas were once in softwoods such as hemlock, fir, cedar, or spruce; or these areas might have been old beaver flowages and meadows. Heavy cutting and clearing for agriculture (wet meadows) have eliminated the softwoods. Over time, these areas may return gradually to softwoods, though many red maple swamps show no evidence of that trend as yet.

SUCCESSION. The seedling/sapling stage lasts about ten years (figure 36 and table 11). It begins as a dense mixture of stump sprouts and wetland shrubs, gradually developing a sapling overstory of nearly pure red maple. Wildlife species that use the persistent shrub and herbaceous ground cover layers in swamp hardwoods include many species of salamanders, frogs, turtles, and snakes, especially ribbon snake; birds including green-backed heron, woodcock, black-billed and yellow-billed cuckoos, gray catbird, least flycatcher, yellow warbler, chestnut-sided warbler, rose-breasted grosbeak, swamp sparrow, song sparrow, red-winged blackbird, and common grackle; and mammals including snowshoe hare, star-nosed mole, water shrew, cottontail, meadow vole, mink, bobcat, white-tailed deer, and moose.

The poletimber stage (ten to fifty-nine years) consists of a closed canopy of red maple. In addition, red maple swamps are one of the few types of stands where a significant understory remains during the poletimber stage. In southern New England, escaped exotics such as tartarian honeysuckle (*Lonicera tatarica*), multiflora rose, and Japanese barberry also are found commonly

in the understory. Some black alder and blueberry may be present, but the most noticeable component is the dense herbaceous ground cover — ferns, skunk cabbage, and sedges — and temporary pools of water that are key habitat features for species such as the northern two-lined salamander, American toad, wood and northern leopard frogs, northern water snake, green-backed heron, American black duck, northern waterthrush, and southern bog lemming.

Fig. 35. Red maple swamp. Amherst, Massachusetts, May 1990. Photo by Richard M. DeGraaf.



Mean d.b.h. (in)	2-4	4-6	6-8	8-10	10-12	11-13	12-14
Basal area (ft^2)	40-60	60-70	70-80	80-90	90-100	100-120	100-120
No. stems per acre	1000-2000	400-700	250-350	165-250	125-165	125-150	110-125
Maximum height (ft)	30-40	40-50	50-60	60-70	70-80	70-80	70-80
Maximum d.b.h. (in)	6-8	10-12	12-14	14-16	16-18	16-18	16-18

Fig. 36. Swamp hardwoods stand development and wildlife species occurrence.

In the sawtimber stage, the same types of conditions remain: (1) a closed canopy, and (2) an herbaceous ground cover, which continues to provide habitat features for similar species mentioned previously in the younger age and smaller size classes. Some small and medium size (<14 inches dbh) defective and dead stems normally are present.

The character of overmature red maple swamps can only be surmised because few, if any, exist. Certainly dead and defective trees would increase in number and size. We would anticipate some midstory trees and shrubs along

with the herbaceous ground cover. Possibly, some trend toward a softwood understory would be evident. The number of species follows trends similar to other hardwood types: (1) high numbers of wildlife species in regenerating stands, (2) low numbers in poletimber stands, and (3) high numbers in mature and overmature stands.

SILVICULTURAL TREATMENTS. Silvicultural treatments in swamp hardwoods are marginal operations because of the low value of the species (primarily red maple) and the operational and legal difficulties of harvesting in wetlands and near water courses. Perhaps the primary incentive for managing swamp hardwoods is the potential for very significant wildlife species responses. These are places where foresters need to watch for heron rookeries or raptor nests and be prepared to adjust any management actions to accommodate any visible nest sites and nesting activity, which should not be difficult since any harvesting would need to be done on frozen ground during the winter.

The only regeneration option we'll discuss here is clearcutting with, of course, some reserved patches and individual wildlife trees (high exposed perches, larger cavity trees, and softwood inclusions). In many swamp hardwood stands, there is a component of pine or spruce that can be reserved as potential softwood inclusions. The regeneration following clearcutting is confined to red maple stump sprouts together with a dense growth of shrubs (alder, winterberry, leatherleaf (*Chamaedaphne calyculata*), viburnums, etc.) and a vigorous resurgence of wetland ground vegetation and temporary pools among the slash (see table 11). Because of the low economic values involved, it is feasible to reserve a variety of trees as cavity and den sites, and also to

Table 11
Characteristic Structural Habitat Features of and Potential Number of Species Associated with Silvicultural Options in Swamp Hardwoods in a Ten-Year Window

Size class	Treatment options	Overstory	Structural habitat features	A[a]	R	B	M	Total
Regeneration	None	Open	Wetland shrub layer; wetland ground cover layer	9	12	91	47	159
Sapling-pole	No treatment	Closed	Small dead trees; wetland ground cover layer	19	11	43	29	102
	Thinning[b]	Partial	Small reserved cavity trees; shrubby midstory; wetland shrub and ground cover layers; slash	19	13	53	36	121
Sawtimber	No treatment	Closed	Cavity/dead trees; shrubby midstory; wetland shrub and ground cover layers	19	11	54	35	119
	Clearcut	Open	Exposed perches; wetland shrub and ground cover layers; slash	9	12	91	47	159

[a]A = Amphibians; R = Reptiles; B = Birds; and M = Mammals.
[b]Commercial or noncommercial thinning.

retain high and low exposed perches that benefit species such as the wood duck, hooded merganser, screech-owl, great blue heron, common raven, Acadian flycatcher, eastern kingbird, house wren, Virginia opossum, various bats, porcupine, fisher, and ermine. This type of treatment would encourage the presence of beaver, which over time would create an impoundment and then a meadow as the site was abandoned.

Thinning, possibly for fuelwood, is a minor option in swamp hardwoods, removing about half of the basal area. Possible losses in stem quality are not important. The main effect of thinning is to maintain a dense shrub understory and midstory for species such as the white-eyed and yellow-throated vireos, American redstart, and common yellowthroat, and to keep a reserve of larger cavity trees available. Potential species numbers are not greatly different from untreated sawtimber stands.

Converting red maple to other types is difficult. The only alternatives are: (1) repeated clearcutting to convert the area to a shrub swamp wetland to maintain open canopy conditions in largely unbroken forest landscapes, and (2) a long wait to see if a softwood component appears in the understory.

Spruce and Fir Types

The red spruce–balsam fir type occurs principally in northern New England and New York, adjacent Canada, and the highest elevations of the Appalachian range (figure 37). Red spruce and balsam fir also occur as pure types, depending on site conditions and stand age (figures 38 and 39). White spruce becomes a more common associate in the northwest part of the type's range; hemlock increases toward the southern part at lower elevations. Black spruce and tamarack occur in wet areas toward the northern part.

Spruce–fir is a climax type and remains persistent under light to moderate disturbance. Heavy disturbance results in hardwood-softwood mixtures followed by a predominance of fir. Over time, without additional disturbance, the proportion of red spruce increases due to its longevity—about 400 years as compared to a maximum of 150 to 200 for fir—and usually much less.

Two broad types of spruce–fir sites are recognized: primary and secondary (Frank and Bjorkbom 1973).

PRIMARY SITES. Primary softwood sites consist of moderately to somewhat poorly drained areas at lower elevations (spruce–flat, Westveld 1941); and shallow-to-bedrock areas at elevations above 1,500 to 2,500 feet in New England and New York (spruce–slope, Westveld 1941). Primary sites probably also include knolls of gravelly or sandy outwash at low elevations.

Although primary sites vary, they share certain vegetative characteristics. Primary softwood sites exhibit a high proportion of softwoods. When heavily disturbed (for example, by clearcutting), successional hardwoods such as aspen and paper birch rapidly invade, together with *Rubus* species and other shrubs. However, softwoods usually remain evident in the overstory or a coniferous understory rapidly develops, or both. Over time, these

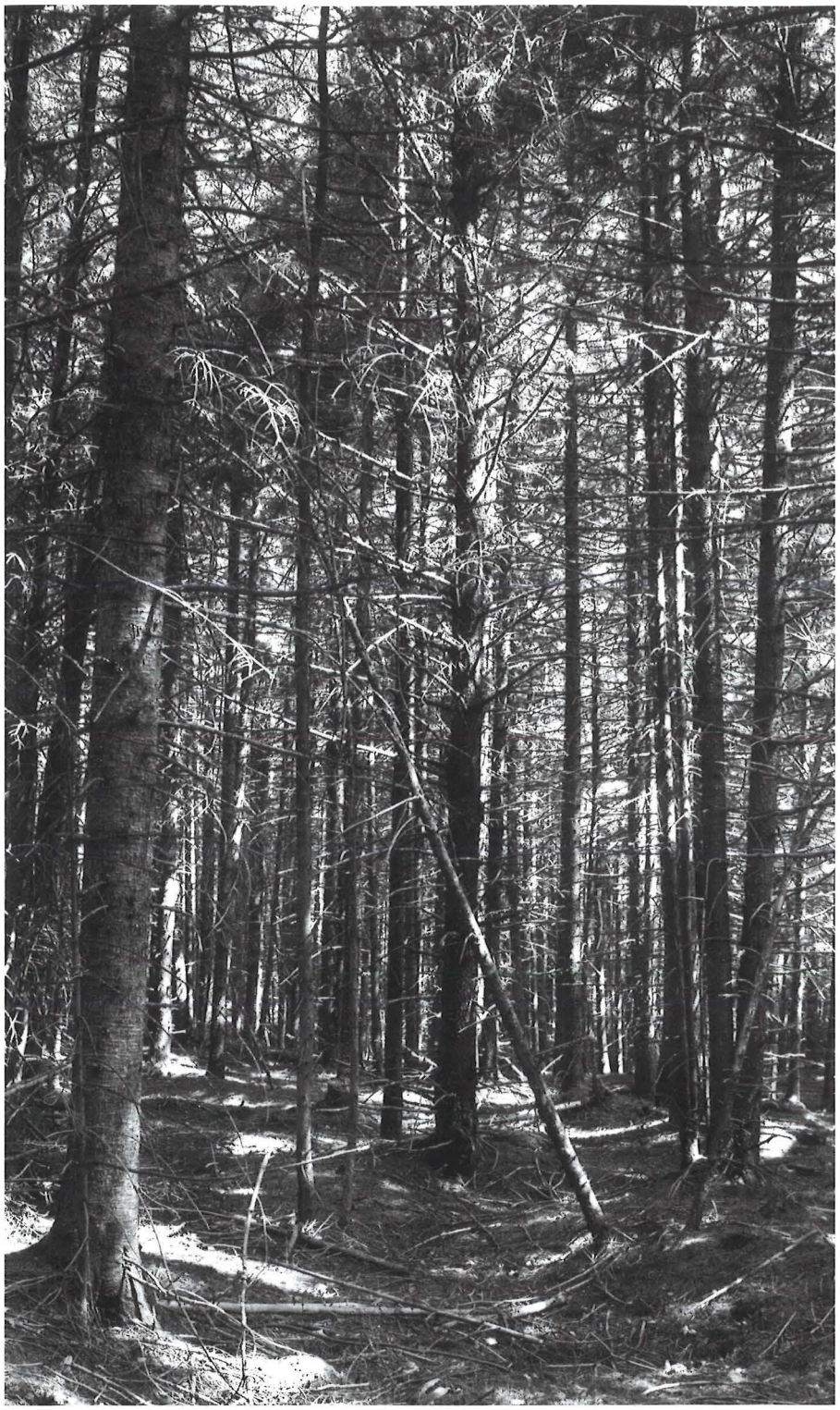


Fig. 37. Spruce–fir stand. Tenkiln Area, Green Mountain National Forest, Vermont, May 1946. Photo by USDA Forest Service.

Fig. 38. Red spruce stand. Mount Tabor, Vermont, June 1948. Photo by USDA Forest Service.

mixedwood stands revert to nearly pure (75%) spruce–fir as the early-successional hardwoods die out.

Mixedwood stands on primary sites generally support a layer of deciduous shrubs and small trees in addition to the coniferous understory. At low elevations, these include hobblebush and striped maple (*Acer pensylvanicum*); at higher elevations, mountain ash and mountain maple (*A. spicatum*) are more common. On moist sites, *Oxalis* species and goldthread are common. On dry, sandy and gravelly sites, ericaceous plants and *Lycopodium* species are common.

Pure softwood stands, on the other hand, often contain sparse herbaceous and shrub layers until the canopy is broken by overmaturity, windthrow, or insect damage. On primary sites, spruce, fir, and hemlock attain maximum

diameters of 20 to 22 inches, 12 to 14 inches, and 24 to 30 inches, respectively. However, decay and mortality are common at diameters of 12 to 14 inches, 8 to 10 inches, and 18 to 20 inches dbh, respectively.

SECONDARY SITES. These are well-drained to moderately well-drained side slopes at mid elevations. The soils vary from sandy tills to moderately well-drained pans. Soils are better than those found on primary sites, and competition from hardwoods is greater. Pole and sawtimber stands generally are mixedwood with less than 50 percent softwoods. Over long periods of time, these sites tend to revert to pure softwoods. If heavily disturbed (for example, by clearcutting), the new stand may be nearly pure hardwoods, but over time gradually will develop a softwood understory. In central New England, red spruce and balsam fir commonly seed into pastures and sometimes into old fields, commonly producing essentially pure stands. Farther north, white spruce commonly seeds into old fields.

Poletimber and sawtimber stands contain deciduous shrubs (for example, hobblebush) in the understory. Herbaceous layers vary greatly in species and density — up to 30 to 40 percent ground coverage.

Fig. 39. Balsam fir stand. West Milan, New Hampshire, August 1985. Photo by Richard M. DeGraaf.

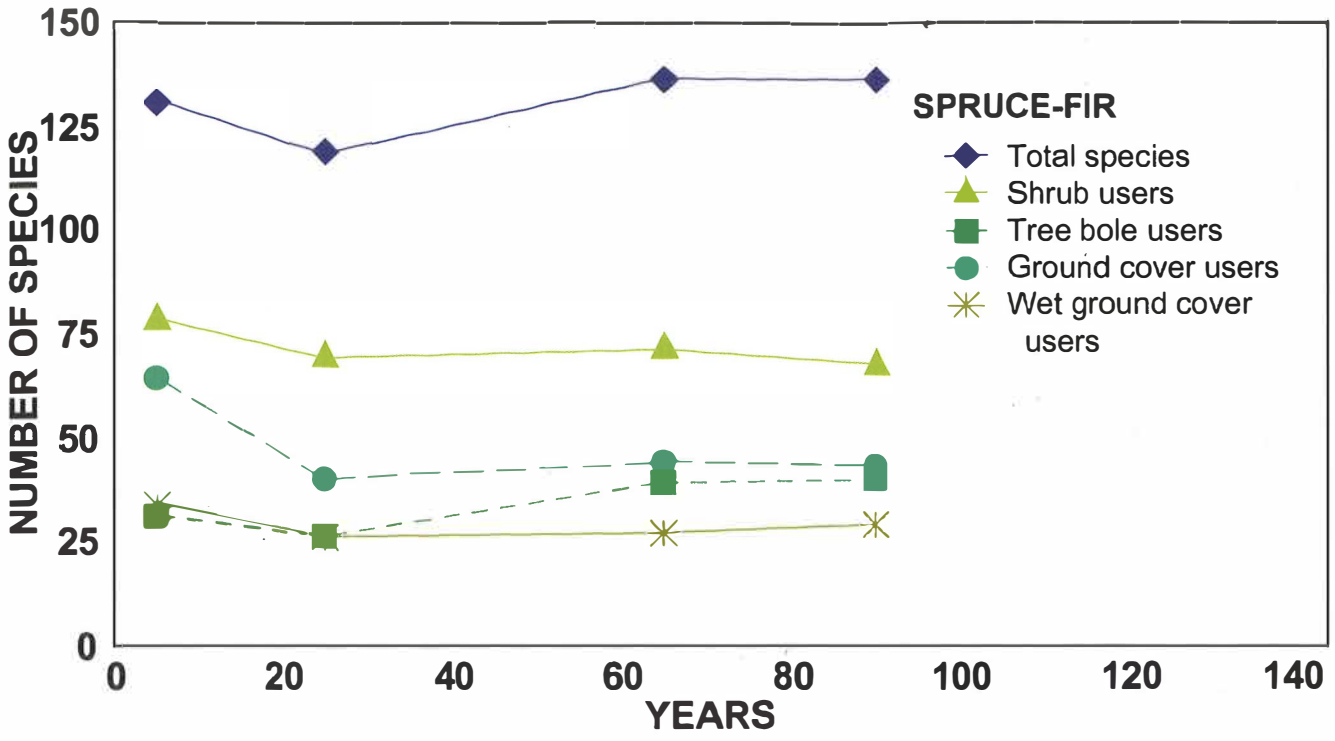
Although spruce, fir, and hemlock tend to grow better on secondary rather than primary sites, tree sizes are not greatly different. Maximum sizes are approximately 20 to 24 inches, 12 to 14 inches, and 30 to 36 inches dbh for spruce, fir, and hemlock, respectively, with overmature and defective sizes of 14 to 16 inches, 10 to 12 inches, and 20 to 22 inches dbh, respectively, on both primary and secondary sites. The hardwoods commonly found on secondary sites—including red maple, birches, and aspen—generally show defect and cavities at 14 to 16 inches dbh (or earlier in the case of quaking aspen).

SUCCESSION. On wet primary sites, the herbaceous/shrub layer (*Rubus* spp. and sedges) following clearcutting of spruce–fir stands may last up to ten to fifteen years (figure 40). The period is much shorter on drier primary and secondary sites. The main difference between successional trends on primary sites and secondary sites is the hardwood component—mainly pure softwoods on primary sites and a mixture of hardwoods and softwoods on secondary sites. An associated characteristic is the relative abundance of deciduous cavity trees on secondary sites. On both sites, the successional trend is toward increasing proportions of softwoods.

Spruce–fir stands follow several alternative patterns during maturity and overmaturity. Those comprised primarily of balsam fir reach overmaturity at sixty to seventy years of age; the canopy dies over a period of a few years and the fir understory forms a new sapling stand. At high elevations, fir mortality proceeds across the landscape in "fir waves." In spruce-fir, the canopy essentially remains closed until the stand is roughly sixty to seventy years old, when the fir begins to die. After that, areas of a few to many acres begin to die and regenerate to mixed spruce–fir–hardwood seedling/sapling stands. Canopy openings in overmature spruce–hemlock and spruce–hardwood (secondary sites) are smaller and less distinct. The stands maintain a more uneven-aged character due to differences in species longevity.

Numbers of wildlife species are high in the regeneration stage due to the herbaceous/shrub layer (see figure 40 and table 12). Numbers are lowest in the pole stage as the herbaceous and shrub layers are shaded out, and the stems are still too small for cavity nesters. Species numbers reach the maximum in mature and overmature spruce–fir—again because of the increasing numbers of tree-bole users. Mature stands support more bark-gleaning and hole-nesting species than younger stands due to the presence of snags and live stems with decay columns within the boles. Black-backed woodpecker is typical in such stands. Fir and spruce–fir tend to support more species than does pure spruce. The presence of hardwood trees, even declining ones, adds species to either type; red-eyed vireo, for example.

SILVICULTURAL TREATMENTS. To regenerate spruce–fir stands, we'll discuss the shelterwood and selection systems. We haven't included clearcutting coupled with herbicides and planting—a technique sometimes used for intensive management of industry lands. Clearcutting without herbicides and planting will regenerate to mixed hardwoods unless there is a well-established softwood understory that can be released by careful harvesting.



Mean d.b.h. (in)	2-4	4-5	5-7	7-9	8-10	9-11	10-12
Basal area (ft^2)	80-120	100-150	160-230	200-250	210-270	220-280	220-280
No. stems per acre	1500-3500	1000-1200	800-1000	550-750	500-600	400-500	300-400
Maximum height (ft)	10-20	30-50	50-70	60-80	65-90	70-90	70-90
Maximum d.b.h. (in)	6-8	8-10	10-12	12-14	14-16	16-18	18-20

Fig. 40. Spruce–fir stand development and wildlife species occurrence.

The shelterwood system is the most effective way to regenerate spruce–fir naturally. The first cut leaves a fairly dense partial canopy to begin the regeneration of spruce and fir. The overstory is removed beginning about ten years later in either one or two cuts. In addition to a partial canopy, the system can provide for a dense shrub layer, large cavity trees, hardwood inclusions, and—on spruce–fir flats—a wet herbaceous ground cover. Potential species numbers are only slightly greater following a shelterwood cut than in untreated sawtimber stands (see table 12).

Single-tree or small-group selection also provides enough shade to encourage the regeneration of spruce–fir, commonly with some hemlock in appropriate regions. Sometimes the marking can be directed toward releasing small areas of spruce–fir advanced regeneration through group selection. The system provides for an essentially closed canopy, cavity trees, midstory, slash, and some hardwood inclusions. The lack of a dense shrub layer limits the occurrence of those species that utilize that habitat type, so that the selection system varies little from that of untreated sawtimber stands (see table 12).

Intermediate treatments in spruce–fir include spacing treatments in sapling stands and commercial thinning in poletimber stands. Both treatments provide a partial canopy (60 to 70 percent, perhaps), and some development of a fir understory. In applying these treatments, it is important to reserve potential wildlife trees (larger cavity trees and deciduous overstory inclusions). Potential species numbers vary little from those in unthinned sapling-pole stands (see table 12).

Complete clearcutting on long rotations (longer than eighty years) will convert spruce–fir stands to hardwoods that resemble beech–red maple type or aspen–birch type if the stand contains 10 to 20 percent aspen before cut-

Table 12
Characteristic Structural Habitat Features of and Potential Number of Species Associated with Silvicultural Options in the Spruce–Fir Group in a Ten-Year Window

Size class	Treatment options	Site type	Overstory	Structural habitat features	A[a]	R	B	M	Total
Regeneration	None	Dry	Open	Mixed deciduous/coniferous shrub layer; soft mast	4	1	69	43	117
		Wet		Wetland shrub and ground cover layers; soft mast					
Sapling-pole	No treatment	All	Closed	Small dead trees	9	2	54	30	95
	Spacing/thinning[b]	All	Partial	Slash; herbaceous ground cover	8	7	42	37	94
Sawtimber	No treatment	Dry	Closed	Large cavity/dead trees; hardwood inclusions	9	2	58	36	105
		Wet		Large cavity/dead trees; hardwood inclusions; dead and down material					
	Shelterwood	Dry	Partial	Mixed deciduous and coniferous shrub layer; large cavity/dead trees; hardwood inclusions; slash	8	7	48	45	108
		Wet		Coniferous shrub layer; large cavity/dead trees; hardwood inclusions; wetland herbaceous ground cover; slash					
	Selection	All	Closed	Large cavity trees; hardwood inclusions; midstory; slash	9	2	58	36	105

[a]A = Amphibians; R = Reptiles; B = Birds; and M = Mammals.
[b]Commercial or noncommercial thinning.

ting. Repeated clearcutting on short rotations of fifteen to sixty years will favor the aspen–birch component.

Note: See *A Silvicultural Guide for Spruce–Fir in the Northeast* (Frank and Bjorkbom 1973) for further information on management of spruce and fir types.

Eastern Hemlock Type

Eastern hemlock is a ubiquitous species in the Northeast, and occurs across a wide range of sites with a broad array of associated species (figure 41). Hemlock attains sizes of 32 inches dbh and larger, even on fairly severe sites. However, many larger than 20 inches dbh are defective (Leak 1985), which makes eastern hemlock valuable for den- and cavity-using wildlife species. Hemlock often is considered an integral part of the northern hardwood forest. But typical northern hardwoods tend to predominate on reasonably fine-textured, fairly well-drained sites, whereas hemlock is climax and aggressive on sites that are either wetter or drier than normal. Following the terminology for spruce–fir, we can call these primary and secondary sites.

PRIMARY SITES. These sites are mostly outwash sands and shallow pans that vary from moderately well-drained to somewhat poorly drained and fine-textured sediments with a predominance of silt or clay, or both. The wetter the site is, the more aggressive the hemlock. At higher elevations and latitudes, spruce and fir become more common components.

With disturbance, hardwoods increase in abundance. Red maple and yellow and/or black birch are common along with many other species. Wet, shallow-to-pan areas tend to maintain a high proportion of softwoods. Sediments and moderately well-drained pans may support very few softwoods after heavy disturbance.

Common herbs and shrubs include wood sorrel, goldthread, and bluebead lily (*Clintonia borealis*), hobblebush, various ferns, and clubmosses.

SECONDARY SITES. These sites include areas shallow to bedrock, shallow to detached rock, very gravelly sandy tills, shallow well-drained pans, and areas of fine-textured but well-drained to moderately well-drained sediments. Hemlock is predominant (50 to 75%) in climax stands on these sites throughout New England. In mid- to southern New England, white pine often is present in old stands on secondary sites, though it is replaced gradually by hemlock. In northern New England, red spruce is a common climax associate, becoming more abundant at higher elevations and latitudes. For example, in central New Hampshire, red spruce becomes more aggressive than hemlock at about 1,800 feet elevation on the same soil materials.

Disturbed hemlock stands on secondary sites show increased proportions of hardwoods in proportion to the amount of disturbance. Typical hardwoods include beech, oak, paper birch, aspen, and red maple, among others. Prolonged single-tree selection cutting frequently converts mixed stands to hemlock in southern New England.

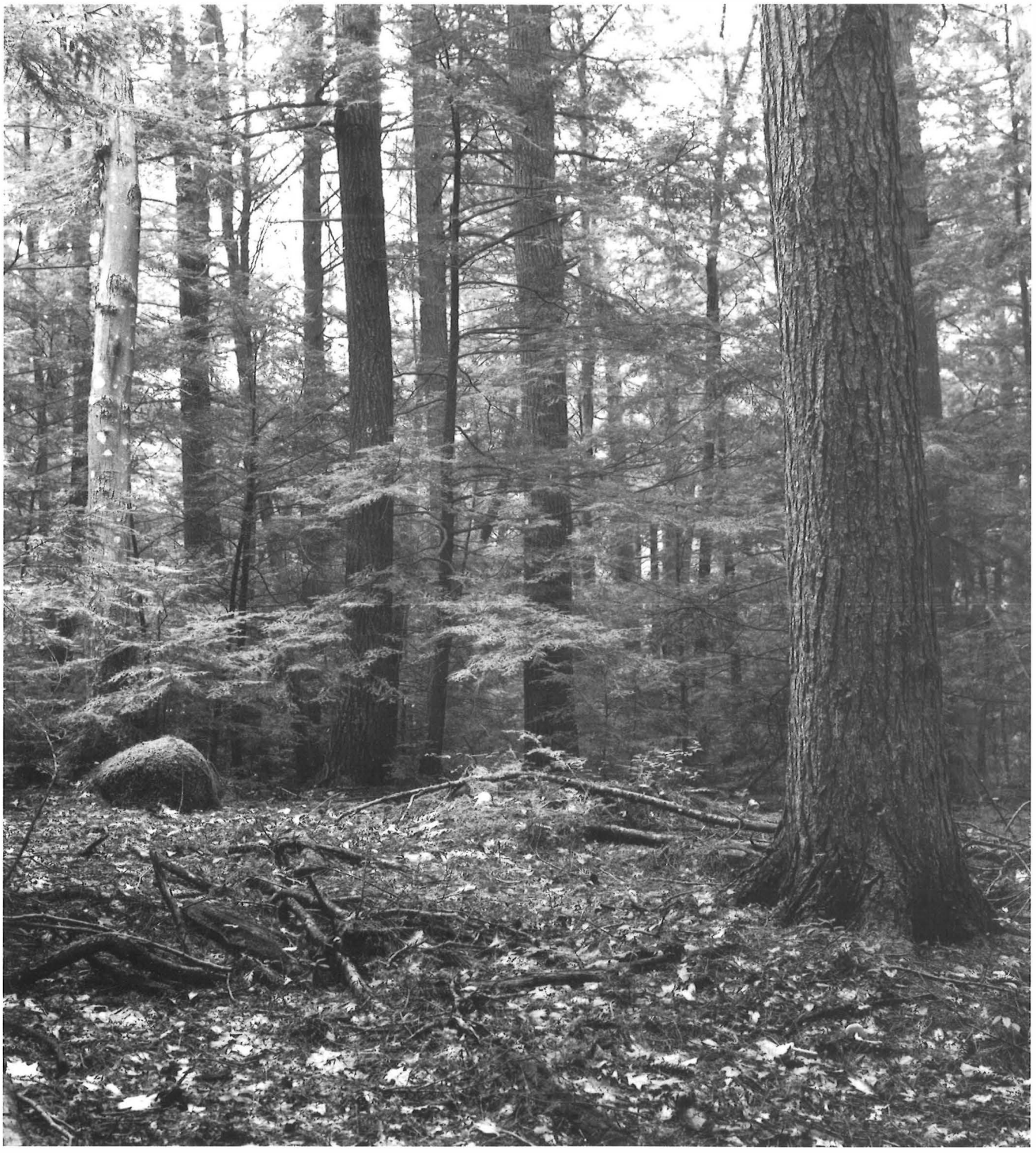
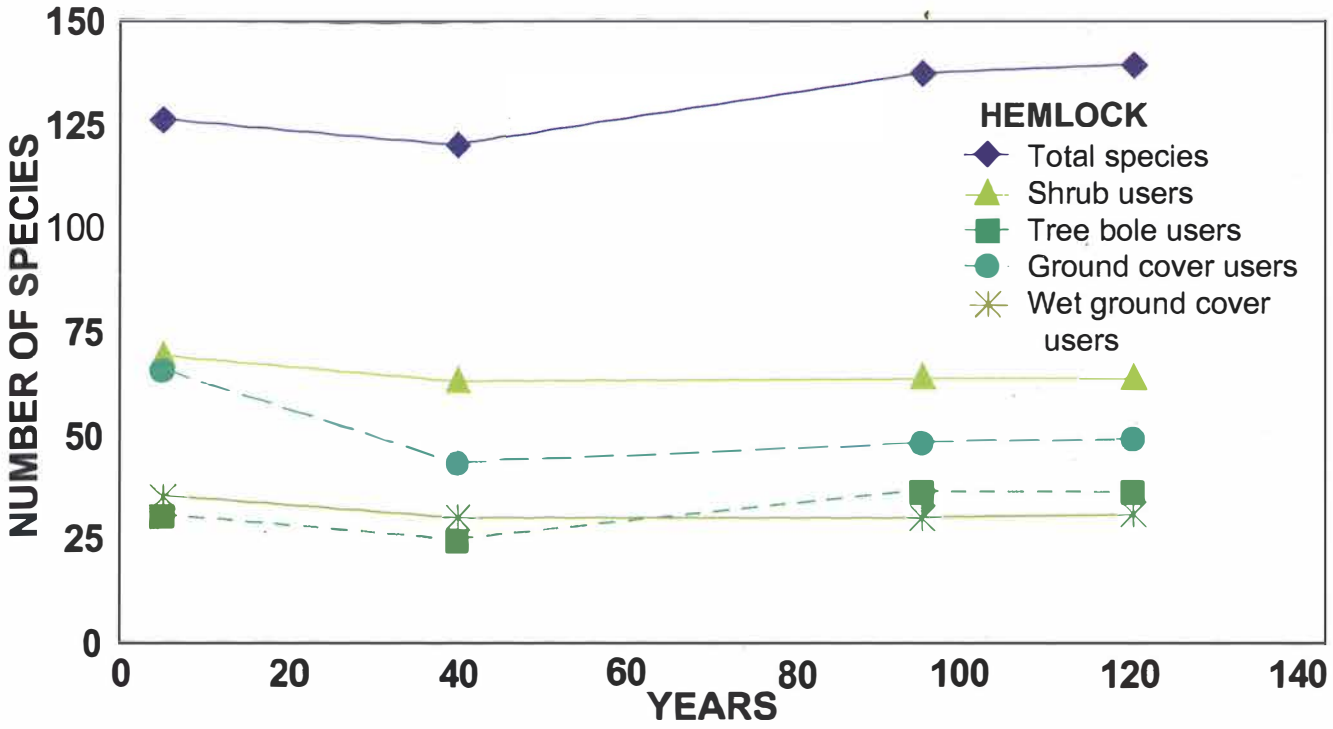


Fig. 41. Eastern hemlock stand. Petersham, Massachusetts, August 1985. Photo by Richard M. DeGraaf.

Although undisturbed hemlock stands on secondary sites contain very little shrubby or herbaceous understory, disturbed hemlock stands or mixed hardwood–hemlock support bracken (*Pteridium aquilinum*), various blueberry species, *Aralia* species, wintergreen, false lily of the valley, and other species typical of dry sites, as well as mixed hardwood and softwood tree seedlings.



Mean d.b.h. (in)	2-4	4-6	6-8	10-12	12-14	14-16	16-18
Basal area (ft^2)	80-100	100-140	140-200	200-240	240-260	240-280	240-280
No. stems per acre	1000-3500	700-1000	600-700	300-350	250-300	200-250	150-175
Maximum height (ft)	10-20	30-50	50-70	60-80	60-90	70-90	70-90
Maximum d.b.h. (in)	6-8	8-10	12-14	14-18	18-22	22-24	24-26

SUCCESSION. Succession in hemlock consists of gradually increasing proportions of softwoods over long periods of time (figure 42)—more rapidly on primary sites than on secondary sites. On both types of sites, the developing stands typically are characterized by closed canopies, hardwood cavity trees and inclusions, and sparse herbaceous ground cover (table 13). Eventually (after 250 to 350 years), an old-growth stand develops, containing 75 to 80 percent softwoods, an uneven-aged structure, sparse ground flora,

Fig. 42. Hemlock stand development and wildlife species occurrence.

and a continuous but sparse understory of hemlock seedlings and saplings. These stands are long lasting until windthrown by major storms. Species such as barred owl, pileated woodpecker, red-breasted nuthatch, brown creeper, golden-crowned and ruby-crowned kinglets, hermit thrush, black-throated green warbler, Blackburnian warbler, Canada warbler, hoary bat, porcupine, fisher, and white-tailed deer (especially where they yard in winter) can be found in hemlock stands, given the structural habitat features that usually are present.

SILVICULTURAL TREATMENTS. The options for regenerating hemlock are similar to those of spruce–fir: shelterwoods or selection. The shelterwood system would utilize a two- or three-cut system. Dense canopy closure is needed in the first cut since hemlock is more tolerant than spruce or fir, and since hemlock commonly grows in regions with more intense hardwood competition. Regeneration success generally is greater on wet sites, usually with shallow pan layers, since softwoods are quite aggressive on such sites. However, windthrow also may be a greater menace—another reason for recommending high stand densities. Sometimes scarification through harvesting disturbance is recommended to initiate hemlock regeneration. However, this practice may not produce hemlock regeneration since birches (yellow to the north and black or sweet birch to the south) can be very aggressive

Table 13
Characteristic Structural Habitat Features of and Potential Number of Species Associated with Silvicultural Options in Hemlock in a Ten-Year Window

Size class	Treatment options	Site type	Overstory	Structural habitat features	A[a]	R	B	M	Total
Regeneration	None	Dry	Open	Mixed deciduous/coniferous shrub layer; soft mast	5	7	83	47	142
		Wet		Coniferous shrub layer; wetland herbaceous ground cover; soft mast					
Sapling-pole	No treatment	All	Closed	Small dead trees; hardwood inclusions	13	8	50	30	101
Sawtimber	No treatment	Dry	Closed	Large cavity/dead trees; hardwood inclusions	14	8	55	36	113
		Wet		Large cavity/dead trees; hardwood inclusions; dead and down material					
	Shelterwood	Dry	Partial	Mixed deciduous and coniferous shrub layer; large cavity/dead trees; hardwood inclusions; slash	14	8	58	43	123
		Wet		Mixed deciduous and coniferous shrub layer; large cavity/dead trees; hardwood inclusions; wetland herbaceous ground cover; slash					
	Selection	All	Closed	Large cavity trees; hardwood inclusions; midstory; slash	14	8	55	36	113

[a]A = Amphibians; R = Reptiles; B = Birds; and M = Mammals.

on scarified seedbeds in hemlock stands. The shelterwood system provides a partial canopy; this is especially true of the second cut in a three-cut system. This system provides a dense coniferous shrub layer, wildlife habitat elements (such as a variety of hardwood inclusions particularly beech and red oak) and larger cavity trees, slash, and—on wet sites—a wetland herbaceous ground cover, resulting in higher species diversity than that in untreated sawtimber stands (see table 13). Example species include blue jay, red-breasted nuthatch, winter wren, snowshoe hare, red squirrel, southern red-backed vole, red fox, bobcat, and white-tailed deer.

The selection system also provides a means to regenerate hemlock. Probably the most efficient method is to release patches of advanced hemlock regeneration through small group openings. This system provides an essentially closed canopy, the opportunity to reserve larger cavity trees and hardwood inclusions (particularly beech and red oak), a midstory, and some slash. Potential wildlife responses in selection stands are quite similar to sawtimber stands without treatment, including saw-whet owl, blue-headed vireo, hermit thrush, black-throated green warbler, and gray fox (see table 13).

Repeated complete clearcutting will tend to convert hemlock to beech–red maple or aspen–birch types as described under the section on spruce–fir. Large group selection cuts also will tend to convert the type. These types of treatments that create open canopy conditions certainly increase the hardwood regeneration and brushy habitat conditions favored by eastern towhees, brown thrashers, and other early-successional forest species. Single-tree selection practiced on fine-textured soils will convert hemlock to tolerant hardwoods over time.

Oak–Pine Types

Oak and pitch pine are generally more important in southern New England, but white pine occurs throughout the region. In general, these types can be organized into four type and site combinations:

- the oak–pine types on sands, gravel, and sandy tills;
- the pitch pine type on sandy and gravelly sites that have been repeatedly burned;
- mixed oak–hardwood types on fine-textured soils from the White Mountains to southern New England;
- temporary old-field pine on fine-textured soils.

OAK–PINE. Red oak (with mixtures of other oaks) and white pine are natural associates on outwash soils and sandy tills in central to southern New England (figure 43). As soil texture becomes a little finer, red oak and other hardwoods become more competitive with pine. Oak–pine also occurs on shallow-to-bedrock soils. Common associates of oak–pine include black,

Fig. 43. White pine–red oak–red maple stand. Belchertown, Massachusetts, August 1985. Photo by Richard M. DeGraaf.

white, and chestnut oak (*Quercus prinus*), as well as red maple, aspen, and gray birch.

Shrubs and herbs include dry-site species such as low blueberries, wintergreen, clubmosses, beaked hazel, and so on. Occasionally, mountain laurel (*Kalmia latifolia*) occurs in abundance under oak stands on rocky side slopes, but its occurrence seems unpredictable. Otherwise, shrub and herb layers are not dense.

The climax is uncertain, because oak and pine tend to alternate in a series of harvests. North of southern New Hampshire, hemlock and spruce seem to be the ultimate climax on dry sandy soils, though oak and sometimes pine remain as persistent associates on south or west exposures.

PITCH PINE. Pitch pine occurs on very coarse, gravelly soils that have been burned repeatedly in the past and so have little soil organic matter (figure 44). Common overstory associates include aspen, gray birch, red maple, white pine, and black and white oaks. Shrub and midstory layers are dominated by bear oak (*Quercus ilicifolia*), which is associated closely with the pitch pine type. The herb and low ericaceous shrub layers are dense in patches, containing blueberry, wintergreen, sheep laurel (*Kalmia angustifolia*), and bearberry (*Arctostaphylos uva-ursi*).

Over long periods of time without fire, the pitch pine type may revert to oak–pine as described above.

MIXED OAK–HARDWOOD. From the White Mountains southward, red oak occurs on fine-textured soils of various origins (figure 45). Common associates include a mixture of maples, oaks, birches, ash, and hickories. Many herb and shrub species, including many spring ephemerals, may be present, but densities are not necessarily high until canopy closure is reduced.

The origin and succession of these stands are unclear. Many occur on abandoned agricultural lands, which may explain the oak component — oaks can withstand substantial grazing. Fire may have contributed to the oak component — older trees can survive light ground fire. The presence of sugar maple indicates that the successional trend may be toward northern hardwoods. In central to northern New England, stands growing on soils derived from silt and clay sediments have developed toward a hemlock climax, but only over a period of several rotations.

OLD-FIELD PINE. Although a temporary type resulting from farmland abandonment, old-field pine deserves mention due to its prevalence (figure 46). Although it occurs on all types of sites, we restrict our discussion here primarily to old-field pine on fine-textured soils that rapidly succeed toward hardwoods. Old-field pine on sandy soils quickly takes on the character of oak–pine.

Old-field pine commonly develops as pure, dense stands of pine with a component of very coarse, large-limbed pine and an occasional wide-crowned hardwood that was left for shade on the now-abandoned pasture. Remnant clumps of juniper (*Juniperus* spp.) commonly can be found as part of the shrub layer openings. Woody understories are very sparse unless the stand is

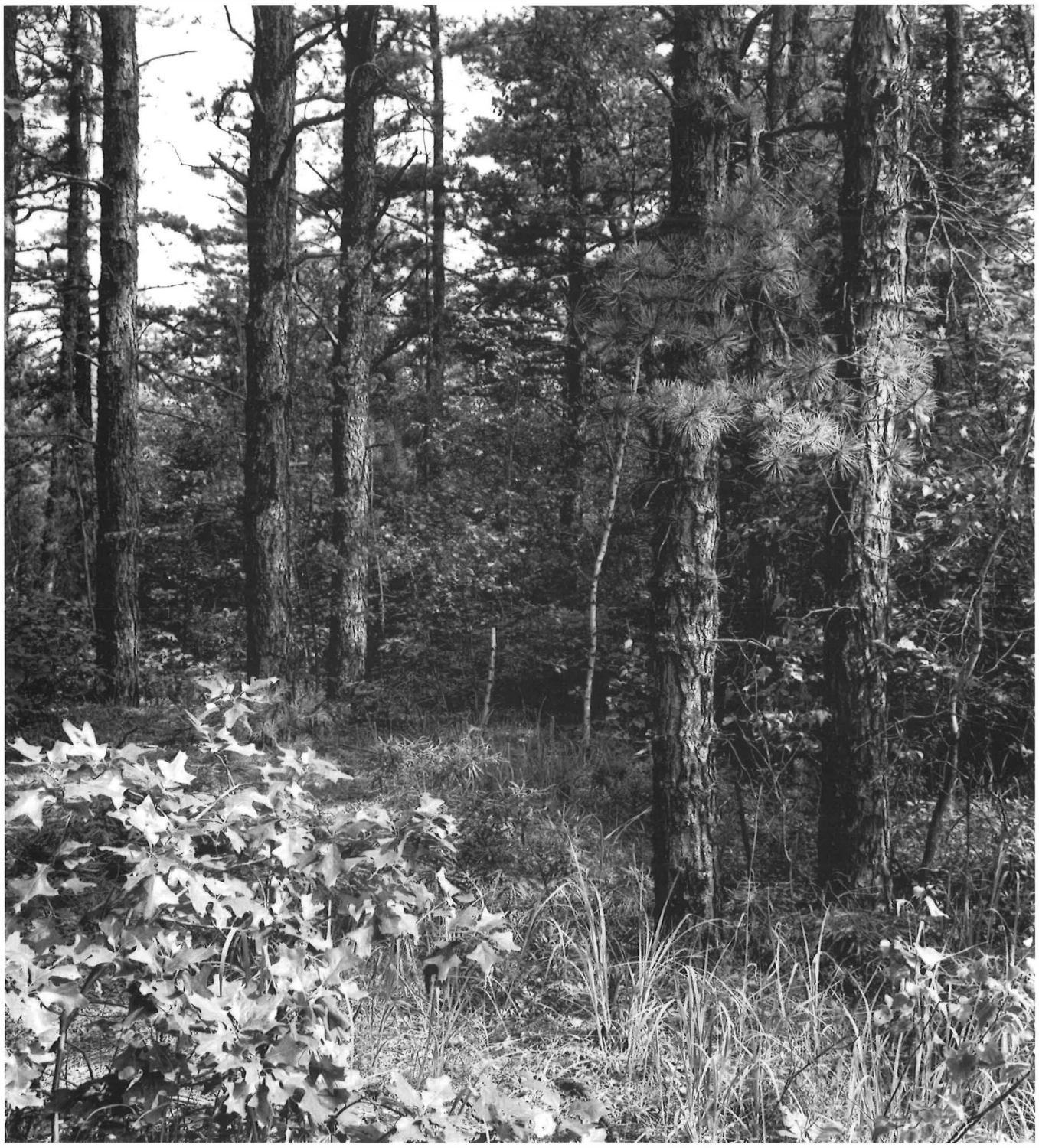


Fig. 44. Pitch pine stand. Montague, Massachusetts, August 1985. Photo by Richard M. DeGraaf.

Fig. 45. Northern red oak stand. Ware, Massachusetts, August 1985. Photo by Richard M. DeGraaf.

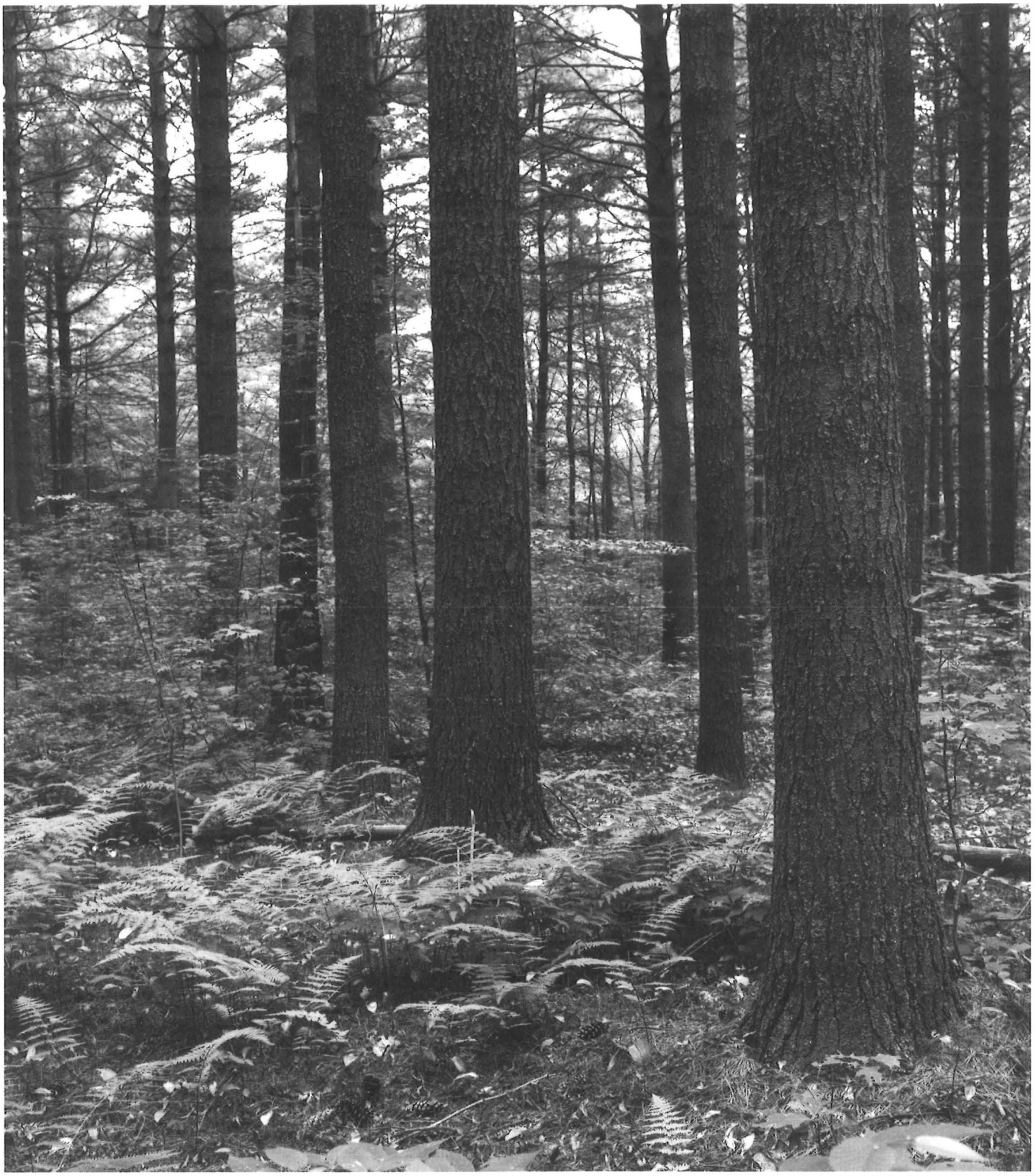


Fig. 46. Old-field pine stand. Sunderland, Massachusetts, July 1985. Photo by Richard M. DeGraaf.

opened up (<70% crown closure) by cutting or windthrow. Under these situations, a hardwood understory of cherry, oak, red maple, and shrubs develops within three to four years, and becomes the midstory over the next decade. On coarse-textured soils, hemlock may invade old-field pine and persist in developing hardwood stands.

SUCCESSION. Natural succession in the oak and pine types is variable and a little uncertain. Oak and pine on sandy soils tend to alternate — groups of oak often support an understory of pine and vice versa. These stands usually exhibit a closed canopy, stratified hardwood-softwood mixtures, and a sparse dry-site ground flora. The presence of large supracanopy pines is a common feature in sawtimber stands.

Old-field pine on fine-textured soils develops dense pure stands once the early-successional species (for example, gray birch, aspen, and juniper) disappear. The understory and ground flora are almost nonexistent until the canopy is broken by damage, cutting, or overmaturity (150-plus years). Then, a dense hardwood understory develops.

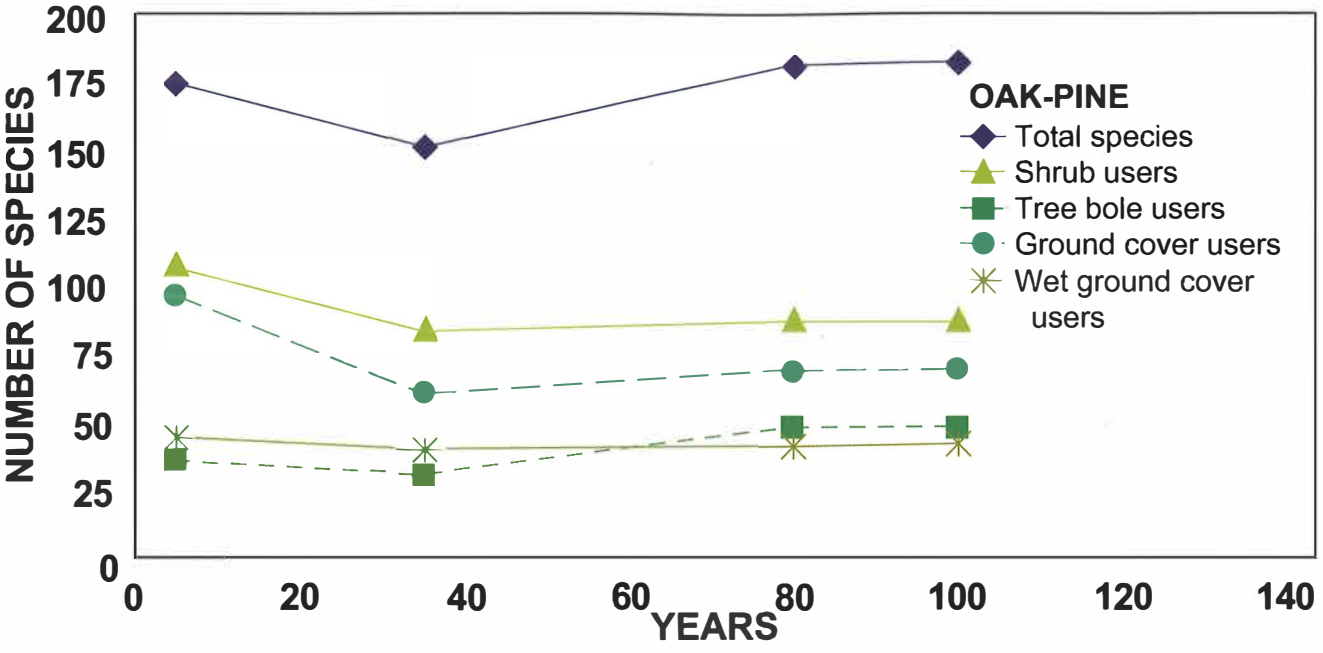
Pitch pine stands usually maintain a dense understory of bear oak and a dense dry-site herb and shrub layer (for example, blueberries and wintergreen). Without fire, pitch pine probably moves toward an oak–pine successional sequence.

Total numbers of wildlife species potentially occurring throughout stand development tend to be higher in oak–pine than in either mixed oak–hardwoods or old-field pine because oak–pine brings together species associated with deciduous and coniferous types (figure 47). Numbers of species are high in regenerating stands, then drop off in pole stands due to the decline of the herb and shrub layers, which are important for eastern bluebird, loggerhead shrike, blue-winged and golden-winged warblers, Tennessee warbler, meadow vole, meadow jumping mouse, and long-tailed weasel (table 14). Numbers of species then rise in mature and overmature stands, mainly due to the increasing numbers of bark probers, hole nesters, and other tree-bole users.

The usual presence of several "bull" pines in the supracanopy of the oak–pine group provides favorable perching and nesting sites for various hawks. Great blue herons, osprey, and bald eagles also can use the supracanopy features where the oak–pine group occurs near large water bodies and other wetlands.

The variety and production of hard mast reaches its peak in the oak–pine group, especially where various oak species, hickories, and beech are found together. Wildlife species that either depend upon or readily feed on acorns and other hard mast include ruffed grouse, wild turkey, red-bellied woodpecker, blue jay, red and gray squirrels, chipmunk, various mice, gray fox, black bear, striped skunk, and white-tailed deer. Wood duck, American black duck, and mallard also can benefit from hard mast where the oak–pine group occurs adjacent to shallow water bodies, streams, and other wetlands.

SILVICULTURAL TREATMENTS. Oak–pine stands may be difficult to regenerate since they often occur on mesic old-field sites characterized by



Mean d.b.h. (in)	2-4	6-8	9-13	12-16	15-20	16-22	18-24
Basal area (ft^2)	60-120	180-240	220-280	240-300	250-320	250-320	250-320
No. stems per acre	1400-2000	600-1000	350-550	200-300	150-200	120-150	100-120
Maximum height (ft)	15-30	40-60	60-80	70-100	80-110	80-120	80-120
Maximum d.b.h. (in)	8-10	12-14	16-18	20-24	26-28	30-32	32-34

PINE FOLLOWED BY OAK

Mean d.b.h. (in)	3-4	5-7	7-9	9-11	11-14	12-16	13-17
Basal area (ft^2)	60-70	80-90	90-100	100-110	100-120	100-130	100-140
No. stems per acre	800-1200	350-600	250-350	160-250	120-160	95-125	90-100
Maximum height (ft)	30-50	40-70	50-80	65-90	70-100	70-100	80-100
Maximum d.b.h. (in)	8-10	10-14	14-16	16-20	20-24	24-26	24-28

OAK FOLLOWED BY PINE

Fig. 47. Oak–pine stand development and wildlife species occurrence.

severe competition from other hardwood species. On dry, sandy sites, pine is the preferable choice over oak, which tends to be of higher quality on better sites. Shelterwood harvest should be conducted in the late fall after a good seed fall for the species of interest. At least half of the canopy should remain, and the midstory and understory vegetation should be well disturbed by the harvesting operation. Part of the intent, especially with oak, is to bury the seeds. Once the regeneration is about knee-high or more, the overstory can be removed using harvesting methods that will minimize damage to the regeneration. Especially with pine, some overstory trees and reserve patches should remain to minimize weevil damage, and to provide wildlife perches, larger cavity trees, and inclusions to maintain vertical structure for its habitat value. Shelterwood systems provide partial canopy closure, a mixed shrub and tree seedling layer that will tend to be mostly deciduous on mesic sites, overstory inclusions and mast trees, and slash. Potential wildlife species diversity is much higher under this scenario than in untreated sawtimber stands (see table 14).

Table 14
Characteristic Structural Habitat Features of and Potential Number of Species Associated with Silvicultural Options in the Oak–Pine Group in a Ten-Year Window

Size class	Treatment options	Site type	Overstory	Structural habitat features	A[a]	R	B	M	Total
Regeneration	None	Dry, sandy	Open	Mixed deciduous/coniferous shrub layer; soft mast	6	11	96	47	160
		Mesic		Deciduous shrub and ground cover layers; soft mast					
Sapling-pole	No treatment	All	Closed	Small dead trees	16	12	48	29	105
	Thinning[b]	All	Partial	Deciduous shrub layer; herbaceous ground cover	17	14	57	37	125
Sawtimber	No treatment	All	Closed	Large cavity/dead trees; hardwood inclusions; hard mast; dead and down material	16	12	60	37	125
	Shelterwood	Dry, sandy	Partial	Mixed deciduous and coniferous shrub layer; large cavity/dead trees; hardwood inclusions; hard mast, slash	17	14	72	45	148
		Mesic		Deciduous shrub layer; large cavity/dead trees; hardwood inclusions; herbaceous ground cover; slash					
	Group selection	Dry, sandy	Closed	Large cavity trees; hardwood inclusions; midstory; mixed deciduous and coniferous shrub layer; hard mast; slash	16	12	60	37	125
		Mesic		Large cavity trees; hardwood inclusions; midstory; deciduous shrub layer; hard mast; slash					

[a]A = Amphibians; R = Reptiles; B = Birds; and M = Mammals.
[b]Commercial or noncommercial thinning.

Selection is a second alternative for regenerating oak–pine. One logical approach is to use group selection to release advanced regeneration of either species. When advanced growth is absent or sparse, group selection should be applied in much the same way as a shelterwood harvest: late fall after a good seed year, coupled with sufficient harvesting disturbance to remove the competing advanced growth and provide ground disturbance. Groups should be small — 0.25 to 0.67 acres perhaps — which maximizes the seedfall and keeps the competing vegetation somewhat in check. Light-foliaged and short-lived competition, such as grey birch, do not severely hamper the development of oak and pine. Selection provides for an essentially closed canopy (since the groups are small), a midstory, larger cavity trees, mast trees (particularly beech and red oak), and hardwood inclusions. Wildlife species responses under this scenario generally are similar to an untreated sawtimber stand (see table 14); however, keep in mind that group selection is a means for maintaining oak–pine stands, while under no treatment, this type gradually will give way to hemlock on dry sandy soils or mixed hardwoods on mesic sites. Typical species associated with the oak–pine group include northern redbelly snake, eastern worm snake, black racer, turkey vulture, sharp-shinned and Cooper's hawks, wild turkey, mourning dove, red-bellied woodpecker, pileated woodpecker, blue jay, tufted titmouse, red-breasted and white-breasted nuthatches, wood thrush, hermit thrush, pine warbler, scarlet tanager, eastern towhee, chipping sparrow, Virginia opossum, gray squirrel, southern flying squirrel, white-footed mouse, and white-tailed deer.

Oak–pine types in some areas can be converted to aspen–birch (which includes gray birch) by repeated clearcutting on a short rotation. Old-field pine naturally reverts to northern hardwoods, mixed oak–hardwoods, or hemlock — a process that is hastened by thinning.

5

Nonforested Habitats

FIELDS, WETLANDS, and other open or semi-open habitats are an integral part of the New England landscape. The decline of New England agriculture over the last hundred years has reduced these habitats to a fraction of their former extent. The open habitats maintained by agricultural activities and grazing remain an important cultural feature, especially in southern New England and portions of Vermont. In 1989, the Bureau of the Census reported the total proportion of such lands (cropland and pasture) in New England ranged from 3 to 13 percent as follows: Maine and New Hampshire, 3 percent each; Rhode Island, 4 percent; Massachusetts, 5 percent; Connecticut, 7 percent; and Vermont, 13 percent (U.S. Department of Commerce 1989a, 1989b, 1989c, 1989d, 1989e, 1989f). The current proportion of cropland and pasture now ranges from 2.6 to 11.1 percent as follows: New Hampshire, 2.6 percent; Maine, 2.9 percent; Rhode Island 4.3 percent; Massachusetts, 4.8 percent; Connecticut, 6.2 percent; and Vermont, 11.1 percent (U.S. Department of Agriculture, 2004a, 2004b, 2004c, 2004d, 2004e, 2004f). The total proportion of freshwater wetlands in New England ranges from less than 5 to 25 percent as follows: New Hampshire and Vermont, 4 percent each; Massachusetts, Connecticut, and Rhode Island, 5 to 15 percent each; and Maine, 15 to 25 percent (Tiner 1984). For current information, contact the appropriate state natural resource office. When comparing wetland figures note the mapping scales used; smaller scales tend to result in higher wetland area totals.

Nonforested habitats are important components of managed forests. Upland and wetland nonforest types provide basic habitats for distinct groups of species (that is, nonforest only and nonforest–water users) and seasonally important habitat elements for species that also use forest, krummholz, and water habitats (such as brood habitat for ruffed grouse and turkey, and early spring forage for deer after the stress of winter). Many bird species that breed in the Arctic spend the winter in open habitats in New England, including tree sparrows, redpolls, and occasionally snowy owls. Many types of nonforested habitats are important bird migration stops during northward and southward

trips; wet fields are used by shorebirds, waterfowl, and pipits, among others. In the fall, seed-eating birds use upland and wetland nonforested habitats during migration. Wetlands have different wildlife communities than do upland open habitats. Upland open habitats support species that are not found in forested habitats, such as box turtles, field sparrows, and many other grassland bird species.

The presence of upland and wetland nonforested habitats is necessary for almost 22 percent of the wildlife species found in New England today and seasonally important to another 70 percent of the region's species. Although these habitats constitute a relatively small proportion of the total landscape, nonforest habitats contribute a share of potential wildlife habitat disproportionate to the overall forest environment. The presence or absence of these habitats and water to a considerable extent limit the degree of forest diversity that can be achieved with respect to wildlife habitat.

Mixtures of habitat elements — forest types, nonforest types, krummholz, and water — across landscapes produce edges or boundaries between different habitats, successional stages, or plant communities. Two basic types of edges are: (1) those between mixtures of forest, nonforest, krummholz, and water habitats; and (2) those produced by even-aged management where stands of different ages abut one another.

Field-forest edges tend to be relatively long-lasting and support distinct wildlife communities. Mixtures of forested and nonforested habitats produce long-lasting brushy edge habitats for species that otherwise would not be found in either heavily forested or very open habitats. For example, one would expect to see Cooper's hawks, cardinals, indigo buntings, catbirds, song sparrows, cottontails, and foxes along these brushy edges between forested and nonforest habitat. Additionally, one might expect to see sharp-shinned hawks, ovenbirds, chipmunks, and weasels in the forest, and kestrels, field sparrows, and meadow voles in the field. The mix of forested and nonforested habitats produces a very diverse array of species in New England.

A distribution of stands of different size classes, on the other hand, produces edges that are relatively short-lived from a wildlife habitat standpoint and that do not support distinct wildlife communities. Although recognizable for decades, the importance of edge to the bird community — the group of species most sensitive to habitat structure — ceases to be significant after ten to fifteen years. For example, at the edge between a five-year-old clearcut and a sawtimber stand of northern hardwoods, one would expect to see early-successional species that will nest near the edge of the clearcut, such as chestnut-sided warblers, common yellowthroats, and willow flycatchers, and species from the mature stand such as black-capped chickadees, wood pewees, and downy woodpeckers that likewise will nest near the edge. In New England, edges between even-aged forest stands normally do not have unique assemblages of species as do ecotones — edges between different habitat types (DeGraaf 1992).

The following section describes upland and freshwater wetland and deepwater habitats that normally occur within forested habitats in New England. Several other special features, such as cliffs and caves, also are described. Rep-

resentative plant species as well as wildlife are given for these habitats and special features. **Note:** The lists of species for each habitat type or special feature are examples of fairly common ones. These lists are not inclusive; they emphasize species that are associated closely with these habitats, regardless of season of use or part of New England in which they occur. Be mindful of species' distributions when using these lists (see DeGraaf and Yamasaki 2001). For more information on these types, see Appendix B.

Upland Nonforested Habitats

Under even-aged management, timber harvest briefly will provide early-successional forested habitat. After clearcutting, woody growth usually occupies the site within one or two years. The area left in grasses and other herbs is restricted to the landing and skid trails, and soon they too may begin to disappear as the regenerating stand develops. Old fields that contain a fair amount of shrubs and small trees have wildlife communities that are quite different from those communities found in regenerating stands (figure 48). The difference largely is due to the amount of dense, continuous herbaceous cover, which lasts longer in old fields than in regeneration stands. Some species use both types of early-successional uplands, for example, goldfinches, cedar waxwings, and song sparrows. But there are others that require fields, sedge meadows, or other primarily herbaceous openings, such as red-winged blackbirds, bobolinks, and savannah, vesper, and grasshopper sparrows. One would expect to see indigo buntings at forest-field edges, and Baltimore orioles and warbling vireos singing and nesting near the tops of scattered trees in grassy openings. Regenerating clearcuts during the first five to ten years support willow flycatchers, mourning and chestnut-sided warblers, Swainson's thrushes, rose-breasted grosbeaks, redstarts, and white-throated sparrows, among others.

These examples demonstrate some of the differences between the wildlife communities that use grassy/brushy openings and forest regeneration. Both are early-successional habitats, and fields will revert to forest eventually, but maintaining the full spectrum of potential wildlife species in an area requires the maintenance of some grassy/brushy habitats. Awareness of the differences in wildlife values of these early-successional habitats is required in order to evaluate the availability of upland nonforested habitats and then recommend treatments that would maintain or develop these habitats through various management practices.

A well-developed herbaceous layer is possible on certain types of sites in New England, but it is usually a temporary condition in stands with significant overstory canopies. Frequent disturbance can maintain an herbaceous layer in managed stands, and this is one way of providing adequate brood habitat for ruffed grouse, for example, in lieu of grassy open habitats. Low-density thinnings or open shelterwood cuts also can be used periodically to develop an herbaceous layer. Although important to several forest-dwelling species, this type of temporary arrangement does not provide sufficient grassy habitat for those species that require open nonforested habitats.

In the tables that follow, habitat-breadth occurrence is indicated parenthetically: F = Forest, K = Krummholz, N = Nonforest, W = Water.

CULTIVATED FIELDS. Tilled agricultural cropland typically provide high-quality foraging habitat.

Fig. 48. Old field. Belchertown, Massachusetts, 1990. Photo by Richard M. DeGraaf.

Wildlife Species That Use Cultivated Fields

Reptiles

Blanding's turtle (FNW)

Birds

American kestrel (FN), killdeer (N), rock dove (N), mourning dove (FN), snowy owl (N), northern flicker (FN), American crow (FN), horned lark (N), northern rough-winged swallow (FNW), bank swallow (FNW), American robin (FKN), European starling (N), Lapland longspur (N), snow bunting (N), red-winged blackbird (FN), common grackle (FNW), brown-headed cowbird (FN), house sparrow (N)

Mammals

Red fox (FN), raccoon (FN), striped skunk (FN)

GRASSY OPENINGS. Wildlife species that use only nonforest types tend to be found using larger grassy openings (more than 5 to 10 acres); species with wider habitat-breadth combinations (habitat generalists) can be found using smaller-sized openings. Upland grassy openings such as hayfields (figure 49) generally provide high quality foraging, nesting, or wintering habitats.

Wildlife Species That Use Grassy Openings

Reptiles

Blanding's turtle (FNW), eastern box turtle (FNW), northern black racer (FN), eastern smooth green snake (FN)

Birds

Turkey vulture (FN), broad-winged hawk (FN), red-tailed hawk (FN), rough-legged hawk (N), American kestrel (FN), ring-necked pheasant (N), northern bobwhite (FN), northern shrike (FN), horned lark (N), northern rough-winged swallow (FNW), cliff swallow (FN), barn swallow (FNW), field sparrow (FN), vesper sparrow (N), savannah sparrow (N), grasshopper sparrow (N), song sparrow (FN), indigo bunting (FN), bobolink (N), red-winged blackbird (FN), eastern meadowlark (N), common redpoll (FN), hoary redpoll (FN), pine siskin (FN)

Mammals

Least shrew (FN), eastern cottontail (FN), woodchuck (FN), meadow vole (FN), woodland vole (FN), meadow jumping mouse (FN), red fox (FN)

FORB OPENINGS. Upland openings composed predominantly of broad-leaved herbaceous cover, for example, goldenrod (*Solidago* spp.), sensitive fern (*Onoclea* spp.), and various clovers, typically provide high-quality habitat.

Wildlife Species That Use Forb Openings

Reptiles

Eastern box turtle (FNW)

Birds

Common redpoll (FN), hoary redpoll (FN), pine siskin (FN)

Mammals

Eastern cottontail (FN), woodchuck (FN), meadow vole (FN)

Fig. 49. Hayfield. Guildhall, Vermont, August 1987. Photo by Richard M. DeGraaf.

SHRUB OPENINGS. Abandoned agricultural fields reverting to forest and characterized by old-field grasses, shrubs, and small trees, or barrens on shallow or other dry sites persisting in shrubs such as blueberry or huckleberry (*Gaylussacia* spp.) generally provide high-quality habitats.

Wildlife Species That Use Shrub Openings

Reptiles

Eastern box turtle (FNW), spotted turtle (FNW), black rat snake (FN)

Birds

Ring-necked pheasant (N), American woodcock (FN), willow flycatcher (FN), northern mockingbird (FN), blue-winged warbler (FN), golden-winged warbler (FN), prairie warbler (FN), fox sparrow (FKN), song sparrow (FN), white-throated sparrow (FKN)

Mammals

Eastern cottontail (FN), New England cottontail (FN), snowshoe hare (FKN), white-footed mouse (FKN), ermine (FKN), striped skunk (FN)

PASTURE. Dry or rocky upland fields and meadows too wet for cultivation commonly are grazed by livestock (figure 50).

Wildlife Species That Typically Prefer Using Pasture Habitat

Reptiles

Spotted turtle (FNW), eastern box turtle (FNW), eastern hognose snake (FN), eastern smooth green snake (FN)

Birds

Turkey vulture (FN), broad-winged hawk (FN), red-tailed hawk (FN), rough-legged hawk (N), American kestrel (FN), upland sandpiper (N), northern shrike (FN), brown thrasher (FN), common yellowthroat (FN), yellow-breasted chat (FN), field sparrow (FN), American goldfinch (FN)

Mammals

Eastern mole (FN), eastern cottontail (FN), woodchuck (FN), meadow vole (FN)

SAVANNA. Grasslands with shrubs and widely scattered trees, resulting from either soil-moisture regimes or disturbances such as fire and grazing, typically provide high-quality habitat.

Wildlife Species That Use Savanna

Birds

Loggerhead shrike (FN), northern shrike (FN), chipping sparrow (FN), Baltimore oriole (FN)

Mammals

Eastern cottontail (FN), woodchuck (FN)

ORCHARDS. Stands of fruit trees, usually apples, whether or not maintained for fruit production (figure 51), with a dense grassy-herbaceous ground cover, generally provide high-quality habitat.

Fig. 50. Wet pasture. Amherst, Massachusetts, 1985. Photo by Richard M. DeGraaf.

Wildlife Species That Use Orchards

Birds

Yellow-bellied sapsucker (FN), eastern kingbird (FN), white-breasted nuthatch (FN), eastern bluebird (FN), orchard oriole (FN)

Mammals

Eastern cottontail (FN), woodchuck (FN), meadow vole (FN), woodland vole (FN), black bear (FNW)

Other species such as ruffed grouse, eastern screech owls, and great crested flycatchers also use orchards regularly for foraging and nesting.

KRUMMHOLZ AND ALPINE ZONES. The subalpine forest and alpine zones, generally above 3,500 feet in elevation, are characterized by smaller, wind-sheared trees (especially spruce) below timberline and by low, shrubby, slow-growing woody plants, and ground cover of boreal lichens, sedges, and grasses above timberline (figure 52).

Wildlife Species for which Krummholz and Alpine Zones Provide Habitat

Birds

Bicknell's thrush (FK), American pipit (N), blackpoll warbler (FK), white-throated sparrow (FKN), dark-eyed junco (FKN), pine grosbeak (FKN)

Mammals

Snowshoe hare (FKN), rock vole (FKN), lynx (FKN), moose (FKNW)

Fig. 51. Abandoned orchard. Amherst, Massachusetts, May 1990. Photo by Richard M. DeGraaf.

Fig. 52. Krummholz/alpine zones. White Mountains, New Hampshire, August 1985. Photo by Richard M. DeGraaf.

Wetland Nonforested Habitats

Wetlands are transitional habitats between terrestrial (upland) and aquatic systems and here include various palustrine wetlands. In wetland habitats, the degree of water saturation largely determines the soil conditions and degree of soil development, and the types of plant and animal communities that the wetlands support. Hydrophytes are the dominant plants. The single feature that most wetlands share is soil or substrate that is at least periodically saturated or flooded by water.

Palustrine wetlands are dominated by emergents, mosses, lichens, persistent emergents, shrubs, and trees, and include sedge meadows, shallow and deep fresh marshes, shrub swamps, bogs, and ponds (Cowardin et al. 1979). Sedge meadow wildlife communities are somewhat similar to those in upland openings, but species such as ribbon snakes, rails, snipe, sedge wrens, and

star-nosed moles are associated primarily with the wetter sedge meadow community. The presence of water year-round in fresh marshes, shrub swamps, and ponds is essential to the various amphibians, turtles, waterfowl, and numerous aerial feeders that differentiate wetland from upland nonforested wildlife communities. Virtually all wetlands are important to aerial feeding birds and bats.

SEDGE MEADOWS. Wetlands characterized by sedges and cattails, surface water depths to 6 inches in winter and early spring, and exposed but saturated soil surface in summer, typically provide preferred habitat for some species.

Wildlife Species That Prefer Sedge Meadows

Amphibians

Blue-spotted salamander (FN), northern leopard frog (FNW)

Reptiles

Spotted turtle (FNW), bog turtle (NW), ribbon snake (FNW)

Birds

Sedge wren (N)

Mammals

Virginia opossum (FN), water shrew (FNW), northern short-tailed shrew (FKN), star-nosed mole (FNW), little brown myotis (FNW), northern long-eared bat (FNW), silver-haired bat (FNW), eastern pipistrelle (FNW), big brown bat (FNW), eastern cottontail (FN), southern bog lemming (FKN), northern bog lemming (FKN), meadow jumping mouse (FN)

SHALLOW MARSHES. Wetlands characterized by persistent emergent vegetation such as *Typha* and *Pontederia* species, and water depths to 1.5 feet typically provide preferred habitat for some species.

Wildlife Species That Prefer Shallow Marshes

Amphibians

Blue-spotted salamander (FN), northern spring peeper (FN), northern leopard frog (FNW)

Reptiles

Spotted turtle (FNW), painted turtle (NW)

Birds

Pied-billed grebe (NW), American bittern (NW), least bittern (N), great blue heron (FNW), green heron (FNW), Canada goose (NW), American black duck (FNW), mallard (NW), blue-winged teal (N), northern shoveler (N), green-winged teal (N), northern harrier (N), king rail (N), Virginia rail (N), sora (N), common moorhen (NW), black tern (NW), eastern screech-owl (FN), tree swallow (FNW), red-winged blackbird (FN), American goldfinch (FN)

Mammals

Virginia opossum (FN), water shrew (FNW), little brown myotis (FNW), northern long-eared bat (FNW), silver-haired bat (FNW), eastern pipistrelle (FNW), big brown bat (FNW), eastern cottontail (FN), muskrat (NW), southern bog lemming (FKN), meadow jumping mouse (FN), raccoon (FN), mink (FNW)

DEEP MARSHES. Wetlands characterized by emergent vegetation such as *Typha* and *Pontederia* species, and floating-leaved plants such as *Nymphaea*, *Nuphar*, and *Brasenia* species, and water depths to 6 feet typically provide habitats for some species.

Wildlife Species That Use Deep Marshes

Amphibians

Red-spotted newt (FNW)

Reptiles

Spotted turtle (FNW), painted turtle (NW)

Birds

Pied-billed grebe (NW), gadwall (NW), American coot (NW), black tern (NW)

Mammals

Virginia opossum (FN), water shrew (FNW), little brown myotis (FNW), northern long-eared bat (FNW), silver-haired bat (FNW), eastern pipistrelle (FNW), big brown bat (FNW), muskrat (NW), raccoon (FN), mink (FNW), moose (FKNW)

SHRUB SWAMPS. Wetlands dominated by woody shrubs (figure 53) such as buttonbush (*Cephalanthus occidentalis*), alders, silky dogwood (*Cornus amomum*), and red maple and white ash saplings typically provide preferred habitat for some species.

Wildlife Species That Prefer Shrub Swamps

Amphibians

Blue-spotted salamander (FN)

Birds

Black-crowned night-heron (N), yellow-crowned night-heron (N), glossy ibis (N), red-shouldered hawk (FN), common snipe (N), yellow-bellied flycatcher (FKN), alder flycatcher (FN), white-eyed vireo (FN), common yellowthroat (FN), song sparrow (FN), swamp sparrow (FN), common grackle (FNW), American goldfinch (FN)

Mammals

Virginia opossum (FN), water shrew (FNW), smoky shrew (FN), little brown myotis (FNW), northern long-eared bat (FNW), silver-haired bat (FNW), eastern pipistrelle (FNW), big brown bat (FNW), eastern cottontail (FN), New England cottontail (FN), snowshoe hare (FKN), raccoon (FN), lynx (FKN)

BOGS. Wetlands characterized by peat accumulation—usually as a floating mat of vegetation—caused by cold, acidic conditions typically provide preferred habitat for some species.

Wildlife Species That Prefer Bogs

Amphibians

Four-toed salamander (FNW)

Reptiles

Bog turtle (NW)

Birds

Northern hawk-owl (FN), great gray owl (FN), boreal owl (FN), olive-sided flycatcher (FN), palm warbler (FN), Wilson's warbler (FN), Lincoln's sparrow (FN), rusty blackbird (FN)

Mammals

Masked shrew (FN), water shrew (FNW), smoky shrew (FN), little brown myotis (FNW), northern long-eared bat (FNW), silver-haired bat (FNW), eastern pipistrelle (FNW), big brown bat (FNW), snowshoe hare (FKN), northern bog lemming (FKN), raccoon (FN)

Fig. 53. Shrub swamp. Berlin, New Hampshire, July 1983. Photo by Richard M. DeGraaf.

PONDS. Small (≤20 acres) palustrine bodies of water including beaver ponds (figure 54), characterized by emergent or floating-leaved plants, or both, typically provide preferred habitat for some species.

Fig. 54. Beaver pond. New Salem, Massachusetts, June 1990. Photo by Richard M. DeGraaf.

Wildlife Species That Prefer Pond Habitats

Amphibians

Jefferson salamander (FN), blue-spotted salamander (FN), spotted salamander (FN), red-spotted newt (FNW), bullfrog (NW), mink frog (FNW)

Reptiles

Common snapping turtle (NW), northern red-bellied cooter (NW), painted turtle (NW), common musk turtle (NW)

Birds

Pied-billed grebe (NW)

Mammals

Water shrew (FNW), Little brown myotis (FNW), northern long-eared bat (FNW), silver-haired bat (FNW), eastern pipistrelle (FNW), big brown bat (FNW), beaver (FNW), mink (FNW), moose (FKNW)

Bats are listed here because they can get a drink at ponds and other deep-water habitats, as well as forage on insects flying above the water — a foraging opportunity usually not present in a closed canopy forest.

Deepwater Habitats

Deepwater or lacustrine habitats are permanently flooded lands below the deep-water boundary of wetlands. Water is generally too deep to support emergent vegetation (figure 55). The presence of these aquatic habitats within forested landscapes greatly increases the number of wildlife species that potentially can occur.

LAKES. Lacustrine habitats are characterized by the following features: (1) water depth at least 6.5 feet; (2) situated in topographic depressions or dammed river channels; (3) lack of trees, shrubs, persistent emergents, emergent mosses, or lichens with more than 30 percent areal coverage; and (4) total area exceeds 10 acres.

Wildlife Species for which Lacustrine Habitats and Their Associated Lakeshore Riparian Zones Typically Provide Preferred Habitat

Amphibians

Common mudpuppy (NW), red-spotted newt (FNW), bullfrog (NW), mink frog (FNW), pickerel frog (FNW)

Reptiles

Common snapping turtle (NW), map turtle (NW), northern red-bellied cooter (NW), common musk turtle (NW), eastern spiny softshell (W)

Birds

Common loon (W), ring-necked duck (NW), common goldeneye (FNW), hooded merganser (FNW), common merganser (FNW), red-breasted merganser (NW), osprey (W), bald eagle (FW), common raven (FKNW)

Mammals

Water shrew (FNW), little brown myotis (FNW), northern long-eared bat (FNW), silver-haired bat (FNW), eastern pipistrelle (FNW), big brown bat (FNW), beaver (FNW), mink (FNW), river otter (FNW), moose (FKNW)

STREAMS. Intermittent or permanent watercourses with slow water velocities (<30 cubic feet per second at high-flow periods) typically provide preferred habitat for some species.

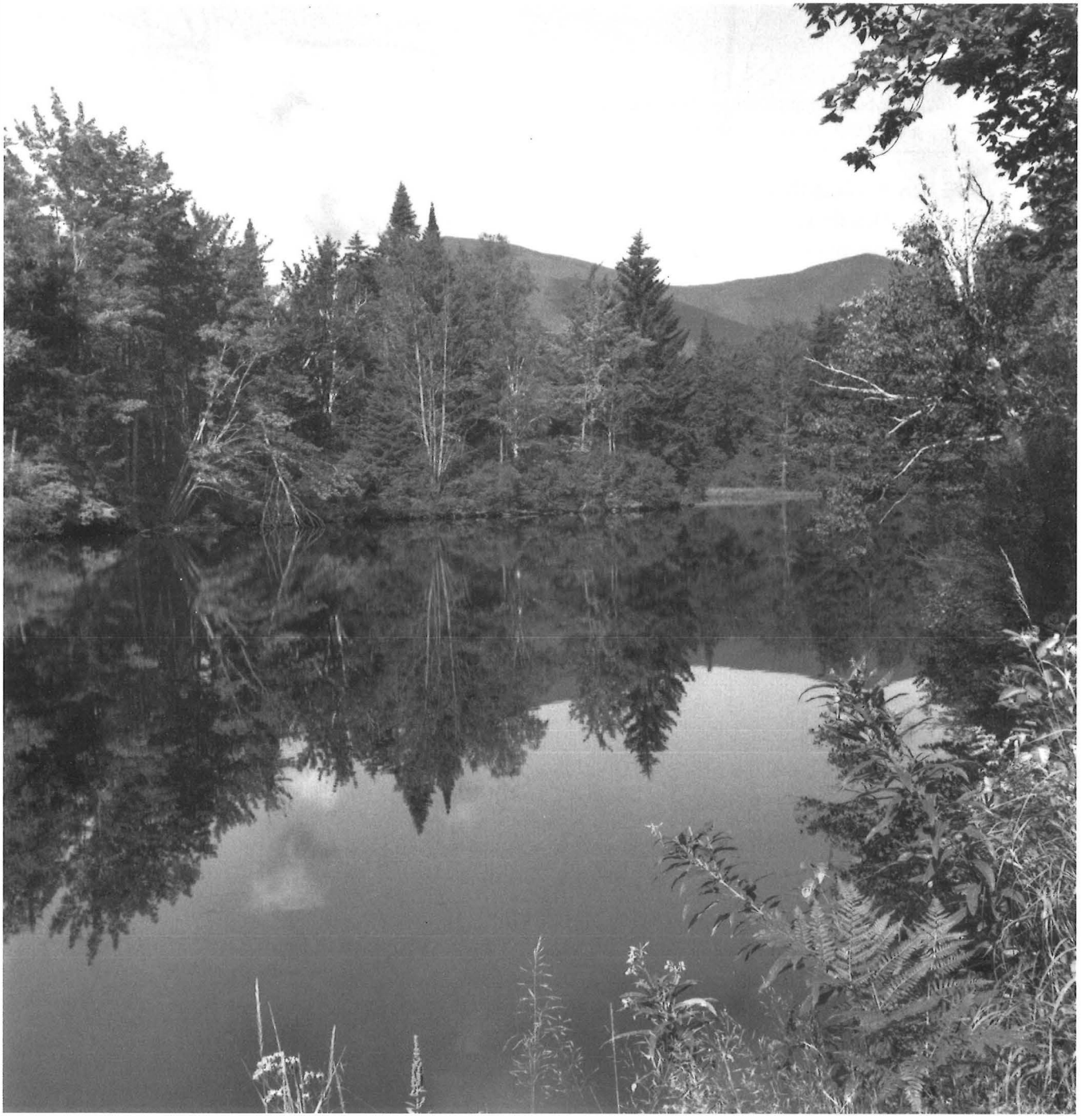


Fig. 55. Lake. Berlin, New Hampshire, July 1984. Photo by Richard M. DeGraaf.

Wildlife Species That Typically Prefer Streams

Amphibians

Common mudpuppy (NW), northern dusky salamander (FNW), northern spring salamander (FW), northern two-lined salamander (FW), pickerel frog (FNW)

Reptiles

Bog turtle (NW), wood turtle (FNW), ribbon snake (FNW)

Birds

Spotted sandpiper (NW)

Mammals

Water shrew (FNW), little brown myotis (FNW), northern long-eared bat (FNW), silver-haired bat (FNW), eastern pipistrelle (FNW), big brown bat (FNW), beaver (FNW), mink (FNW), river otter (FNW), moose (FKNW)

RIVERS. Riparian zones are especially valuable habitats for many species such as mink, otter, beaver, and for cavity dwellers such as raccoons. Streams and rivers attract many kinds of wildlife; not only the water but also the ecotonal habitats usually associated with watercourses provide habitats for species not associated directly with either the water or the adjacent forest or meadow. Forest management along watercourses or shores probably has the potential to affect more wildlife species than anywhere else, because of the number of ecotonal microhabitats involved. Cavity trees along watercourses are used preferentially by many species—many large trees tend to occur to such habitats and those that lean are used preferentially by woodpeckers. Wetland and deepwater habitats that are contained in a channel though which the water flows (water velocities >30 cubic feet per second at low flow) and with the associated forested riparian zones typically provide preferred habitat for some species.

Wildlife Species That Typically Prefer Rivers

Amphibians

Common mudpuppy (NW)

Reptiles

Wood turtle (FNW), map turtle (NW), eastern spiny softshell (W)

Birds

Spotted sandpiper (NW)

Mammals

Water shrew (FNW), little brown myotis (FNW), northern long-eared bat (FNW), silver-haired bat (FNW), eastern pipistrelle (FNW), big brown bat (FNW), beaver (FNW), mink (FNW), river otter (FNW), moose (FKNW)

Other Nonforested Habitat Types

Certain habitat components occur independently of forest cover types or management activity: streams, ponds, cliffs, caves, and even derelict buildings. These and other habitat features are important to many wildlife species, and their values differ depending on the surrounding or adjacent forest or nonforest types. Thus, wildlife species use is indirectly affected by forest management.

STABLE BANKS. Stable, grassy-topped sand (figure 56) or gravel banks resulting from excavation activities or naturally cut stream banks typically provide preferred habitat for some species.

Wildlife Species That Typically Prefer Stable Banks

Reptiles

Eastern spiny softshell (W)

Birds

Belted kingfisher (NW), bank swallow (FNW)

Mammals

Woodchuck (FN), coyote (FN), red fox (FN), gray fox (FN), striped skunk (FN), river otter (FNW)

LEDGE/CLIFF. Ledges, cliffs, talus accumulations, and outcrops typically provide nesting and denning sites for some species.

Wildlife Species That Use Ledges/Cliffs for Nesting and Denning Sites

Reptiles

Northern copperhead (F), timber rattlesnake (F)

Birds

Golden eagle (FKNW), peregrine falcon (FKNW), common raven (FKNW)

Mammals

Eastern pipistrelle (FNW), porcupine (FKN), bobcat (FKN)

CAVE, MINE. Caves and old mine shafts provide a unique and preferred overwintering hibernacula sites for some bat species.

Wildlife Species That Overwinter in Caves or Mines

Mammals

Little brown myotis (FNW), northern long-eared bat (FNW), Indiana myotis (FNW), eastern small-footed myotis (FNW), eastern pipistrelle (FNW), big brown bat (FNW)

STRUCTURES. Bridge foundations, trestles, cribwork, and other structures typically provide preferred habitat for some species.

Wildlife Species That Use Structures

Reptiles

Eastern milk snake (FN)

Birds

Rock dove (N), chimney swift (N), eastern phoebe (FN), cliff swallow (FN), barn swallow (FNW), house sparrow (N)

Fig. 56. Bank swallow colony. Bellows Falls, Vermont, August 1990. Photo by Richard M. DeGraaf.

Mammals

Little brown myotis (FNW), northern long-eared bat (FNW), eastern small-footed myotis (FNW), eastern pipistrelle (FNW), big brown bat (FNW), deer mouse (FKN), Norway rat (N), house mouse (N)

DERELICT BUILDING, DEBRIS. Abandoned buildings and piles of scrap wood characterize this specialized habitat type that generally provides preferred habitat for some species.

Wildlife Species That Use Derelict Buildings and Debris

Reptiles

Five-lined skink (F), northern brown snake (FN), northern redbelly snake (FN), northern ringneck snake (FN), northern black racer (FN), black rat snake (FN), eastern milk snake (FN)

Birds

Rock dove (N), barn owl (N), chimney swift (N), eastern phoebe (FN), cliff swallow (FN), barn swallow (FNW), house wren (FN), European starling (N), house sparrow (N)

Mammals

Little brown myotis (FNW), eastern small-footed myotis (FNW), eastern pipistrelle (FNW), big brown bat (FNW), woodchuck (FN), deer mouse (FKN), white-footed mouse (FKN), Norway rat (N), house mouse (N)

Summary

WHEN A LANDOWNER'S primary goal is to maintain or enhance wildlife habitat diversity, a habitat composition goal based on the inherent capability and diversity of the landscape needs to be articulated. The following steps can be taken to develop management strategies and prescriptions to meet the habitat composition goal. These steps take into account the complex nature of species' food chains and food webs of various wildlife communities, as well as the capability of the landscape to provide a variety of needed habitat conditions across a range of sites.

The first step is to evaluate the potential wildlife habitat capability of the property or forest, which depends foremost on the combinations of forest, nonforest, water, and krummholz habitat conditions that exist on the property and surrounding area. Landscapes with all four habitat conditions have more potential wildlife habitat capability than landscapes with only one or two broad habitat conditions.

The second step is to inventory the existing cover-type and size-class distribution, and compare existing vegetation with desired habitat composition goals. Goals need to reflect the breadth of forest habitat conditions desired, range of site conditions available, and the types of forest products currently available and desired throughout the property and surrounding area. No individual cover-type group or size class supplies all of the habitat requirements needed by the 259 wildlife species using New England forested habitat throughout the year (figure 57).

After establishing habitat composition goals, the manager must:

- Determine the silvicultural options needed to regenerate the existing cover types.
- Determine the silvicultural options needed to begin adjusting size-class composition.
- Determine the owner's constraints (for example, size of canopy breaks permitted, silvicultural practices not desired, size of

ownership, management cycle or time to stand re-entry) and alternative ways to proceed.

- Decide with the landowner which vegetative management treatments need to be completed first to meet the short-term management objectives.

After completing the first two steps, the third step for the forest manager is to decide how to provide the important structural habitat features for a wide range of wildlife species in time and space on a property or forest. Various silvicultural treatments provide established ways of manipulating vegetative structure either through direct or indirect effects over time.

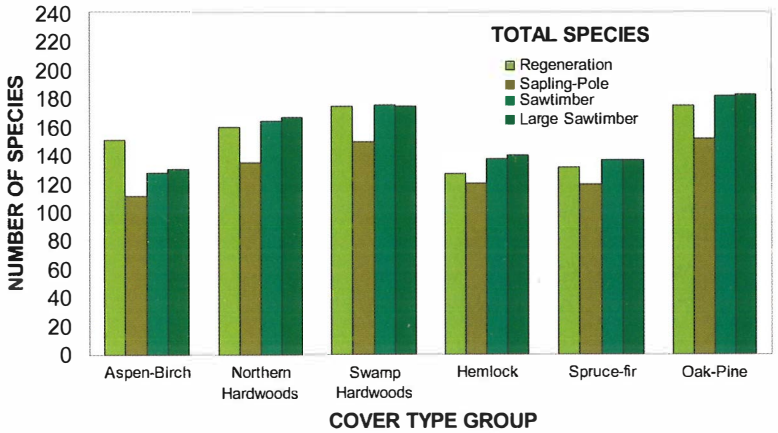


Fig. 57. Total number of species that use forested habitats, by cover type group.

Direct effects include overstory removals and intermediate thinnings that:

- can retain or remove live and dead standing stems and increase residual basal area growth;
- manipulate the degree of canopy closure;
- retain or remove cavity and mast trees;
- affect the amount of dead and down woody material on the forest floor.

Dead and live trees with cavities, mast tree retention and development, and dead and down woody material can be provided adequately through either even-aged or uneven-aged management. High exposed perches and low perches usually are associated with even-aged management, though high supracanopy nesting opportunities can be developed with uneven-aged methods.

Indirect effects include changes in herbaceous, shrub, and midstory layer responses to overstory removals, improvement cuts, and intermediate thinnings across the range of site conditions. Even-aged and uneven-aged management routinely produce changes in these vegetative layers.

Even-aged management provides opportunities to regenerate intolerant hardwoods such as aspen and paper birch cover types by clearcutting, opportunities that uneven-aged management systems do not provide. The indirect effects on harvested areas include a flush of herbaceous ground cover after the first several years, followed by the development of a significant shrub layer of commercial and noncommercial woody seedlings and sprouts within five years. This shrub layer usually grows into a densely stocked sapling stand within ten years after cutting. Shelterwood systems with residual canopy closures less than 50 percent provide some of these habitat conditions for several years post-harvest also. These types of stand-regeneration practices produce distinct and recognizable forage and shelter opportunities for numerous species that usually are not available when using uneven-aged management (figure 58).

Even-aged management provides potential habitat conditions for up to 26 percent more species than uneven-aged management that regenerates similar cover types. Bird species display a greater sensitivity to silvicultural treatment than other taxonomic groups. Forests that contain a distribution of regeneration, sapling-poletimber, sawtimber, and large sawtimber in distinct units of 5 acres and larger and that are treated with even-aged management can provide more potential habitats than uneven-aged management, when applied at an appropriate scale so that entire landscapes are not affected during any one management period.

Uneven-aged management provides opportunities to manage large and small properties for essentially continuous overstory canopies and intermixed size classes of tolerant hardwoods and softwoods by single-tree selection. Indirect effects on harvested areas vary with the degree of residual canopy closure and range of site conditions. With residual canopy closures usually greater than 70 percent, minimal herbaceous ground cover and shrub conditions are expected, and midstory layers usually develop. Proportions of intolerant and intermediate tree species decrease over time. Uneven-aged management applied across large homogeneous areas tends to limit early-successional habitat conditions and intolerant cover types. In much of New England, however, large areas are broken up by discontinuity in soils, geology, elevation, and drainage pattern that lead to variation in species composition, variation in response to treatment, and sometimes it is necessary to use even-aged methods interspersed with the general uneven-aged method.

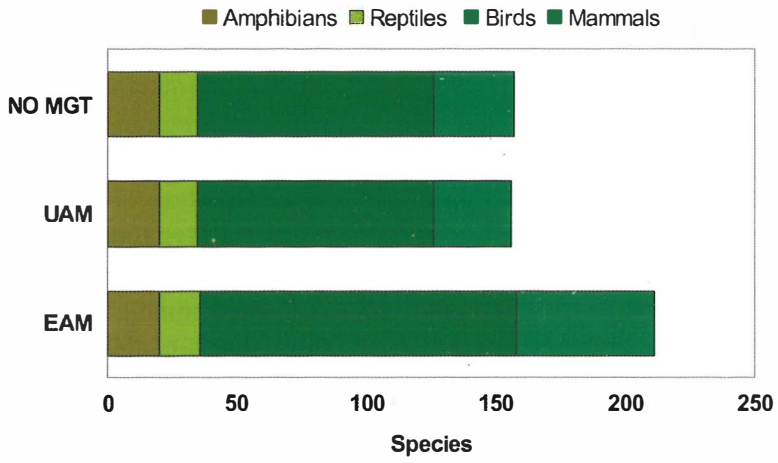


Fig. 58. Potential number of wildlife species by silvicultural system and cover type group. (No MGT = no management; UAM = uneven-aged management; EAM = even-aged management.)

Group selection, using openings up to 1 to 2 acres in size, is a form of uneven-aged management that provides habitat conditions between single-tree selection and even-aged approaches. At regular intervals (ten to twenty years), up to about 10 percent of the stand is regenerated in groups, while single-tree selection sometimes is applied between the openings. Intolerant species regenerate in the larger groups, while intermediate and tolerant species dominate the small openings. Distinct size classes are recognizable for a few decades following cutting. The main limitation on wildlife habitat is the small size of the openings. Group selection provides for a potential number of species between that suggested for even-aged and typical uneven-aged approaches (see figure 58).

Combinations of these systems, rather than strict adherence to only one system, increases the habitat conditions possible through vegetative management. The special care that is taken to provide a range of diverse habitat conditions throughout a forest or property eventually will result in increased use by a wider variety of wildlife species than otherwise might be expected. The basic differences in the landscapes of northern and southern New England guide the management strategies selected.

NORTHERN NEW ENGLAND. In extensively forested northern New England, several basic differences in stand structure and, in turn, wildlife communities result from uneven-aged and even-aged management. Use of uneven-aged management with group selection provides habitat components such as patches of early-successional habitat and young forest that generally would not be present, or would occur rarely in the absence of management or uncontrolled fire. Wildlife communities, therefore, are somewhat more diverse in forests managed with group selection than in those that are left unmanaged.

Even-aged management with clearcut regeneration provides large patches (20 acres or more) of early-successional habitat, young forest, and mature and old forest conditions in a shifting mosaic over time. Such management provides habitat for the most diverse wildlife community, and maintains forest and wildlife diversity through time. Most of the wildlife diversity is associated with seedling and sapling stands; once beyond the poletimber stage, stands have about the same wildlife species whether they are even-aged sawtimber or old forest.

SOUTHERN NEW ENGLAND. In southern New England, much of the landscape contains agricultural lands, suburban developments, and forests. Other parts of the landscape are quite forested. The management options appropriate to each are different. In either type, however, habitat conditions in unmanaged and uneven-aged managed forests are not dramatically different, and their forest wildlife populations are fairly similar. The managed forests will have somewhat higher diversity due to early-successional and young forest conditions that are created periodically.

Where the landscape is somewhat open due to agriculture or extensive wetlands, the need to provide early-successional habitat through even-aged management is lessened. Often a substantial increase in wildlife diversity can be achieved in such situations with uneven-aged management by placing group cuts near cropland, old fields, orchards, or other open habitats. Such placement increases the effective area of early-successional or young forest habitats.

Where the landscape is heavily forested, uneven-aged management using larger group openings will increase habitat diversity somewhat by maintaining a presence of components such as soft mast, young forest, and larger cavity trees, for example. The greatest impact on wildlife diversity results from even-aged management, using either shelterwood cuts or small clearcuts (>5 acres), however, because a wide range of conditions from early-successional habitats to old forest is perpetuated in a shifting mosaic.

Using the Appendixes

Species habitat matrices present summary information in a simple, condensed, tabular form. The matrices in these appendixes are an integral part of this book. Familiarize yourself with their arrangement and the elements that they contain (figure 59). The matrices show the typical habitats used by the various species in New England and demonstrate the importance of management in providing for early-successional habitat and nonforest species. Four sets of matrices provide the information on habitat associations of inland New England wildlife species pertaining to: (A) forest habitats, (B) nonforest habitats, (C) relationships of size-class and habitat breadth, and (D) key structural habitat features.

Special habitat features are listed for many species in Appendixes A and B. These features are considered essential for a species to occur regularly or to reproduce. Many species generally are associated with a given forest type or group of types—cavity-nesting waterfowl, for example. However, in this example, the special habitat features—tree cavities and water—also must be present. Thus, the species/habitat associations must be viewed as a complex of within-stand and special habitat requirements occurring in species' overall or general habitat. Some special habitat features can be provided through forest management—the aforementioned cavities, for example, either by delayed rotation or streamside buffer strips where timber harvest is restricted.

Species Activities/Season of Occurrence

Habitat utilization by species is rated separately in the "seasonal use" column in Appendixes A, B, and D for life history activities and seasons as follows for birds and mammals:

BR—Breeding season (for mammals, refers to the period when young are born and are being nurtured);

BF—Breeding season, feeding;

WS—Winter shelter;

WF—Winter feeding.

For amphibians and reptiles, habitat use is shown for breeding (BR) and nonbreeding (NB) activity periods only, because, with few exceptions, they

are inactive during winter, and overwinter underground or in bottom sediments. Consult the species accounts in *New England Wildlife: Habitat, Natural History, and Distribution* (DeGraaf and Yamasaki 2001) for the time periods of those activities.

Habitat Suitability

The suitability (quality) of each community type for a given species was based on ratings by the experts acknowledged, and on the authors' field experience. Although they are subjective, they represent the best estimates currently available. On the matrix, the light shading indicates utilized habitat, and the dark shading indicates preferred habitat. If specific habitat components are required by a species for its regular occurrence, these are listed under special habitat features.

Appendix A: Forest Cover Types and Groups

The six forest types and groups of types used to describe forest habitats are condensed from the eleven forest cover types used to present forest/wildlife habitat associations in *New England Wildlife: Habitat, Natural History, and Distribution* (DeGraaf and Yamasaki 2001). The eleven forest cover types used in that publication were based on the classification system presented in *Forest Cover Types of the United States and Canada* (Eyre 1980). Similar types are grouped, especially when they reflect similarities in wildlife species composition and responses to silvicultural treatment and area shown in Appendix A.

Forest development is indicated by size class as follows:

S *Regeneration through seedlings*: Live trees and associated vegetation less than 1.0 inch dbh and at least 1 foot in height.

Sp *Sapling though poletimber*: Saplings are live trees 1.0 to 4.9 inches dbh; poles are live trees 5.0 to 8.9 inches dbh for softwoods and 5.0 to 10.9 inches dbh for hardwoods. The matrix assumes that stands are fully stocked, that is, contain approximately 75 square feet of basal area per acre.

St *Sawtimber*: A stand with at least half of the stocking in sawtimber-size trees — at least 9.0 inches dbh for softwoods or 11.0 inches for hardwoods.

L *Large sawtimber*: A stand with at least half of the stocking in large sawtimber trees — at least 20 inches dbh for softwoods and 24 inches dbh for hardwoods.

U *Uneven-aged*: Stands of northern hardwood cover types that contain trees of all size classes.

These apply to all forest cover types under even-aged management, with one exception. Only in the northern hardwoods cover type group do we list wildlife habitat associations for uneven-aged stands.

A more complete description of the forest cover types and groups can be found in chapter 4, Silvicultural Methods (page 85). A summary of the forest cover types and groups follows.

Aspen–Birch

ASPEN. This type includes quaking aspen (*Populus tremuloides*) and bigtooth aspen (*P. grandidentata*) but in New England, quaking aspen is more likely to occur in pure stands. Common associates are paper birch (*Betula papyrifera*) and pin cherry (*Prunus pensylvanica*), which, when occurring in a mixture, die out early. These species occur on a variety of sites and soil types. The aspen type occurs on most soils except very dry sands or very wet swamps. Aspen is unique in that almost all stands originate as suckers arising from existing root systems. It sometimes will reproduce from seed on burns, clearcuts, and other scarified sites.

Aspen is a relatively short-lived pioneer type—it does not reproduce under its own shade. On dry sites, aspen is replaced by softwoods, red maple (*Acer rubrum*), or various oaks (*Quercus* spp.); on mesic sites by mixed hardwoods; and on wet sites by balsam fir (*Abies balsamea*) (Brinkman and Roe 1975).

PAPER BIRCH. Paper birch is pure or dominant. Associated species include quaking and bigtooth aspen, balsam fir, red spruce (*Picea rubens*), white pine, yellow birch (*B. alleghaniensis*), and, in southern New England, hemlock (*Tsuga canadensis*). The type pioneers on burned areas and clearcuts, and grows best on deep fertile, well-drained sites. Raspberries and blackberries (*Rubus* spp.) make up a high proportion of the ground cover at the time of establishment of paper birch stands. These are shaded out in about ten years, but pin cherry can persist for thirty or more years. Paper birch is succeeded by spruce–fir in northern parts of its range, and to the south by northern hardwoods and hemlock on fertile, well-drained sites (Safford 1980).

Northern Hardwoods

SUGAR MAPLE–ASH, SUGAR MAPLE–BEECH–YELLOW BIRCH, AND BEECH–RED MAPLE. The true northern hardwood type is dominated by sugar maple (*A. saccharum*), beech (*Fagus grandifolia*), and yellow birch, and occurs widely as a pure type in northern New England. It grades into a mixed hardwood or transition type in southern New England; associated species throughout the region include basswood (*Tilia americana*), red maple, hemlock, white ash (*Fraxinus americana*), white pine, balsam fir, black cherry (*Prunus serotina*), paper birch, sweet birch (*B. lenta*), and red spruce.

Northern hardwood is the basic hardwood type in northern New England, and occurs to an elevation of 2,500 feet (760 meters). It prefers fertile loamy soils and good moisture conditions. Striped maple (*A. pensylvanicum*), witch hazel (*Hamamelis virginiana*), and hobblebush (*Viburnum alnifolium*) are common in the understory throughout the region. Best development of the type occurs on moist, fertile, well-drained loamy soils. On drier sites, beech becomes more prominent. On wet sites, the type blends into a red maple–yellow birch–hemlock or a red spruce mixture. The type tends to be climax. From New England to Pennsylvania, the beech *Nectria* complex gradually has reduced the proportion of beech in many stands (Berglund 1980).

Swamp Hardwoods

RED MAPLE. Red maple is pure or dominant. In New England, red maple and associated species are common on wet sites; the type is essentially pure in southern New England. Associates are yellow birch, balsam fir, and sugar maple in northern New England; black gum (*Nyssa sylvatica*), sycamore (*Platanus occidentalis*) and silver maple (*A. saccharinum*) in southern New England. In New England and the Upper Peninsula of Michigan, it occupies moist to wet muck or peat soils in swamps, depressions, or along sluggish streams, and so is often found as an inclusion in northern hardwoods on wetter sites (Powell and Erdmann 1980). It can be differentiated readily from northern hardwoods by the absence of beech and the increased proportion of yellow birch and red spruce.

Spruce–Fir

BALSAM FIR. Balsam fir is characteristically pure or predominant. There are many associates mostly on moist or wet-site soils in northern New England; these include paper birch, quaking and bigtooth aspen, red spruce, and in swamps northern white cedar (*Thuja occidentalis*). In southern New England, hemlock and red maple are common associates. The type is common in northern New England, occurring on upland sites, on low-lying moist flats, and in swamps. Pure stands result (usually) from heavy cutting, blowdown, or following infestation of spruce budworm. This type may be climax in the zone below timberline. Only black spruce (*Picea mariana*) grows above it (Westveld 1953).

The type occurs extensively in Quebec, where five distinct subtypes are recognized. In the United States, the type is not as complex; however, balsam fir is an important component in the following types in northern New England: red spruce–balsam fir, black spruce, aspen, and paper birch. Common understory species include speckled alder (*Alnus rugosa*), mountain maple (*A. spicatum*), and pin cherry, among large shrubs and small trees. Low understory plants include Canada yew (*Taxus canadensis*), red raspberry, blueberries (*Vaccinium* spp.), and hobblebush (Frank et al. 1980).

RED SPRUCE–BALSAM FIR. The type may consist of red spruce and balsam fir or together they may predominate in a mixture of associates—the composition varies by site and disturbance history. We include here the northern white cedar type and associates, which commonly are associated in northern New England. This is a northern New England type, occupying moderately to poorly drained flats, but not swamps. Associates are red maple, paper and yellow birch, and aspens, primarily, but also white pine, hemlock, and occasionally black spruce and tamarack (*Larix laricina*).

The type occurs near sea level in eastern Maine, from an elevation of 2,400 to 4,500 feet (730 to 1,370 meters) in the White Mountains of New Hampshire, from an elevation of 2,500 to 3,800 feet (760 to 1,160 meters) in the Green Mountains of Vermont, and occurs on the tops of some of the higher Berkshire Hills in western Massachusetts.

The type occurs on two kinds of sites in New England: (1) poorly drained flats and ridges or benches at lakeshores, streams, and swamps and bogs; and (2) well-drained to dry, shallow soils on steep, rocky, upper mountain slopes.

Stands are usually very dense; the ground may be essentially devoid of plants except for mosses and a few seedlings of red spruce and balsam fir. Regenerated stands, however, produce a thick growth of blueberry, creeping snowberry (*Gaultheria hispidula*), mountain holly (*Nemopanthus mucronata*), raspberry, and downy serviceberry (*Amelanchier arborea*) among others (Griffin 1980).

RED SPRUCE. Red spruce is pure or accounts for a majority of the stocking; common associates in northern New England are balsam fir, paper and yellow birch; others include sugar maple, red maple, mountain-ash (*Sorbus americana*), eastern white pine, and eastern hemlock. Red spruce occurs near sea level in eastern Maine and from an elevation of 1,500 to 4,500 feet (450 to 1,370 meters) inland throughout northern New England on moderately well-drained to poorly drained flats (but not true swamps), and on well-drained slopes, including thinly soiled upper slopes. Red spruce pioneers on abandoned fields and pastures in northern New England, and on these fairly well-drained sites it is usually replaced by shade-tolerant hardwoods, especially sugar maple and beech. Red spruce is long-lived and, barring major disturbance, is very stable. Older stands develop an uneven-aged character even though of even-aged origin. The understory is frequently sparse, or even absent; the ground beneath red spruce stands is covered with tree litter and patches of short-lived red spruce seedlings.

Old-field red spruce contains a ground cover of bunchberry (*Cornus canadensis*) on wet sites and hobblebush on well-drained sites. Regenerated stands usually produce raspberries in abundance (Blum 1980).

Hemlock

EASTERN HEMLOCK. Eastern hemlock is pure or predominant over any associate, but associates are numerous; these commonly include beech,

sugar maple, yellow birch, red maple, black cherry, white pine, northern red oak (*Q. rubra*) and white oak (*Q. alba*), sweet birch, and in northern New England, paper birch, balsam fir, and red spruce. In southern New England, the type prefers cool locations such as moist ravines and north-facing slopes; in the northern parts of its New England distribution, warmer, drier sites are tolerated. It occurs from sea level to an elevation of 3,000 feet (915 meters) in New England.

Eastern hemlock is very shade tolerant. Its long life span and ability to respond to release after almost two centuries of suppression have allowed the type to persist; early logging, and the fires that followed, greatly reduced the occurrence of this shallow-rooted climax species. Under mature stands, understory development is sparse; openings to admit light commonly produce striped maple, hobblebush, mapleleaf viburnum, among others. False lily-of-the-valley (*Maianthemum canadense*) is probably the most common herb (Wiant 1980).

Oak–Pine

NORTHERN RED OAK. Northern red oak accounts for a majority of the stocking. Associates vary according to site and locale, and include black oak (*Q. velutina*), scarlet oak (*Q. coccinea*), and chestnut oak (*Q. prinus*), hickories (*Carya* spp.), and red maple. In northern New England, the type has a spotty distribution, occupying ridge crests and upper south-facing slopes. On better sites, associates are black cherry, sugar maple, white ash, and beech. The type is rare in northern New England and reaches best development in New England in western Massachusetts and northern Connecticut on loam and silt-loam soils. The type is subclimax; shade-tolerant species such as beech and sugar maple increase in proportion over time (Trimble 1980).

WHITE PINE–NORTHERN RED OAK–RED MAPLE. Northern red oak, eastern white pine, and red maple predominate; white ash is the most common associate, but others include paper, yellow, and sweet birches, sugar maple, beech, hemlock, and black cherry. This type occurs across southern and central New England to an elevation of 1,500 feet (450 meters), generally on deep, well-drained fertile soils.

This type is common in the transition between northern hardwoods and spruce–fir types in northern New England, and between northern hardwoods and oak types — characteristic of central types — in southern New England. The type often follows "old-field" white pine in New England, where hardwood seedlings and saplings form the understory (Baldwin and Ward 1980). Common understory shrubs include witch hazel, alternate-leaved dogwood (*Cornus alternifolia*), mapleleaf viburnum (*Viburnum acerifolium*), and mountain laurel (*Kalmia latifolia*).

EASTERN WHITE PINE. Eastern white pine is pure or usually predominant. We include red pine, which has a spotty distribution throughout New

England on sandy, gravelly, or sandy loam soils, and white pine–hemlock, a common subtype in central and southern New England, where it occupies a range of soil types in cool locations such as ravines and northern slopes (in the southern parts of its range). These other pine types are included primarily because they support similar wildlife communities.

Eastern white pine frequently occurs in pure stands; common New England associates on light soils are pitch pine (*Pinus rigida*), gray birch (*Betula populifolia*), quaking and bigtooth aspen, red maple, and white oak. On heavier soils, paper birch, sweet birch, yellow birch, white ash, black cherry, northern red oak, sugar maple, hemlock, red spruce, and northern white cedar are associated in New England, but none are characteristic. The type is widespread in central New England from sea level to an elevation of 2,500 feet (760 meters). This type occurs over a wide range of conditions and sites; establishment is often easier on poor sites because hardwood competition is less. Once established on better sites, white pine usually will grow faster than hardwoods.

White pine is a common pioneer species on abandoned agricultural land in New England. The type seldom succeeds itself, but on dry, sandy soils it may persist a long time and even approach permanence. On heavier soils, white pine usually is succeeded by northern hardwoods, white pine–hemlock, or mixed hardwoods.

Eastern white pine is a major component of two other New England forest cover types — white pine–northern red oak–red maple and white pine–hemlock — occurring in various proportions in other types throughout the region.

In pure or almost pure white pine stands, the understory is composed primarily of ericaceous shrubs such as blueberries, huckleberries (*Gaylussacia* spp.), azaleas (*Rhododendron* spp.), and mountain laurel. In New England, common lady's slipper (*Cypripedium* spp.) is common on light soils and highbush blueberry (*Vaccinium corymbosum*) on wetter sites (Wendel 1980).

Appendix B: Terrestrial, Wetland, Deepwater, and Other Nonforested Habitat Types

Twenty-four nonforest cover types are used to present forest/wildlife habitat associations in Appendix B. Terrestrial nonforested cover types are based on descriptions in *Fisheries and Wildlife Habitat Management Handbook* (U.S. Department of Agriculture 1975), and *Land Resources in New Hampshire* (U.S. Department of Agriculture 1982). Wetland and deepwater types are based on descriptions in *Classification of Wetlands and Deepwater Habitats of the United States* (Cowardin et al. 1979). Similar types are grouped, especially when they reflect similarities in species composition and responses to treatments that comprise the nonforested habitat matrix. Other nonforest types are based on smaller-scale habitats that usually are not typed on maps, but that offer distinct habitat elements for a variety wildlife species occurrence in nonforested habitats. Many wildlife species that occur in forested habitats

either prefer or require one or more nonforested habitats, usually for breeding. For example, eastern American toad (*Bufo a. americanus*) and mole salamanders (*Ambystoma* spp.) occur throughout many woodlands, except for brief, critical breeding periods in wetlands.

The nonforested habitat types are described briefly below.

Terrestrial

UPLAND FIELD. Several upland nonforest types are aggregated under the general term "upland field":

Cultivated—tilled agricultural cropland;

Grass—hayfields, etc.;

Forb—broadleaved herbaceous cover, such as goldenrod (*Solidago*) and sensitive fern (*Onoclea*);

Shrub/old field—abandoned agricultural fields reverting to forest, characterized by grasses, shrubs, small trees;

Pastures—usually too wet or rocky for cultivation.

SAVANNA. This habitat comprises grasslands with shrubs and widely, irregularly scattered trees, which result from either soil-moisture regimes or disturbances such as fire or grazing.

ORCHARD. These may be old or contemporary plantings of fruit trees, usually with grassy ground cover.

KRUMMHOLZ ZONE. The transition zone from subalpine forest to alpine tundra is characterized by dwarfed, deformed, wind-sheared trees, including the subalpine forest.

ALPINE ZONE. The elevated slopes above the timberline are characterized by low, shrubby, slow-growing woody plants and ground cover of boreal lichens, sedges, and grasses.

Wetland/Deepwater

In general, wetlands are lands where saturation with water largely determines the nature of soil development and the types of plant and animal communities living in the soil and on its surface. The dominant plants are hydrophytes. The single feature that most wetlands share is soil or substrate that is saturated or covered by water at least periodically. Wetlands are transitional sites between terrestrial and aquatic systems, where the water table is usually at or near the surface, or where the land is covered by shallow water.

Deepwater habitats are permanently flooded lands lying below the deepwater boundary of wetlands. Deepwater habitats include environments where surface water is permanent and often deep, so that water, rather than air, is the principal medium within which the dominant organisms live, whether or not they are attached to the substrate. As in wetlands, the dominant plants are hydrophytes; however, the water is generally too deep to support emergent vegetation.

PALUSTRINE. Palustrine habitats are non-tidal wetlands dominated by emergent mosses, lichens, persistent emergents, shrubs, or trees (Cowardin et al. 1979).

Sedge meadow — dominated by sedges (*Carex*), cattails (*Typha*), etc.; surface water depths to 6 inches in winter and early spring; soil surface exposed but saturated in summer. Typed as fen or northern sedge meadow by Curtis (1959) and persistent emergent wetland in Cowardin et al. (1979).

Shallow marsh — characterized by persistent emergent vegetation and water depths to 1.5 feet; tend to maintain a similar appearance as time passes. Typed as inland shallow fresh marsh by Golet and Larson (1974) and persistent emergent wetland by Cowardin et al. (1979).

Deep marsh — characterized by emergent and floating-leaved plants and water depths to 6 feet. Typed as inland deep fresh marsh by Golet and Larson (1974) and emergent wetland and aquatic bed by Cowardin et al. (1979).

Shrub swamp — dominated by woody vegetation less than 20 feet tall; soil seasonally or permanently flooded to a depth of 1 foot. Typical woody species include alders (*Alnus* spp.), buttonbush (*Cephalanthus occidentalis*), and red osier dogwood (*Cornus stolonifera*). Typed as shrub swamp by Golet and Larson (1974) and scrub-shrub wetland by Cowardin et al. (1979).

Bog — characterized by peat accumulation due to cold, acidic conditions; sometimes a floating mat of *Sphagnum*, which tends to be dominant; sundew (*Drosera* spp.) and pitcher plant (*Sarracenia* spp.) are generally common. Woody species often include Labrador tea (*Ledum groenlandicum*), bog rosemary (*Andromeda glaucophylla*), bog laurel (*Kalmia polifolia*), and leatherleaf (*Chamaedaphne calyculata*), among others. Typed as bog by Dansereau and Segadas-vianna (1952) and scrub-shrub wetland, forested wetland, and moss-lichen wetland in Cowardin et al. (1979).

Pond — permanent palustrine water body, characterized by emergent and/or floating-leaved plants, up to 20 acres in size. Typed as open water by Golet and Larson (1974) and aquatic bed, unconsolidated bottom, and emergent wetland by Cowardin et al. (1979).

LACUSTRINE. Deepwater habitats are termed lacustrine when they have all of the following characteristics: (1) situated in a topographic depression or a dammed river channel; (2) lacking trees, shrubs, persistent emergents, emergent mosses or lichens with greater than 30 percent areal coverage; and (3) total area exceeds 10 acres.

Lake — characterized by water depth of 6.5 feet and a deeper limnetic zone. Typed as open water by Golet and Larson (1974) and aquatic bed, unconsolidated bottom, and emergent wetland by Cowardin et al. (1979).

RIVERINE. Wetlands and deepwater habitats are riverine when they are contained within a channel through which the water flows.

Stream — characterized as intermittent or permanent, up to 30 cubic feet per second at high flow. Typed as intermittent and upper perennial systems with unconsolidated bottom and shore, aquatic bed, and emergent scrub-shrub and forest wetlands by Cowardin et al. (1979).

River — characterized by low- and high-gradient nontidal flows of at least 30 cubic feet per second at low flow. Typed as lower and upper perennial systems by Cowardin et al. (1979).

Riparian zone — stream and river floodplains and associated woody, shrubby, and herbaceous vegetation.

Other Nonforested Habitat Types

STABLE BANKS. These habitats may be excavated sand or gravel banks or naturally cut stream banks topped by an overhanging grassy top.

LEDGE, CLIFF. These may be exposed bedrock, cliffs, talus accumulation, and large outcrops.

CAVE, MINE. Natural caves and old mine shafts characterize this specialized habitat type.

STRUCTURES. These may be bridge foundations, trestles, cribwork, etc.

DERELICT BUILDING, DEBRIS. Abandoned buildings and piles of scrap wood characterize this specialized habitat type.

Appendix C: Habitat Breadth and Size Class

Habitat breadth — the range of habitats that is used or is acceptable to wildlife species — is presented in terms of four basic habitats in Appendix C. Size-class

relations are presented for four timber size classes. The habitats are the most general categories to describe wildlife habitat relationships, because they transcend forest cover types, the various nonforest habitats, and of course structural habitat features within stands. Species with the narrowest range of utilized habitats are associated with only one of the habitats or size classes. Species with the widest range are associated with all four habitats or size classes; others are intermediate.

The four timber size classes are:

S = regeneration through seedlings

Sp = saplings through poletimber

St = sawtimber

L = large sawtimber

The four general habitats are:

Forest — any deciduous or coniferous forest regardless of type, age, or size class;

Nonforest — any upland or aquatic habitat that currently does not support trees.

Krummholz — subalpine birch, red spruce, and balsam fir forests at elevations above managed forest;

Water — any palustrine, lacustrine, or riverine habitat.

Appendix D: Special Habitat Features

Special habitat features for many species are listed in Appendix D. These features are considered to be important for that species to occur regularly or to reproduce. Many species generally are associated with a given forest type, but the presence of a particular habitat feature is essential to their occurrence. For example, cavity-nesting waterfowl use a variety of forest types, but the specific habitat feature — in this particular case water — also must be present. Thus, the species/habitat associations must be viewed as a complex of within-stand and special habitat requirements occurring in a species' overall habitat.

Some special habitat features can be provided through forest management — the aforementioned cavities, for example, either by delaying harvest or designating streamside buffer strips where timber harvesting is minimal — but the stream or pond cannot. The most important structural habitat features that can be provided through forest management and their associations with inland terrestrial wildlife species are shown in Appendix D in three matrices: forest only species, forest-nonforest species, and nonforest only species. Some habitat features that cannot be provided through forest management are noted with an asterisk in the following list of classification criteria:

Perch types.

High exposed — supracanopy nesting and exposed hunting sites

Low exposed — exposed hawking sites low to the ground

Canopy Closure.

<30% — open canopy

31 to 70% — partial canopy

>70% — closed canopy

Overstory inclusions.

Deciduous — one tree or stand of deciduous trees in a coniferous forest

Coniferous — one tree or a stand of coniferous trees in a deciduous forest

Tree boles.

Adjacent to water:
Dead, >6 inches dbh
Live, >12 inches dbh
Live, >18 inches dbh

General forest:
Dead and soft, <6 inches dbh
Dead and hard, 6–12 inches dbh
Dead and hard, 12–18 inches dbh
Live, columnar decay, 8–23 inches dbh
Live, broken top, 12–18 inches dbh
Live, broken top or large limb >18 inches dbh
Live, hollow >24 inches dbh

Midstory layer.

Woody vegetation 10–30 feet in height

Shrub layer.

Deciduous seedlings, saplings, shrubs 2–10 feet in height

Coniferous seedlings, saplings, shrubs 2–10 feet in height

Mixed deciduous and coniferous vegetation 2–10 feet in height

Ericaceous shrubs 2–10 feet in height

Wetland shrubs

Ground cover layer.

Upland herbaceous:
<30% ground cover 0–2 feet in height — minimal
30–75% ground cover 0–2 feet in height — partial
>75% ground cover 0–2 feet in height — dense

Wetland vegetation:
Emergent wetland and bank vegetation

Ground surface layer.

Waterside decaying logs

*Rocky forest floor

Dead and down trees, limbs, branches

Forest litter and moss — leaves, twigs, moss

Gravel and soil — exposed gravel, sand, or soil as in open gravel pits

Subterranean habitats.
Miscellaneous features.

Temporary pools — vernal and autumnal

*Seeps — wet places where ground water emerges on the surface

*Woods roads — unpaved roads through forests

Slashpiles — loosely piled logging debris

Hard mast — nut-bearing trees and shrubs

Soft mast — fleshy fruits produced by trees, shrubs, and herbaceous plants

Appendix A: Species Occurrence and Utilization, by Forested Habitat

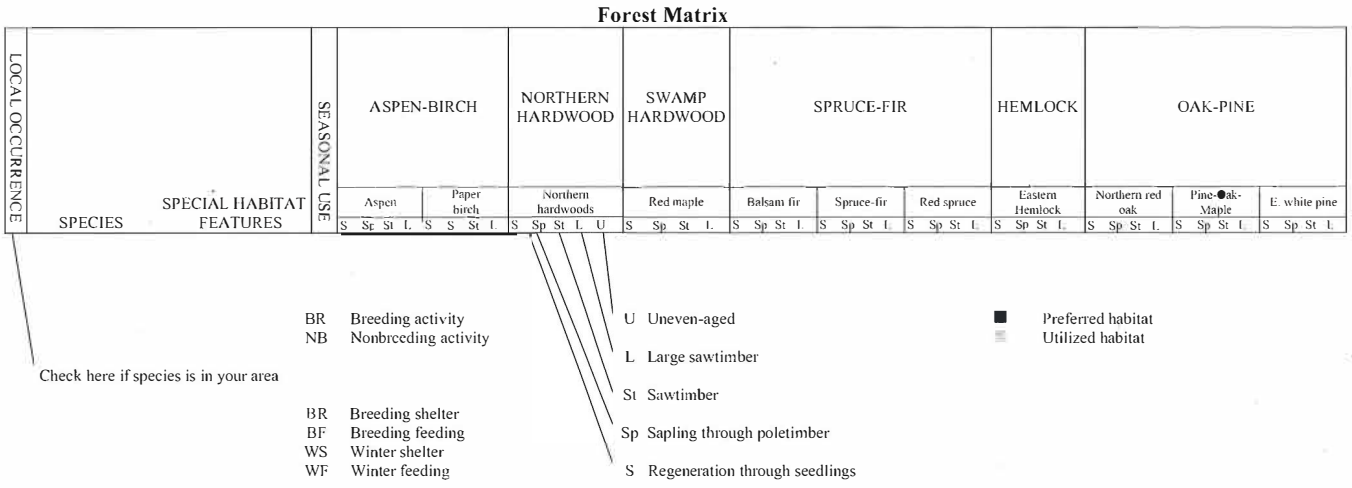


Fig. 59a. The key to elements in the species/habitat matrices.

Forest Matrix

LOCAL OCCURRENCE	SPECIES	SPECIAL HABITAT FEATURES	SEASONAL USE	ASPEN–BIRCH		NORTHERN HARDWOOD	SWAMP HARDWOOD	SPRUCE–FIR			HEMLOCK	OAK–PINE		
				Aspen	*Paper birch*	*Northern hardwoods*	*Red maple*	*Balsam fir*	*Spruce-fir*	*Red spruce*	*Eastern Hemlock*	*Northern red oak*	*Pine–Oak–Maple*	*E. white pine*
				S Sp St L	S Sp St L	S Sp St L U	S Sp St L	S Sp St L	S Sp St L	S Sp St L	S Sp St L	S Sp St L	S Sp St L	S Sp St L
	Marbled salamander *Ambystoma opacum*	Temporary (autumnal) pools or swamps in upland woods for breeding	BR				■ ■ ■					■ ■ ■	■ ■ ■	
			NB				■ ■ ■							
	Jefferson salamander *Ambystoma jeffersonianum*	Vernal pools or semipermanent water adjacent to upland habitat for breeding	BR				■ ■ ■					■ ■ ■ ■	■ ■ ■ ■	
			NB											
	Blue-spotted salamander *Ambystoma laterale*	Vernal pools or semipermanent water for breeding; adjacent to upland habitat	BR											
			NB											
	Spotted salamander *Ambystoma maculatum*	Mesic woods, vernal pools, or semipermanent water for breeding	BR											
			NB											
	Red-spotted newt *Notophthalmus v. viridescens*	Water bodies with aquatic vegetation for adult newts; juveniles (efts) are terrestrial	BR											
			NB											
	Northern dusky salamander *Desmognathus fuscus*	Permanent forested seeps, springs, headwater streams	BR											
			NB											
	Northern redback salamander *Plethodon cinereus*	Logs, stumps, rocks, etc.	BR											
			NB											
	Northern slimy salamander *Plethodon glutinosus*	Rock outcroppings, logs in wooded areas	BR				■ ■ ■							
			NB											
	Four-toed salamander *Hemidactylium scutatum*	Wet woodlands containing sphagnum moss	BR											
			NB											
	Northern spring salamander *Gyrinophilus p. porphyriticus*	Woodland headwater streams; high-gradient seeps or springs	BR											
			NB											
	Northern two-lined salamander *Eurycea bislineata*	Well-shaded streams for breeding	BR											
			NB											
	Eastern spadefoot *Scaphiopus holbrookii*	Sandy soils; temporary, seasonally or periodically flooded areas (5 to 30 cm deep)	BR											
			NB											
	Eastern American toad *Bufo a. americanus*	Shallow, still water for breeding	BR											
			NB											

	Fowler's toad *Bufo fowleri*	Well-drained, sandy soils; shallow water for breeding	BR NB												
	Northern spring peeper *Pseudacris c. crucifer*	Pools for breeding adjacent to forested or shrub habitat	BR NB												
	Gray treefrog *Hyla versicolor*	Seeps or shallow water adjacent to upland forests for breeding; hibernates under leaves, logs	BR NB												
	Green frog *Rana clamitans melanota*	Margins of riverine or lacustrine habitats for breeding	BR NB												
	Mink frog *Rana septentrionalis*	Margins of lacustrine habitats with abundant lily pads; adjacent wetlands	BR NB												
	Wood frog *Rana sylvatica*	Vernal pools in forest habitat	BR NB												
	Northern leopard frog *Rana pipiens*	Shallow pools of standing water adjacent to wet meadows	N NB												
	Pickerel frog *Rana palustris*	Shallow, clear water of bogs, woodland streams, and lake margins	BR NB												
	Spotted turtle *Clemmys guttata*	Wetland complex with vernal pools, adjacent upland forest, and well-drained opening for nesting	BR NB												
	Wood turtle *Clemmys insculpta*	Forested rivers, streams within 200 m of well-drained sandy or gravelly substrates for nesting	BR NB												
	Eastern box turtle *Terrapene c. carolina*	Old fields, clearings, and ecotones with sandy soils	BR NB												
	Blanding's turtle *Emydoidea blandingii*	Wetland complex with shallow water (<0.5 m); adjacent upland fields or forest for nesting	BR NB												
	Five-lined skink *Eumeces fasciatus*	Steep, rocky, open woods with logs and slash piles	BR NB												
	Northern brown snake *Storeria d. dekayi*		BR NB												
	Northern redbelly snake *Storeria o. occipitomaculata*	Woodland debris—bark and rotting wood	BR NB	■ ■ ■	■ ■ ■	■ ■ ■ ■	■ ■ ■			■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■
	Common garter snake *Thamnophis sirtalis*		BR NB												
	Ribbon snake *Thamnophis sauritus*	Permanent shallow water in open, grassy habitat	BR NB				■ ■ ■ ■								
	Eastern hognose snake *Heterodon platyrhinos*	Sandy soils, open woodlands	BR NB				■ ■ ■						■ ■ ■		

Forest Matrix *(continued)*

LOCAL OCCURRENCE	SPECIES	SPECIAL HABITAT FEATURES	SEASONAL USE	ASPEN–BIRCH		NORTHERN HARDWOOD	SWAMP HARD-WOOD	SPRUCE–FIR			HEMLOCK	OAK–PINE		
				Aspen	*Paper birch*	*Northern hardwoods*	*Red maple*	*Balsam fir*	*Spruce-fir*	*Red spruce*	*Eastern Hemlock*	*Northern red oak*	*Pine-Oak-Maple*	*E. white pine*
				S Sp St L	S Sp St L	S Sp St L U	S Sp St L	S Sp St L	S Sp St L	S Sp St L	S Sp St L	S Sp St L	S Sp St L	S Sp St L
	Northern ringneck snake *Diadophis punctatus edwardsii*	Mesic areas with abundant cover	BR				■ ■ ■							
			NB											
	Eastern worm snake *Carphophis a. amoenus*	Well-drained, loose soils for burrowing or covering	BR										■ ■ ■	
			NB											
	Northern black racer *Coluber c. constrictor*	Upland areas that are periodically cleared or mowed; adjacent forest and wetlands	BR										■ ■ ■ ■	
			NB											
	Eastern smooth green snake *Liochlorophis vernalis*	Upland grassy openings	BR											
			NB											
	Black rat snake *Elaphe o. obsoleta*		BR										■ ■ ■ ■	
			NB											
	Eastern milk snake *Lampropeltis t. triangulum*	Slash, wood piles, debris or loose soils for egg laying	BR											
			NB											
	Northern copperhead *Agkistrodon contortrix mokasen*	Rocky hillsides, talus slopes	BR										■ ■ ■	
			NB											
	Timber rattlesnake *Crotalus horridus*	Rock ledges on forested hillsides	BR											
			NB											
	Great blue heron *Ardea herodias*	Tall dead trees for nesting	BR				■							
			BF											
			WS											
			WF											
	Green heron *Butorides virescens*	Forested wetlands or riparian habitats	BR				■ ■ ■							
			BF											
			WS											
			WF											
	Turkey vulture *Cathartes aura*	Forest clearings and fields; large branch stubs of dead trees for roosting	BR										■	
			BF											
			WS										■ ■	■ ■
			WF											

	Wood duck *Aix sponsa*	Trees >16 in (40.6 cm) dbh with large cavities and 4 in (10.2 cm) diameter entrance holes	BR BF WS WF				■							
	American black duck *Anas rubripes*	Wooded wetlands, streambanks (inland)	BR BF WS WF											
	Common goldeneye *Bucephala clangula*	Cavity trees >20 in (51 cm) dbh; clear, cold, shallow water	BR BF WS WF			■	■	■	■	■				
	Hooded merganser *Lophodytes cucullatus*	Undisturbed wooded areas with cavity trees >25 in (38 cm) dbh; clear, fresh water	BR BF WS WF			■ ■	■ ■	■ ■	■ ■					
	Common merganser *Mergus merganser*	Large cavity trees at water's edge	BR BF WS WF			■ ■	■ ■							
	Bald eagle *Haliaeetus leucocephalus*	Large, undisturbed water bodies containing fish; large, live supracanopy nest trees within 0.25 mile of shore	BR BF WS WF											■ ■
	Sharp-shinned hawk *Accipiter striatus*	Extensive open mixed woodlands	BR BF WS WF			■ ■ ■ ■ ■ ■ ■ ■ ■ ■ ■ ■			■ ■ ■ ■ ■ ■ ■ ■				■ ■ ■ ■ ■ ■ ■ ■	
	Cooper's hawk *Accipiter cooperii*	Mature deciduous or coniferous woodlands; field-forest ecotones	BR BF WS WF									■ ■ ■ ■ ■ ■ ■ ■	■ ■ ■ ■ ■ ■ ■ ■	
	Northern goshawk *Accipiter gentilis*	Extensive mature mixed woodlands	BR BF WS WF		■ ■	■ ■ ■ ■								
	Red-shouldered hawk *Buteo lineatus*	Cool, moist mature forest	BR BF WS WF				■ ■ ■ ■							

Forest Matrix *(continued)*

LOCAL OCCURRENCE	SPECIES	SPECIAL HABITAT FEATURES	SEASONAL USE	ASPEN–BIRCH								NORTHERN HARDWOOD					SWAMP HARDWOOD				SPRUCE–FIR										HEMLOCK				OAK–PINE									
				Aspen				*Paper birch*				*Northern hardwoods*					*Red maple*				*Balsam fir*				*Spruce–fir*				*Red spruce*				*Eastern Hemlock*				*Northern red oak*				*Pine–Oak–Maple*				*E. white pine*			
				S	Sp	St	L	S	Sp	St	L	S	Sp	St	L	U	S	Sp	St	L	S	Sp	St	L	S	Sp	St	L	S	Sp	St	L	S	Sp	St	L	S	Sp	St	L	S	Sp	St	L	S	Sp	St	L
	Broad-winged hawk *Buteo platypterus*	Extensive woodlands with roads or clearings	BR					■	■			■	■				■	■																				■	■						
			BF																																										
			WS																																										
			WF																																										
	Red-tailed hawk *Buteo jamaicensis*	Mature trees for nesting; nonforest openings for foraging	BR																																		■	■						
			BF														■																													
			WS																																										
			WF														■																													
	Golden eagle *Aquila chrysaetos*	Cliffs for nesting; wide expanses of open land	BR																																										
			BF																																										
			WS																																										
			WF																																										
	American kestrel *Falco sparverius*	Cavity trees >12 in (30.5 cm); open flat terrain	BR																																										
			BF																																										
			WS																																										
			WF																																										
	Merlin *Falco columbarius*	Old corvid nests, natural cavities, or old woodpecker holes in open woodlands	BR																					■	■																				
			BF																					■	■																				
			WS																					■	■																				
			WF																					■	■																				
	Peregrine falcon *Falco peregrinus*	High cliffs or tall urban buildings; abundant avian prey	BR																																										
			BF																																										
			WS																																										
			WF																																										
	Ruffed grouse *Bonasa umbellus*	Drumming log sites amid dense saplings; herbaceous cover on old roads, small openings	BR		■																																						
			BF		■																																								
			WS		■	■	■																																					
			WF		■	■	■																																					
	Spruce grouse *Falcipennis canadensis*	Coniferous forest	BR																			■	■	■		■	■	■		■	■	■												
			BF																			■	■	■		■	■	■		■	■	■												
			WS																			■	■	■		■	■	■		■	■	■												
			WF																			■	■	■		■	■	■		■	■	■												

	Wild turkey *Meleagris gallopavo*	Open, mast-producing woodlands; large conifers for roosting; herbaceous cover in woodland clearings, small openings	BR BF WS WF													
	Northern bobwhite *Colinus virginianus*	Brushy field edges; well-drained sandy or loamy soils	BR BF WS WF													
	American woodcock *Scolopax minor*	Fertile, moist soils containing earthworms; small clearings and dense brushy swales	BR BF WS WF													
	Mourning dove *Zenaida macroura*	Open land with bare ground	BR BF WS WF													
	Black-billed cuckoo *Coccyzus erythropthalmus*	Low, dense thickets	BR BF WS WF													
	Yellow-billed cuckoo *Coccyzus americanus*	Low, dense thickets	BR BF WS WF													
	Eastern screech-owl *Otus asio*	Cavity trees >12 in (30.5 cm) dbh	BR BF WS WF													
	Great horned owl *Bubo virginianus*	Large, abandoned hawk nests; large tree cavities	BR BF WS WF													
	Northern hawk-owl *Surnia ulula*	Coniferous forests	BR BF WS WF													
	Barred owl *Strix varia*	Cool, damp lowlands; cavity trees >20 in (50.8 cm) dbh	BR BF WS WF													

Forest Matrix *(continued)*

LOCAL OCCURRENCE	SPECIES	SPECIAL HABITAT FEATURES	SEASONAL USE	ASPEN–BIRCH								NORTHERN HARDWOOD					SWAMP HARDWOOD				SPRUCE–FIR										HEMLOCK				OAK–PINE							
				Aspen				*Paper birch*				*Northern hardwoods*					*Red maple*				*Balsam fir*				*Spruce–fir*				*Red spruce*				*Eastern Hemlock*				*Northern red oak*				*Pine–Oak–Maple*			
				S	Sp	St	L	S	Sp	St	L	S	Sp	St	L	U	S	Sp	St	L	S	Sp	St	L	S	Sp	St	L	S	Sp	St	L	S	Sp	St	L	S	Sp	St	L	S	Sp	St	L
	Great gray owl *Strix nebulosa*	Meadows, swamps near woodlands	BR																																							
			BF																																							
			WS																■																								
			WF														■				■																							
	Long-eared owl *Asio otus*	Dense conifer thickets in open country; coniferous forested wetlands	BR																													■	■							■	■		
			BF																																							
			WS																													■	■							■	■		
			WF																																							
	Boreal owl *Aegolius funereus*	Cavity trees, often with large holes; mixedwood or coniferous forest and coniferous forested wetlands	BR																																							
			BF																																							
			WS																																							
			WF																																							
	Northern saw-whet owl *Aegolius acadicus*	Cavity trees >12 in (30.1 cm) dbh near forest clearings	BR										■	■	■			■	■									■	■			■	■										
			BF									■	■	■	■		■											■	■			■	■										
			WS										■	■	■			■	■									■	■			■	■					■	■			■	■
			WF														■											■	■			■	■										
	Common nighthawk *Chordeiles minor*	Barren areas with rocky substrate; graveled rooftops	BR																																							
			BF																																							
			WS																																							
			WF																																							
	Whip-poor-will *Caprimulgus vociferus*	Ungrazed woodlands with openings, old field edges, abandoned orchards	BR						■				■																										■			■		
			BF						■				■																										■			■		
			WS																																								
			WF																																								
	Ruby-throated hummingbird *Archilochus colubris*	Tubular nectar-bearing flowers, preferably red	BR										■	■	■			■	■																		■	■						
			BF						■				■	■	■			■	■																		■	■						
			WS																																								
			WF																																								
	Red-headed woodpecker *Melanerpes erythrocephalus*	Cavity trees in savanna or open country	BR															■	■																				■	■			
			BF															■	■																				■	■			
			WS															■	■																				■	■			
			WF															■	■																				■	■			

| | | |

Forest Matrix *(continued)*

LOCAL OCCURRENCE	SPECIES	SPECIAL HABITAT FEATURES	SEASONAL USE	ASPEN–BIRCH		NORTHERN HARDWOOD	SWAMP HARD-WOOD	SPRUCE–FIR			HEMLOCK	OAK–PINE		
				Aspen	*Paper birch*	*Northern hardwoods*	*Red maple*	*Balsam fir*	*Spruce–fir*	*Red spruce*	*Eastern Hemlock*	*Northern red oak*	*Pine–Oak–Maple*	*E. white pine*
				S Sp St L	S Sp St L	S Sp St L U	S Sp St L	S Sp St L	S Sp St L	S Sp St L	S Sp St L	S Sp St L	S Sp St L	S Sp St L
	Yellow-bellied flycatcher *Empidonax flaviventris*	Low, wet coniferous forest	BR					■	■	■ ■				
			BF					■	■	■ ■				
			WS											
			WF											
	Acadian flycatcher *Empidonax virescens*	Extensive mature, deciduous woodlands; closed canopy; open understory for foraging	BR											
			BF											
			WS											
			WF											
	Alder flycatcher *Empidonax alnorum*	Dense woody regeneration, low shrubs; thickets and clearings	BR				■							
			BF				■							
			WS											
			WF											
	Willow flycatcher *Empidonax traillii*	Low deciduous trees and shrubs in clearings; thick hardwood regeneration	BR			■								
			BF			■								
			WS											
			WF											
	Least flycatcher *Empidonax minimus*	Open deciduous or mixed forest; forest edges	BR			■ ■ ■ ■	■						■ ■ ■	
			BF			■ ■ ■ ■	■						■ ■ ■	
			WS											
			WF											
	Eastern phoebe *Sayornis phoebe*	Exposed perches, cliffs, or ledges in streamside clearings; buildings or structures in openings for nesting	BR											
			BF											
			WS											
			WF											
	Great crested flycatcher *Myiarchus crinitus*	Mature deciduous forest; cavity trees on forest edges	BR											
			BF											
			WS											
			WF											
	Eastern kingbird *Tyrannus tyrannus*	Clearings, fields, orchards, shrub swamps; perches for aerial foraging	BR											
			BF											
			WS											
			WF											

	Loggerhead shrike *Lanius ludovicianus*	Open country with short grasses, scattered trees, shrubs	BR BF WS WF												
	Northern shrike *Lanius excubitor*	Scattered trees or shrubs in open country	BR BF WS WF												
	White-eyed vireo *Vireo griseus*	Low shrubs, thickets	BR BF WS WF				■ ■								
	Yellow-throated vireo *Vireo flavifrons*	Mature deciduous forest	BR BF WS WF				■ ■ ■ ■							■ ■ ■ ■	
	Blue-headed vireo *Vireo solitarius*	Mixedwood or coniferous forest	BR BF WS WF						■ ■ ■ ■	■ ■ ■ ■	■ ■ ■ ■				■ ■ ■ ■
	Warbling vireo *Vireo gilvus*	Scattered deciduous trees in open areas; often adjacent to water	BR BF WS WF				■ ■ ■ ■								
	Philadelphia vireo *Vireo philadelphicus*	Hardwood forest edges; early successional forests	BR BF WS WF		■ ■										
	Red-eyed vireo *Vireo olivaceus*	Closed deciduous forest canopy	BR BF WS WF			■ ■ ■ ■ ■ ■									
	Gray jay *Perisoreus canadensis*	Coniferous forests	BR BF WS WF						■ ■ ■ ■ ■ ■ ■ ■ ■ ■ ■ ■	■ ■ ■ ■ ■ ■ ■ ■ ■ ■ ■ ■					

Forest Matrix *(continued)*

LOCAL OCCURRENCE	SPECIES	SPECIAL HABITAT FEATURES	SEASONAL USE	ASPEN–BIRCH		NORTHERN HARDWOOD	SWAMP HARD-WOOD	SPRUCE–FIR			HEMLOCK	OAK–PINE		
				Aspen	*Paper birch*	*Northern hardwoods*	*Red maple*	*Balsam fir*	*Spruce–fir*	*Red spruce*	*Eastern Hemlock*	*Northern red oak*	*Pine–Oak–Maple*	*E. white pine*
				S Sp St L	S Sp St L	S Sp St L U	S Sp St L	S Sp St L	S Sp St L	S Sp St L	S Sp St L	S Sp St L	S Sp St L	S Sp St L
	Blue jay *Cyanocitta cristata*		BR	▫ ▫ ▫	■ ▫	■ ▫ ▫	■ ▫ ▫	▫ ▫ ▫	▫ ▫ ▫	▫ ▫ ▫	■ ■ ■	■ ▫	■ ■ ■	▫ ▫ ▫
			BF	▫ ▫ ▫	▫ ▫ ▫	▫ ▫ ▫ ▫	▫ ▫ ▫	▫ ▫ ▫	▫ ▫ ▫	▫ ▫ ▫	▫ ▫ ▫	▫ ▫ ▫	■ ■ ■	▫ ▫ ▫
			WS	▫ ▫ ▫	▫ ▫ ▫	▫ ▫ ▫ ▫	▫ ▫ ▫	▫ ▫ ▫	▫ ▫ ▫	▫ ▫ ▫	▫ ▫ ▫	▫ ▫ ▫	■ ■ ■	▫ ▫ ▫
			WF	▫ ▫ ▫	▫ ▫ ▫	▫ ▫ ▫ ▫	▫ ▫ ▫	▫ ▫ ▫	▫ ▫ ▫	▫ ▫ ▫	▫ ▫ ▫	▫ ▫ ▫	■ ■ ■	▫ ▫ ▫
	American crow *Corvus brachyrhynchos*	Open areas for foraging	BR	▫ ▫	▫ ▫	▫ ▫ ▫	▫ ▫	▫ ▫	▫ ▫	▫ ▫	▫ ▫	▫ ▫	■ ■	■ ■
			BF	▫	▫	▫	▫	▫	▫	▫	▫	▫	▫	▫
			WS	▫ ▫	▫ ▫	▫ ▫ ▫	▫ ▫	▫ ▫	▫ ▫	▫ ▫	▫ ▫	▫ ▫	▫ ▫	▫ ▫
			WF	▫ ▫	▫ ▫	▫ ▫ ▫	▫ ▫	▫ ▫	▫ ▫	▫ ▫	▫ ▫	▫ ▫	▫ ▫	▫ ▫
	Common raven *Corvus corax*	Cliffs, abandoned raptor nests	BR			▫ ▫ ▫		▫ ▫	▫ ▫	▫ ▫		▫ ▫	▫ ▫	▫ ▫
			BF	▫	▫	▫	▫	▫	▫	▫	▫	▫	▫	▫
			WS			▫ ▫ ▫		▫ ▫ ▫	▫ ▫ ▫	▫ ▫ ▫		▫ ▫ ▫	▫ ▫ ▫	▫ ▫ ▫
			WF	▫	▫	▫	▫	▫	▫	▫		▫	▫	▫
	Purple martin *Progne subis*	Martin houses, tree cavities, abandoned woodpecker cavities near ponds, lakes, openings	BR											
			BF	▫	▫	▫	▫	▫	▫	▫	▫	▫	▫	▫
			WS											
			WF											
	Tree swallow *Tachycineta bicolor*	Cavity trees >10 in (25 cm) dbh; old woodpecker cavities; near open areas	BR	▫	▫	▫	▫ ▫ ■ ■	▫	▫	▫	▫	▫	▫	▫
			BF	▫	▫	▫	■	▫	▫	▫	▫	▫	▫	▫
			WS											
			WF											
	Northern rough-winged swallow *Stelgidopteryx serripennis*	Sandy or clay banks; stabilized by grassy overhang near, but up to 1 km from water	BR											
			BF	▫	▫	▫	▫	▫	▫	▫	▫	▫	▫	▫
			WS											
			WF											
	Bank swallow *Riparia riparia*	Stabilized steep banks of sand, gravel, or clay; near open areas, preferably flowing water	BR											
			BF	▫	▫	▫	▫	▫	▫	▫	▫	▫	▫	▫
			WS											
			WF											
	Cliff swallow *Petrochelidon pyrrhonota*	Open areas, water; vertical wall with an overhang; mud for nest construction	BR											
			BF	▫	▫	▫	▫	▫	▫	▫	▫	▫	▫	▫
			WS											
			WF											

	Barn swallow *Hirundo rustica*	Abandoned or little-used buildings for nesting	BR BF WS WF											
	Black-capped chickadee *Poecile atricapillus*	Cavity trees or stubs in small woodlands; clearings or open woodlands	BR BF WS WF			■ ■ ■ ■	■ ■ ■ ■							
	Boreal chickadee *Poecile hudsonicus*	Softwood snags, stubs	BR BF WS WF					■ ■ ■ ■ ■ ■ ■ ■	■ ■ ■ ■ ■ ■ ■ ■	■ ■ ■ ■ ■ ■ ■ ■				
	Tufted titmouse *Baeolophus bicolor*	Hardwood cavity trees >8 in (20 cm) dbh	BR BF WS WF										■ ■ ■ ■ ■ ■ ■ ■	
	Red-breasted nuthatch *Sitta canadensis*	Cavity trees >12 in (31 cm) dbh in mixed or coniferous woods	BR BF WS WF					■ ■ ■ ■ ■ ■ ■ ■	■ ■ ■ ■ ■ ■ ■ ■	■ ■ ■ ■ ■ ■ ■ ■	■ ■ ■ ■ ■ ■ ■ ■			■ ■ ■ ■ ■ ■ ■ ■
	White-breasted nuthatch *Sitta carolinensis*	Cavity trees >12 in (31 cm) dbh in hardwoods and mixedwoods	BR BF WS WF			■ ■ ■ ■ ■ ■ ■ ■ ■ ■ ■ ■							■ ■ ■ ■ ■ ■ ■ ■	
	Brown creeper *Certhia americana*	Woodland trees with sloughing or loose bark	BR BF WS WF											
	Carolina wren *Thryothorus ludovicianus*	Cavity trees amidst brushy vegetation, thickets, swamps	BR BF WS WF				■ ■ ■ ■ ■ ■ ■ ■ ■ ■ ■ ■							
	House wren *Troglodytes aedon*	Cavity trees, shrubs	BR BF WS WF											

Forest Matrix *(continued)*

LOCAL OCCURRENCE	SPECIES	SPECIAL HABITAT FEATURES	SEASONAL USE	ASPEN–BIRCH		NORTHERN HARDWOOD	SWAMP HARD-WOOD	SPRUCE–FIR			HEMLOCK	OAK–PINE		
				Aspen	*Paper birch*	*Northern hardwoods*	*Red maple*	*Balsam fir*	*Spruce-fir*	*Red spruce*	*Eastern Hemlock*	*Northern red oak*	*Pine–Oak–Maple*	*E. white pine*
				S Sp St L	S Sp St L	S Sp St L U	S Sp St L	S Sp St L	S Sp St L	S Sp St L	S Sp St L	S Sp St L	S Sp St L	S Sp St L
	Winter wren *Troglodytes troglodytes*	Moist, mixed or coniferous woodlands with down logs; low woody vegetation	BR				■ ■				■ ■			
			BF				■ ■				■ ■			
			WS											
			WF											
	Golden-crowned kinglet *Regulus satrapa*	Dense conifer thickets or stands, especially spruce	BR						■ ■ ■	■ ■ ■				
			BF						■ ■ ■	■ ■ ■				
			WS											
			WF											
	Ruby-crowned kinglet *Regulus calendula*	Conifer stands, or mixed stands with a predominance of soft-woods, especially spruce or fir	BR					■ ■ ■	■ ■ ■	■ ■ ■				
			BF					■ ■ ■	■ ■ ■	■ ■ ■				
			WS											
			WF											
	Blue-gray gnatcatcher *Polioptila caerulea*	Open, deciduous woodlands	BR				■ ■ ■						■ ■	
			BF				■ ■ ■						■ ■	
			WS											
			WF											
	Eastern bluebird *Sialia sialis*	Low cavity trees or nest boxes; open country	BR			■							■	
			BF			■							■	
			WS											
			WF											
	Veery *Catharus fuscescens*	Moist woodlands with understory of low trees and shrubs	BR			■	■ ■ ■							
			BF			■	■ ■ ■							
			WS											
			WF											
	Bicknell's thrush *Catharus bicknelli*	Stunted coniferous forest at high elevations	BR							■ ■				
			BF							■ ■				
			WS											
			WF											
	Swainson's thrush *Catharus ustulatus*	Coniferous or mixed forest	BR			■		■	■	■				
			BF			■		■	■	■				
			WS											
			WF											

	Hermit thrush *Catharus guttatus*	Coniferous or mixed woodlands with dense undergrowth	BR BF WS WF			■ ■			■■ ■■		■■ ■■		■■ ■■ ■■	■■ ■■
	Wood thrush *Hylocichla mustelina*	Cool, moist, mature deciduous or mixed forest	BR BF WS WF			■■■ ■■■							■■ ■■	
	American robin *Turdus migratorius*		BR BF WS WF											
	Gray catbird *Dumetella carolinensis*	Low, dense shrubby vegetation in open country or forest understory	BR BF WS WF				■ ■						■ ■	
	Northern mockingbird *Mimus polyglottos*	Low thickets; high exposed perches; persistent fruit	BR BF WS WF				■ ■ ■ ■							
	Brown thrasher *Toxostoma rufum*	Hardwood forest-field ecotone	BR BF WS WF										■ ■	
	Bohemian waxwing *Bombycilla garrulus*	Soft mast (fruit, berries)	BR BF WS WF											
	Cedar waxwing *Bombycilla cedrorum*	Soft mast (fruit, berries)	BR BF WS WF		■		■ ■ ■							
	Blue-winged warbler *Vermivora pinus*	Old fields with scattered shrubs and small trees	BR BF WS WF		■ ■								■ ■	

Forest Matrix *(continued)*

LOCAL OCCURRENCE	SPECIES	SPECIAL HABITAT FEATURES	SEASONAL USE	ASPEN–BIRCH		NORTHERN HARDWOOD	SWAMP HARDWOOD	SPRUCE–FIR			HEMLOCK	OAK–PINE		
				Aspen	*Paper birch*	*Northern hardwoods*	*Red maple*	*Balsam fir*	*Spruce–fir*	*Red spruce*	*Eastern Hemlock*	*Northern red oak*	*Pine–Oak–Maple*	*E. white pine*
				S Sp St L	S Sp St L	S Sp St L U	S Sp St L	S Sp St L	S Sp St L	S Sp St L	S Sp St L	S Sp St L	S Sp St L	S Sp St L
	Golden-winged warbler *Vermivora chrysoptera*	Brushy edges; openings with saplings, forbs, or grasses	BR											
			BF											
			WS											
			WF											
	Tennessee warbler *Vermivora peregrina*	Brushy, semi-open country	BR		■	■								
			BF		■	■								
			WS											
			WF											
	Nashville warbler *Vermivora ruficapilla*	Young hardwood/mixedwood stands; dry open mixedwood stands interspersed with brush, thickets	BR	■	■				■					
			BF	■	■				■					
			WS											
			WF											
	Northern parula *Parula americana*	Presence of bearded lichen (*Usnea*)	BR			■ ■ ■			■ ■ ■	■ ■ ■				
			BF			■ ■ ■			■ ■ ■	■ ■ ■				
			WS											
			WF											
	Yellow warbler *Dendroica petechia*	Small scattered trees or dense shrubs; commonly near water	BR				■	■						
			BF				■	■						
			WS											
			WF											
	Chestnut-sided warbler *Dendroica pensylvanica*	Early-successional deciduous stands; dense hardwood regeneration 3 to 10 ft (1 to 3 m) tall	BR	■	■	■	■							
			BF	■	■	■	■							
			WS											
			WF											
	Magnolia warbler *Dendroica magnolia*	Young stands of spruce or fir, sometimes of hemlock	BR					■	■ ■	■ ■				
			BF					■	■ ■	■ ■				
			WS											
			WF											
	Cape May warbler *Dendroica tigrina*	Spruce–fir forests	BR					■	■	■				
			BF					■	■	■				
			WS											
			WF											

	Black-throated blue warbler *Dendroica caerulescens*	Hardwood/mixedwood stands with well-developed understory; often in with mountain laurel	BR BF WS WF			■ ■ ■ ■ ■ ■									
	Yellow-rumped warbler *Dendroica coronata*	Coniferous trees (summer); bayberry thickets (winter)	BR BF WS WF						■ ■ ■ ■						
	Black-throated green warbler *Dendroica virens*	Mixedwood/coniferous stands	BR BF WS WF			■ ■ ■ ■ ■ ■						■ ■ ■ ■			
	Blackburnian warbler *Dendroica fusca*	Coniferous/mixedwood stands	BR BF WS WF					■ ■ ■ ■	■ ■ ■ ■	■ ■ ■ ■		■ ■ ■ ■			
	Pine warbler *Dendroica pinus*	Pine stands	BR BF WS WF											■ ■	
	Prairie warbler *Dendroica discolor*	Hardwood saplings, especially gray birch; in dry old fields; burns	BR BF WS WF		■ ■								■ ■		
	Palm warbler *Dendroica palmarum*	Young, open coniferous stands, bogs; thick shrub growth	BR BF WS WF												
	Bay-breasted warbler *Dendroica castanea*	Dense coniferous stands, especially of spruce and fir	BR BF WS WF					■ ■ ■ ■	■ ■ ■ ■	■ ■ ■ ■					
	Blackpoll warbler *Dendroica striata*	Stunted spruce, especially at higher elevations	BR BF WS WF						■ ■ ■ ■	■ ■ ■ ■					
	Cerulean warbler *Dendroica cerulea*	Tall deciduous trees; often near water	BR BF WS WF									■ ■ ■ ■	■ ■		

Forest Matrix *(continued)*

LOCAL OCCURRENCE	SPECIES	SPECIAL HABITAT FEATURES	SEASONAL USE	ASPEN–BIRCH		NORTHERN HARDWOOD	SWAMP HARD-WOOD	SPRUCE–FIR			HEMLOCK	OAK–PINE		
				Aspen	*Paper birch*	*Northern hardwoods*	*Red maple*	*Balsam fir*	*Spruce–fir*	*Red spruce*	*Eastern Hemlock*	*Northern red oak*	*Pine–Oak–Maple*	*E. white pine*
				S Sp St L	S Sp St L	S Sp St L U	S Sp St L	S Sp St L	S Sp St L	S Sp St L	S Sp St L	S Sp St L	S Sp St L	S Sp St L
	Black-and-white warbler *Mniotilta varia*	Deciduous/mixedwood stands	BR			■ ■							■	
			BF			■ ■							■	
			WS											
			WF											
	American redstart *Setophaga ruticilla*	Open deciduous/mixedwood stands with a dense shrub/mid-story	BR			■	■							
			BF			■	■							
			WS											
			WF											
	Worm-eating warbler *Helmitheros vermivorus*	Well-developed understory	BR										■ ■	
			BF										■ ■	
			WS											
			WF											
	Ovenbird *Seiurus aurocapillus*	Open, mature mesic or dry forest	BR			■ ■ ■						■ ■ ■	■ ■	
			BF			■ ■ ■						■ ■ ■	■ ■	
			WS											
			WF											
	Northern waterthrush *Seiurus noveboracensis*	Cool, shaded, wet ground with shallow pools	BR				■ ■							
			BF				■ ■							
			WS											
			WF											
	Louisiana waterthrush *Seiurus motacilla*	Woodlands with flowing water	BR				■ ■							
			BF				■ ■							
			WS											
			WF											
	Mourning warbler *Oporornis philadelphia*	Large openings of hardwood regeneration; dense shrubs	BR	■	■	■	■							
			BF	■	■	■	■							
			WS											
			WF											
	Common yellowthroat *Geothlypis trichas*	Dense hardwood regeneration, shrub layer	BR			■	■ ■						■ ■	
			BF			■	■ ■						■ ■	
			WS											
			WF											

	Hooded warbler *Wilsonia citrina*	Dense understory	BR BF WS WF				■ ■								
	Wilson's warbler *Wilsonia pusilla*	Cold shrub swamps, bogs; thickets	BR BF WS WF												
	Canada warbler *Wilsonia canadensis*	Dense deciduous/ericaceous understory; especially along streams, bogs	BR BF WS WF				■ ■ ■ ■ ■ ■ ■ ■						■ ■ ■ ■		
	Yellow-breasted chat *Icteria virens*	Dense thickets and vines with scattered young trees, often near water	BR BF WS WF												
	Scarlet tanager *Piranga olivacea*	Hardwood/mixedwood forest canopy	BR BF WS WF			■ ■ ■ ■ ■ ■								■ ■ ■ ■ ■ ■	
	Eastern towhee *Pipilo erythrophthalmus*	Dense, brushy understory; well-drained soils	BR BF WS WF										■ ■ ■ ■	■ ■ ■ ■ ■ ■	■ ■
	American tree sparrow *Spizella arborea*	Open country; brushy cover; weedy fields (winter)	BR BF WS WF												
	Chipping sparrow *Spizella passerina*	Clearings with bare ground; coniferous or thorny shrubs	BR BF WS WF											■ ■	■ ■
	Field sparrow *Spizella pusilla*	Old fields	BR BF WS WF												
	Fox sparrow *Passerella iliaca*	Dense herbaceous vegetation; field-forest ecotones	BR BF WS WF											■ ■	

Forest Matrix *(continued)*

LOCAL OCCURRENCE	SPECIES	SPECIAL HABITAT FEATURES	SEASONAL USE	ASPEN–BIRCH		NORTHERN HARDWOOD	SWAMP HARD-WOOD	SPRUCE–FIR			HEMLOCK	OAK–PINE		
				Aspen	*Paper birch*	*Northern hardwoods*	*Red maple*	*Balsam fir*	*Spruce-fir*	*Red spruce*	*Eastern Hemlock*	*Northern red oak*	*Pine–Oak–Maple*	*E. white pine*
				S Sp St L	S Sp St L	S Sp St L U	S Sp St L	S Sp St L	S Sp St L	S Sp St L	S Sp St L	S Sp St L	S Sp St L	S Sp St L
	Song sparrow *Melospiza melodia*	Brushy cover, hardwood regeneration; conspicuous song perches	BR BF WS WF				■ ■ ■ ■							
	Lincoln's sparrow *Melospiza lincolnii*	Brushy thickets along field edges or drainways; wet grassy or sedge meadows	BR BF WS WF											
	Swamp sparrow *Melospiza georgiana*	Brushy wetlands with emergent vegetation	BR BF WS WF											
	White-throated sparrow *Zonotrichia albicollis*		BR BF WS WF											
	Dark-eyed junco *Junco hyemalis*	Woods roads, cut banks; uprooted trees	BR BF WS WF					■ ■	■ ■	■ ■				
	Northern cardinal *Cardinalis cardinalis*	Thickets, vines	BR BF WS WF				■ ■ ■ ■							
	Rose-breasted grosbeak *Pheucticus ludovicianus*	Forest edges, dense hardwood thickets and sapling stands; brushy fields	BR BF WS WF			■ ■						■ ■	■ ■	
	Indigo bunting *Passerina cyanea*	Scattered, tall trees in grassy openings; forest-field ecotones	BR BF WS WF											

	Red-winged blackbird *Agelaius phoeniceus*	Emergent vegetation adjacent to open fields	BR BF WS WF				■ ■								
	Rusty blackbird *Euphagus carolinus*	Northern forested wetlands; alder swales	BR BF WS WF				■ ■ ■ ■	■ ■ ■ ■	■ ■ ■ ■	■ ■ ■ ■					
	Common grackle *Quiscalus quiscula*	Wet, open country, shrub swamps, pond edges	BR BF WS WF				■ ■ ■ ■							■ ■ ■ ■	■ ■ ■ ■
	Brown-headed cowbird *Molothrus ater*	Open grassy habitat	BR BF WS WF	■ ■ ■ ■	■ ■ ■ ■	■ ■ ■ ■	■ ■ ■ ■	■ ■ ■ ■	■ ■ ■ ■	■ ■ ■ ■	■ ■ ■ ■	■ ■ ■ ■	■ ■ ■ ■	■ ■ ■ ■	■ ■ ■ ■
	Orchard oriole *Icterus spurius*	Open country with scattered deciduous trees	BR BF WS WF				■ ■ ■ ■							■ ■ ■ ■	
	Baltimore oriole *Icterus galbula*	Tall, scattered deciduous trees (preferably elm)	BR BF WS WF	■ ■ ■ ■		■ ■ ■ ■	■ ■ ■ ■					■ ■ ■ ■	■ ■ ■ ■	■ ■ ■ ■	
	Pine grosbeak *Pinicola enucleator*	Northern conifer forest	BR BF WS WF					■ ■ ■ ■	■ ■ ■ ■	■ ■ ■ ■				■ ■ ■ ■	■ ■ ■ ■
	Purple finch *Carpodacus purpureus*	Coniferous trees	BR BF WS WF	■ ■ ■ ■	■ ■ ■ ■	■ ■ ■ ■	■ ■ ■ ■	■ ■ ■ ■	■ ■ ■ ■	■ ■ ■ ■	■ ■ ■ ■	■ ■ ■ ■	■ ■ ■ ■	■ ■ ■ ■	■ ■ ■ ■
	House finch *Carpodacus mexicanus*	Open ground with low seed-producing plants	BR BF WS WF											■ ■ ■ ■	
	Red crossbill *Loxia curvirostra*	Northern conifer forest	BR BF WS WF						■ ■ ■ ■	■ ■ ■ ■	■ ■ ■ ■				

Forest Matrix *(continued)*

LOCAL OCCURRENCE	SPECIES	SPECIAL HABITAT FEATURES	SEASONAL USE	ASPEN–BIRCH								NORTHERN HARDWOOD					SWAMP HARDWOOD				SPRUCE–FIR												HEMLOCK				OAK–PINE							
				Aspen				*Paper birch*				*Northern hardwoods*					*Red maple*				*Balsam fir*				*Spruce–fir*				*Red spruce*				*Eastern Hemlock*				*Northern red oak*				*Pine–Oak–Maple*				*E. white pine*			
				S	Sp	St	L	S	Sp	St	L	S	Sp	St	L	U	S	Sp	St	L	S	Sp	St	L	S	Sp	St	L	S	Sp	St	L	S	Sp	St	L	S	Sp	St	L	S	Sp	St	L	S	Sp	St	L
	White-winged crossbill *Loxia leucoptera*	Northern conifer forest	BR																						■	■			■	■																
			BF																						■	■			■	■																
			WS																						■	■			■	■																
			WF																						■	■			■	■																
	Common redpoll *Carduelis flammea*	Open country (winter)	BR																																										
			BF																																									
			WS					■																																				
			WF					■																																				
	Hoary redpoll *Carduelis hornemanni*	Open country (winter)	BR																																									
			BF																																									
			WS					■									■																												
			WF					■				■					■																												
	Pine siskin *Carduelis pinus*	Coniferous trees	BR																		■	■	■		■	■	■		■	■	■														
			BF																		■	■	■		■	■	■		■	■	■														
			WS																																									
			WF																																									
	American goldfinch *Carduelis tristis*	Open, weedy fields and marshes with scattered small trees	BR														■																												
			BF														■																												
			WS															■	■	■																										
			WF															■	■	■																										
	Evening grosbeak *Coccothraustes vespertinus*	Spruce and fir forest (breeding season)	BR																										■	■	■														
			BF																										■	■	■														
			WS																																									
			WF																																									
	Virginia opossum *Didelphis virginiana*	Hollow log or tree cavity	BR															■	■																										
			BF														■	■	■	■																										
			WS															■	■																										
			WF														■	■	■	■																										
	Masked shrew *Sorex cinereus*	Damp woodlands, ground cover	BR																																									
			BF																																									
			WS																																									
			WF																																									

	Water shrew *Sorex palustris*	Herbaceous cover, cold-water wetlands	BR BF WS WF												
	Smoky shrew *Sorex fumeus*	Loose, damp leaf litter	BR BF WS WF			■ ■ ■ ■									
	Long-tailed shrew *Sorex dispar*	Rocky, wooded sites	BR BF WS WF												
	Pygmy shrew *Sorex hoyi*	Moist leaf mold near water	BR BF WS WF												
	Northern short-tailed shrew *Blarina brevicauda*	Low vegetation, damp, loose leaf litter	BR BF WS WF												
	Least shrew *Cryptotis parva*	Loose soil	BR BF WS WF												
	Hairy-tailed mole *Parascalops breweri*	Loose, moist, well-drained soil	BR BF WS WF												
	Eastern mole *Scalopus aquaticus*	Soft, moist soils containing earthworms	BR BF WS WF												
	Star-nosed mole *Condylura cristata*	Wet muck, humus	BR BF WS WF												
	Little brown myotis *Myotis lucifugus*	Females: dark, warm sites for maternity colonies. Forest openings for feeding	BR BF WS WF												

Forest Matrix *(continued)*

LOCAL OCCURRENCE	SPECIES	SPECIAL HABITAT FEATURES	SEASONAL USE	ASPEN–BIRCH		NORTHERN HARDWOOD	SWAMP HARD-WOOD	SPRUCE–FIR			HEMLOCK	OAK–PINE		
				Aspen	*Paper birch*	*Northern hardwoods*	*Red maple*	*Balsam fir*	*Spruce–fir*	*Red spruce*	*Eastern Hemlock*	*Northern red oak*	*Pine–Oak–Maple*	*E. white pine*
				S Sp St L	S Sp St L	S Sp St L U	S Sp St L	S Sp St L	S Sp St L	S Sp St L	S Sp St L	S Sp St L	S Sp St L	S Sp St L
	Northern long-eared bat *Myotis septentrionalis*	Large cavity trees for roosting. Caves, mine shafts for hibernation near 40°F (2 to 7°C); high humidity and calm air	BR BF WS WF											
	Indiana myotis *Myotis sodalis*	Tree cavities and loose bark for roosting. Cool, stable temperatures in caves (hibernacula)	BR BF WS WF				■ ■ ■							
	Eastern small-footed myotis *Myotis leibii*	Caves and mine shafts for hibernacula	BR BF WS WF											
	Silver-haired bat *Lasionycteris noctivagans*	Dead trees with loose bark or cavities; wetlands nearby for foraging	BR BF WS WF											
	Eastern pipistrelle *Pipistrellus subflavus*	Warm, draft-free, damp hibernacula; open woods for foraging	BR BF WS WF											
	Big brown bat *Eptesicus fuscus*	Cold, dry caves or buildings for hibernacula	BR BF WS WF											
	Red bat *Lasiurus borealis*	Deciduous trees on forest edges for roosting	BR BF WS WF											
	Hoary bat *Lasiurus cinereus*	Roosts in coniferous and deciduous foliage	BR BF WS WF											

	Eastern cottontail *Sylvilagus floridanus*	Brush piles, stone walls, dens, or burrows; herbaceous and shrubby cover	BR BF WS WF	■ ■	■ ■	■ ■								
	New England cottontail *Sylvilagus transitionalis*	Closely spaced patches of young, dense woody cover	BR BF WS WF	■ ■	■ ■	■ ■	■ ■							
	Snowshoe hare *Lepus americanus*	Dense brushy or softwood cover	BR BF WS WF	■ ■	■ ■	■ ■	■ ■	■ ■	■ ■	■ ■	■ ■		■ ■	■ ■
	European hare *Lepus europaeus*	Fields, meadows	BR BF WS WF											
	Eastern chipmunk *Tamias striatus*	Tree or shrub cover; elevated perches, decaying stumps/logs, stone walls	BR BF WS WF											
	Woodchuck *Marmota monax*	Open land with well-drained soils in which to burrow	BR BF WS WF											
	Gray squirrel *Sciurus carolinensis*	Mast-producing trees; tall trees for dens and leaf nests	BR BF WS WF									■■ ■■ ■■ ■■	■■ ■■ ■■ ■■	
	Red squirrel *Tamiasciurus hudsonicus*	Woodlands with mature trees; conifers preferred	BR BF WS WF					■■ ■■ ■■ ■■	■■ ■■ ■■ ■■	■■ ■■ ■■ ■■	■■ ■■ ■■ ■■			■■ ■■ ■■ ■■
	Southern flying squirrel *Glaucomys volans*	Mature woodland with cavity trees; edges of old fields with redcedar trees	BR BF WS WF			■■■ ■■■ ■■■ ■■■						■■ ■■ ■■ ■■	■■ ■■ ■■ ■■	
	Northern flying squirrel *Glaucomys sabrinus*	Mature trees, cavities for winter dens; aboreal lichens	BR BF WS WF			■■■ ■■■ ■■■ ■■■		■■ ■■ ■■ ■■	■■ ■■ ■■ ■■	■■ ■■ ■■ ■■			■■ ■■ ■■ ■■	

Forest Matrix *(continued)*

LOCAL OCCURRENCE	SPECIES	SPECIAL HABITAT FEATURES	SEASONAL USE	ASPEN–BIRCH		NORTHERN HARDWOOD	SWAMP HARDWOOD	SPRUCE–FIR			HEMLOCK	OAK–PINE		
				Aspen	*Paper birch*	*Northern hardwoods*	*Red maple*	*Balsam fir*	*Spruce–fir*	*Red spruce*	*Eastern Hemlock*	*Northern red oak*	*Pine–Oak–Maple*	*E. white pine*
				S Sp St L	S Sp St L	S Sp St L U	S Sp St L	S Sp St L	S Sp St L	S Sp St L	S Sp St L	S Sp St L	S Sp St L	S Sp St L
	Beaver *Castor canadensis*	Low-gradient woodland streams with adjacent young hardwoods	BR											
			BF	■ ■ ■ ■	■ ■ ■ ■		■ ■ ■ ■							
			WS											
			WF	■ ■ ■ ■	■ ■ ■ ■		■ ■ ■ ■							
	Deer mouse *Peromyscus maniculatus*	Down logs, rotting stumps	BR					■ ■ ■ ■	■ ■ ■ ■	■ ■ ■ ■	■ ■ ■ ■			■ ■ ■ ■
			BF					■ ■ ■ ■	■ ■ ■ ■	■ ■ ■ ■	■ ■ ■ ■			■ ■ ■ ■
			WS					■ ■ ■ ■	■ ■ ■ ■	■ ■ ■ ■	■ ■ ■ ■			■ ■ ■ ■
			WF					■ ■ ■ ■	■ ■ ■ ■	■ ■ ■ ■	■ ■ ■ ■			■ ■ ■ ■
	White-footed mouse *Peromyscus leucopus*	Down logs, rotting stumps, cavities	BR			■ ■ ■ ■ ■						■ ■ ■ ■	■ ■ ■ ■	
			BF			■ ■ ■ ■ ■						■ ■ ■ ■	■ ■ ■ ■	
			WS			■ ■ ■ ■ ■						■ ■ ■ ■	■ ■ ■ ■	
			WF			■ ■ ■ ■ ■						■ ■ ■ ■	■ ■ ■ ■	
	Southern red-backed vole *Clethrionomys gapperi*	Springs, brooks, seeps, bogs; debris or slash cover	BR			■ ■		■ ■	■ ■	■ ■	■ ■		■ ■	■ ■
			BF			■ ■		■ ■	■ ■	■ ■	■ ■		■ ■	■ ■
			WS			■ ■		■ ■	■ ■	■ ■	■ ■		■ ■	■ ■
			WF			■ ■		■ ■	■ ■	■ ■	■ ■		■ ■	■ ■
	Meadow vole *Microtus pennsylvanicus*	Herbaceous vegetation; loose soils	BR											
			BF											
			WS											
			WF											
	Rock vole *Microtus chrotorrhinus*	Cool moist, rocky woodlands with herbaceous ground cover and flowing water	BR											
			BF											
			WS											
			WF											
	Woodland vole *Microtus pinetorum*	Moist, well-drained soils; variable depths of leaf litter or grass cover	BR											
			BF											
			WS											
			WF											
	Southern bog lemming *Synaptomys cooperi*	Moist soils; grass-sedge ground cover	BR											
			BF											
			WS											
			WF											

	Northern bog lemming *Synaptomys borealis*	Moist to wet loose soils; decaying leaf litter or herbaceous ground cover	BR BF WS WF												
	Meadow jumping mouse *Zapus hudsonius*	Open wooded stands; herbaceous ground cover; loose soils. Hibernates in winter	BR BF WS WF												
	Woodland jumping mouse *Napaeozapus insignis*	Moist, cool woodlands; loose soils, herbaceous ground cover. Hibernates in winter	BR BF WS WF												
	Porcupine *Erethizon dorsatum*	Rock ledges or den trees	BR BF WS WF												
	Coyote *Canis latrans*	Well-drained, secluded den sites	BR BF WS WF												
	Gray wolf *Canis lupus*	Seclusion; abundant prey base. Potential habitat in north	BR BF WS WF												
	Red fox *Vulpes vulpes*	Well-drained den sites. Tends to hunt more open or semi-open habitats	BR BF WS WF												
	Gray fox *Urocyon cinereoargenteus*	Hollow logs, tree cavities, rock crevices. Tends to hunt forest edges	BR BF WS WF												
	Black bear *Ursus americanus*	Dens in any semiprotected areas (fallen trees, talus slopes, slash piles); seeps and wet areas in early spring; mast	BR BF WS WF												
	Raccoon *Procyon lotor*	Hollow trees, dens usually >10 ft (3 m) above ground	BR BF WS WF												

Forest Matrix *(continued)*

LOCAL OCCURRENCE	SPECIES	SPECIAL HABITAT FEATURES	SEASONAL USE	ASPEN–BIRCH				NORTHERN HARDWOOD					SWAMP HARDWOOD				SPRUCE–FIR												HEMLOCK				OAK–PINE							
				Aspen				*Paper birch*				*Northern hardwoods*					*Red maple*				*Balsam fir*				*Spruce-fir*				*Red spruce*				*Eastern Hemlock*				*Northern red oak*				*Pine-Oak-Maple*				*E. white pine*			
				S	Sp	St	L	S	Sp	St	L	S	Sp	St	L	U	S	Sp	St	L	S	Sp	St	L	S	Sp	St	L	S	Sp	St	L	S	Sp	St	L	S	Sp	St	L	S	Sp	St	L
	American marten *Martes americana*	Hollow trees, coarse woody debris	BR																		■	■	■		■	■	■		■	■	■		■	■	■									
			BF																		■	■	■		■	■	■		■	■	■		■	■	■									
			WS																		■	■	■		■	■	■		■	■	■		■	■	■									
			WF																		■	■	■		■	■	■		■	■	■		■	■	■									
	Fisher *Martes pennanti*	Hollow trees, logs; dense regenerating softwoods	BR										■	■																													
			BF									■	■	■	■																													
			WS											■	■																													
			WF									■	■	■	■																													
	Ermine *Mustela erminea*	Dense, brushy cover, slash. Areas of abundant prey	BR																																							
			BF																																							
			WS																																							
			WF																																							
	Long-tailed weasel *Mustela frenata*	Areas of abundant prey. Previously excavated den sites. Wooded edges	BR																																							
			BF																																							
			WS																																							
			WF																																							
	Mink *Mustela vison*	Hollow logs, natural cavities, under tree roots. Forest-wetland edges	BR														■	■	■	■																							
			BF														■	■	■	■																							
			WS														■	■	■	■																							
			WF														■	■	■	■																							
	Striped skunk *Mephitis mephitis*	Well-drained soils for burrows/den sites. Open uplands; around human habitation	BR																																							
			BF																																							
			WS																																							
			WF																																							
	River otter *Lontra canadensis*	Water (e.g., stream, pond, lake, or river); bank dens	BR																																							
			BF																																							
			WS																																							
			WF																																							
	Mountain lion *Puma concolor*	Seclusion; abundant prey base (e.g., deer)	BR																																							
			BF																																							
			WS																																							
			WF																																							

	Lynx *Lynx canadensis*	Abundant prey base (e.g., snowshoe hare). Dense softwood regeneration; secluded den sites	BR													
			BF	■	■	■	■	■	■	■						
			WS				■	■	■	■						
			WF	■	■	■	■	■	■	■						
	Bobcat *Lynx rufus*	Dense, woody understory; rock ledges and talus; successional habitats with abundant prey base (e.g., lagomorphs)	BR													
			BF													
			WS													
			WF					■	■	■	■					
	White-tailed deer *Odocoileus virginianus*	Softwood yarding cover in north; adequate winter browse; summer herbaceous forage and mast	BR													
			BF	■	■	■		■	■							
			WS					■ ■	■ ■	■ ■	■ ■		■ ■			
			WF	■										■ ■	■ ■	
	Moose *Alces alces*	Wetlands (summer)	BR													
			BF	■	■	■	■ ■	■	■							
			WS				■ ■									
			WF	■	■	■	■ ■	■	■	■						

Appendix B: Species Occurrence and Utilization, by Nonforested Habitat

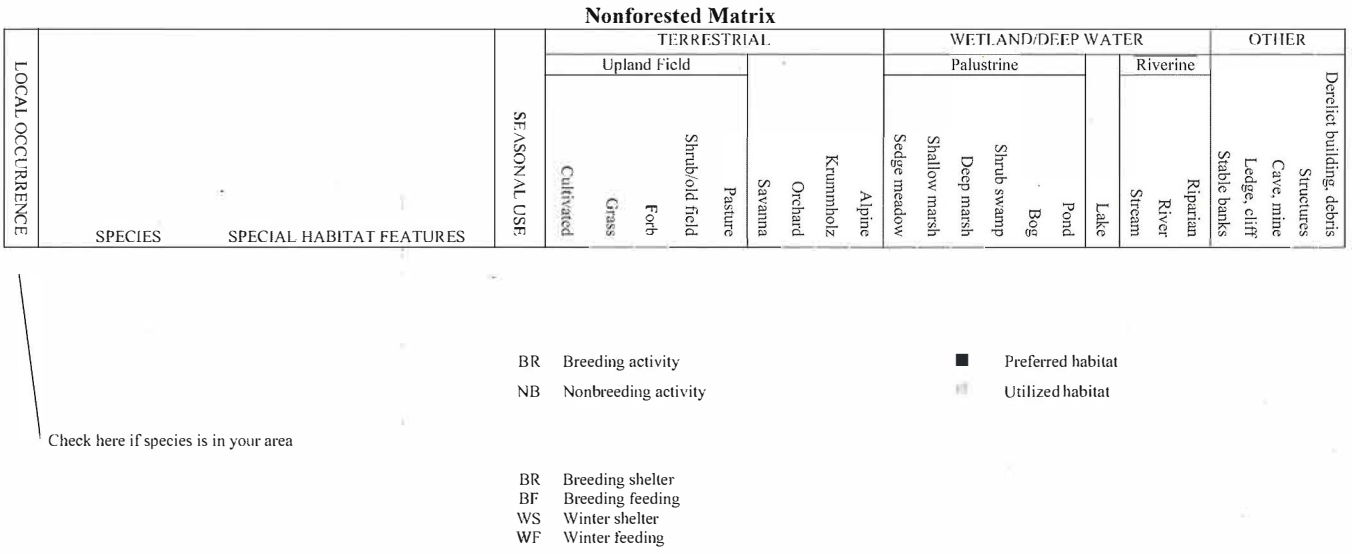


Fig. 59b. The key to elements in the species matrices.

Nonforested Matrix

LOCAL OCCURRENCE	SPECIES	SPECIAL HABITAT FEATURES	SEASONAL USE	TERRESTRIAL												WETLAND/DEEPWATER												OTHER					
				Upland Field												Palustrine													Riverine					
				Cultivated	Grass	Forb	Shrub/old field	Pasture	Savanna	Orchard	Krummholz	Alpine	Sedge meadow	Shallow marsh	Deep marsh	Shrub swamp	Bog	Pond	Lake	Stream	River	Riparian	Stable banks	Ledge, cliff	Cave, mine	Structures	Derelict building, debris
	Common mudpuppy *Necturus maculosus*	Flowing water >1m deep, hiding cover for breeding	BR NB																■ ■	■ ■	■ ■					
	Marbled salamander *Ambystoma opacum*	Temporary (autumnal) pools or swamps in upland woods for breeding	BR NB													▪ ▪					▪ ▪					
	Jefferson salamander *Ambystoma jeffersonianum*	Vernal pools or semipermanent water adjacent to upland habitat for breeding	BR NB										▪	▪	▪	▪	▪	■			▪					
	Blue-spotted salamander *Ambystoma laterale*	Vernal pools or semipermanent water for breeding; adjacent to upland habitat	BR NB										■	■	▪	■	▪	■			▪					
	Spotted salamander *Ambystoma maculatum*	Mesic woods, vernal pools, or semipermanent water for breeding	BR NB										▪	▪	▪	▪	▪	■			▪					
	Red-spotted newt *Notophthalmus v. viridescens*	Water bodies with aquatic vegetation for adult newts; juveniles (efts) are terrestrial	BR NB										▪	▪	■	▪	▪	■	■	▪						
	Northern dusky salamander *Desmognathus fuscus*	Permanent forested seeps, springs, headwater streams	BR NB															▪		■ ▪		■ ▪				
	Northern redback salamander *Plethodon cinereus*	Logs, stumps, rocks, etc	BR NB																							
	Northern slimy salamander *Plethodon glutinosus*	Rock outcroppings, logs in wooded areas	BR NB																				▪ ▪	▪ ▪		▪ ▪
	Four-toed salamander *Hemidactylium scutatum*	Wet woodlands containing sphagnum moss	BR NB										▪	▪		▪	■ ■			▪						
	Northern spring salamander *Gyrinophilus p. porphyriticus*	Woodland headwater streams; high-gradient seeps or springs	BR NB																	■ ■		▪ ▪				
	Northern two-lined salamander *Eurycea bislineata*	Well-shaded streams for breeding	BR NB																	■ ■		■ ■				

| | | |

Nonforested Matrix *(continued)*

LOCAL OCCURRENCE	SPECIES	SPECIAL HABITAT FEATURES	SEASONAL USE	TERRESTRIAL										WETLAND/DEEPWATER											OTHER				
				Upland Field						Savanna	Orchard	Krummholz	Alpine	Palustrine						Lake	Riverine			Stable banks	Ledge, cliff	Cave, mine	Structures	Derelict building, debris
				Cultivated	Grass	Forb	Shrub/old field	Pasture						Sedge meadow	Shallow marsh	Deep marsh	Shrub swamp	Bog	Pond		Stream	River	Riparian					
	Northern red-bellied cooter *Pseudemys rubriventris bangsi*	Muddy-bottom shallows with thick aquatic vegetation; near open uplands for nesting	BR																■	■								
			NB																■	■								
	Painted turtle *Chrysemys picta*	Wetlands with basking sites (floating logs); areas of open water (15 m^2 minimum)	BR																									
			NB												■	■			■									
	Blanding's turtle *Emydoidea blandingii*	Wetland complex with shallow water (<0.5 m); adjacent upland fields or forest for nesting	BR	■	■																		■					
			NB																									
	Common musk turtle *Sternotherus odoratus*	Permanent water bodies 0.3 to 3.0 m deep within 15 m of well-drained areas for nesting	BR																									
			NB																■	■								
	Eastern spiny softshell *Apalone s. spinifera*	Shallow water with muddy bottoms for burrowing; aquatic vegetation	BR																	■		■	■	■				
			NB																	■		■						
	Five-lined skink *Eumeces fasciatus*	Steep, rocky, open woods with logs and slash piles	BR																									■
			NB																									■
	Northern water snake *Nerodia s. sipedon*	Branches, logs overhanging water, or boulders of dams and causeways in reservoirs	BR																									
			NB																									
	Northern brown snake *Storeria d. dekayi*		BR																									■
			NB																									■
	Northern redbelly snake *Storeria o. occipitomaculata*	Woodland debris--bark and rotting wood	BR																									■
			NB																									■
	Common garter snake *Thamnophis sirtalis*		BR																									
			NB																									
	Ribbon snake *Thamnophis sauritus*	Permanent shallow water in open, grassy habitat	BR											■							■		■					
			NB																		■		■					
	Eastern hognose snake *Heterodon platyrhinos*	Sandy soils, open woodlands	BR					■																				
			NB																									
	Northern ringneck snake *Diadophis punctatus edwardsii*	Mesic areas with abundant cover	BR																									■
			NB																									■
	Eastern worm snake *Carphophis a. amoenus*	Well-drained, loose soils for burrowing or covering	BR																									
			NB																									

	Northern black racer *Coluber c. constrictor*	Upland areas that are periodically cleared or mowed; adjacent forest and wetlands	BR NB	■						■ ■
	Eastern smooth green snake *Liochlorophis vernalis*	Upland grassy openings	BR NB	■		■				
	Black rat snake *Elaphe o. obsoleta*		BR NB		■ ■					■
	Eastern milk snake *Lampropeltis t. triangulum*	Slash, wood piles, debris, or loose soils for egg laying	BR NB							■ ■ ■ ■
	Northern copperhead *Agkistrodon contortrix mokasen*	Rocky hillsides, talus slopes	BR NB							■ ■
	Timber rattlesnake *Crotalus horridus*	Rock ledges on forested hillsides	BR NB							■ ■
	Common loon *Gavia immer*	Large, undisturbed water bodies with stable water levels and islands	BR BF WS WF					■ ■		
	Pied-billed grebe *Podilymbus podiceps*	Marshes with emergent vegetation >5 ha (12.5 acres)	BR BF WS WF			■ ■ ■ ■ ■ ■				
	Double-crested cormorant *Phalacrocorax auritus*	Undisturbed nesting sites	BR BF WS WF							
	American bittern *Botaurus lentiginosus*	Undisturbed tall marsh vegetation	BR BF WS WF			■ ■				
	Least bittern *Ixobrychus exilis*	Deep marshes with clumps of emergent vegetation	BR BF WS WF			■ ■				
	Great blue heron *Ardea herodias*	Tall dead trees for nesting	BR BF WS WF			■ ■				
	Great egret *Ardea alba*	Fresh and saltwater marshes, shallow open water	BR BF WS WF							

Nonforested Matrix *(continued)*

LOCAL OCCURRENCE	SPECIES	SPECIAL HABITAT FEATURES	SEASONAL USE	TERRESTRIAL												WETLAND/DEEPWATER															OTHER				
				Upland Field												Palustrine															Riverine				
				Cultivated	Grass	Forb	Shrub/old field	Pasture	Savanna	Orchard	Krummholz	Alpine				Sedge meadow	Shallow marsh	Deep marsh	Shrub swamp	Bog	Pond		Lake							Riparian	River	Stream	Stable banks	Ledge, cliff	Cave, mine	Structures	Derelict building, debris
	Snowy egret *Egretta thula*	Wetlands, especially coastal marshes	BR BF WS WF														▫			▫														
	Little blue heron *Egretta caerulea*	Tidal or freshwater wetland habitat	BR BF WS WF														▫		▫	▫			▫							▫	▫				
	Cattle egret *Bubulcus ibis*	Wetlands for nesting; upland openings for feeding	BR BF WS WF		▫			▫																										
	Green heron *Butorides virescens*	Forested wetlands or riparian habitats	BR BF WS WF													▫	■	▫	▫		▫	▫							▫	▫	▫				
	Black-crowned night-heron *Nycticorax nycticorax*	Riparian forest	BR BF WS WF														▫		■		▫													
	Yellow-crowned night-heron *Nyctanassa violacea*	Riparian forest	BR BF WS WF														▫	▫	■															
	Glossy ibis *Plegadis falcinellus*	Wetlands	BR BF WS WF													▫	▫		■															
	Turkey vulture *Cathartes aura*	Forest clearings and fields; large branch stubs of dead trees for roosting	BR BF WS WF		■			■	▫																									

	Canada goose *Branta canadensis*	Open water; herbaceous ground cover. Elevated nest sites	BR BF WS WF							
	Mute swan *Cygnus olor*	Shallow ponds, rivers with abundant aquatic vegetation	BR BF WS WF							
	Wood duck *Aix sponsa*	Trees >16 in (40.6 cm) dbh with large cavities and 4 in (10.2 cm) diameter entrance holes	BR BF WS WF							
	Gadwall *Anas strepera*	Moderate to large bodies of water with submerged aquatic plants	BR BF WS WF							
	American wigeon *Anas americana*		BR BF WS WF							
	American black duck *Anas rubripes*	Wooded wetlands, streambanks (inland)	BR BF WS WF							
	Mallard *Anas platyrhynchos*		BR BF WS WF							
	Blue-winged teal *Anas discors*		BR BF WS WF							
	Northern shoveler *Anas clypeata*	Shallow water with muddy bottoms, surrounded by dry grassy areas	BR BF WS WF							
	Northern pintail *Anas acuta*	Drakes need mudbanks or exposed shorelines	BR BF WS WF							

Nonforested Matrix *(continued)*

LOCAL OCCURRENCE	SPECIES	SPECIAL HABITAT FEATURES	SEASONAL USE	TERRESTRIAL												WETLAND/DEEPWATER												OTHER				
				Upland Field												Palustrine												Lake	Riverine			Stable banks	Ledge, cliff	Cave, mine	Structures	Derelict building, debris
				Cultivated	Grass	Forb	Shrub/old field	Pasture	Savanna	Orchard	Krummholz	Alpine				Sedge meadow	Shallow marsh	Deep marsh	Shrub swamp	Bog	Pond								Stream	River	Riparian				
	Green-winged teal *Anas crecca*	Shallow marshes	BR														■																	
			BF														■																	
			WS																														
			WF																														
	Canvasback *Aythya valisineria*	Stretches of open water and emergent vegetation	BR																														
			BF																														
			WS																														
			WF																														
	Ring-necked duck *Aythya collaris*	Expanses of open water	BR																									■					
			BF																									■					
			WS																														
			WF																														
	Bufflehead *Bucephala albeola*	Winters on coastal bays and on open water inland	BR																														
			BF																														
			WS																														
			WF																														
	Common goldeneye *Bucephala clangula*	Cavity trees >20 in (51 cm) dbh; clear, cold, shallow water	BR																														
			BF																														
			WS																									■					
			WF																									■					
	Hooded merganser *Lophodytes cucullatus*	Undisturbed wooded areas with cavity trees >25 in (38 cm) dbh; clear, fresh water	BR																									■					
			BF																									■					
			WS																														
			WF																														
	Common merganser *Mergus merganser*	Large cavity trees at water's edge	BR																									■			■		
			BF																									■			■		
			WS																														
			WF																														
	Red-breasted merganser *Mergus serrator*	Clear water for feeding	BR																									■					
			BF																									■					
			WS																														
			WF																														

	Osprey *Pandion haliaetus*	Clear lakes, rivers containing fish; supracanopy or exposed nest sites	BR BF WS WF				■		
	Bald eagle *Haliaeetus leucocephalus*	Large, undisturbed water bodies containing fish; large, live supracanopy nest trees within 0.25 mile of shore	BR BF WS WF				■ ■		
	Northern harrier *Circus cyaneus*	Marshes or open country with low vegetation	BR BF WS WF			■ ■			
	Sharp-shinned hawk *Accipiter striatus*	Extensive open mixed woodlands	BR BF WS WF						
	Cooper's hawk *Accipiter cooperii*	Mature deciduous or coniferous woodlands; field-forest ecotones	BR BF WS WF						
	Northern goshawk *Accipiter gentilis*	Extensive mature mixed woodlands	BR BF WS WF						
	Red-shouldered hawk *Buteo lineatus*	Cool, moist mature forest	BR BF WS WF			■		■ ■ ■ ■	
	Broad-winged hawk *Buteo platypterus*	Extensive woodlands with roads or clearings	BR BF WS WF	■ ■					
	Red-tailed hawk *Buteo jamaicensis*	Mature trees for nesting; nonforest openings for foraging	BR BF WS WF	■ ■ ■ ■					
	Rough-legged hawk *Buteo lagopus*	Open country	BR BF WS WF	■ ■					

Nonforested Matrix *(continued)*

LOCAL OCCURRENCE	SPECIES	SPECIAL HABITAT FEATURES	SEASONAL USE	TERRESTRIAL										WETLAND/DEEPWATER												OTHER				
				Upland Field						Savanna	Orchard	Krummholz	Alpine	Palustrine								Lake	Riverine			Stable banks	Ledge, cliff	Cave, mine	Structures	Derelict building, debris
				Cultivated	Grass	Forb	Shrub/old field	Pasture						Sedge meadow	Shallow marsh	Deep marsh	Shrub swamp	Bog	Pond			Stream	River	Riparian					
	Golden eagle *Aquila chrysaetos*	Cliffs for nesting; wide expanses of open land	BR																								■			
			BF											▪	▪												▪			
			WS																											
			WF																			▪								
	American kestrel *Falco sparverius*	Cavity trees >12 in (30.5 cm); open flat terrain	BR					■																						
			BF	▪	■			▪		▪	▪			▪	▪															
			WS		■			▪		▪	▪																			
			WF	■	■			▪		▪	▪																			
	Merlin *Falco columbarius*	Old corvid nests, natural cavities, or old woodpecker holes in open woodlands	BR															▪											
			BF															▪											
			WS																											
			WF																											
	Peregrine falcon *Falco peregrinus*	High cliffs or tall urban buildings; abundant avian prey	BR																								■			
			BF								▪	▪	▪	▪	▪	▪	▪	▪	▪	▪				▪						
			WS																											
			WF	▪	▪	▪	▪	▪		▪				▪	▪	▪	▪	▪					▪	▪						
	Gray partridge *Perdix perdix*	Grasslands, grain crops	BR		■			▪																						
			BF	▪	■			▪																						
			WS		■			▪																						
			WF	▪	■			▪																						
	Ring-necked pheasant *Phasianus colchicus*	Cultivated fields, farmland	BR	▪	■	▪	▪	▪		▪	▪																			
			BF	▪	■	▪	▪	▪		▪	▪																			
			WS	▪	▪	▪	■	▪		▪	▪																			
			WF	▪	▪	▪	■	▪		▪	▪																			
	Ruffed grouse *Bonasa umbellus*	Drumming log sites amid dense saplings; herbaceous cover on old roads, small openings	BR																											
			BF				▪				▪																			
			WS																											
			WF				▪				▪																			
	Spruce grouse *Falcipennis canadensis*	Coniferous forest	BR									▪						▪												
			BF									▪						▪												
			WS									▪						▪												
			WF									▪						▪												

	Wild turkey *Meleagris gallopavo*	Open, mast-producing woodlands; large conifers for roosting; herbaceous cover in woodland clearings, small openings	BR BF WS WF							
	Northern bobwhite *Colinus virginianus*	Brushy field edges; well-drained sandy or loamy soils	BR BF WS WF	■ ■ ■ ■						
	King rail *Rallus elegans*	Thick marsh vegetation, stable water levels	BR BF WS WF			■ ■				
	Virginia rail *Rallus limicola*	Wetlands with sedges and cattails	BR BF WS WF			■ ■				
	Sora *Porzana carolina*	Emergent vegetation	BR BF WS WF			■ ■				
	Common moorhen *Gallinula chloropus*	Emergent vegetation in water 1 to 3 ft (0.3 to 1 m) deep	BR BF WS WF			■ ■				
	American coot *Fulica americana*	Emergent vegetation in water 1 to 4 ft (0.3 to 1.2 m) deep	BR BF WS WF			■ ■				
	Killdeer *Charadrius vociferus*	Bare ground, sparse ground vegetation in fairly open areas	BR BF WS WF	■ ■						
	Willet *Catoptrophorus semipalmatus*	Fresh and saltwater marshes, ponds	BR BF WS WF							
	Spotted sandpiper *Actitis macularia*	Margins of freshwater bodies	BR BF WS WF						■ ■	

Nonforested Matrix *(continued)*

LOCAL OCCURRENCE	SPECIES	SPECIAL HABITAT FEATURES	SEASONAL USE	TERRESTRIAL														WETLAND/DEEPWATER																		OTHER					
				Upland Field														Palustrine																		Riverine					
				Cultivated	Grass	Forb	Shrub/old field	Pasture	Savanna	Orchard	Krummholz	Alpine	Sedge meadow	Shallow marsh	Deep marsh	Shrub swamp	Bog	Pond	Lake	Riparian	River	Stream	Stable banks	Ledge, cliff	Cave, mine	Structures	Derelict building, debris													
	Upland sandpiper	Large, open grasslands	BR	▪	▪			■																															
	Bartramia longicauda		BF	▪	▪			■																															
			WS																																				
			WF																																					
	Common snipe	Moist, organic soils; large, open spaces, low; scattered vegetation; bogs, swamps	BR										▪	▪		■	▪			▪																			
	Gallinago gallinago		BF										▪	▪		■	▪			▪																			
			WS				▪						▪	▪		■	▪			▪																			
			WF				▪						▪	▪		■	▪			▪																			
	American woodcock	Fertile, moist soils containing earthworms; small clearings and dense swales	BR			▪	▪						▪				▪	▪		▪																			
	Scolopax minor		BF	▪		▪	■						▪				▪	▪		▪																			
			WS																																				
			WF																																					
	Ring-billed gull	Plowed fields, extensive mown grass (e.g., golf courses)	BR																																				
	Larus delawarensis		BF																																				
			WS																▪		▪	▪																		
			WF		▪			▪					▪						▪		▪	▪																		
	Herring gull		BR																▪																				
	Larus argentatus		BF																▪		▪																		
			WS																▪		▪																		
			WF																▪		▪																		
	Great black-backed gull		BR																																				
	Larus marinus		BF																																				
			WS																																				
			WF																▪		▪																		
	Common tern	Gravelly, sandy beaches; grassy uplands along marine shore	BR																▪																			
	Sterna hirundo		BF																▪																			
			WS																																			
			WF																																			
	Black tern	Aquatic habitats with extensive stands of emergent vegetation and areas of shallow, open water	BR											■	■				▪																			
	Chlidonias niger		BF											■	■				▪																			
			WS																																			
			WF																																			

	Rock dove *Columba livia*		BR BF WS WF	■							■ ■ ■ ■
	Mourning dove *Zenaida macroura*	Open land with bare ground	BR BF WS WF	■							
	Black-billed cuckoo *Coccyzus erythropthalmus*	Low, dense thickets	BR BF WS WF								
	Yellow-billed cuckoo *Coccyzus americanus*	Low, dense thickets	BR BF WS WF								
	Barn owl *Tyto alba*	Barns, silos, abandoned buildings, tree cavities	BR BF WS WF	■							■ ■
	Eastern screech-owl *Otus asio*	Cavity trees >12 in (30.5 cm) dbh	BR BF WS WF					■			■ ■ ■
	Great horned owl *Bubo virginianus*	Large, abandoned hawk nests; large tree cavities	BR BF WS WF								
	Snowy owl *Nyctea scandiaca*	Open country	BR BF WS WF	■ ■							
	Northern hawk-owl *Surnia ulula*	Coniferous forests	BR BF WS WF								
	Barred owl *Strix varia*	Cool, damp lowlands; cavity trees >20 in (50.8 cm) dbh	BR BF WS WF					■			■ ■

Nonforested Matrix *(continued)*

LOCAL OCCURRENCE	SPECIES	SPECIAL HABITAT FEATURES	SEASONAL USE	TERRESTRIAL										WETLAND/DEEPWATER												OTHER					
				Upland Field										Palustrine											Riverine						
				Cultivated	*Grass*	*Forb*	*Shrub/old field*	*Pasture*	*Savanna*	*Orchard*	*Krummholz*	*Alpine*		*Sedge meadow*	*Shallow marsh*	*Deep marsh*	*Shrub swamp*	*Bog*	*Pond*		*Lake*		*Stream*	*River*	*Riparian*		*Stable banks*	*Ledge, cliff*	*Cave, mine*	*Structures*	*Derelict building, debris*	
	Great gray owl *Strix nebulosa*	Meadows, swamps near woodlands	BR BF WS WF	▪	▪	▪	▪	▪									▪	■													
	Long-eared owl *Asio otus*	Dense conifer thickets in open country; coniferous forested wetlands	BR BF WS WF		▪	▪	▪	▪	▪	▪				▪	▪																
	Short-eared owl *Asio flammeus*	Extensive open grasslands, dunes	BR BF WS WF	▪	▪			▪						▪	▪																
	Boreal owl *Aegolius funereus*	Cavity trees, often with large holes; mixedwood or coniferous forest and coniferous forested wetlands	BR BF WS WF															■ ■													
	Northern saw-whet owl *Aegolius acadicus*	Cavity trees >12 in (30.1 cm) dbh near forest clearings	BR BF WS WF					▪	▪	▪														▪							
	Common nighthawk *Chordeiles minor*	Barren areas with rocky substrate; graveled rooftops	BR BF WS WF	▪	▪	▪	▪	▪	▪	▪				▪										▪		▪			▪		
	Whip-poor-will *Caprimulgus vociferus*	Ungrazed woodlands with openings, old field edges, abandoned orchards	BR BF WS WF		▪	▪	▪	▪	▪	▪																				
	Chimney swift *Chaetura pelagica*	Chimneys; large, hollow dead trees in openings and wetlands	BR BF WS WF	▪	▪	▪	▪	▪	▪	▪				▪															■	■	

	Ruby-throated hummingbird *Archilochus colubris*	Tubular nectar-bearing flowers, preferably red	BR BF WS WF								
	Belted kingfisher *Ceryle alcyon*	Perches over streams, ponds; banks for nest sites	BR BF WS WF								■
	Red-headed woodpecker *Melanerpes erythrocephalus*	Cavity trees in savanna or open country	BR BF WS WF								
	Red-bellied woodpecker *Melanerpes carolinus*	Extensive mature woodlands with dead trees or trees with large, dead limbs	BR BF WS WF						■ ■ ■ ■		
	Yellow-bellied sapsucker *Sphyrapicus varius*	Trees >10 in (26 cm) dbh; particularly aspens containing decayed wood	BR BF WS WF		 ■ ■						
	Downy woodpecker *Picoides pubescens*	Decay columns in trees >6 in (15 cm) dbh or larger limbs	BR BF WS WF						■ ■ ■ ■		
	Hairy woodpecker *Picoides villosus*	Decayed wood column in trees >10 in (25 cm) dbh or larger limbs	BR BF WS WF						■ ■ ■ ■		
	Three-toed woodpecker *Picoides tridactylus*	Spruce and fir trees >12 in (31 cm) dbh with column of decayed wood; dead trees with loose bark	BR BF WS WF								
	Black-backed woodpecker *Picoides arcticus*	Spruce and fir trees >10 in (25 cm) dbh with column of decayed wood; dead trees with loose bark	BR BF WS WF								
	Northern flicker *Colaptes auratus*	Open areas, forest edges; trees >12 in (31 cm) dbh with column of decayed wood	BR BF WS WF	 ■ ■							

Nonforested Matrix *(continued)*

LOCAL OCCURRENCE	SPECIES	SPECIAL HABITAT FEATURES	SEASONAL USE	TERRESTRIAL												WETLAND/DEEPWATER														OTHER					
				Upland Field												Palustrine														Riverine					
				Cultivated	Grass	Forb	Shrub/old field	Pasture	Savanna	Orchard	Krummholz	Alpine	Sedge meadow	Shallow marsh	Deep marsh	Shrub swamp	Bog	Pond	Lake	Stream	River	Riparian	Stable banks	Ledge, cliff	Cave, mine	Structures	Derelict building, debris
	Pileated woodpecker *Dryocopus pileatus*	Mature forest; trees >20 in (51 cm) dbh with column of decayed wood	BR BF WS WF																		■ ■ ■ ■					
	Olive-sided flycatcher *Contopus cooperi*	Tall perch adjacent to low, wet coniferous thicket, bog	BR BF WS WF													■ ■										
	Eastern wood-pewee *Contopus virens*	Forest edge or open woods	BR BF WS WF																		■ ■					
	Yellow-bellied flycatcher *Empidonax flaviventris*	Low, wet coniferous forest	BR BF WS WF													■ ■										
	Acadian flycatcher *Empidonax virescens*	Extensive mature, deciduous woodlands; closed canopy; open understory for foraging	BR BF WS WF																							
	Alder flycatcher *Empidonax alnorum*	Dense woody regeneration, low shrubs; thickets and clearings	BR BF WS WF													■ ■					■ ■					
	Willow flycatcher *Empidonax traillii*	Low deciduous trees and shrubs in clearings; thick hardwood regeneration	BR BF WS WF				■ ■																			
	Least flycatcher *Empidonax minimus*	Open deciduous or mixed forest; forest edges	BR BF WS WF																							

	Eastern phoebe *Sayornis phoebe*	Exposed perches, cliffs, or ledges in streamside clearings; buildings or structures in openings for nesting	BR BF WS WF							■ ■
	Great crested flycatcher *Myiarchus crinitus*	Mature deciduous forest; cavity trees on forest edges	BR BF WS WF							
	Eastern kingbird *Tyrannus tyrannus*	Clearings, fields, orchards, shrub swamps; perches for aerial foraging	BR BF WS WF		■ ■					
	Loggerhead shrike *Lanius ludovicianus*	Open country with short grasses, scattered trees, shrubs	BR BF WS WF		■ ■					
	Northern shrike *Lanius excubitor*	Scattered trees or shrubs in open country	BR BF WS WF	■ ■	■ ■					
	White-eyed vireo *Vireo griseus*	Low shrubs, thickets	BR BF WS WF				■ ■			
	Yellow-throated vireo *Vireo flavifrons*	Mature deciduous forest	BR BF WS WF							
	Warbling vireo *Vireo gilvus*	Scattered deciduous trees in open areas; often adjacent to water	BR BF WS WF						■ ■	
	Philadelphia vireo *Vireo philadelphicus*	Hardwood forest edges; early successional forests	BR BF WS WF							
	Red-eyed vireo *Vireo olivaceus*	Closed deciduous forest canopy	BR BF WS WF							

Nonforested Matrix *(continued)*

LOCAL OCCURRENCE	SPECIES	SPECIAL HABITAT FEATURES	SEASONAL USE	TERRESTRIAL										WETLAND/DEEPWATER												OTHER				
				Upland Field										Palustrine										Lake	Riverine					
				Cultivated	*Grass*	*Forb*	*Shrub/old field*	*Pasture*	*Savanna*	*Orchard*	*Krummholz*	*Alpine*		*Sedge meadow*	*Shallow marsh*	*Deep marsh*	*Shrub swamp*	*Bog*	*Pond*					*Stream*	*River*	*Riparian*	*Stable banks*	*Ledge, cliff*	*Cave, mine*	*Structures*	*Derelict building, debris*
	Gray jay *Perisoreus canadensis*	Coniferous forests	BR								▫																			
			BF								▫																			
			WS								▫																			
			WF								▫																			
	Blue jay *Cyanocitta cristata*		BR						▫	▫														▫					
			BF						▫	▫														▫					
			WS							▫														▫					
			WF							▫														▫					
	American crow *Corvus brachyrhynchos*	Open areas for foraging	BR																											
			BF	■	▫	▫	▫	▫	▫	▫																				
			WS																											
			WF	■	▫	▫		▫	▫	▫																				
	Fish crow *Corvus ossifragus*		BR												▫	▫			▫		▫			▫	▫	▫				
			BF												▫	▫			▫		▫			▫	▫	▫				
			WS																					▫	▫	▫				
			WF																					▫	▫	▫				
	Common raven *Corvus corax*	Cliffs, abandoned raptor nests	BR																								■			
			BF								▫																			
			WS																											
			WF															▫					■							
	Horned lark *Eremophila alpestris*	Bare, exposed soil	BR	▫	■			▫																						
			BF	▫	■			▫																						
			WS	■	▫			▫																						
			WF	■	▫			▫																						
	Purple martin *Progne subis*	Martin houses, tree cavities, abandoned woodpecker cavities near ponds, lakes, openings	BR																										▫	
			BF	▫	▫	▫	▫	▫	▫	▫				▫	▫	▫			▫		▫			▫	▫	▫				
			WS																											
			WF																											
	Tree swallow *Tachycineta bicolor*	Cavity trees >10 in (25 cm) dbh; old woodpecker cavities; near open areas	BR														▫	▫							▫					
			BF	▫	▫	▫	▫	▫	▫	▫				▫	■	▫	▫	▫	▫		▫			▫	▫	▫				
			WS																											
			WF																											

	Northern rough-winged swallow *Stelgidopteryx serripennis*	Sandy or clay banks; stabilized by grassy overhang near, but up to 1 km from water	BR BF WS WF	■	■						
	Bank swallow *Riparia riparia*	Stabilized steep banks of sand, gravel, or clay; near open areas, preferably flowing water	BR BF WS WF	■							
	Cliff swallow *Petrochelidon pyrrhonota*	Open areas, water; vertical wall with an overhang; mud for nest construction	BR BF WS WF		■						
	Barn swallow *Hirundo rustica*	Abandoned or little-used buildings for nesting	BR BF WS WF		■						
	Black-capped chickadee *Poecile atricapillus*	Cavity trees or stubs in small woodlands; clearings or open woodlands	BR BF WS WF								
	Boreal chickadee *Poecile hudsonicus*	Softwood snags, stubs	BR BF WS WF								
	Tufted titmouse *Baeolophus bicolor*	Cavity trees >8 in (20 cm) dbh	BR BF WS WF								
	Red-breasted nuthatch *Sitta canadensis*	Cavity trees >12 in (31 cm) dbh in mixed or coniferous woods	BR BF WS WF								
	White-breasted nuthatch *Sitta carolinensis*	Cavity trees >12 in (31 cm) dbh in hardwoods and mixedwoods	BR BF WS WF				■				
	Brown creeper *Certhia americana*	Woodland trees with sloughing or loose bark	BR BF WS WF								

Nonforested Matrix *(continued)*

LOCAL OCCURRENCE	SPECIES	SPECIAL HABITAT FEATURES	SEASONAL USE	TERRESTRIAL										WETLAND/DEEPWATER												OTHER				
				Upland Field										Palustrine										Lake	Riverine					
				Cultivated	*Grass*	*Forb*	*Shrub/old field*	*Pasture*	*Savanna*	*Orchard*	*Krummholz*	*Alpine*		*Sedge meadow*	*Shallow marsh*	*Deep marsh*	*Shrub swamp*	*Bog*	*Pond*					*Stream*	*River*	*Riparian*	*Stable banks*	*Ledge, cliff*	*Cave, mine*	*Structures*	*Derelict building, debris*
	Carolina wren *Thryothorus ludovicianus*	Cavity trees amidst brushy vegetation, thickets, swamps	BR BF WS WF				▪ ▪																	▪ ▪ ▪ ▪				▪	
	House wren *Troglodytes aedon*	Cavity trees, shrubs	BR BF WS WF				▪ ▪		▪ ▪															▪ ▪				▪	■
	Winter wren *Troglodytes troglodytes*	Moist, mixed or coniferous woodlands with down logs; low woody vegetation	BR BF WS WF													▪ ▪								▪ ▪					
	Sedge wren *Cistothorus platensis*	Sedge meadows or drier edges of marshes	BR BF WS WF											■ ■															
	Marsh wren *Cistothorus palustris*	Marshes	BR BF WS WF												▪ ▪	▪ ▪														
	Golden-crowned kinglet *Regulus satrapa*	Dense conifer thickets or stands, especially spruce	BR BF WS WF								▪ ▪																			
	Ruby-crowned kinglet *Regulus calendula*	Conifer stands, or mixed stands with a predominance of softwoods, especially spruce or fir	BR BF WS WF								▪ ▪							▪ ▪												
	Blue-gray gnatcatcher *Polioptila caerulea*	Open, deciduous woodlands	BR BF WS WF				▪ ▪		▪ ▪								▪ ▪													

	Eastern bluebird *Sialia sialis*	Low cavity trees or nest boxes; open country	BR BF WS WF		■ ■				■ ■	
	Veery *Catharus fuscescens*	Moist woodlands with understory of low trees and shrubs	BR BF WS WF							
	Bicknell's thrush *Catharus bicknelli*	Stunted coniferous forest at high elevations	BR BF WS WF		■ ■					
	Swainson's thrush *Catharus ustulatus*	Coniferous or mixed forest	BR BF WS WF							
	Hermit thrush *Catharus guttatus*	Coniferous or mixed woodlands with dense undergrowth	BR BF WS WF							
	Wood thrush *Hylocichla mustelina*	Cool, moist mature deciduous or mixed forest	BR BF WS WF							
	American robin *Turdus migratorius*		BR BF WS WF	■						
	Gray catbird *Dumetella carolinensis*	Low, dense shrubby vegetation in open country or forest understory	BR BF WS WF						■ ■	
	Northern mockingbird *Mimus polyglottos*	Low thickets; high exposed perches; persistent fruit	BR BF WS WF		■					
	Brown thrasher *Toxostoma rufum*	Hardwood forest-field ecotone	BR BF WS WF		■ ■					

Nonforested Matrix *(continued)*

LOCAL OCCURRENCE	SPECIES	SPECIAL HABITAT FEATURES	SEASONAL USE	TERRESTRIAL: Upland Field: Cultivated	Grass	Forb	Shrub/old field	Pasture	Savanna	Orchard	Krummholz	Alpine	WETLAND/DEEPWATER: Palustrine: Sedge meadow	Shallow marsh	Deep marsh	Shrub swamp	Bog	Pond	Lake	Riverine: Stream	River	Riparian	OTHER: Stable banks	Ledge, cliff	Cave, mine	Structures	Derelict building, debris
	European starling *Sturnus vulgaris*	Cavity trees >10 in (25 cm) dbh; avoids extensive forests	BR																								■
			BF																								■
			WS																								
			WF	■																							
	American pipit *Anthus rubescens*	Alpine or arctic tundra; rocky, hummocky terrain	BR									■															
			BF									■															
			WS																								
			WF																								
	Bohemian waxwing *Bombycilla garrulus*	Soft mast (fruit, berries)	BR																								
			BF																								
			WS																								
			WF																								
	Cedar waxwing *Bombycilla cedrorum*	Soft mast (fruit, berries)	BR																								
			BF																								
			WS																								
			WF																								
	Blue-winged warbler *Vermivora pinus*	Old fields with scattered shrubs and small trees	BR				■																				
			BF				■																				
			WS																								
			WF																								
	Golden-winged warbler *Vermivora chrysoptera*	Brushy edges; openings with saplings, forbs, or grasses	BR				■																				
			BF				■																				
			WS																								
			WF																								
	Tennessee warbler *Vermivora peregrina*	Brushy, semi-open country	BR																								
			BF																								
			WS																								
			WF																								
	Nashville warbler *Vermivora ruficapilla*	Young hardwood/mixedwood stands; open mixedwood stands interspersed with brush, thickets	BR																								
			BF																								
			WS																								
			WF																								

	Nashville warbler *Vermivora ruficapilla*	Young hardwood/mixedwood stands; open mixedwood stands interspersed with brush, thickets	BR BF WS WF							
	Northern parula *Parula americana*	Presence of bearded lichen (*Usnea*)	BR BF WS WF							
	Yellow warbler *Dendroica petechia*	Small scattered trees or dense shrubs; commonly near water	BR BF WS WF						■ ■	
	Chestnut-sided warbler *Dendroica pensylvanica*	Early-successional deciduous stands; dense hardwood regeneration 3 to 10 ft (1 to 3 m) tall	BR BF WS WF							
	Yellow-rumped warbler *Dendroica coronata*	Coniferous trees (summer); bayberry thickets (winter)	BR BF WS WF							
	Prairie warbler *Dendroica discolor*	Hardwood saplings, especially gray birch, in dry old fields	BR BF WS WF	■ ■						
	Palm warbler *Dendroica palmarum*	Young, open coniferous stands, bogs; thick shrub growth	BR BF WS WF				■ ■			
	Bay-breasted warbler *Dendroica castanea*	Dense coniferous stands, especially of spruce and fir	BR BF WS WF							
	Blackpoll warbler *Dendroica striata*	Stunted spruce, especially at higher elevations	BR BF WS WF		■ ■					
	Cerulean warbler *Dendroica cerulea*	Tall deciduous trees; often near water	BR BF WS WF						■ ■	

Nonforested Matrix *(continued)*

LOCAL OCCURRENCE	SPECIES	SPECIAL HABITAT FEATURES	SEASONAL USE	TERRESTRIAL														WETLAND/DEEPWATER															OTHER					
				Upland Field										Alpine	Krummholz	Orchard	Savanna	Palustrine										Lake	Riverine				Derelict building, debris	Structures	Cave, mine	Ledge, cliff	Stable banks	
				Cultivated	Grass	Forb	Shrub/old field	Pasture										Pond	Bog	Shrub swamp	Deep marsh	Shallow marsh	Sedge meadow					Riparian	River	Stream									
	Black-and-white warbler *Mniotilta varia*	Deciduous/mixedwood stands	BR													▪	▪		▪									▪										
			BF													▪	▪		▪									▪										
			WS																																		
			WF																																		
	American redstart *Setophaga ruticilla*	Open deciduous/mixedwood stands with a dense shrub/mid-story	BR					▪								▪	▪											▪										
			BF					▪								▪	▪											▪										
			WS																																		
			WF																																		
	Northern waterthrush *Seiurus noveboracensis*	Cool, shaded, wet ground with shallow pools	BR																▪	▪	▪																
			BF																▪	▪	▪																
			WS																																		
			WF																																		
	Louisiana waterthrush *Seiurus motacilla*	Woodlands with flowing water	BR																▪									▪		■							
			BF																▪									▪		■							
			WS																																		
			WF																																		
	Mourning warbler *Oporornis philadelphia*	Larger openings of hardwood regeneration; dense shrubs	BR					▪												▪	▪																
			BF					▪												▪	▪																
			WS																																		
			WF																																		
	Common yellowthroat *Geothlypis trichas*	Dense hardwood regeneration, shrub layer	BR					▪	■									▪	▪	■	▪	▪	▪					■									
			BF					▪	■									▪	▪	■	▪	▪	▪					■									
			WS																																		
			WF																																		
	Hooded warbler *Wilsonia citrina*	Dense understory	BR					▪												▪																	
			BF					▪												▪																	
			WS																																		
			WF																																		
	Wilson's warbler *Wilsonia pusilla*	Cold shrub swamps, bogs; thickets	BR																■	▪								▪									
			BF																■	▪								▪									
			WS																																		
			WF																																		

	Canada warbler *Wilsonia canadensis*	Dense deciduous/ericaceous understory; especially along streams, bogs	BR BF WS WF							
	Yellow-breasted chat *Icteria virens*	Dense thickets and vines with scattered young trees, often near water	BR BF WS WF	■ ■				■ ■		
	Eastern towhee *Pipilo erythrophthalmus*	Dense, brushy understory; well-drained soils	BR BF WS WF							
	American tree sparrow *Spizella arborea*	Open country; brushy cover; weedy fields (winter)	BR BF WS WF							
	Chipping sparrow *Spizella passerina*	Clearings with bare ground; coniferous or thorny shrubs	BR BF WS WF		■ ■					
	Field sparrow *Spizella pusilla*	Old fields	BR BF WS WF	■ ■						
	Vesper sparrow *Pooecetes gramineus*	Open country with short, herbaceous vegetation; conspicuous perches	BR BF WS WF	■ ■						
	Savannah sparrow *Passerculus sandwichensis*	Open country with herbaceous cover of moderate height	BR BF WS WF	■ ■ ■ ■						
	Grasshopper sparrow *Ammodramus savannarum*	Larger openings; continuous, tall herbaceous cover; conspicuous perches	BR BF WS WF	■ ■						
	Fox sparrow *Passerella iliaca*	Dense herbaceous vegetation; field-forest ecotones	BR BF WS WF	■ ■						

Nonforested Matrix *(continued)*

LOCAL OCCURRENCE	SPECIES	SPECIAL HABITAT FEATURES	SEASONAL USE	TERRESTRIAL										WETLAND/DEEPWATER											OTHER				
				Upland Field						Savanna	Orchard	Krummholz	Alpine	Palustrine						Lake	Riverine			Stable banks	Ledge, cliff	Cave, mine	Structures	Derelict building, debris
				Cultivated	Grass	Forb	Shrub/old field	Pasture						Sedge meadow	Shallow marsh	Deep marsh	Shrub swamp	Bog	Pond		Stream	River	Riparian					
	Song sparrow *Melospiza melodia*	Brushy cover, hardwood regeneration; conspicuous song perches	BR		■		■										■					■					
			BF		■		■										■					■					
			WS		■		■																				
			WF		■		■																				
	Lincoln's sparrow *Melospiza lincolnii*	Brushy thickets along field edges or drainways; wet grassy or sedge meadows	BR															■								
			BF															■								
			WS																							
			WF																							
	Swamp sparrow *Melospiza georgiana*	Brushy wetlands with emergent vegetation	BR														■									
			BF														■									
			WS																							
			WF																							
	White-throated sparrow *Zonotrichia albicollis*		BR									■														
			BF									■														
			WS				■																			
			WF				■																			
	Dark-eyed junco *Junco hyemalis*	Woods roads, cut banks; uprooted trees	BR									■														
			BF									■														
			WS																							
			WF																							
	Lapland longspur *Calcarius lapponicus*	Open areas with sparse vegetation (winter)	BR																							
			BF																							
			WS	■																						
			WF	■																						
	Snow bunting *Plectrophenax nivalis*	Open areas with sparse vegetation (winter)	BR																							
			BF																							
			WS	■																						
			WF	■																						
	Northern cardinal *Cardinalis cardinalis*	Thickets, vines	BR																							
			BF																							
			WS																							
			WF																							

	Rose-breasted grosbeak *Pheucticus ludovicianus*	Forest edges, dense hardwood thickets and sapling stands; brushy fields	BR BF WS WF							
	Indigo bunting *Passerina cyanea*	Scattered, tall trees in grassy openings; forest-field ecotones	BR BF WS WF							
	Bobolink *Dolichonyx oryzivorus*	Large expanses of grassland or old hayfields with little or no alfalfa	BR BF WS WF							
	Red-winged blackbird *Agelaius phoeniceus*	Emergent vegetation adjacent to open fields	BR BF WS WF							
	Eastern meadowlark *Sturnella magna*	Grasslands; elevated song perches	BR BF WS WF							
	Rusty blackbird *Euphagus carolinus*	Northern forested wetlands; alder swales	BR BF WS WF							
	Common grackle *Quiscalus quiscula*	Wet, open country, shrub swamps, pond edges	BR BF WS WF							
	Brown-headed cowbird *Molothrus ater*	Open grassy habitat	BR BF WS WF							
	Orchard oriole *Icterus spurius*	Open country with scattered deciduous trees	BR BF WS WF							
	Baltimore oriole *Icterus galbula*	Tall, scattered deciduous trees (preferably elm)	BR BF WS WF							

Nonforested Matrix *(continued)*

LOCAL OCCURRENCE	SPECIES	SPECIAL HABITAT FEATURES	SEASONAL USE	TERRESTRIAL										WETLAND/DEEPWATER														OTHER				
				Upland Field										Palustrine												Riverine							
				Cultivated	Grass	Forb	Shrub/old field	Pasture	Savanna	Orchard	Krummholz	Alpine	Sedge meadow	Shallow marsh	Deep marsh	Shrub swamp	Bog	Pond	Lake	Stream	River	Riparian	Stable banks	Ledge, cliff	Cave, mine	Structures	Derelict building, debris
	Pine grosbeak	Northern conifer forest	BR								■																			
	Pinicola enucleator		BF								■																			
			WS							▪	▪																			
			WF	▪						▪	▪																			
	Purple finch	Coniferous trees	BR					▪																						
	Carpodacus purpureus		BF					▪																						
			WS				▪	▪																						
			WF				▪	▪	▪	▪																				
	House finch	Open ground with low seed-producing plants	BR																											
	Carpodacus mexicanus		BF																											
			WS																											
			WF						▪	▪																				
	Red crossbill	Northern conifer forest	BR								▪																			
	Loxia curvirostra		BF								▪																			
			WS																											
			WF																											
	White-winged crossbill	Northern conifer forest	BR								▪																			
	Loxia leucoptera		BF								▪																			
			WS																											
			WF																											
	Common redpoll	Open country (winter)	BR																											
	Carduelis flammea		BF																											
			WS	▪	■	■	▪	▪	▪	▪			▪	▪	▪															
			WF	▪	■	■	▪	▪	▪	▪			▪	▪	▪															
	Hoary redpoll	Open country (winter)	BR																											
	Carduelis hornemanni		BF																											
			WS	▪	■	■	▪	▪	▪	▪			▪	▪	▪															
			WF	▪	■	■	▪	▪	▪	▪			▪	▪	▪															
	Pine siskin	Coniferous trees	BR														▪				▪									
	Carduelis pinus		BF														▪				▪									
			WS		▪	▪	▪	▪	▪							▪														
			WF		■	■	▪	▪	▪							▪														

| | | |

Nonforested Matrix *(continued)*

LOCAL OCCURRENCE	SPECIES	SPECIAL HABITAT FEATURES	SEASONAL USE	TERRESTRIAL									WETLAND/DEEPWATER												OTHER					
				Upland Field									Palustrine									Lake	Riverine								
				Cultivated	Grass	Forb	Shrub/old field	Pasture	Savanna	Orchard	Krummholz	Alpine	Sedge meadow	Shallow marsh	Deep marsh	Shrub swamp	Bog	Pond					Stream	River	Riparian	Stable banks	Ledge, cliff	Cave, mine	Structures	Derelict building, debris	
	Least shrew *Cryptotis parva*	Loose soil	BR		■																									
			BF		■																									
			WS		■																									
			WF		■																									
	Hairy-tailed mole *Parascalops breweri*	Loose, moist, well-drained soil	BR																											
			BF																											
			WS																											
			WF																											
	Eastern mole *Scalopus aquaticus*	Soft, moist soils containing earthworms	BR					■																						
			BF					■																						
			WS					■																						
			WF					■																						
	Star-nosed mole *Condylura cristata*	Wet muck, humus	BR										■																	
			BF										■																	
			WS										■																	
			WF										■																	
	Little brown myotis *Myotis lucifugus*	Females: dark, warm sites for maternity colonies. Forest openings for feeding	BR																								■	■	
			BF										■	■	■	■	■	■				■	■	■	■					
			WS																								■			
			WF																											
	Northern long-eared bat *Myotis septentrionalis*	Large cavity trees for roosting. Caves, mine shafts for hibernation near 40°F (2 to 7°C); high humidity and calm air	BR																									■		
			BF										■	■	■	■	■	■				■	■	■	■					
			WS																								■			
			WF																											
	Indiana myotis *Myotis sodalis*	Tree cavities and loose bark for roosting. Cool, stable temperatures in caves (hibernacula)	BR																											
			BF																											
			WS																								■			
			WF																											
	Eastern small-footed myotis *Myotis leibii*	Caves and mine shafts for hibernacula	BR																								■	■	■	
			BF																								■			
			WS																											
			WF																											

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Nonforested Matrix *(continued)*

LOCAL OCCURRENCE	SPECIES	SPECIAL HABITAT FEATURES	SEASONAL USE	TERRESTRIAL									WETLAND/DEEPWATER										OTHER				
				Upland Field									Palustrine									Riverine					
				Cultivated	Grass	Forb	Shrub/old field	Pasture	Savanna	Orchard	Krummholz	Alpine	Sedge meadow	Shallow marsh	Deep marsh	Shrub swamp	Bog	Pond	Lake	Stream	River	Riparian	Stable banks	Ledge, cliff	Cave, mine	Structures	Derelict building, debris
	Eastern chipmunk	Tree or shrub cover; elevated perches, decaying stumps/logs, stone walls	BR		■		■				■															
	Tamias striatus		BF		■		■				■															
			WS		■		■				■															
			WF																							
	Woodchuck	Open land with well-drained soils in which to burrow	BR	■	■	■	■	■	■	■												■				■
	Marmota monax		BF	■	■	■	■	■	■	■																
			WS	■	■	■	■	■	■	■												■				■
			WF																							
	Gray squirrel	Mast-producing trees; tall trees for dens and leaf nests	BR																		■					
	Sciurus carolinensis		BF																		■					
			WS																		■					
			WF																		■					
	Red squirrel	Woodlands with mature trees; conifers preferred	BR								■															
	Tamiasciurus hudsonicus		BF								■															
			WS								■															
			WF								■															
	Southern flying squirrel	Mature woodland with cavity trees; favors cavities with entrance diameters of 1.6 to 2 in (4 to 5 cm)	BR							■																■
	Glaucomys volans		BF							■																
			WS							■																■
			WF							■																
	Northern flying squirrel	Mature trees, cavities for winter dens; aboreal lichens	BR																							■
	Glaucomys sabrinus		BF																							
			WS																							
			WF																							
	Beaver	Low-gradient woodland streams with adjacent young hardwoods	BR															■	■	■	■	■				
	Castor canadensis		BF											■	■	■	■	■	■	■	■	■				
			WS															■	■	■	■	■				
			WF											■	■	■	■	■	■	■	■	■				
	Deer mouse	Down logs, rotting stumps	BR					■			■	■													■	■
	Peromyscus maniculatus		BF					■			■	■													■	■
			WS					■			■	■													■	■
			WF					■			■	■													■	■

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Nonforested Matrix *(continued)*

LOCAL OCCURRENCE	SPECIES	SPECIAL HABITAT FEATURES	SEASONAL USE	TERRESTRIAL: Upland Field: Cultivated	Grass	Forb	Shrub/old field	Pasture	TERRESTRIAL: Savanna	Orchard	Krummholz	Alpine	WETLAND/DEEPWATER: Palustrine: Sedge meadow	Shallow marsh	Deep marsh	Shrub swamp	Bog	Pond	Lake	Riverine: Stream	River	Riparian	OTHER: Stable banks	Ledge, cliff	Cave, mine	Structures	Derelict building, debris
	Meadow jumping mouse *Zapus hudsonius*	Open wooded stands; herbaceous ground cover; loose soils. Hibernates in winter	BR		■								■	■														
			BF		■								■	■														
			WS		■																							
			WF																									
	Woodland jumping mouse *Napaeozapus insignis*	Moist, cool woodlands; loose soils, herbaceous ground cover. Hibernates in winter	BR																									
			BF																									
			WS																									
			WF																									
	Porcupine *Erethizon dorsatum*	Rock ledges or den trees	BR																						■			
			BF																									
			WS																									
			WF																									
	Coyote *Canis latrans*	Well-drained, secluded den sites	BR																					■				
			BF																									
			WS																					■				
			WF																									
	Gray wolf *Canis lupus*	Seclusion; abundant prey base. Potential habitat in north	BR																					■	■			
			BF																									
			WS																					■	■			
			WF																									
	Red fox *Vulpes vulpes*	Well-drained den sites. Tends to hunt more open or semi-open habitats	BR																					■				
			BF		■																							
			WS																					■				
			WF	■	■																							
	Gray fox *Urocyon cinereoargenteus*	Hollow logs, tree cavities, rock crevices. Tends to hunt forest edges	BR																					■				
			BF																									
			WS																					■				
			WF																									
	Black bear *Ursus americanus*	Dens in any semiprotected areas (fallen trees, talus slopes, slash piles); seeps and wet areas in early spring; mast	BR																									
			BF							■																		
			WS																									
			WF																									

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Nonforested Matrix *(continued)*

LOCAL OCCURRENCE	SPECIES	SPECIAL HABITAT FEATURES	SEASONAL USE	TERRESTRIAL												WETLAND/DEEPWATER														OTHER			
				Upland Field						*Cultivated*	*Grass*	*Forb*	*Shrub/old field*	*Pasture*	*Savanna*	*Orchard*	*Krummholz*	*Alpine*	*Palustrine*							*Lake*	*Riverine*			*Stable banks*	*Ledge, cliff*	*Cave, mine*	*Structures*	*Derelict building, debris*
																			Sedge meadow	*Shallow marsh*	*Deep marsh*	*Shrub swamp*	*Bog*	*Pond*		*Stream*	*River*	*Riparian*				
	Bobcat *Lynx rufus*	Dense, woody understory; rock ledges and talus; successional habitats with abundant prey base (e.g., lagomorphs)	BR																											■			
			BF																											■			
			WS																											■			
			WF																											■			
	White-tailed deer *Odocoileus virginianus*	Softwood yarding cover in north; adequate winter browse; summer herbaceous forage and mast	BR																														
			BF																														
			WS																														
			WF																														
	Moose *Alces alces*	Wetlands (summer)	BR																														
			BF																		■			■			■	■	■				
			WS														■																
			WF														■																

Appendix C: Species Occurrence and Utilization, by Size Class, Home Range Area, and Habitat Breadth

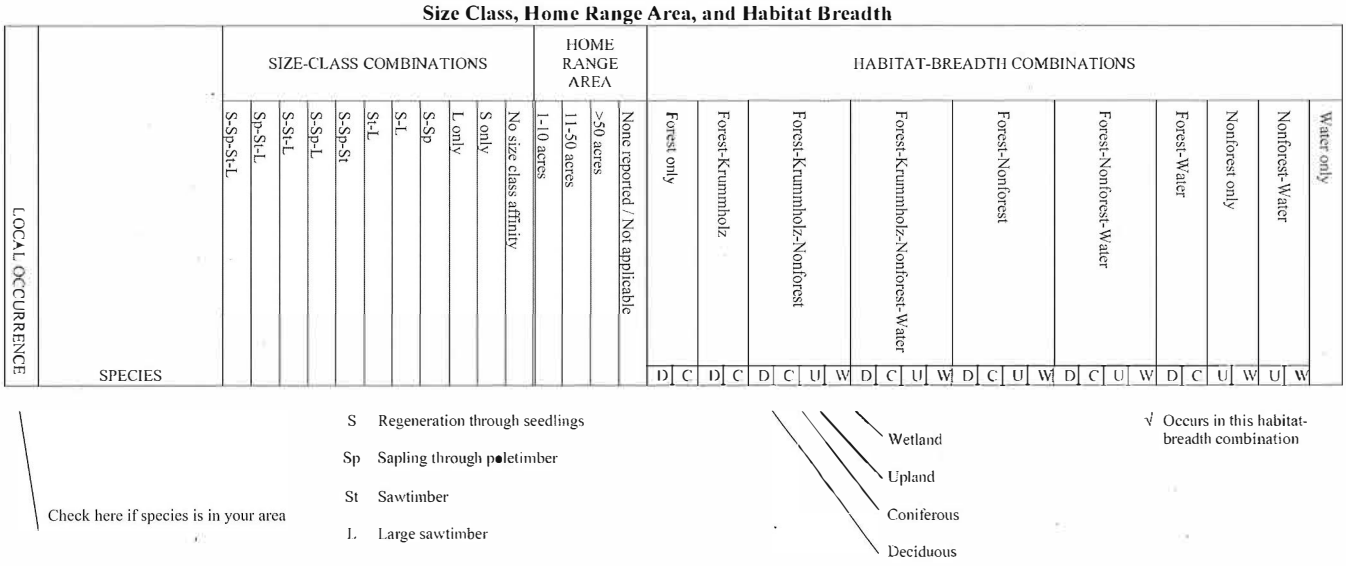


Fig. 59c. The key to elements in the species matrices.

Size Class, Home Range Area, and Habitat Breadth

LOCAL OCCURRENCE	SPECIES	SIZE-CLASS COMBINATIONS								HOME RANGE AREA				HABITAT–BREADTH COMBINATIONS																									
		S–Sp–St–L	*S–Sp–St*	*Sp–St–L*	*S–St–L*	*S–Sp*	*St–L*	*S only*	*No size class affinity*	*1–10 acres*	*11–50 acres*	*>50 acres*	*None reported/not applicable*	*Forest only*		*Forest–Krummholz*		*Forest–Krummholz–Nonforest*				*Forest–Krummholz–Nonforest–Water*				*Forest–Nonforest*				*Forest–Nonforest–Water*				*Forest–Water*		*Nonforest only*		*Nonforest–Water*		*Water only*
														D	*C*	*D*	*C*	*D*	*C*	*U*	*W*	*D*	*C*	*U*	*W*	*D*	*C*	*U*	*W*	*D*	*C*	*U*	*W*	*D*	*C*	*U*	*W*	*U*	*W*	
	Common mudpuppy *Necturus maculosus*								✓	✓																														
	Marbled salamander *Ambystoma opacum*	✓								✓																✓	✓		✓											
	Jefferson salamander *Ambystoma jeffersonianum*	✓								✓																✓	✓		✓											
	Blue-spotted salamander *Ambystoma laterale*	✓								✓																✓	✓		✓											
	Spotted salamander *Ambystoma maculatum*	✓									✓															✓	✓		✓											
	Red-spotted newt *Notophthalmus v. viridescens*	✓								✓																				✓	✓		✓							
	Northern dusky salamander *Desmognathus fuscus*	✓								✓																				✓	✓		✓							
	Northern redback salamander *Plethodon cinereus*	✓								✓				✓	✓																									
	Northern slimy salamander *Plethodon glutinosus*	✓								✓				✓	✓																									
	Four-toed salamander *Hemidactylium scutatum*	✓								✓																				✓	✓		✓							
	Northern spring salamander *Gyrinophilus p. porphyriticus*	✓								✓																								✓	✓					
	Northern two-lined salamander *Eurycea bislineata*	✓								✓																								✓	✓					
	Eastern spadefoot *Scaphiopus holbrookii*			✓						✓																	✓	✓												
	Eastern American toad *Bufo a. americanus*	✓								✓																				✓	✓	✓	✓							
	Fowler's toad *Bufo fowleri*	✓								✓																				✓	✓	✓	✓							
	Northern spring peeper *Pseudacris c. crucifer*			✓						✓																✓	✓		✓											

	Gray treefrog *Hyla versicolor*	✓								✓																				✓			✓						
	Bullfrog *Rana catesbeiana*								✓	✓																											✓	
	Green frog *Rana clamitans melanota*	✓								✓																				✓			✓						
	Mink frog *Rana septentrionalis*	✓								✓																				✓			✓						
	Wood frog *Rana sylvatica*	✓								✓							✓	✓	✓	✓																			
	Northern leopard frog *Rana pipiens*			✓						✓																				✓		✓	✓						
	Pickerel frog *Rana palustris*	✓								✓																				✓		✓	✓						
	Common snapping turtle *Chelydra s. serpentina*								✓		✓																										✓	✓	
	Spotted turtle *Clemmys guttata*	✓								✓																				✓	✓	✓	✓						
	Bog turtle *Clemmys muhlenbergii*								✓	✓																											✓	
	Wood turtle *Clemmys insculpta*	✓								✓																				✓	✓	✓	✓						
	Eastern box turtle *Terrapene c. carolina*	✓								✓																				✓	✓	✓	✓						
	Map turtle *Graptemys geographica*								✓		✓																										✓		
	Northern red-bellied cooter *Pseudemys rubriventris bangsi*								✓		✓																										✓	✓	
	Painted turtle *Chrysemys picta*								✓	✓																											✓	✓	
	Blanding's turtle *Emydoidea blandingii*	✓								✓																				✓	✓	✓	✓						
	Common musk turtle *Sternotherus odoratus*								✓	✓																											✓	✓	
	Eastern spiny softshell *Apalone s. spinifera*								✓	✓																													✓
	Five-lined skink *Eumeces fasciatus*	✓								✓				✓																								
	Northern water snake *Nerodia s. sipedon*								✓	✓																											✓	
	Northern brown snake *Storeria d. dekayi*	✓								✓																✓	✓	✓	✓									
	Northern redbelly snake *Storeria o. occipitomaculata*			✓						✓																✓	✓	✓	✓									

Size Class, Home Range Area, and Habitat Breadth *(continued)*

LOCAL OCCURRENCE	SPECIES	SIZE-CLASS COMBINATIONS								HOME RANGE AREA				HABITAT–BREADTH COMBINATIONS																											
		S–Sp–St–L	*S–Sp–St*	*Sp–St–L*	*S–St–L*	*S–Sp*	*St–L*	*S only*	*No size class affinity*	*1–10 acres*	*11–50 acres*	*>50 acres*	*None reported/not applicable*	*Forest only*		*Forest–Krummholz*		*Forest–Krummholz–Nonforest*				*Forest–Krummholz–Nonforest–Water*				*Forest–Nonforest*				*Forest–Nonforest–Water*				*Forest–Water*		*Nonforest only*		*Nonforest–Water*		*Water only*
														D	*C*	*D*	*C*	*D*	*C*	*U*	*W*	*D*	*C*	*U*	*W*	*D*	*C*	*U*	*W*	*D*	*C*	*U*	*W*	*D*	*C*	*U*	*W*	*U*	*W*	
	Common garter snake *Thamnophis sirtalis*	✓								✓												✓	✓	✓	✓																
	Ribbon snake *Thamnophis sauritus*	✓								✓																				✓	✓		✓							
	Eastern hognose snake *Heterodon platyrhinos*			✓						✓																✓	✓	✓	✓											
	Northern ringneck snake *Diadophis punctatus edwardsii*			✓						✓																✓	✓	✓												
	Eastern worm snake *Carphophis a. amoenus*			✓						✓																✓	✓	✓												
	Northern black racer *Coluber c. constrictor*	✓								✓																✓	✓	✓	✓											
	Eastern smooth green snake *Liochlorophis vernalis*							✓		✓																✓	✓	✓	✓											
	Black rat snake *Elaphe o. obsoleta*	✓										✓														✓		✓												
	Eastern milk snake *Lampropeltis t. triangulum*	✓										✓														✓	✓	✓												
	Northern copperhead *Agkistrodon contortrix mokasen*			✓							✓			✓																										
	Timber rattlesnake *Crotalus horridus*			✓							✓			✓																										
	Common loon *Gavia immer*								✓			✓																												✓
	Pied-billed grebe *Podilymbus podiceps*								✓	✓																												✓		
	Double-crested cormorant *Phalacrocorax auritus*								✓				✓																											✓
	American bittern *Botaurus lentiginosus*								✓	✓																												✓		
	Least bittern *Ixobrychus exilis*								✓	✓																													✓	✓	

| | | |

Size Class, Home Range Area, and Habitat Breadth *(continued)*

LOCAL OCCURRENCE	SPECIES	SIZE-CLASS COMBINATIONS								HOME RANGE AREA				HABITAT–BREADTH COMBINATIONS																													
		S–Sp–St–L	*S–Sp–St*	*Sp–St–L*	*S–St–L*	*S–Sp*	*St–L*	*S only*	*No size class affinity*	*1–10 acres*	*11–50 acres*	*>50 acres*	*None reported/not applicable*	*Forest only*		*Forest–Krummholz*		*Forest–Krummholz–Nonforest*				*Forest–Krummholz–Nonforest–Water*				*Forest–Nonforest*				*Forest–Nonforest–Water*				*Forest–Water*		*Nonforest only*		*Nonforest–Water*		*Water only*
														D	*C*	*D*	*C*	*D*	*C*	*U*	*W*	*D*	*C*	*U*	*W*	*D*	*C*	*U*	*W*	*D*	*C*	*U*	*W*	*D*	*C*	*U*	*W*	*U*	*W*	*U*	*W*	
	Ring-necked duck *Aythya collaris*								✓	✓																															✓	
	Bufflehead *Bucephala albeola*								✓				✓																													✓
	Common goldeneye *Bucephala clangula*						✓			✓																				✓	✓		✓									
	Hooded merganser *Lophodytes cucullatus*						✓			✓																				✓	✓		✓									
	Common merganser *Mergus merganser*						✓			✓																				✓	✓		✓									
	Red-breasted merganser *Mergus serrator*								✓	✓																															✓	
	Osprey *Pandion haliaetus*								✓			✓																														✓
	Bald eagle *Haliaeetus leucocephalus*						✓					✓																								✓	✓					
	Northern harrier *Circus cyaneus*								✓			✓																										✓	✓			
	Sharp-shinned hawk *Accipiter striatus*	✓										✓														✓	✓	✓														
	Cooper's hawk *Accipiter cooperii*	✓										✓														✓	✓	✓														
	Northern goshawk *Accipiter gentilis*	✓										✓														✓	✓	✓														
	Red-shouldered hawk *Buteo lineatus*				✓							✓														✓	✓		✓													
	Broad-winged hawk *Buteo platypterus*				✓							✓														✓	✓	✓														
	Red-tailed hawk *Buteo jamaicensis*				✓							✓														✓	✓	✓														
	Rough-legged hawk *Buteo lagopus*								✓				✓																									✓	✓			

	Golden eagle *Aquila chrysaetos*							✓				✓										✓	✓	✓	✓																
	American kestrel *Falco sparverius*							✓				✓														✓	✓	✓	✓												
	Merlin *Falco columbarius*						✓					✓															✓		✓												
	Peregrine falcon *Falco peregrinus*	✓										✓										✓	✓	✓	✓																
	Gray partridge *Perdix perdix*								✓			✓																							✓						
	Ring-necked pheasant *Phasianus colchicus*								✓		✓																								✓						
	Ruffed grouse *Bonasa umbellus*	✓									✓														✓	✓	✓													
	Spruce grouse *Falcipennis canadensis*	✓										✓						✓		✓																				
	Wild turkey *Meleagris gallopavo*	✓										✓														✓	✓	✓												
	Northern bobwhite *Colinus virginianus*				✓					✓																	✓	✓												
	King rail *Rallus elegans*								✓	✓																										✓				
	Virginia rail *Rallus limicola*								✓	✓																										✓				
	Sora *Porzana carolina*								✓	✓																										✓				
	Common moorhen *Gallinula chloropus*								✓		✓																												✓		
	American coot *Fulica americana*								✓		✓																												✓		
	Killdeer *Charadrius vociferus*								✓	✓																										✓	✓			
	Willet *Catoptrophorus semipalmatus*								✓			✓																										✓		
	Spotted sandpiper *Actitis macularia*								✓	✓																												✓	✓	
	Upland sandpiper *Bartramia longicauda*								✓		✓																										✓				
	Common snipe *Gallinago gallinago*								✓	✓																										✓	✓			
	American woodcock *Scolopax minor*					✓					✓														✓	✓	✓	✓												
	Ring-billed gull *Larus delawarensis*								✓			✓																										✓	✓	

Size Class, Home Range Area, and Habitat Breadth *(continued)*

LOCAL OCCURRENCE	SPECIES	SIZE-CLASS COMBINATIONS								HOME RANGE AREA				HABITAT–BREADTH COMBINATIONS																											
		S–Sp–St–L	*S–Sp–St*	*Sp–St–L*	*S–St–L*	*S–Sp*	*St–L*	*S only*	*No size class affinity*	*1–10 acres*	*11–50 acres*	*>50 acres*	*None reported/not applicable*	*Forest only*		*Forest–Krummholz*		*Forest–Krummholz–Nonforest*				*Forest–Krummholz–Nonforest–Water*				*Forest–Nonforest*				*Forest–Nonforest–Water*				*Forest–Water*		*Nonforest only*		*Nonforest–Water*		*Water only*
														D	*C*	*D*	*C*	*D*	*C*	*U*	*W*	*D*	*C*	*U*	*W*	*D*	*C*	*U*	*W*	*D*	*C*	*U*	*W*	*D*	*C*	*U*	*W*	*U*	*W*	*U*	*W*	
	Herring gull *Larus argentatus*								✓				✓																												✓
	Great black-backed gull *Larus marinus*								✓				✓																												✓
	Common tern *Sterna hirundo*								✓	✓																															✓
	Black tern *Chlidonias niger*								✓	✓																													✓		
	Rock dove *Columba livia*								✓	✓																											✓				
	Mourning dove *Zenaida macroura*	✓								✓															✓	✓	✓														
	Black-billed cuckoo *Coccyzus erythropthalmus*	✓									✓														✓	✓	✓	✓													
	Yellow-billed cuckoo *Coccyzus americanus*	✓									✓														✓		✓														
	Barn owl *Tyto alba*								✓			✓																								✓					
	Eastern screech-owl *Otus asio*	✓										✓													✓	✓	✓	✓													
	Great horned owl *Bubo virginianus*	✓										✓						✓	✓	✓	✓																				
	Snowy owl *Nyctea scandiaca*								✓				✓																								✓	✓			
	Northern hawk-owl *Surnia ulula*	✓											✓													✓		✓													
	Barred owl *Strix varia*	✓										✓													✓	✓	✓														
	Great gray owl *Strix nebulosa*	✓											✓												✓	✓	✓	✓													
	Long-eared owl *Asio otus*	✓										✓													✓	✓	✓	✓													

	Short-eared owl *Asio flammeus*								✓				✓																					✓	✓			
	Boreal owl *Aegolius funereus*	✓											✓														✓		✓										
	Northern saw-whet owl *Aegolius acadicus*	✓										✓														✓	✓	✓										
	Common nighthawk *Chordeiles minor*	✓									✓															✓	✓	✓	✓									
	Whip-poor-will *Caprimulgus vociferus*	✓									✓															✓	✓	✓										
	Chimney swift *Chaetura pelagica*								✓			✓																					✓	✓			
	Ruby-throated hummingbird *Archilochus colubris*	✓								✓																✓	✓	✓										
	Belted kingfisher *Ceryle alcyon*								✓			✓																							✓		
	Red-headed woodpecker *Melanerpes erythrocephalus*	✓								✓																✓		✓										
	Red-bellied woodpecker *Melanerpes carolinus*						✓			✓																✓	✓	✓										
	Yellow-bellied sapsucker *Sphyrapicus varius*			✓						✓																✓	✓	✓										
	Downy woodpecker *Picoides pubescens*	✓								✓																✓	✓	✓										
	Hairy woodpecker *Picoides villosus*						✓			✓																✓	✓	✓										
	Three-toed woodpecker *Picoides tridactylus*						✓					✓															✓		✓										
	Black-backed woodpecker *Picoides arcticus*	✓										✓															✓		✓										
	Northern flicker *Colaptes auratus*	✓								✓																✓	✓	✓										
	Pileated woodpecker *Dryocopus pileatus*						✓					✓		✓	✓																							
	Olive-sided flycatcher *Contopus cooperi*				✓					✓																✓	✓		✓									
	Eastern wood-pewee *Contopus virens*			✓						✓																✓	✓	✓										
	Yellow-bellied flycatcher *Empidonax flaviventris*	✓								✓								✓		✓																		
	Acadian flycatcher *Empidonax virescens*						✓			✓				✓																								
	Alder flycatcher *Empidonax alnorum*							✓		✓																✓	✓		✓									

Size Class, Home Range Area, and Habitat Breadth *(continued)*

LOCAL OCCURRENCE	SPECIES	SIZE-CLASS COMBINATIONS								HOME RANGE AREA				HABITAT–BREADTH COMBINATIONS																											
		S–Sp–St–L	*S–Sp–St*	*Sp–St–L*	*S–St–L*	*S–Sp*	*St–L*	*S only*	*No size class affinity*	*1–10 acres*	*11–50 acres*	*>50 acres*	*None reported/not applicable*	*Forest only*		*Forest–Krummholz*		*Forest–Krummholz–Nonforest*				*Forest–Krummholz–Nonforest–Water*				*Forest–Nonforest*				*Forest–Nonforest–Water*				*Forest–Water*		*Nonforest only*		*Nonforest–Water*		*Water only*
														D	*C*	*D*	*C*	*D*	*C*	*U*	*W*	*D*	*C*	*U*	*W*	*D*	*C*	*U*	*W*	*D*	*C*	*U*	*W*	*D*	*C*	*U*	*W*	*U*	*W*	
	Willow flycatcher *Empidonax traillii*							✓		✓																✓		✓												
	Least flycatcher *Empidonax minimus*			✓						✓																✓	✓	✓												
	Eastern phoebe *Sayornis phoebe*						✓			✓																✓	✓	✓												
	Great crested flycatcher *Myiarchus crinitus*						✓			✓																✓	✓	✓												
	Eastern kingbird *Tyrannus tyrannus*							✓		✓																✓		✓	✓											
	Loggerhead shrike *Lanius ludovicianus*							✓			✓																✓	✓	✓											
	Northern shrike *Lanius excubitor*	✓											✓													✓	✓	✓	✓											
	White-eyed vireo *Vireo griseus*							✓		✓																✓		✓	✓											
	Yellow-throated vireo *Vireo flavifrons*						✓			✓				✓																										
	Blue-headed vireo *Vireo solitarius*			✓						✓				✓	✓																									
	Warbling vireo *Vireo gilvus*						✓			✓																✓		✓												
	Philadelphia vireo *Vireo philadelphicus*					✓				✓																✓	✓	✓												
	Red-eyed vireo *Vireo olivaceus*	✓								✓																✓	✓	✓												
	Gray jay *Perisoreus canadensis*	✓								✓						✓																								
	Blue jay *Cyanocitta cristata*	✓								✓																✓	✓	✓												
	American crow *Corvus brachyrhynchos*				✓							✓														✓	✓	✓												

	Fish crow *Corvus ossifragus*								✓			✓																												✓	
	Common raven *Corvus corax*	✓										✓										✓	✓		✓																
	Horned lark *Eremophila alpestris*								✓		✓																									✓					
	Purple martin *Progne subis*							✓			✓																		✓	✓	✓	✓								
	Tree swallow *Tachycineta bicolor*	✓									✓																		✓	✓	✓	✓								
	Northern rough-winged swallow *Stelgidopteryx serripennis*							✓			✓																		✓	✓	✓	✓								
	Bank swallow *Riparia riparia*							✓			✓																		✓	✓	✓	✓								
	Cliff swallow *Petrochelidon pyrrhonota*							✓			✓														✓	✓	✓	✓												
	Barn swallow *Hirundo rustica*							✓			✓																		✓	✓	✓	✓								
	Black-capped chickadee *Poecile atricapillus*	✓								✓							✓	✓	✓																					
	Boreal chickadee *Poecile hudsonicus*			✓						✓								✓		✓																				
	Tufted titmouse *Baeolophus bicolor*			✓						✓															✓	✓	✓													
	Red-breasted nuthatch *Sitta canadensis*			✓						✓							✓	✓	✓	✓																				
	White-breasted nuthatch *Sitta carolinensis*			✓						✓															✓	✓	✓													
	Brown creeper *Certhia americana*			✓						✓															✓	✓	✓	✓												
	Carolina wren *Thryothorus ludovicianus*	✓								✓															✓		✓													
	House wren *Troglodytes aedon*	✓								✓															✓		✓													
	Winter wren *Troglodytes troglodytes*	✓								✓															✓	✓		✓												
	Sedge wren *Cistothorus platensis*								✓	✓																										✓					
	Marsh wren *Cistothorus palustris*								✓	✓																										✓					
	Golden-crowned kinglet *Regulus satrapa*	✓								✓				✓	✓																										
	Ruby-crowned kinglet *Regulus calendula*	✓								✓								✓		✓																				

Size Class, Home Range Area, and Habitat Breadth *(continued)*

LOCAL OCCURRENCE	SPECIES	SIZE-CLASS COMBINATIONS								HOME RANGE AREA				HABITAT–BREADTH COMBINATIONS																											
		S–Sp–St–L	*S–Sp–St*	*Sp–St–L*	*S–St–L*	*S–Sp*	*St–L*	*S only*	*No size class affinity*	*1–10 acres*	*11–50 acres*	*>50 acres*	*None reported/not applicable*	*Forest only*		*Forest–Krummholz*		*Forest–Krummholz–Nonforest*				*Forest–Krummholz–Nonforest–Water*				*Forest–Nonforest*				*Forest–Nonforest–Water*				*Forest–Water*		*Nonforest only*		*Nonforest–Water*		*Water only*
														D	*C*	*D*	*C*	*D*	*C*	*U*	*W*	*D*	*C*	*U*	*W*	*D*	*C*	*U*	*W*	*D*	*C*	*U*	*W*	*D*	*C*	*U*	*W*	*U*	*W*	
	Blue-gray gnatcatcher *Polioptila caerulea*			✓						✓																✓		✓	✓												
	Eastern bluebird *Sialia sialis*							✓		✓																✓	✓	✓													
	Veery *Catharus fuscescens*	✓								✓				✓	✓																										
	Bicknell's thrush *Catharus bicknelli*	✓								✓						✓																									
	Swainson's thrush *Catharus ustulatus*	✓									✓			✓	✓																										
	Hermit thrush *Catharus guttatus*	✓								✓																✓	✓	✓	✓												
	Wood thrush *Hylocichla mustelina*	✓								✓				✓	✓																										
	American robin *Turdus migratorius*	✓								✓								✓	✓	✓	✓																				
	Gray catbird *Dumetella carolinensis*	✓								✓																✓	✓	✓	✓												
	Northern mockingbird *Mimus polyglottos*							✓		✓																✓		✓													
	Brown thrasher *Toxostoma rufum*							✓		✓																✓	✓	✓													
	European starling *Sturnus vulgaris*								✓	✓																										✓					
	American pipit *Anthus rubescens*								✓				✓																							✓					
	Bohemian waxwing *Bombycilla garrulus*							✓					✓													✓	✓	✓													
	Cedar waxwing *Bombycilla cedrorum*	✓								✓																✓	✓	✓	✓												
	Blue-winged warbler *Vermivora pinus*							✓		✓																✓		✓	✓												

	Golden-winged warbler *Vermivora chrysoptera*							✓		✓																	✓		✓													
	Tennessee warbler *Vermivora peregrina*							✓		✓																	✓	✓	✓	✓												
	Nashville warbler *Vermivora ruficapilla*	✓								✓																	✓	✓	✓	✓												
	Northern parula *Parula americana*			✓						✓																	✓	✓		✓												
	Yellow warbler *Dendroica petechia*							✓		✓																	✓	✓	✓	✓												
	Chestnut-sided warbler *Dendroica pensylvanica*					✓				✓																	✓		✓	✓												
	Magnolia warbler *Dendroica magnolia*					✓				✓					✓																										
	Cape May warbler *Dendroica tigrina*			✓						✓					✓																										
	Black-throated blue warbler *Dendroica caerulescens*	✓								✓				✓	✓																										
	Yellow-rumped warbler *Dendroica coronata*			✓						✓								✓	✓	✓	✓																				
	Black-throated green warbler *Dendroica virens*			✓						✓				✓	✓																										
	Blackburnian warbler *Dendroica fusca*			✓						✓				✓	✓																										
	Pine warbler *Dendroica pinus*	✓								✓					✓																										
	Prairie warbler *Dendroica discolor*							✓		✓																	✓	✓	✓													
	Palm warbler *Dendroica palmarum*							✓		✓																		✓		✓												
	Bay-breasted warbler *Dendroica castanea*	✓								✓																		✓	✓												
	Blackpoll warbler *Dendroica striata*	✓								✓						✓																								
	Cerulean warbler *Dendroica cerulea*						✓			✓				✓																										
	Black-and-white warbler *Mniotilta varia*	✓								✓																	✓	✓	✓	✓												
	American redstart *Setophaga ruticilla*	✓								✓																	✓	✓	✓													
	Worm-eating warbler *Helmitheros vermivorus*						✓			✓				✓																										
	Ovenbird *Seiurus aurocapillus*			✓						✓				✓	✓																										

Size Class, Home Range Area, and Habitat Breadth *(continued)*

LOCAL OCCURRENCE	SPECIES	SIZE-CLASS COMBINATIONS								HOME RANGE AREA				HABITAT–BREADTH COMBINATIONS																											
		S–Sp–St–L	*S–Sp–St*	*Sp–St–L*	*S–St–L*	*S–Sp*	*St–L*	*S only*	*No size class affinity*	*1–10 acres*	*11–50 acres*	*>50 acres*	*None reported/not applicable*	*Forest only*		*Forest–Krummholz*		*Forest–Krummholz–Nonforest*				*Forest–Krummholz–Nonforest–Water*				*Forest–Nonforest*				*Forest–Nonforest–Water*				*Forest–Water*		*Nonforest only*		*Nonforest–Water*		*Water only*
														D	*C*	*D*	*C*	*D*	*C*	*U*	*W*	*D*	*C*	*U*	*W*	*D*	*C*	*U*	*W*	*D*	*C*	*U*	*W*	*D*	*C*	*U*	*W*	*U*	*W*	*U*	*W*	
	Northern waterthrush *Seiurus noveboracensis*	✓								✓																✓	✓		✓													
	Louisiana waterthrush *Seiurus motacilla*	✓								✓																				✓			✓									
	Mourning warbler *Oporornis philadelphia*							✓		✓																✓	✓	✓	✓													
	Common yellowthroat *Geothlypis trichas*	✓								✓																✓	✓	✓	✓													
	Hooded warbler *Wilsonia citrina*				✓					✓																✓		✓	✓													
	Wilson's warbler *Wilsonia pusilla*							✓		✓																	✓		✓													
	Canada warbler *Wilsonia canadensis*	✓								✓																✓	✓		✓													
	Yellow-breasted chat *Icteria virens*							✓		✓																✓		✓														
	Scarlet tanager *Piranga olivacea*			✓						✓				✓	✓																										
	Eastern towhee *Pipilo erythrophthalmus*	✓								✓																✓	✓	✓														
	American tree sparrow *Spizella arborea*							✓					✓													✓	✓	✓	✓													
	Chipping sparrow *Spizella passerina*	✓								✓																✓	✓	✓														
	Field sparrow *Spizella pusilla*							✓		✓																✓	✓	✓														
	Vesper sparrow *Pooecetes gramineus*								✓	✓																												✓	✓			
	Savannah sparrow *Passerculus sandwichensis*								✓	✓																												✓	✓			
	Grasshopper sparrow *Ammodramus savannarum*								✓	✓																												✓				

	Fox sparrow *Passerella iliaca*							✓		✓								✓	✓	✓																		
	Song sparrow *Melospiza melodia*							✓		✓															✓	✓	✓	✓										
	Lincoln's sparrow *Melospiza lincolnii*							✓		✓															✓	✓	✓	✓										
	Swamp sparrow *Melospiza georgiana*							✓		✓															✓			✓										
	White-throated sparrow *Zonotrichia albicollis*	✓								✓								✓	✓	✓																		
	Dark-eyed junco *Junco hyemalis*	✓								✓								✓	✓	✓																		
	Lapland longspur *Calcarius lapponicus*								✓			✓																						✓				
	Snow bunting *Plectrophenax nivalis*								✓			✓																						✓	✓			
	Northern cardinal *Cardinalis cardinalis*	✓								✓															✓	✓	✓	✓										
	Rose-breasted grosbeak *Pheucticus ludovicianus*	✓								✓															✓	✓	✓											
	Indigo bunting *Passerina cyanea*							✓		✓															✓	✓	✓											
	Bobolink *Dolichonyx oryzivorus*								✓		✓																						✓	✓				
	Red-winged blackbird *Agelaius phoeniceus*							✓		✓															✓		✓	✓										
	Eastern meadowlark *Sturnella magna*								✓		✓																						✓					
	Rusty blackbird *Euphagus carolinus*	✓									✓														✓	✓	✓	✓										
	Common grackle *Quiscalus quiscula*	✓								✓																			✓	✓	✓	✓						
	Brown-headed cowbird *Molothrus ater*	✓								✓															✓	✓	✓	✓										
	Orchard oriole *Icterus spurius*	✓								✓															✓		✓											
	Baltimore oriole *Icterus galbula*			✓						✓															✓		✓											
	Pine grosbeak *Pinicola enucleator*	✓									✓							✓	✓	✓																		
	Purple finch *Carpodacus purpureus*	✓								✓															✓	✓	✓											
	House finch *Carpodacus mexicanus*	✓								✓															✓	✓	✓											

Size Class, Home Range Area, and Habitat Breadth *(continued)*

LOCAL OCCURRENCE	SPECIES	SIZE-CLASS COMBINATIONS								HOME RANGE AREA				HABITAT–BREADTH COMBINATIONS																											
		S–Sp–St–L	S–Sp–St	Sp–St–L	S–St–L	S–Sp	St–L	S only	No size class affinity	1–10 acres	11–50 acres	>50 acres	None reported/not applicable	Forest only		Forest–Krummholz		Forest–Krummholz–Nonforest				Forest–Krummholz–Nonforest–Water				Forest–Nonforest				Forest–Nonforest–Water				Forest–Water		Nonforest only		Nonforest–Water		Water only
														D	C	D	C	D	C	U	W	D	C	U	W	D	C	U	W	D	C	U	W	D	C	U	W	U	W	
	Red crossbill *Loxia curvirostra*			✓						✓							✓																							
	White-winged crossbill *Loxia leucoptera*			✓						✓						✓	✓																							
	Common redpoll *Carduelis flammea*							✓					✓													✓	✓	✓	✓											
	Hoary redpoll *Carduelis hornemanni*							✓					✓													✓	✓	✓	✓											
	Pine siskin *Carduelis pinus*	✓								✓																✓	✓	✓	✓											
	American goldfinch *Carduelis tristis*	✓								✓																✓	✓	✓	✓											
	Evening grosbeak *Coccothraustes vespertinus*			✓						✓																✓	✓	✓												
	House sparrow *Passer domesticus*								✓	✓																										✓				
	Virginia opossum *Didelphis virginiana*	✓									✓															✓		✓	✓											
	Masked shrew *Sorex cinereus*	✓								✓																✓	✓	✓	✓											
	Water shrew *Sorex palustris*	✓								✓																				✓	✓		✓							
	Smoky shrew *Sorex fumeus*	✓								✓																✓	✓		✓											
	Long-tailed shrew *Sorex dispar*	✓								✓						✓	✓																							
	Pygmy shrew *Sorex hoyi*	✓								✓								✓	✓	✓	✓																			
	Northern short-tailed shrew *Blarina brevicauda*	✓								✓								✓	✓	✓	✓																			
	Least shrew *Cryptotis parva*							✓		✓																✓		✓	✓											

	Hairy-tailed mole *Parascalops breweri*	✓								✓																✓	✓	✓													
	Eastern mole *Scalopus aquaticus*				✓					✓																✓		✓													
	Star-nosed mole *Condylura cristata*				✓					✓																				✓	✓		✓								
	Little brown myotis *Myotis lucifugus*				✓								✓																	✓	✓	✓	✓								
	Northern long-eared bat *Myotis septentrionalis*				✓								✓																	✓	✓	✓	✓								
	Indiana myotis *Myotis sodalis*				✓								✓																	✓	✓	✓	✓								
	Eastern small-footed myotis *Myotis leibii*				✓								✓																	✓	✓	✓	✓								
	Silver-haired bat *Lasionycteris noctivagans*				✓								✓																	✓	✓	✓	✓								
	Eastern pipistrelle *Pipistrellus subflavus*				✓								✓																	✓	✓	✓	✓								
	Big brown bat *Eptesicus fuscus*				✓								✓																	✓	✓	✓	✓								
	Red bat *Lasiurus borealis*	✓											✓																	✓	✓	✓	✓								
	Hoary bat *Lasiurus cinereus*	✓											✓																	✓	✓	✓	✓								
	Eastern cottontail *Sylvilagus floridanus*							✓		✓																✓	✓	✓	✓												
	New England cottontail *Sylvilagus transitionalis*					✓				✓																✓	✓	✓	✓												
	Snowshoe hare *Lepus americanus*	✓								✓							✓	✓	✓	✓																					
	European hare *Lepus europaeus*							✓			✓														✓		✓														
	Black-tailed jackrabbit *Lepus californicus*								✓		✓																										✓				
	Eastern chipmunk *Tamias striatus*	✓								✓							✓	✓	✓																					
	Woodchuck *Marmota monax*				✓							✓														✓	✓	✓													
	Gray squirrel *Sciurus carolinensis*						✓			✓				✓	✓																										
	Red squirrel *Tamiasciurus hudsonicus*	✓								✓						✓	✓																								
	Southern flying squirrel *Glaucomys volans*						✓			✓																✓		✓													

Size Class, Home Range Area, and Habitat Breadth *(continued)*

LOCAL OCCURRENCE	SPECIES	SIZE-CLASS COMBINATIONS								HOME RANGE AREA				HABITAT–BREADTH COMBINATIONS																											
		S–Sp–St–L	*S–Sp–St*	*Sp–St–L*	*S–St–L*	*S–Sp*	*St–L*	*S only*	*No size class affinity*	*1–10 acres*	*11–50 acres*	*>50 acres*	*None reported/not applicable*	*Forest only*		*Forest–Krummholz*		*Forest–Krummholz–Nonforest*				*Forest–Krummholz–Nonforest–Water*				*Forest–Nonforest*				*Forest–Nonforest–Water*				*Forest–Water*		*Nonforest only*		*Nonforest–Water*		*Water only*
														D	*C*	*D*	*C*	*D*	*C*	*U*	*W*	*D*	*C*	*U*	*W*	*D*	*C*	*U*	*W*	*D*	*C*	*U*	*W*	*D*	*C*	*U*	*W*	*U*	*W*	
	Northern flying squirrel *Glaucomys sabrinus*						✓			✓				✓	✓																										
	Beaver *Castor canadensis*	✓								✓																				✓	✓		✓							
	Deer mouse *Peromyscus maniculatus*	✓								✓								✓	✓	✓																				
	White-footed mouse *Peromyscus leucopus*	✓								✓								✓	✓	✓	✓																			
	Southern red-backed vole *Clethrionomys gapperi*	✓								✓								✓	✓	✓	✓																			
	Meadow vole *Microtus pennsylvanicus*							✓		✓																✓	✓	✓	✓											
	Rock vole *Microtus chrotorrhinus*	✓								✓								✓	✓	✓																				
	Woodland vole *Microtus pinetorum*	✓								✓																✓		✓												
	Muskrat *Ondatra zibethicus*								✓	✓																													✓	
	Southern bog lemming *Synaptomys cooperi*	✓								✓								✓	✓	✓	✓																			
	Northern bog lemming *Synaptomys borealis*	✓								✓									✓	✓	✓																			
	Norway rat *Rattus norvegicus*								✓	✓																										✓				
	House mouse *Mus musculus*								✓	✓																										✓				
	Meadow jumping mouse *Zapus hudsonius*					✓				✓																✓	✓	✓	✓											
	Woodland jumping mouse *Napaeozapus insignis*	✓								✓																✓	✓	✓	✓											
	Porcupine *Erethizon dorsatum*	✓									✓							✓	✓	✓	✓																			

	Coyote *Canis latrans*	✓										✓														✓	✓	✓	✓											
	Gray wolf *Canis lupus*	✓										✓														✓	✓	✓	✓											
	Red fox *Vulpes vulpes*	✓										✓														✓	✓	✓	✓											
	Gray fox *Urocyon cinereoargenteus*	✓										✓														✓	✓	✓	✓											
	Black bear *Ursus americanus*	✓										✓																		✓	✓	✓	✓							
	Raccoon *Procyon lotor*	✓										✓														✓	✓	✓	✓											
	American marten *Martes americana*	✓										✓				✓	✓																							
	Fisher *Martes pennanti*	✓										✓						✓	✓	✓	✓																			
	Ermine *Mustela erminea*	✓								✓								✓	✓	✓	✓																			
	Long-tailed weasel *Mustela frenata*					✓				✓								✓	✓	✓	✓																			
	Mink *Mustela vison*	✓										✓																		✓	✓		✓							
	Striped skunk *Mephitis mephitis*	✓										✓														✓	✓	✓	✓											
	River otter *Lontra canadensis*			✓								✓																		✓	✓		✓							
	Mountain lion *Puma concolor*	✓										✓														✓	✓	✓	✓											
	Lynx *Lynx canadensis*	✓										✓						✓	✓		✓																			
	Bobcat *Lynx rufus*	✓										✓						✓	✓	✓	✓																			
	White-tailed deer *Odocoileus virginianus*	✓										✓														✓	✓	✓	✓											
	Moose *Alces alces*	✓										✓										✓	✓	✓	✓															

Appendix D: Species Occurrence and Utilization, by Habitat Breadth for Structural Habitat Features Typically Provided through Forest Vegetation Management

Structural Habitat Features

LOCAL OCCURRENCE / SPECIES	SEASONAL USE	Perch		Overstory canopy			Inclusions		Tree boles						Midstory layer – Woody vegetation 10-30' in height	Shrub layer			Ground cover		Ground	Miscellaneous		
		Exposed – High	Exposed – Low	<30% - Open	30-70% - Partial	>70% - Closed	Deciduous	Coniferous	Adjacent to water: Dead, at least 6" dbh	Adjacent to water: Live, at least 18" dbh	General forest: Dead and soft, less than 6" dbh	General forest: Dead and hard, 6-12" dbh	General forest: Dead and hard, 12-18" dbh	General forest: Live, columnar decay, 8-12" dbh	General forest: Live, broken top, 12-18" dbh	General forest: Live, broken top or large limb >18" dbh	General forest: Live, hollow >24" dbh	Deciduous seedlings, saplings, shrubs, 2-10' in height	Coniferous seedlings, saplings, shrubs, 2-10' in height	Mixed deciduous/coniferous vegetation 2-10' in height	Ericaceous shrubs 2-10' in height	Wetland shrubs	<30% coverage in 0-2' zone	30-75% coverage in 0-2' zone	>75% coverage in 0-2' zone	Emergent wetland vegetation/bank vegetation	Dead and down material	Sand / gravel / bare ground surfaces	Temporary pools	Slash piles	Hard mast – nuts	Soft mast – fruit, berries
	BR																														
	NB																														
	BR																														
	BF																														
	WS																														
	WF																														

■ Structural habitat feature used

Check here if species is in your area

BR Breeding season/shelter
BF Breeding season/feeding
WS Nonbreeding season/shelter
WF Nonbreeding season/feeding

Fig. 59d. The key to elements in the species matrices.

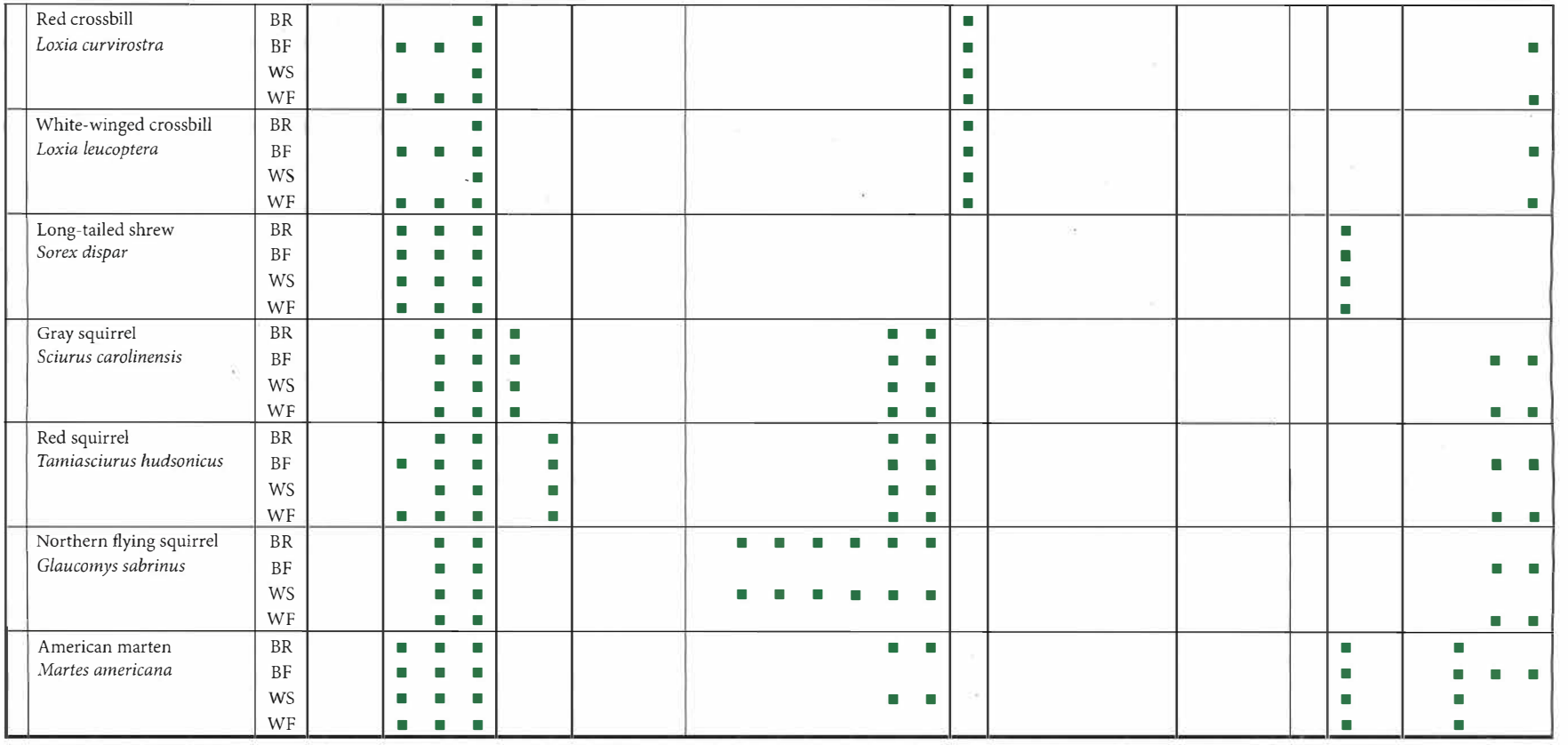
Species Using Forest Habitats Only

LOCAL OCCURRENCE	SPECIES	SEASONAL USE	Perch	Overstory canopy			Inclusions		Tree boles										Midstory layer—Woody vegetation 10–30′ in height	Shrub layer					Ground cover				Ground		Miscellaneous			
									General forest							Adjacent to water									Upland herbaceous			Emergent wetland vegetation/bank vegetation					
			Low exposed	High exposed	Closed, >70%	Partial, 30–70%	Open, <30%	Coniferous	Deciduous	Live, hollow >24″ dbh	Live, broken top or large limb >18″ dbh	Live, broken top, 12–18″ dbh	Live, columnar decay, 8–12″ dbh	Dead and hard, 12–18″ dbh	Dead and hard, 6–12″ dbh	Dead and soft, less than 6″ dbh	Live, at least 18″ dbh	Live, at least 12″ dbh	Dead, at least 6″ dbh		Wetland shrubs	Ericaceous shrubs 2–10′ in height	Mixed deciduous, coniferous vegetation 2–10′ in height	Coniferous seedlings, saplings, shrubs 2–10′ in height	Deciduous seedlings, saplings, shrubs 2–10′ in height	>75% coverage in 0–2′ zone	30–75% coverage in 0–2′ zone	<30% coverage in 0–2′ zone	Sand / gravel / bare ground surfaces	Dead and down material	Soft mast—fruit, berries	Hard mast—nuts	Slash piles	Temporary pools
	Northern redback salamander *Plethodon cinereus*	BR			■	■	■																						■	■				
		NB			■	■	■																						■	■				
	Northern slimy salamander *Plethodon glutinosus*	BR			■	■	■																						■	■				
		NB			■	■	■																						■	■				
	Five-lined skink *Eumeces fasciatus*	BR					■																			■	■				■	■		
		NB					■																			■	■				■	■		
	Northern copperhead *Agkistrodon contortrix mokasen*	BR					■																							■	■			
		NB					■																							■	■			
	Timber rattlesnake *Crotalus horridus*	BR			■	■	■														■	■											
		NB			■	■	■														■	■											
	Pileated woodpecker *Dryocopus pileatus*	BR			■	■	■				■			■			■													■			
		BF			■	■	■				■			■			■													■			
		WS			■	■	■				■			■			■													■			
		WF			■	■	■				■			■			■													■			
	Acadian flycatcher *Empidonax virescens*	BR	■		■														■	■											■		
		BF	■		■														■	■											■		
		WS																															
		WF																															
	Yellow-throated vireo *Vireo flavifrons*	BR				■			■																							■		
		BF				■			■																							■		
		WS																															
		WF																															

Blue-headed vireo *Vireo solitarius*	BR			■	■				■	■					
	BF			■	■				■	■					■
	WS														
	WF														
Gray jay *Perisoreus canadensis*	BR		■ ■	■					■						
	BF		■ ■	■					■						■
	WS		■ ■	■											
	WF		■ ■	■											■
Golden-crowned kinglet *Regulus satrapa*	BR		■	■	■										
	BF		■ ■	■	■										
	WS		■	■	■										
	WF		■ ■	■	■										
Veery *Catharus fuscescens*	BR		■ ■		■				■	■	■			■	
	BF		■ ■		■				■	■	■				■
	WS														
	WF														
Bicknell's thrush *Catharus bicknelli*	BR		■ ■	■						■					
	BF		■ ■	■						■					■
	WS														
	WF														
Swainson's thrush *Catharus ustulatus*	BR		■ ■	■					■	■					
	BF		■ ■	■					■	■					■
	WS														
	WF														
Wood thrush *Hylocichla mustelina*	BR			■	■ ■				■	■					
	BF		■ ■	■	■ ■				■	■					■
	WS														
	WF														
Magnolia warbler *Dendroica magnolia*	BR		■ ■	■	■				■	■					
	BF		■ ■	■	■				■	■					
	WS														
	WF														
Cape May warbler *Dendroica tigrina*	BR		■	■											
	BF		■	■											
	WS														
	WF														
Black-throated blue warbler *Dendroica caerulescens*	BR		■ ■	■	■					■	■				
	BF		■ ■	■	■					■	■				
	WS														
	WF														
Black-throated green warbler *Dendroica virens*	BR			■	■				■						
	BF			■	■				■						■
	WS														
	WF														

Species Using Forest Habitats Only *(continued)*

LOCAL OCCURRENCE	SPECIES	SEASONAL USE	Perch: Low exposed	Perch: High exposed	Overstory canopy: Closed, >70%	Overstory canopy: Partial, 30–70%	Overstory canopy: Open, <30%	Inclusions: Coniferous	Inclusions: Deciduous	Tree boles: Adjacent to water: Live, at least 18" dbh	Tree boles: Adjacent to water: Live, at least 12" dbh	Tree boles: Adjacent to water: Dead, at least 6" dbh	Tree boles: General forest: Live, hollow >24" dbh	Tree boles: General forest: Live, broken top or large limb >18" dbh	Tree boles: General forest: Live, broken top, 12–18" dbh	Tree boles: General forest: Live, columnar decay, 8–12" dbh	Tree boles: General forest: Dead and hard, 12–18" dbh	Tree boles: General forest: Dead and hard, 6–12" dbh	Tree boles: General forest: Dead and soft, less than 6" dbh	Midstory layer—Woody vegetation 10–30' in height	Shrub layer: Wetland shrubs	Shrub layer: Ericaceous shrubs 2–10' in height	Shrub layer: Mixed deciduous, coniferous vegetation 2–10' in height	Shrub layer: Coniferous seedlings, saplings, shrubs 2–10' in height	Shrub layer: Deciduous seedlings, saplings, shrubs 2–10' in height	Ground cover: Upland herbaceous: >75% coverage in 0–2' zone	Ground cover: Upland herbaceous: 30–75% coverage in 0–2' zone	Ground cover: Upland herbaceous: <30% coverage in 0–2' zone	Ground cover: Emergent wetland vegetation/bank vegetation	Ground: Sand / gravel / bare ground surfaces	Ground: Dead and down material	Miscellaneous: Soft mast—fruit, berries	Miscellaneous: Hard mast—nuts	Miscellaneous: Slash piles	Miscellaneous: Temporary pools
	Blackburnian warbler *Dendroica fusca*	BR			■			■																	■									
		BF			■			■																	■									
		WS																																
		WF																																
	Pine warbler *Dendroica pinus*	BR			■	■	■	■																										
		BF			■	■	■	■																										
		WS																																
		WF																																
	Blackpoll warbler *Dendroica striata*	BR			■	■															■				■	■								
		BF			■	■															■				■	■								
		WS																																
		WF																																
	Cerulean warbler *Dendroica cerulea*	BR			■	■																												
		BF			■	■																												
		WS																																
		WF																																
	Worm-eating warbler *Helmitheros vermivorus*	BR			■	■	■																			■				■				
		BF			■	■	■																			■				■				
		WS																																
		WF																																
	Ovenbird *Seiurus aurocapillus*	BR			■	■																								■				
		BF			■	■																								■				
		WS																																
		WF																																
	Scarlet tanager *Piranga olivacea*	BR			■	■		■	■												■										■			
		BF			■	■		■	■												■										■			
		WS					■																											
		WF																																


Red crossbill
Loxia curvirostra
BR
BF
WS
WF
White-winged crossbill
Loxia leucoptera
BR
BF
WS
WF
Long-tailed shrew
Sorex dispar
BR
BF
WS
WF
Gray squirrel
Sciurus carolinensis
BR
BF
WS
WF
Red squirrel
Tamiasciurus hudsonicus
BR
BF
WS
WF
Northern flying squirrel
Glaucomys sabrinus
BR
BF
WS
WF
American marten
Martes americana
BR
BF
WS
WF

Species Using Forest and Nonforest Habitats

LOCAL OCCURRENCE	SPECIES	SEASONAL USE	Perch or nest: Low exposed	Perch or nest: High exposed	Overstory canopy: Closed, >70%	Overstory canopy: Partial, 31–70%	Overstory canopy: Open, <30%	Inclusions: Coniferous	Inclusions: Deciduous	Tree boles: Adjacent to water: Live, at least 18" dbh	Tree boles: Adjacent to water: Live, at least 12" dbh	Tree boles: Adjacent to water: Dead, at least 6" dbh	Tree boles: General forest: Live, hollow >24" dbh	Tree boles: General forest: Live, broken top or large limb >18" dbh	Tree boles: General forest: Live, broken top, 12–18" dbh	Tree boles: General forest: Live, columnar decay, 8–12" dbh	Tree boles: General forest: Dead and hard, 12–18" dbh	Tree boles: General forest: Dead and hard, 6–12" dbh	Tree boles: General forest: Dead and soft, less than 6" dbh	Midstory—Woody vegetation in 10–30' zone	Shrub layer: Deciduous seedlings, saplings, shrubs in 2–10' zone	Shrub layer: Coniferous seedlings, saplings, shrubs in 2–10' zone	Shrub layer: Mixed deciduous, coniferous vegetation in 2–10' zone	Shrub layer: Ericaceous in 2–10' zone	Shrub layer: Wetland shrubs	Ground cover: Upland herbaceous: <30% coverage in 0–2' zone	Ground cover: Upland herbaceous: 30–75% coverage in 0–2' zone	Ground cover: Upland herbaceous: >75% coverage in 0–2' zone	Ground cover: Emergent wetland vegetation/bank vegetation	Ground: Dead and down material	Ground: Sand / gravel / bare ground surfaces	Miscellaneous: Temporary pools	Miscellaneous: Slash piles	Miscellaneous: Hard mast—nuts	Miscellaneous: Soft mast—fruit, berries
	Marbled salamander *Ambystoma opacum*	BR			■	■																			■				■	■				
		NB			■	■																			■				■	■				
	Jefferson salamander *Ambystoma jeffersonianum*	BR			■	■																			■				■					
		NB			■	■																			■				■					
	Blue-spotted salamander *Ambystoma laterale*	BR			■	■																			■				■					
		NB			■	■																			■				■					
	Spotted salamander *Ambystoma maculatum*	BR			■	■																			■				■					
		NB			■	■	■																		■				■					
	Red-spotted newt *Notophthalmus v. viridescens*	BR																																
		NB			■	■																												
	Northern dusky salamander *Desmognathus fuscus*	BR				■																				■	■							
		NB				■																				■	■							
	Four-toed salamander *Hemidactylium scutatum*	BR			■	■																				■	■							
		NB			■	■																				■	■							
	Northern spring salamander *Gyrinophilus p. porphyriticus*	BR			■	■																												
		NB			■	■																												
	Northern two-lined salamander *Eurycea bislineata*	BR			■	■																							■	■				
		NB			■	■																							■	■				
	Eastern spadefoot *Scaphiopus holbrookii*	BR				■	■																								■	■		
		NB				■	■																								■	■		
	Eastern American toad *Bufo a. americanus*	BR				■																						■	■	■		■	■	
		NB				■	■																					■	■	■		■	■	

	Fowler's toad	BR									■		■	■		■	
	Bufo fowleri	NB		■	■	■					■	■	■	■		■	
	Northern spring peeper	BR									■	■	■	■		■	
	Pseudacris c. crucifer	NB		■	■	■					■	■	■	■		■	
	Gray treefrog	BR		■	■	■					■			■	■	■	
	Hyla versicolor	NB		■	■	■									■		
	Green frog	BR									■			■		■	
	Rana clamitans melanota	NB		■	■	■					■			■			
	Mink frog	BR												■			
	Rana septentrionalis	NB		■	■	■								■			
	Wood frog	BR		■	■	■					■			■		■	■
	Rana sylvatica	NB		■	■	■					■			■		■	■
	Northern leopard frog	BR		■							■		■	■			
	Rana pipiens	NB		■							■			■			
	Pickerel frog	BR		■	■	■					■		■	■			
	Rana palustris	NB		■	■	■					■		■	■			
	Spotted turtle	BR									■		■	■		■	
	Clemmys guttata	NB		■	■	■					■		■	■		■	
	Wood turtle	BR									■	■	■	■	■		■
	Clemmys insculpta	NB		■	■	■					■		■	■			
	Eastern box turtle	BR		■							■		■	■	■	■	■
	Terrapene c. carolina	NB		■							■		■	■	■	■	
	Blanding's turtle	BR									■	■	■	■	■		■
	Emydoidea blandingii	NB		■	■	■					■		■	■		■	
	Northern brown snake	BR		■	■	■							■		■	■	
	Storeria d. dekayi	NB		■	■	■							■		■	■	
	Northern redbelly snake	BR		■	■	■							■		■	■	
	Storeria o. occipitomaculata	NB		■	■	■							■		■	■	
	Common garter snake	BR		■	■	■					■		■	■	■	■	
	Thamnophis sirtalis	NB		■	■	■					■		■	■	■	■	
	Ribbon snake	BR		■	■	■					■		■	■		■	
	Thamnophis sauritus	NB		■	■	■					■		■	■		■	
	Eastern hognose snake	BR		■									■		■	■	
	Heterodon platyrhinos	NB		■									■		■	■	
	Northern ringneck snake	BR		■	■	■									■	■	
	Diadophis punctatus edwardsii	NB		■	■	■									■	■	
	Eastern worm snake	BR		■	■	■							■		■		
	Carphophis a. amoenus	NB		■	■	■							■		■		
	Northern black racer	BR		■							■		■	■	■	■	
	Coluber c. constrictor	NB		■							■		■	■	■	■	
	Eastern smooth green snake	BR		■									■				
	Liochlorophis vernalis	NB		■									■				

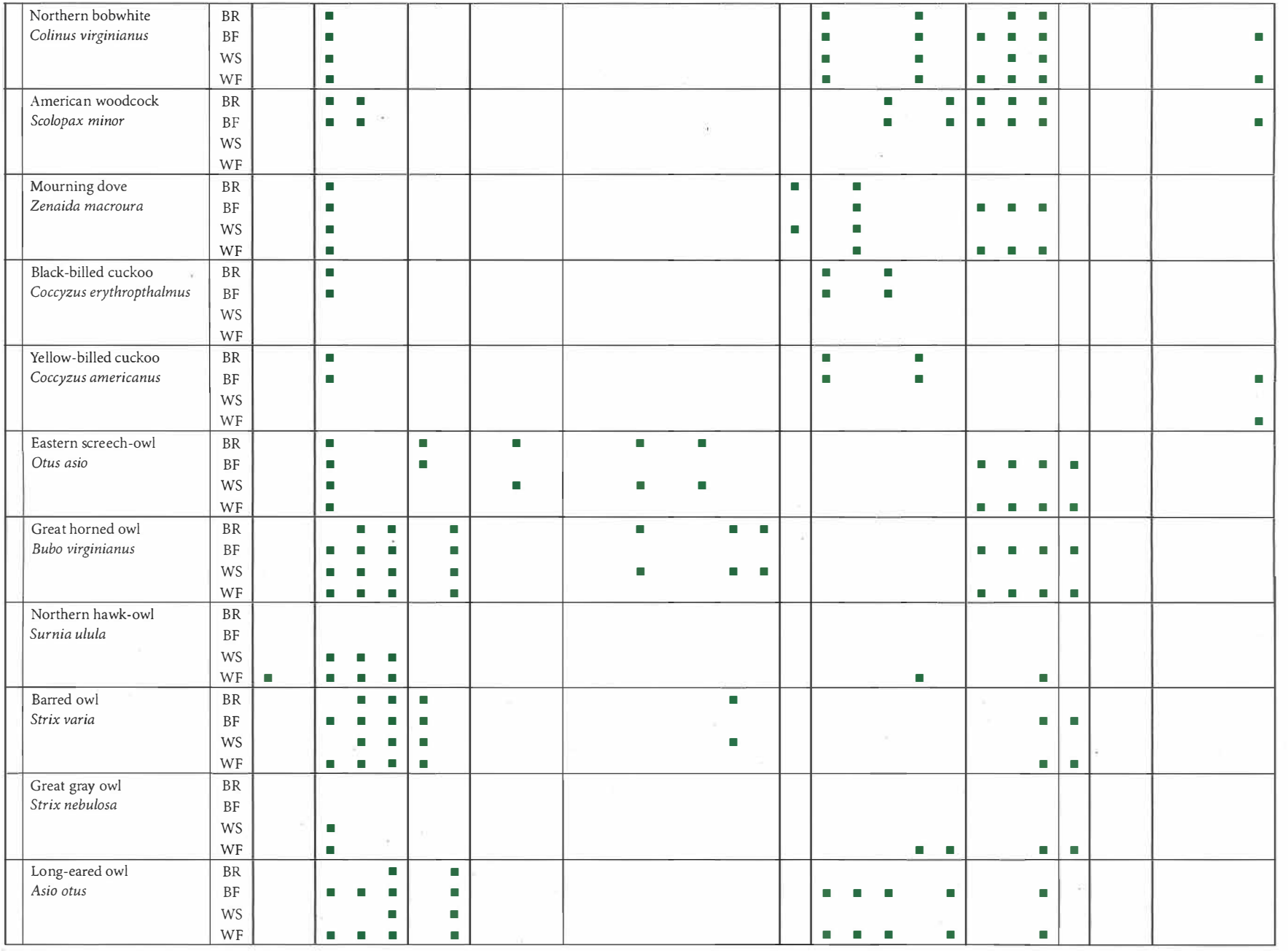
Species Using Forest and Nonforest Habitats *(continued)*

LOCAL OCCURRENCE	SPECIES	SEASONAL USE	Perch or nest: Low exposed	Perch or nest: High exposed	Overstory canopy: Closed, >70%	Overstory canopy: Partial, 31–70%	Overstory canopy: Open, <30%	Inclusions: Coniferous	Inclusions: Deciduous	Tree boles: Adjacent to water: Live, at least 18" dbh	Tree boles: Adjacent to water: Live, at least 12" dbh	Tree boles: Adjacent to water: Dead, at least 6" dbh	Tree boles: General forest: Live, hollow >24" dbh	Tree boles: General forest: Live, broken top or large limb >18" dbh	Tree boles: General forest: Live, broken top, 12–18" dbh	Tree boles: General forest: Live, columnar decay, 8–12" dbh	Tree boles: General forest: Dead and hard, 12–18" dbh	Tree boles: General forest: Dead and hard, 6–12" dbh	Tree boles: General forest: Dead and soft, less than 6" dbh	Midstory—Woody vegetation in 10–30' zone	Shrub layer: Deciduous seedlings, saplings, shrubs in 2–10' zone	Shrub layer: Coniferous seedlings, saplings, shrubs in 2–10' zone	Shrub layer: Mixed deciduous, coniferous vegetation in 2–10' zone	Shrub layer: Ericaceous in 2–10' zone	Shrub layer: Wetland shrubs	Ground cover: Upland herbaceous: <30% coverage in 0–2' zone	Ground cover: Upland herbaceous: 30–75% coverage in 0–2' zone	Ground cover: Upland herbaceous: >75% coverage in 0–2' zone	Ground cover: Emergent wetland vegetation/bank vegetation	Ground: Dead and down material	Ground: Sand / gravel / bare ground surfaces	Miscellaneous: Temporary pools	Miscellaneous: Slash piles	Miscellaneous: Hard mast—nuts	Miscellaneous: Soft mast—fruit, berries
	Black rat snake *Elaphe o. obsoleta*	BR			■	■	■																						■			■	■	
		NB			■	■	■																						■			■	■	
	Eastern milk snake *Lampropeltis t. triangulum*	BR			■	■	■																						■			■	■	
		NB			■	■	■																						■			■	■	
	Great blue heron *Ardea herodias*	BR	■	■																		■	■	■	■	■								
		BF	■	■																		■	■	■	■	■								
		WS																				■	■	■	■	■								
		WF																				■	■	■	■	■								
	Green heron *Butorides virescens*	BR			■	■	■																											
		BF			■	■	■																											
		WS																																
		WF																																
	Turkey vulture *Cathartes aura*	BR			■	■							■											■										
		BF					■							■																				
		WS			■	■																												
		WF					■																											
	Wood duck *Aix sponsa*	BR			■	■	■			■				■												■						■	■	
		BF			■	■	■																											
		WS																																
		WF																																
	American black duck *Anas rubripes*	BR			■	■	■																							■			■	■
		BF			■	■	■																											
		WS																																
		WF																																

Common goldeneye *Bucephala clangula*	BR BF WS WF		■			■	■			■		■		
Hooded merganser *Lophodytes cucullatus*	BR BF WS WF		■			■	■			■		■ ■		
Common merganser *Mergus merganser*	BR BF WS WF		■ ■			■	■			■ ■				
Bald eagle *Haliaeetus leucocephalus*	BR BF WS WF	■ ■ ■ ■	■ ■ ■ ■ ■ ■											
Sharp-shinned hawk *Accipiter striatus*	BR BF WS WF		■ ■ ■ ■ ■ ■	■ ■					■ ■	■ ■				
Cooper's hawk *Accipiter cooperii*	BR BF WS WF		■ ■ ■ ■ ■ ■ ■ ■	■ ■ ■ ■					■ ■	■ ■				
Northern goshawk *Accipiter gentilis*	BR BF WS WF		■ ■ ■ ■ ■ ■ ■ ■ ■ ■	■ ■ ■ ■ ■ ■ ■ ■					■					
Red-shouldered hawk *Buteo lineatus*	BR BF WS WF		■ ■ ■ ■ ■ ■	■ ■ ■ ■					■ ■ ■ ■	■ ■				
Broad-winged hawk *Buteo platypterus*	BR BF WS WF		■ ■ ■	■ ■					■ ■	■				
Red-tailed hawk *Buteo jamaicensis*	BR BF WS WF	■ ■ ■ ■	■ ■ ■ ■ ■	■ ■ ■ ■					■ ■ ■ ■	■ ■				
Golden eagle *Aquila chrysaetos*	BR BF WS WF		■ ■						■ ■ ■	■				

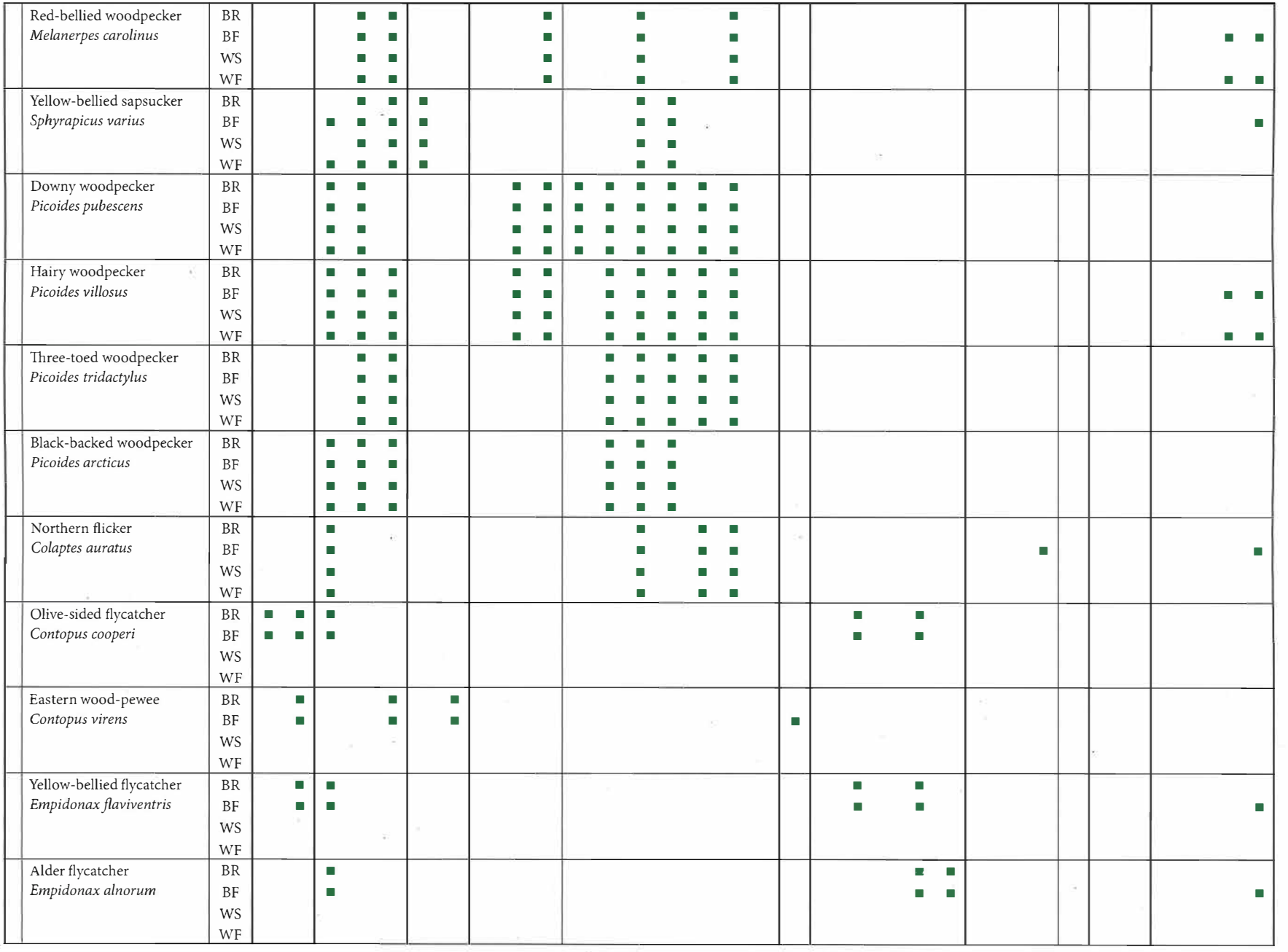
Species Using Forest and Nonforest Habitats (*continued*)

LOCAL OCCURRENCE	SPECIES	SEASONAL USE	Perch or nest: Low exposed	Perch or nest: High exposed	Overstory canopy: Closed, >70%	Overstory canopy: Partial, 31–70%	Overstory canopy: Open, <30%	Inclusions: Coniferous	Inclusions: Deciduous	Tree boles: Adjacent to water: Live, at least 18" dbh	Tree boles: Adjacent to water: Live, at least 12" dbh	Tree boles: Adjacent to water: Dead, at least 6" dbh	Tree boles: General forest: Live, hollow >24" dbh	Tree boles: General forest: Live, broken top or large limb >18" dbh	Tree boles: General forest: Live, broken top, 12–18" dbh	Tree boles: General forest: Live, columnar decay, 8–12" dbh	Tree boles: General forest: Dead and hard, 12–18" dbh	Tree boles: General forest: Dead and hard, 6–12" dbh	Tree boles: General forest: Dead and soft, less than 6" dbh	Midstory—Woody vegetation in 10–30' zone	Shrub layer: Wetland shrubs	Shrub layer: Ericaceous in 2–10' zone	Shrub layer: Mixed deciduous, coniferous vegetation in 2–10' zone	Shrub layer: Coniferous seedlings, saplings, shrubs in 2–10' zone	Shrub layer: Deciduous seedlings, saplings, shrubs in 2–10' zone	Ground cover: Emergent wetland vegetation/bank vegetation	Ground cover: Upland herbaceous: >75% coverage in 0–2' zone	Ground cover: Upland herbaceous: 30–75% coverage in 0–2' zone	Ground cover: Upland herbaceous: <30% coverage in 0–2' zone	Ground: Sand / gravel / bare ground surfaces	Ground: Dead and down material	Miscellaneous: Soft mast—fruit, berries	Miscellaneous: Hard mast—nuts	Miscellaneous: Slash piles	Miscellaneous: Temporary pools
	American kestrel *Falco sparverius*	BR																															
		BF		■																	■	■	■				■	■					
		WS					■										■				■	■					■						
		WF		■			■										■				■	■					■						
	Merlin *Falco columbarius*	BR																															
		BF					■							■	■						■	■		■	■		■	■					
		WS					■							■	■		■				■	■		■	■		■						
		WF					■							■	■		■				■	■		■	■		■						
	Peregrine falcon *Falco peregrinus*	BR																															
		BF																															
		WS																															
		WF																															
	Ruffed grouse *Bonasa umbellus*	BR			■	■		■																■									
		BF					■	■	■															■				■			■		
		WS			■	■		■																■									
		WF					■	■	■															■				■			■		
	Spruce grouse *Falcipennis canadensis*	BR			■	■		■														■	■									
		BF			■	■		■														■	■									
		WS			■	■		■														■	■									
		WF			■	■		■														■	■									
	Wild turkey *Meleagris gallopavo*	BR				■																	■				■			■	■		
		BF					■		■														■				■			■	■		
		WS				■																	■				■			■	■		
		WF					■		■														■				■			■	■		


Northern bobwhite
Colinus virginianus
BR
BF
WS
WF
American woodcock
Scolopax minor
BR
BF
WS
WF
Mourning dove
Zenaida macroura
BR
BF
WS
WF
Black-billed cuckoo
Coccyzus erythropthalmus
BR
BF
WS
WF
Yellow-billed cuckoo
Coccyzus americanus
BR
BF
WS
WF
Eastern screech-owl
Otus asio
BR
BF
WS
WF
Great horned owl
Bubo virginianus
BR
BF
WS
WF
Northern hawk-owl
Surnia ulula
BR
BF
WS
WF
Barred owl
Strix varia
BR
BF
WS
WF
Great gray owl
Strix nebulosa
BR
BF
WS
WF
Long-eared owl
Asio otus
BR
BF
WS
WF

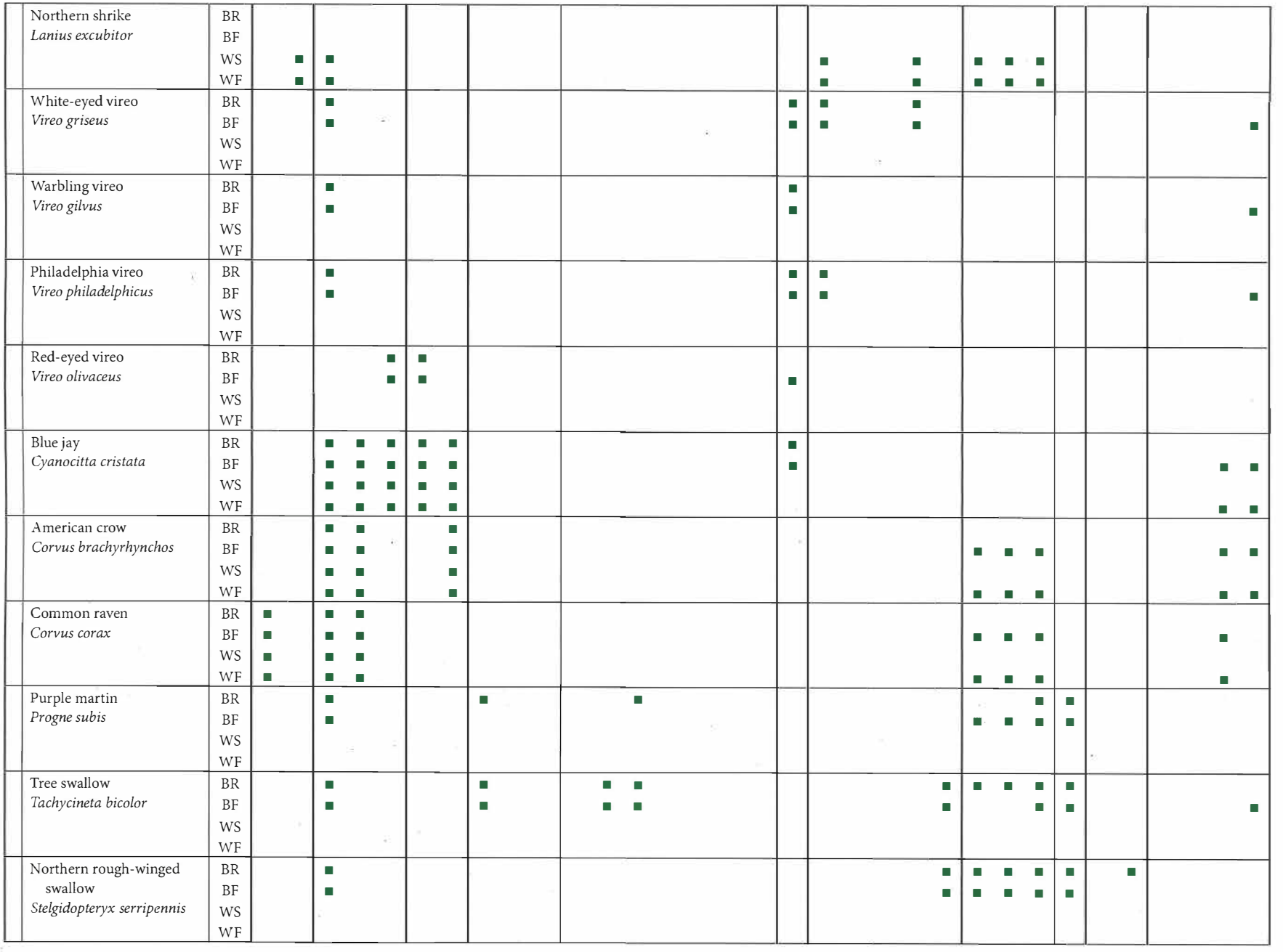
Species Using Forest and Nonforest Habitats *(continued)*

LOCAL OCCURRENCE	SPECIES	SEASONAL USE	Perch or nest	Overstory canopy	Inclusions	Tree boles		Midstory—Woody vegetation in 10–30′ zone	Shrub layer	Ground cover		Ground		Miscellaneous			
						General forest	Adjacent to water			Upland herbaceous	Emergent wetland vegetation/bank vegetation	Dead and down material	Sand / gravel / bare ground surfaces	Temporary pools	Slash piles	Hard mast—nuts	Soft mast—fruit, berries
			High exposed	*Low exposed*	*Deciduous*	*Coniferous*	*Dead, at least 6″ dbh*	*Midstory—Woody vegetation in 10–30′ zone*	*Deciduous seedlings, saplings, shrubs in 2–10′ zone*	*<30% coverage in 0–2′ zone*	*Emergent wetland vegetation/bank vegetation*	*Dead and down material*	*Sand / gravel / bare ground surfaces*	*Temporary pools*	*Slash piles*	*Hard mast—nuts*	*Soft mast—fruit, berries*
									Coniferous seedlings, saplings, shrubs in 2–10′ zone								
									Mixed deciduous, coniferous vegetation in 2–10′ zone	*30–75% coverage in 0–2′ zone*							
									Ericaceous in 2–10′ zone	*>75% coverage in 0–2′ zone*							
									Wetland shrubs								
	Boreal owl *Aegolius funereus*	BR															
		BF															
		WS		■												■	
		WF		■													
	Northern saw-whet owl *Aegolius acadicus*	BR		■	■	■			■								
		BF			■				■								
		WS		■	■	■											
		WF		■	■	■			■								
	Common nighthawk *Chordeiles minor*	BR		■						■			■				
		BF		■						■			■				
		WS															
		WF															
	Whip-poor-will *Caprimulgus vociferus*	BR		■	■					■							
		BF		■	■					■							
		WS															
		WF															
	Ruby-throated hummingbird *Archilochus colubris*	BR		■	■			■	■								
		BF		■	■												
		WS															
		WF															
	Red-headed woodpecker *Melanerpes erythrocephalus*	BR		■	■		■		■							■	■
		BF		■	■		■									■	■
		WS															
		WF															


Red-bellied woodpecker
Melanerpes carolinus
Yellow-bellied sapsucker
Sphyrapicus varius
Downy woodpecker
Picoides pubescens
Hairy woodpecker
Picoides villosus
Three-toed woodpecker
Picoides tridactylus
Black-backed woodpecker
Picoides arcticus
Northern flicker
Colaptes auratus
Olive-sided flycatcher
Contopus cooperi
Eastern wood-pewee
Contopus virens
Yellow-bellied flycatcher
Empidonax flaviventris
Alder flycatcher
Empidonax alnorum
BR
BF
WS
WF

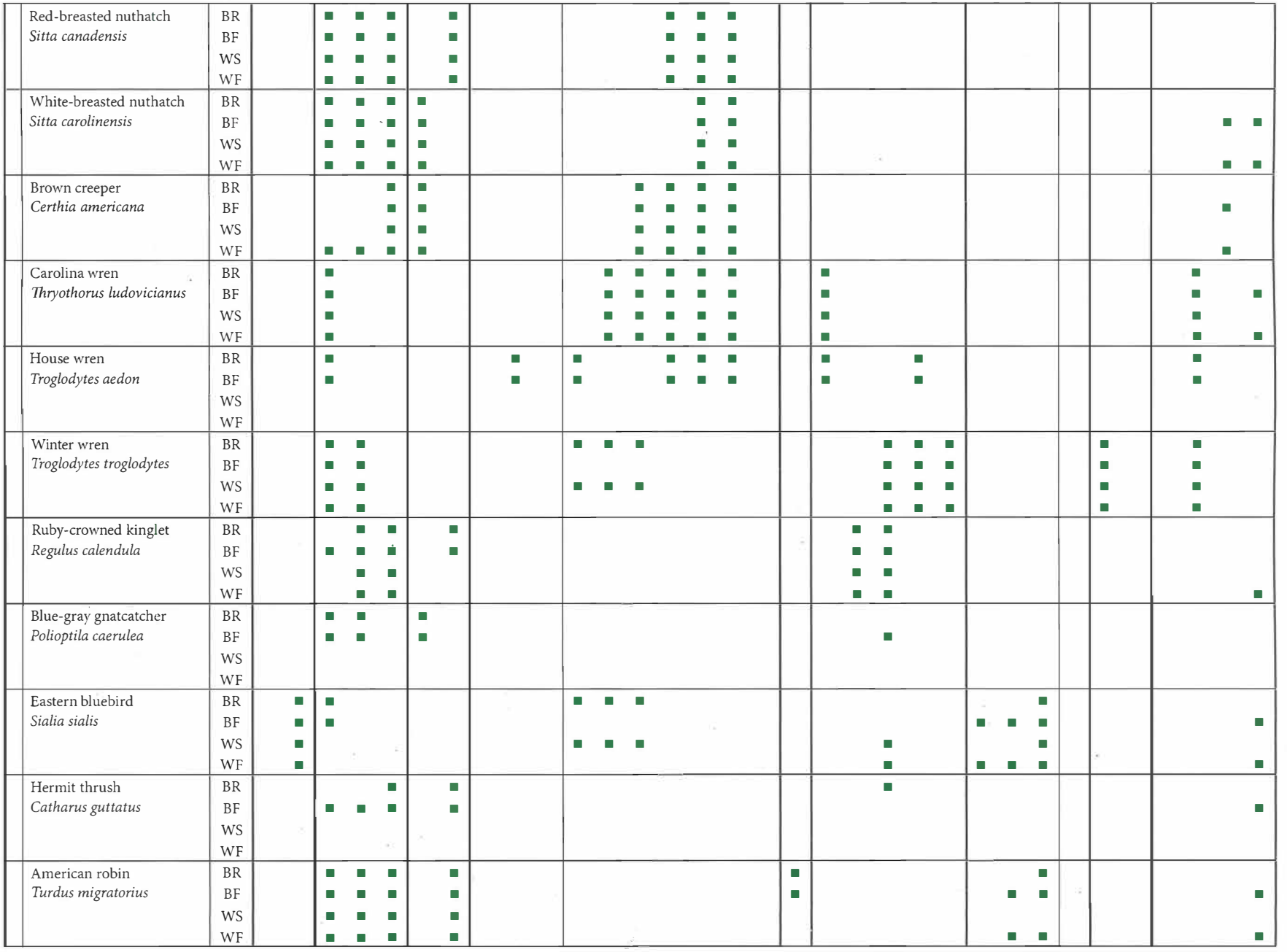
Species Using Forest and Nonforest Habitats *(continued)*

LOCAL OCCURRENCE	SPECIES	SEASONAL USE	Perch or nest: Low exposed	Perch or nest: High exposed	Overstory canopy: Open, <30%	Overstory canopy: Partial, 31–70%	Overstory canopy: Closed, >70%	Inclusions: Deciduous	Inclusions: Coniferous	Tree boles: Adjacent to water: Dead, at least 6" dbh	Tree boles: Adjacent to water: Live, at least 12" dbh	Tree boles: Adjacent to water: Live, at least 18" dbh	Tree boles: General forest: Dead and soft, less than 6" dbh	Tree boles: General forest: Dead and hard, 6–12" dbh	Tree boles: General forest: Dead and hard, 12–18" dbh	Tree boles: General forest: Live, columnar decay, 8–12" dbh	Tree boles: General forest: Live, broken top, 12–18" dbh	Tree boles: General forest: Live, broken top or large limb >18" dbh	Tree boles: General forest: Live, hollow >24" dbh	Midstory—Woody vegetation in 10–30' zone	Shrub layer: Deciduous seedlings, saplings, shrubs in 2–10' zone	Shrub layer: Coniferous seedlings, saplings, shrubs in 2–10' zone	Shrub layer: Mixed deciduous, coniferous vegetation in 2–10' zone	Shrub layer: Ericaceous in 2–10' zone	Shrub layer: Wetland shrubs	Ground cover: Upland herbaceous: <30% coverage in 0–2' zone	Ground cover: Upland herbaceous: 30–75% coverage in 0–2' zone	Ground cover: Upland herbaceous: >75% coverage in 0–2' zone	Ground cover: Emergent wetland vegetation/bank vegetation	Ground: Dead and down material	Ground: Sand / gravel / bare ground surfaces	Miscellaneous: Temporary pools	Miscellaneous: Slash piles	Miscellaneous: Hard mast—nuts	Miscellaneous: Soft mast—fruit, berries
	Willow flycatcher *Empidonax traillii*	BR			■																■				■	■	■	■					
		BF			■																■				■	■	■	■					
		WS																															
		WF																															
	Least flycatcher *Empidonax minimus*	BR				■	■	■														■	■	■		■							
		BF				■	■	■														■	■	■		■							
		WS																															
		WF																															
	Eastern phoebe *Sayornis phoebe*	BR	■	■	■	■		■																			■						
		BF	■	■	■	■		■																			■						
		WS																															
		WF																															
	Great crested flycatcher *Myiarchus crinitus*	BR				■		■											■												■		
		BF				■		■																							■		
		WS																															
		WF																															
	Eastern kingbird *Tyrannus tyrannus*	BR	■	■	■																				■	■							
		BF	■	■	■																				■	■							
		WS																															
		WF																															
	Loggerhead shrike *Lanius ludovicianus*	BR	■	■	■																	■			■	■	■	■					
		BF	■	■	■																	■			■	■	■	■					
		WS																															
		WF																															


Northern shrike
Lanius excubitor
BR
BF
WS
WF
White-eyed vireo
Vireo griseus
BR
BF
WS
WF
Warbling vireo
Vireo gilvus
BR
BF
WS
WF
Philadelphia vireo
Vireo philadelphicus
BR
BF
WS
WF
Red-eyed vireo
Vireo olivaceus
BR
BF
WS
WF
Blue jay
Cyanocitta cristata
BR
BF
WS
WF
American crow
Corvus brachyrhynchos
BR
BF
WS
WF
Common raven
Corvus corax
BR
BF
WS
WF
Purple martin
Progne subis
BR
BF
WS
WF
Tree swallow
Tachycineta bicolor
BR
BF
WS
WF
Northern rough-winged swallow
Stelgidopteryx serripennis
BR
BF
WS
WF

Species Using Forest and Nonforest Habitats *(continued)*

LOCAL OCCURRENCE	SPECIES	SEASONAL USE	Perch or nest: Low exposed	Perch or nest: High exposed	Overstory canopy: Closed, >70%	Overstory canopy: Partial, 31–70%	Overstory canopy: Open, <30%	Inclusions: Coniferous	Inclusions: Deciduous	Tree boles: Adjacent to water: Live, at least 18" dbh	Tree boles: Adjacent to water: Live, at least 12" dbh	Tree boles: Adjacent to water: Dead, at least 6" dbh	Tree boles: General forest: Live, hollow >24" dbh	Tree boles: General forest: Live, broken top or large limb >18" dbh	Tree boles: General forest: Live, broken top, 12–18" dbh	Tree boles: General forest: Live, columnar decay, 8–12" dbh	Tree boles: General forest: Dead and hard, 12–18" dbh	Tree boles: General forest: Dead and hard, 6–12" dbh	Tree boles: General forest: Dead and soft, less than 6" dbh	Midstory—Woody vegetation in 10–30' zone	Shrub layer: Wetland shrubs	Shrub layer: Ericaceous in 2–10' zone	Shrub layer: Mixed deciduous, coniferous vegetation in 2–10' zone	Shrub layer: Coniferous seedlings, saplings, shrubs in 2–10' zone	Shrub layer: Deciduous seedlings, saplings, shrubs in 2–10' zone	Ground cover: Upland herbaceous: >75% coverage in 0–2' zone	Ground cover: Upland herbaceous: 30–75% coverage in 0–2' zone	Ground cover: Upland herbaceous: <30% coverage in 0–2' zone	Ground cover: Emergent wetland vegetation/bank vegetation	Ground: Sand / gravel / bare ground surfaces	Ground: Dead and down material	Miscellaneous: Soft mast—fruit, berries	Miscellaneous: Hard mast—nuts	Miscellaneous: Slash piles	Miscellaneous: Temporary pools
	Bank swallow *Riparia riparia*	BR					■																			■	■	■		■					
		BF					■																			■	■	■							
		WS																																
		WF																																
	Cliff swallow *Petrochelidon pyrrhonota*	BR					■																			■	■	■							
		BF					■																			■	■	■							
		WS																																
		WF																																
	Barn swallow *Hirundo rustica*	BR					■																			■	■	■							
		BF					■																			■	■	■							
		WS																																
		WF																																
	Black-capped chickadee *Poecile atricapillus*	BR			■	■	■													■							■	■	■						
		BF			■	■	■													■							■	■	■						
		WS			■	■	■													■							■	■	■						
		WF			■	■	■													■							■	■	■						
	Boreal chickadee *Poecile hudsonicus*	BR			■	■	■													■							■	■	■						
		BF			■	■	■													■							■	■	■						
		WS																																
		WF																																
	Tufted titmouse *Baeolophus bicolor*	BR			■	■	■	■	■					■						■							■	■	■				■	■	
		BF			■	■	■	■	■																		■	■	■				■	■	
		WS			■	■	■	■	■																		■	■	■				■	■	
		WF			■	■	■	■	■																		■	■	■				■	■	


Red-breasted nuthatch
Sitta canadensis
BR
BF
WS
WF
White-breasted nuthatch
Sitta carolinensis
BR
BF
WS
WF
Brown creeper
Certhia americana
BR
BF
WS
WF
Carolina wren
Thryothorus ludovicianus
BR
BF
WS
WF
House wren
Troglodytes aedon
BR
BF
WS
WF
Winter wren
Troglodytes troglodytes
BR
BF
WS
WF
Ruby-crowned kinglet
Regulus calendula
BR
BF
WS
WF
Blue-gray gnatcatcher
Polioptila caerulea
BR
BF
WS
WF
Eastern bluebird
Sialia sialis
BR
BF
WS
WF
Hermit thrush
Catharus guttatus
BR
BF
WS
WF
American robin
Turdus migratorius
BR
BF
WS
WF

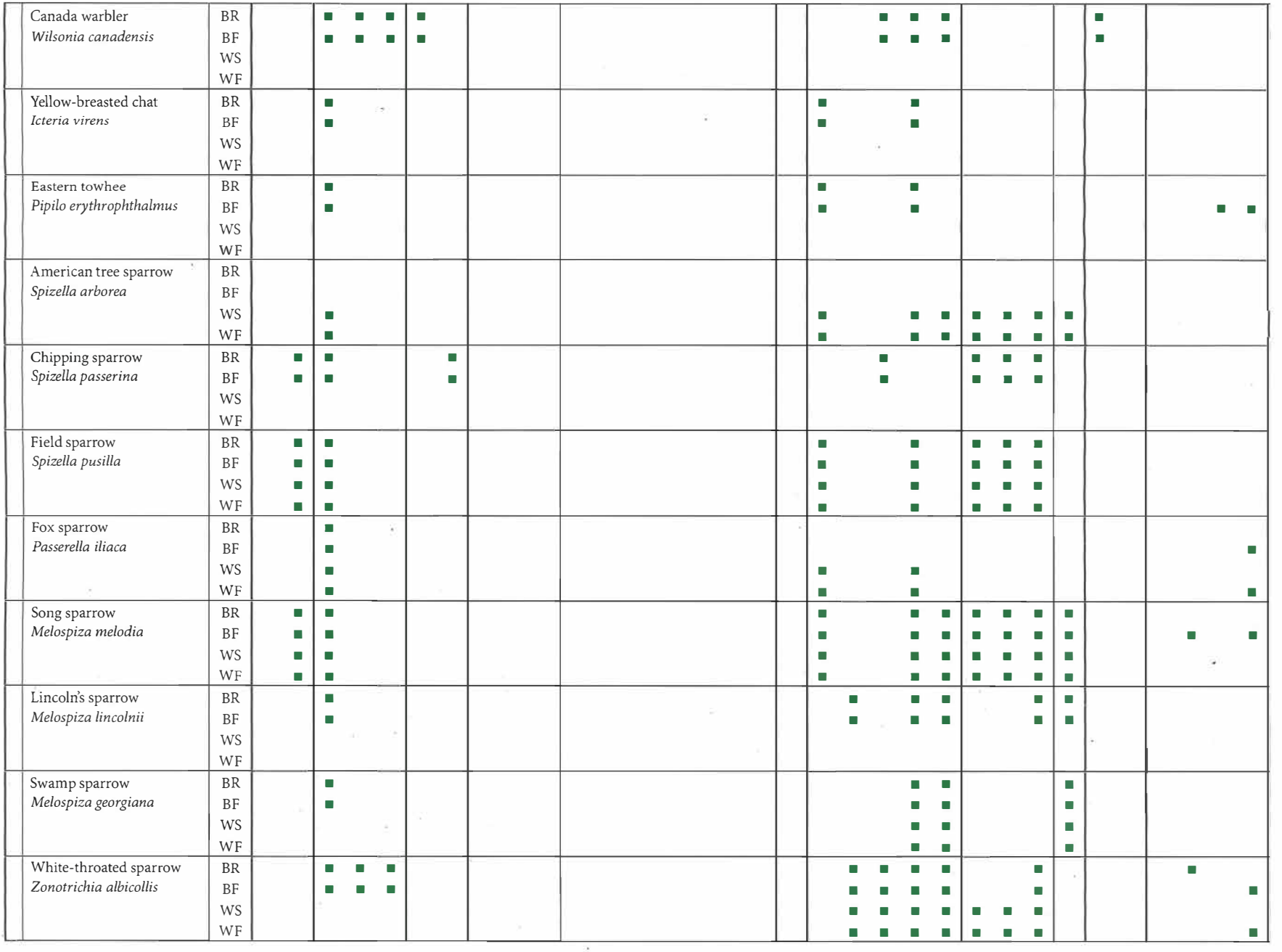
Species Using Forest and Nonforest Habitats *(continued)*

LOCAL OCCURRENCE	SPECIES	SEASONAL USE	Perch or nest: Low exposed	Perch or nest: High exposed	Overstory canopy: Closed, >70%	Overstory canopy: Partial, 31–70%	Overstory canopy: Open, <30%	Inclusions: Coniferous	Inclusions: Deciduous	Tree boles: Adjacent to water: Live, at least 18" dbh	Tree boles: Adjacent to water: Live, at least 12" dbh	Tree boles: Adjacent to water: Dead, at least 6" dbh	Tree boles: General forest: Live, hollow >24" dbh	Tree boles: General forest: Live, broken top or large limb >18" dbh	Tree boles: General forest: Live, broken top, 12–18" dbh	Tree boles: General forest: Live, columnar decay, 8–12" dbh	Tree boles: General forest: Dead and hard, 12–18" dbh	Tree boles: General forest: Dead and hard, 6–12" dbh	Tree boles: General forest: Dead and soft, less than 6" dbh	Midstory—Woody vegetation in 10–30' zone	Shrub layer: Deciduous seedlings, saplings, shrubs in 2–10' zone	Shrub layer: Coniferous seedlings, saplings, shrubs in 2–10' zone	Shrub layer: Mixed deciduous, coniferous vegetation in 2–10' zone	Shrub layer: Ericaceous in 2–10' zone	Shrub layer: Wetland shrubs	Ground cover: Upland herbaceous: <30% coverage in 0–2' zone	Ground cover: Upland herbaceous: 30–75% coverage in 0–2' zone	Ground cover: Upland herbaceous: >75% coverage in 0–2' zone	Ground cover: Emergent wetland vegetation/bank vegetation	Ground: Dead and down material	Ground: Sand / gravel / bare ground surfaces	Miscellaneous: Temporary pools	Miscellaneous: Slash piles	Miscellaneous: Hard mast—nuts	Miscellaneous: Soft mast—fruit, berries
	Gray catbird *Dumetella carolinensis*	BR					■														■				■									■
		BF					■														■				■									■
		WS																																
		WF																																
	Northern mockingbird *Mimus polyglottos*	BR	■				■														■				■		■	■	■					■
		BF	■				■														■				■		■	■	■					■
		WS	■				■														■				■		■	■	■					■
		WF	■				■														■				■		■	■	■					■
	Brown thrasher *Toxostoma rufum*	BR					■														■				■		■	■					■	■
		BF					■														■				■		■	■					■	■
		WS																			■				■									
		WF																			■				■									
	Bohemian waxwing *Bombycilla garrulus*	BR																								■								■
		BF																								■								■
		WS					■																		■	■								
		WF					■																		■	■								
	Cedar waxwing *Bombycilla cedrorum*	BR					■																■		■	■	■	■	■					■
		BF					■																■		■	■	■	■	■					■
		WS					■																■		■	■	■	■	■					■
		WF					■																■		■	■	■	■	■					■
	Blue-winged warbler *Vermivora pinus*	BR					■																			■	■	■						■
		BF					■																			■	■	■						■
		WS																																
		WF																																

	Golden-winged warbler *Vermivora chrysoptera*	BR BF WS WF		■ ■					■ ■		■ ■					
	Tennessee warbler *Vermivora peregrina*	BR BF WS WF		■ ■						■ ■	■ ■	■ ■				
	Nashville warbler *Vermivora ruficapilla*	BR BF WS WF		■ ■ ■ ■		■ ■				■ ■	■ ■	■ ■ ■ ■ ■ ■				
	Northern parula *Parula americana*	BR BF WS WF		■ ■ ■ ■		■ ■			■ ■							
	Yellow warbler *Dendroica petechia*	BR BF WS WF		■ ■		■ ■				■ ■	■ ■ ■ ■	■ ■ ■ ■ ■ ■				
	Chestnut-sided warbler *Dendroica pensylvanica*	BR BF WS WF		■ ■						■ ■	■ ■	■ ■				
	Yellow-rumped warbler *Dendroica coronata*	BR BF WS WF		■ ■		■ ■			■ ■	■ ■	■ ■					■
	Prairie warbler *Dendroica discolor*	BR BF WS WF		■ ■						■ ■ ■ ■	■ ■	■ ■ ■ ■ ■ ■				
	Palm warbler *Dendroica palmarum*	BR BF WS WF		■ ■						■ ■ ■ ■ ■ ■ ■ ■		■ ■				■
	Bay-breasted warbler *Dendroica castanea*	BR BF WS WF		■ ■												
	Black-and-white warbler *Mniotilta varia*	BR BF WS WF		■ ■ ■ ■ ■						■ ■ ■ ■		■ ■			■	

Species Using Forest and Nonforest Habitats *(continued)*

LOCAL OCCURRENCE	SPECIES	SEASONAL USE	Perch or nest: Low exposed	Perch or nest: High exposed	Overstory canopy: Closed, >70%	Overstory canopy: Partial, 31–70%	Overstory canopy: Open, <30%	Inclusions: Coniferous	Inclusions: Deciduous	Tree boles: Adjacent to water: Live, at least 18" dbh	Tree boles: Adjacent to water: Live, at least 12" dbh	Tree boles: Adjacent to water: Dead, at least 6" dbh	Tree boles: General forest: Live, hollow >24" dbh	Tree boles: General forest: Live, broken top or large limb >18" dbh	Tree boles: General forest: Live, broken top, 12–18" dbh	Tree boles: General forest: Live, columnar decay, 8–12" dbh	Tree boles: General forest: Dead and hard, 12–18" dbh	Tree boles: General forest: Dead and hard, 6–12" dbh	Tree boles: General forest: Dead and soft, less than 6" dbh	Midstory—Woody vegetation in 10–30' zone	Shrub layer: Deciduous seedlings, saplings, shrubs in 2–10' zone	Shrub layer: Coniferous seedlings, saplings, shrubs in 2–10' zone	Shrub layer: Mixed deciduous, coniferous vegetation in 2–10' zone	Shrub layer: Ericaceous in 2–10' zone	Shrub layer: Wetland shrubs	Ground cover: Upland herbaceous: <30% coverage in 0–2' zone	Ground cover: Upland herbaceous: 30–75% coverage in 0–2' zone	Ground cover: Upland herbaceous: >75% coverage in 0–2' zone	Ground cover: Emergent wetland vegetation/bank vegetation	Ground: Dead and down material	Ground: Sand / gravel / bare ground surfaces	Miscellaneous: Temporary pools	Miscellaneous: Slash piles	Miscellaneous: Hard mast—nuts	Miscellaneous: Soft mast—fruit, berries
	American redstart *Setophaga ruticilla*	BR			■	■	■		■												■												■
		BF			■	■	■		■												■												■
		WS																															
		WF																															
	Northern waterthrush *Seiurus noveboracensis*	BR			■	■	■																		■	■			■	■			
		BF			■	■	■																		■	■			■	■			
		WS																															
		WF																															
	Louisiana waterthrush *Seiurus motacilla*	BR			■	■																			■	■			■	■			
		BF			■	■																			■	■			■	■			
		WS																															
		WF																															
	Mourning warbler *Oporornis philadelphia*	BR					■		■																								
		BF					■		■																								
		WS																															
		WF																															
	Common yellowthroat *Geothlypis trichas*	BR				■	■																										
		BF				■	■																										
		WS																															
		WF																															
	Hooded warbler *Wilsonia citrina*	BR					■																										
		BF					■																										
		WS																															
		WF																															
	Wilson's warbler *Wilsonia pusilla*	BR					■														■				■	■			■	■			
		BF					■														■				■	■			■	■			
		WS																															
		WF																															


Canada warbler
Wilsonia canadensis
BR
BF
WS
WF
Yellow-breasted chat
Icteria virens
BR
BF
WS
WF
Eastern towhee
Pipilo erythrophthalmus
BR
BF
WS
WF
American tree sparrow
Spizella arborea
BR
BF
WS
WF
Chipping sparrow
Spizella passerina
BR
BF
WS
WF
Field sparrow
Spizella pusilla
BR
BF
WS
WF
Fox sparrow
Passerella iliaca
BR
BF
WS
WF
Song sparrow
Melospiza melodia
BR
BF
WS
WF
Lincoln's sparrow
Melospiza lincolnii
BR
BF
WS
WF
Swamp sparrow
Melospiza georgiana
BR
BF
WS
WF
White-throated sparrow
Zonotrichia albicollis
BR
BF
WS
WF

Species Using Forest and Nonforest Habitats *(continued)*

LOCAL OCCURRENCE	SPECIES	SEASONAL USE	Perch or nest: Low exposed	Perch or nest: High exposed	Overstory canopy: Closed, >70%	Overstory canopy: Partial, 31–70%	Overstory canopy: Open, <30%	Inclusions: Coniferous	Inclusions: Deciduous	Tree boles: General forest: Live, hollow >24" dbh	Tree boles: General forest: Live, broken top or large limb >18" dbh	Tree boles: General forest: Live, broken top, 12–18" dbh	Tree boles: General forest: Live, columnar decay, 8–12" dbh	Tree boles: General forest: Dead and hard, 12–18" dbh	Tree boles: General forest: Dead and hard, 6–12" dbh	Tree boles: General forest: Dead and soft, less than 6" dbh	Tree boles: Adjacent to water: Live, at least 18" dbh	Tree boles: Adjacent to water: Live, at least 12" dbh	Tree boles: Adjacent to water: Dead, at least 6" dbh	Midstory—Woody vegetation in 10–30' zone	Shrub layer: Deciduous seedlings, saplings, shrubs in 2–10' zone	Shrub layer: Coniferous seedlings, saplings, shrubs in 2–10' zone	Shrub layer: Mixed deciduous, coniferous vegetation in 2–10' zone	Shrub layer: Ericaceous in 2–10' zone	Shrub layer: Wetland shrubs	Ground cover: Upland herbaceous: <30% coverage in 0–2' zone	Ground cover: Upland herbaceous: 30–75% coverage in 0–2' zone	Ground cover: Upland herbaceous: >75% coverage in 0–2' zone	Ground cover: Emergent wetland vegetation/bank vegetation	Ground: Dead and down material	Ground: Sand / gravel / bare ground surfaces	Miscellaneous: Temporary pools	Miscellaneous: Slash piles	Miscellaneous: Hard mast—nuts	Miscellaneous: Soft mast—fruit, berries
	Dark-eyed junco *Junco hyemalis*	BR			■	■	■	■													■	■	■	■			■	■	■		■			■
		BF			■	■	■	■													■	■	■	■			■	■	■		■			
		WS			■	■	■	■													■	■	■	■			■	■	■					
		WF			■	■	■	■													■	■	■	■			■	■	■					
	Northern cardinal *Cardinalis cardinalis*	BR	■				■																	■	■	■								■
		BF	■				■																	■	■	■								
		WS	■				■																	■	■	■								
		WF	■				■																	■	■	■								
	Rose-breasted grosbeak *Pheucticus ludovicianus*	BR		■		■	■													■	■												■
		BF		■		■	■													■	■												
		WS																															
		WF																															
	Indigo bunting *Passerina cyanea*	BR	■				■														■	■												■
		BF	■				■														■	■												
		WS																															
		WF																															
	Red-winged blackbird *Agelaius phoeniceus*	BR					■																		■	■								
		BF					■																		■	■								
		WS																															
		WF																															
	Rusty blackbird *Euphagus carolinus*	BR			■	■	■	■														■	■	■	■	■							■
		BF			■	■	■	■														■	■	■	■	■							
		WS																															
		WF																															

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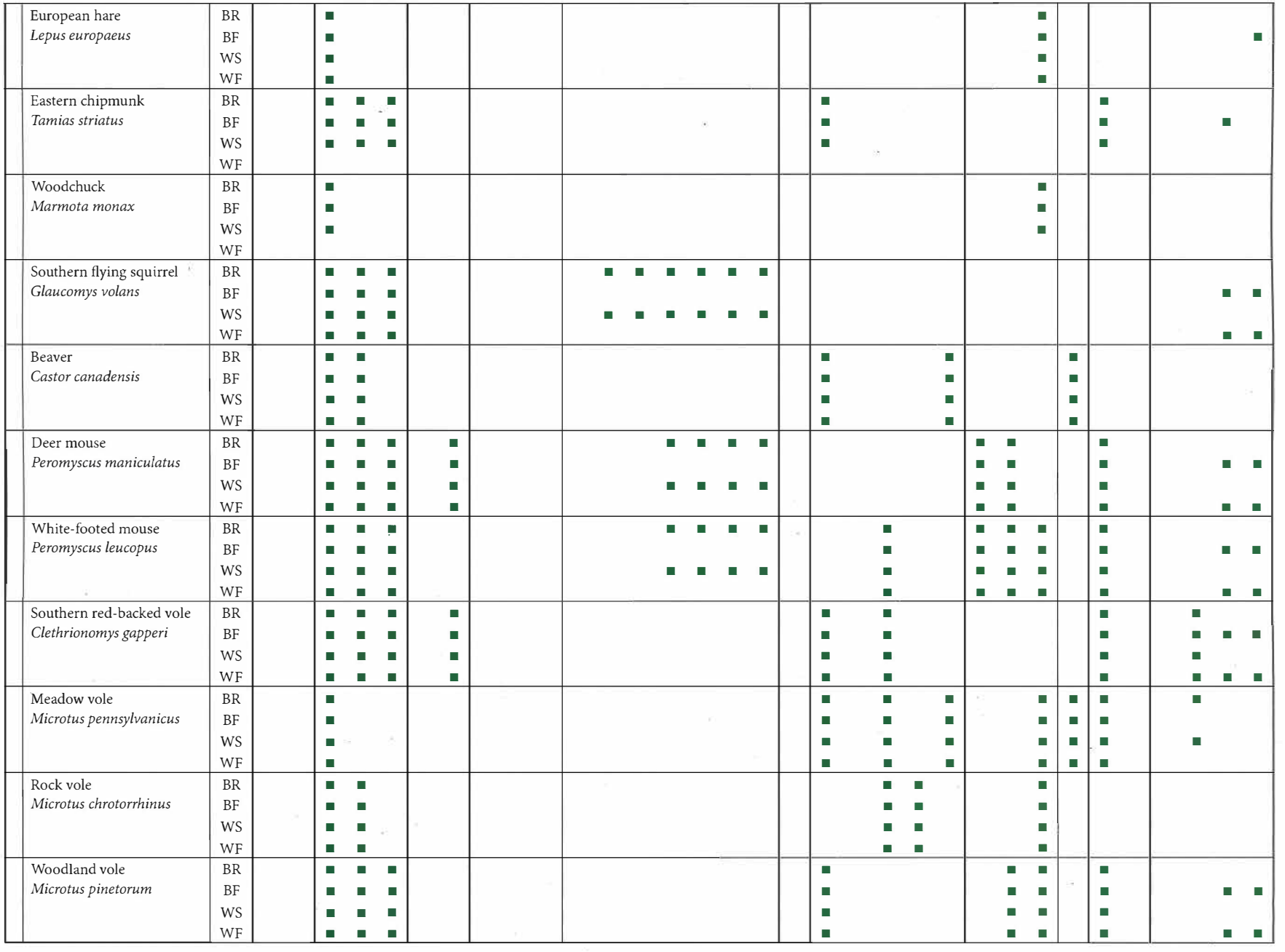
Species Using Forest and Nonforest Habitats *(continued)*

LOCAL OCCURRENCE	SPECIES	SEASONAL USE	Perch or nest: Low exposed	Perch or nest: High exposed	Overstory canopy: Closed, >70%	Overstory canopy: Partial, 31–70%	Overstory canopy: Open, <30%	Inclusions: Coniferous	Inclusions: Deciduous	Tree boles: Adjacent to water: Live, at least 18" dbh	Tree boles: Adjacent to water: Live, at least 12" dbh	Tree boles: Adjacent to water: Dead, at least 6" dbh	Tree boles: General forest: Live, hollow >24" dbh	Tree boles: General forest: Live, broken top or large limb >18" dbh	Tree boles: General forest: Live, broken top, 12–18" dbh	Tree boles: General forest: Live, columnar decay, 8–12" dbh	Tree boles: General forest: Dead and hard, 12–18" dbh	Tree boles: General forest: Dead and hard, 6–12" dbh	Tree boles: General forest: Dead and soft, less than 6" dbh	Midstory—Woody vegetation in 10–30' zone	Shrub layer: Deciduous seedlings, saplings, shrubs in 2–10' zone	Shrub layer: Coniferous seedlings, saplings, shrubs in 2–10' zone	Shrub layer: Mixed deciduous, coniferous vegetation in 2–10' zone	Shrub layer: Ericaceous in 2–10' zone	Shrub layer: Wetland shrubs	Ground cover: Upland herbaceous: <30% coverage in 0–2' zone	Ground cover: Upland herbaceous: 30–75% coverage in 0–2' zone	Ground cover: Upland herbaceous: >75% coverage in 0–2' zone	Ground cover: Emergent wetland vegetation/bank vegetation	Ground: Dead and down material	Ground: Sand / gravel / bare ground surfaces	Miscellaneous: Temporary pools	Miscellaneous: Slash piles	Miscellaneous: Hard mast—nuts	Miscellaneous: Soft mast—fruit, berries
	Evening grosbeak *Coccothraustes vespertinus*	BR			■	■	■	■														■												
		BF			■	■	■	■														■												
		WS			■	■	■	■														■												
		WF			■	■	■	■														■												
	Virginia opossum *Didelphis virginiana*	BR			■	■	■						■		■																■		■	■
		BF			■	■	■																								■		■	■
		WS			■	■	■																								■		■	■
		WF			■	■	■																								■		■	■
	Masked shrew *Sorex cinereus*	BR			■	■	■																									■		
		BF			■	■	■																									■		
		WS			■	■	■																									■		
		WF			■	■	■																									■		
	Water shrew *Sorex palustris*	BR			■	■	■																		■	■	■	■	■	■	■	■		
		BF			■	■	■																		■	■	■	■	■	■	■	■		
		WS			■	■	■																		■	■	■	■	■	■	■	■		
		WF			■	■	■																		■	■	■	■	■	■	■	■		
	Smoky shrew *Sorex fumeus*	BR			■	■	■	■	■																						■			
		BF			■	■	■	■	■																						■			
		WS			■	■	■	■	■																						■			
		WF			■	■	■	■	■																						■			
	Pygmy shrew *Sorex hoyi*	BR			■	■	■																		■	■	■	■	■	■	■	■		
		BF			■	■	■																		■	■	■	■	■	■	■	■		
		WS			■	■	■																		■	■	■	■	■	■	■	■		
		WF			■	■	■																		■	■	■	■	■	■	■	■		

	Northern short-tailed shrew *Blarina brevicauda*	BR		■	■	■	■					■	■	■	■	■			■
		BF		■	■	■	■					■	■	■	■	■			■
		WS		■	■	■	■					■	■	■	■	■			■
		WF		■	■	■	■					■	■	■	■	■			■
	Least shrew *Cryptotis parva*	BR		■										■	■	■		■	
		BF		■										■	■	■		■	
		WS		■										■	■	■		■	
		WF		■										■	■	■		■	
	Hairy-tailed mole *Parascalops breweri*	BR		■	■											■			
		BF		■	■											■			
		WS		■	■											■			
		WF		■	■											■			
	Eastern mole *Scalopus aquaticus*	BR		■	■										■	■			
		BF		■	■										■	■			
		WS		■	■										■	■			
		WF		■	■										■	■			
	Star-nosed mole *Condylura cristata*	BR		■	■											■	■		
		BF		■	■											■	■		
		WS		■	■											■	■		
		WF		■	■											■	■		
	Little brown myotis *Myotis lucifugus*	BR			■	■				■									
		BF		■								■	■			■	■		
		WS								■									
		WF																	
	Northern long-eared bat *Myotis septentrionalis*	BR			■	■				■									
		BF		■								■	■			■	■		
		WS								■									
		WF																	
	Indiana myotis *Myotis sodalis*	BR			■	■				■									
		BF		■								■	■			■	■		
		WS								■									
		WF																	
	Eastern small-footed myotis *Myotis leibii*	BR			■	■													
		BF		■								■	■			■	■		
		WS																	
		WF																	
	Silver-haired bat *Lasionycteris noctivagans*	BR			■	■				■	■								
		BF		■								■	■			■	■		
		WS																	
		WF																	
	Eastern pipistrelle *Pipistrellus subflavus*	BR			■					■									
		BF		■	■							■	■			■	■		
		WS								■									
		WF																	

Species Using Forest and Nonforest Habitats *(continued)*

LOCAL OCCURRENCE	SPECIES	SEASONAL USE	Perch or nest: Low exposed	Perch or nest: High exposed	Overstory canopy: Closed, >70%	Overstory canopy: Partial, 31–70%	Overstory canopy: Open, <30%	Inclusions: Coniferous	Inclusions: Deciduous	Tree boles: Adjacent to water: Live, at least 18" dbh	Tree boles: Adjacent to water: Live, at least 12" dbh	Tree boles: Adjacent to water: Dead, at least 6" dbh	Tree boles: General forest: Live, hollow >24" dbh	Tree boles: General forest: Live, broken top or large limb >18" dbh	Tree boles: General forest: Live, broken top, 12–18" dbh	Tree boles: General forest: Live, columnar decay, 8–12" dbh	Tree boles: General forest: Dead and hard, 12–18" dbh	Tree boles: General forest: Dead and hard, 6–12" dbh	Tree boles: General forest: Dead and soft, less than 6" dbh	Midstory—Woody vegetation in 10–30' zone	Shrub layer: Deciduous seedlings, saplings, shrubs in 2–10' zone	Shrub layer: Coniferous seedlings, saplings, shrubs in 2–10' zone	Shrub layer: Mixed deciduous, coniferous vegetation in 2–10' zone	Shrub layer: Ericaceous in 2–10' zone	Shrub layer: Wetland shrubs	Ground cover: Upland herbaceous: <30% coverage in 0–2' zone	Ground cover: Upland herbaceous: 30–75% coverage in 0–2' zone	Ground cover: Upland herbaceous: >75% coverage in 0–2' zone	Ground cover: Emergent wetland vegetation/bank vegetation	Ground: Dead and down material	Ground: Sand / gravel / bare ground surfaces	Miscellaneous: Temporary pools	Miscellaneous: Slash piles	Miscellaneous: Hard mast—nuts	Miscellaneous: Soft mast—fruit, berries
	Big brown bat *Eptesicus fuscus*	BR			■	■							■											■		■		■						
		BF					■																											
		WS																																
		WF																																
	Red bat *Lasiurus borealis*	BR			■	■							■											■		■		■						
		BF					■																											
		WS																																
		WF																																
	Hoary bat *Lasiurus cinereus*	BR			■	■							■											■		■		■						
		BF					■																											
		WS																																
		WF																																
	Eastern cottontail *Sylvilagus floridanus*	BR				■	■															■		■		■	■	■	■		■			
		BF																																
		WS																																
		WF																																
	New England cottontail *Sylvilagus transitionalis*	BR				■	■															■		■		■	■	■	■		■			
		BF																																
		WS																																
		WF																																
	Snowshoe hare *Lepus americanus*	BR			■	■	■															■	■	■			■	■	■					
		BF																																
		WS																																
		WF																																


European hare
Lepus europaeus
Eastern chipmunk
Tamias striatus
Woodchuck
Marmota monax
Southern flying squirrel
Glaucomys volans
Beaver
Castor canadensis
Deer mouse
Peromyscus maniculatus
White-footed mouse
Peromyscus leucopus
Southern red-backed vole
Clethrionomys gapperi
Meadow vole
Microtus pennsylvanicus
Rock vole
Microtus chrotorrhinus
Woodland vole
Microtus pinetorum
BR
BF
WS
WF

Species Using Forest and Nonforest Habitats *(continued)*

LOCAL OCCURRENCE	SPECIES	SEASONAL USE	Perch or nest: Low exposed	Perch or nest: High exposed	Overstory canopy: Closed, >70%	Overstory canopy: Partial, 31–70%	Overstory canopy: Open, <30%	Inclusions: Coniferous	Inclusions: Deciduous	Tree boles: Adjacent to water: Live, at least 18" dbh	Tree boles: Adjacent to water: Live, at least 12" dbh	Tree boles: Adjacent to water: Dead, at least 6" dbh	Tree boles: General forest: Live, hollow >24" dbh	Tree boles: General forest: Live, broken top or large limb >18" dbh	Tree boles: General forest: Live, broken top, 12–18" dbh	Tree boles: General forest: Live, columnar decay, 8–12" dbh	Tree boles: General forest: Dead and hard, 12–18" dbh	Tree boles: General forest: Dead and hard, 6–12" dbh	Tree boles: General forest: Dead and soft, less than 6" dbh	Midstory—Woody vegetation in 10–30' zone	Shrub layer: Deciduous seedlings, saplings, shrubs in 2–10' zone	Shrub layer: Coniferous seedlings, saplings, shrubs in 2–10' zone	Shrub layer: Mixed deciduous, coniferous vegetation in 2–10' zone	Shrub layer: Ericaceous in 2–10' zone	Shrub layer: Wetland shrubs	Ground cover: Upland herbaceous: <30% coverage in 0–2' zone	Ground cover: Upland herbaceous: 30–75% coverage in 0–2' zone	Ground cover: Upland herbaceous: >75% coverage in 0–2' zone	Ground cover: Emergent wetland vegetation/bank vegetation	Ground: Dead and down material	Ground: Sand / gravel / bare ground surfaces	Miscellaneous: Temporary pools	Miscellaneous: Slash piles	Miscellaneous: Hard mast—nuts	Miscellaneous: Soft mast—fruit, berries
	Southern bog lemming *Synaptomys cooperi*	BR					■															■	■	■	■	■			■	■				■
		BF					■															■	■	■	■	■			■	■				
		WS					■															■	■	■	■	■			■	■				
		WF					■															■	■	■	■	■			■	■				
	Northern bog lemming *Synaptomys borealis*	BR			■	■	■															■	■	■	■	■			■	■				
		BF			■	■	■															■	■	■	■	■			■	■				
		WS			■	■	■															■	■	■	■	■			■	■				
		WF			■	■	■															■	■	■	■	■			■	■				
	Meadow jumping mouse *Zapus hudsonius*	BR					■																	■		■			■			■		
		BF					■																	■		■			■			■		
		WS					■																	■		■			■			■		
		WF					■																	■		■			■			■		
	Woodland jumping mouse *Napaeozapus insignis*	BR			■	■	■																	■		■			■			■	
		BF			■	■	■																	■		■			■			■	
		WS			■	■	■																	■		■			■			■	
		WF			■	■	■																	■		■			■			■	
	Porcupine *Erethizon dorsatum*	BR			■	■	■	■					■																■		■			■
		BF			■	■	■	■																					■		■			■
		WS			■	■	■	■					■																■		■			■
		WF			■	■	■	■																					■		■			■
	Coyote *Canis latrans*	BR			■	■	■																				■	■	■	■				■
		BF			■	■	■																				■	■	■	■				■
		WS			■	■	■																				■	■	■	■				■
		WF			■	■	■																				■	■	■	■				■

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Species Using Forest and Nonforest Habitats *(continued)*

LOCAL OCCURRENCE	SPECIES	SEASONAL USE	Perch or nest: Low exposed	Perch or nest: High exposed	Overstory canopy: Closed, >70%	Overstory canopy: Partial, 31–70%	Overstory canopy: Open, <30%	Inclusions: Coniferous	Inclusions: Deciduous	Tree boles: Adjacent to water: Live, at least 18" dbh	Tree boles: Adjacent to water: Live, at least 12" dbh	Tree boles: Adjacent to water: Dead, at least 6" dbh	Tree boles: General forest: Live, hollow >24" dbh	Tree boles: General forest: Live, broken top or large limb >18" dbh	Tree boles: General forest: Live, broken top, 12–18" dbh	Tree boles: General forest: Live, columnar decay, 8–12" dbh	Tree boles: General forest: Dead and hard, 12–18" dbh	Tree boles: General forest: Dead and hard, 6–12" dbh	Tree boles: General forest: Dead and soft, less than 6" dbh	Midstory—Woody vegetation in 10–30' zone	Shrub layer: Deciduous seedlings, saplings, shrubs in 2–10' zone	Shrub layer: Coniferous seedlings, saplings, shrubs in 2–10' zone	Shrub layer: Mixed deciduous, coniferous vegetation in 2–10' zone	Shrub layer: Ericaceous in 2–10' zone	Shrub layer: Wetland shrubs	Ground cover: Upland herbaceous: <30% coverage in 0–2' zone	Ground cover: Upland herbaceous: 30–75% coverage in 0–2' zone	Ground cover: Upland herbaceous: >75% coverage in 0–2' zone	Ground cover: Emergent wetland vegetation/bank vegetation	Ground: Dead and down material	Ground: Sand / gravel / bare ground surfaces	Miscellaneous: Temporary pools	Miscellaneous: Slash piles	Miscellaneous: Hard mast—nuts	Miscellaneous: Soft mast—fruit, berries
	Mountain lion *Puma concolor*	BR			■	■																											
		BF					■																											
		WS			■	■																											
		WF					■																											
	Lynx *Lynx canadensis*	BR			■	■																		■	■	■							
		BF					■																		■	■								
		WS			■	■	■																		■	■								
		WF					■																		■	■								
	Bobcat *Lynx rufus*	BR			■	■																■	■	■									
		BF				■	■															■	■	■									
		WS			■	■																■	■	■									
		WF				■	■															■	■	■									
	White-tailed deer *Odocoileus virginianus*	BR			■	■																■	■		■				■				
		BF				■	■															■	■		■				■				
		WS			■		■	■	■													■	■		■				■				
		WF				■	■	■	■													■	■		■				■				
	Moose *Alces alces*	BR			■	■	■															■	■	■	■	■			■	■			
		BF				■	■															■	■	■	■	■			■	■			
		WS			■	■	■															■	■	■	■	■			■	■			
		WF				■	■															■	■	■	■	■			■	■			

Species Using Nonforest or Aquatic Habitats Only

LOCAL OCCURRENCE	SPECIES	SEASONAL USE	Perch or nest: Low, exposed	Perch or nest: High, exposed	Overstory canopy: Closed forest, >70%	Overstory canopy: Partial, 31–70%	Overstory canopy: Open, <30%	Inclusions: Coniferous	Inclusions: Deciduous	Tree boles: Adjacent to water: Live, at least 18" dbh	Tree boles: Adjacent to water: Live, at least 12" dbh	Tree boles: Adjacent to water: Dead, at least 6" dbh	Tree boles: General forest: Live, hollow >24" dbh	Tree boles: General forest: Live, broken top or large limb >18" dbh	Tree boles: General forest: Live, broken top, 12–18" dbh	Tree boles: General forest: Live, columnar decay, 8–12" dbh	Tree boles: General forest: Dead and hard, 12–18" dbh	Tree boles: General forest: Dead and hard, 6–12" dbh	Tree boles: General forest: Dead and soft, less than 6" dbh	Midstory—Woody vegetation in 10–30' zone	Shrub layer: Deciduous seedlings, saplings, shrubs in 2–10' zone	Shrub layer: Coniferous seedlings, saplings, shrubs in 2–10' zone	Shrub layer: Mixed deciduous, coniferous vegetation in 2–10' zone	Shrub layer: Ericaceous in 2–10' zone	Shrub layer: Wetland shrubs	Ground cover: Upland herbaceous: <30% coverage in 0–2' zone	Ground cover: Upland herbaceous: 30–75% coverage in 0–2' zone	Ground cover: Upland herbaceous: >75% coverage in 0–2' zone	Ground cover: Emergent wetland vegetation/Bank vegetation	Ground: Dead and down material	Ground: Sand / gravel / bare ground / sandy beach	Miscellaneous: Temporary pools	Miscellaneous: Slash piles	Miscellaneous: Hard mast—nuts	Miscellaneous: Soft mast—fruit, berries
	Common mudpuppy *Necturus maculosus*	BR																																
		NB																																
	Bullfrog *Rana catesbeiana*	BR																							■ ■			■ ■						
		NB																																
	Common snapping turtle *Chelydra s. serpentina*	BR																													■			
		NB																																
	Bog turtle *Clemmys muhlenbergii*	BR																							■ ■	■ ■		■ ■	■ ■					
		NB																						■ ■										
	Map turtle *Graptemys geographica*	BR																							■ ■			■ ■						
		NB																																
	Northern red-bellied cooter *Pseudemys rubriventris bangsi*	BR																										■ ■						
		NB																																
	Painted turtle *Chrysemys picta*	BR																							■ ■			■ ■						
		NB																																
	Common musk turtle *Sternotherus odoratus*	BR																										■ ■						
		NB																																
	Eastern spiny softshell *Apalone s. spinifera*	BR																										■ ■			■			
		NB																																
	Northern water snake *Nerodia s. sipedon*	BR																										■ ■						
		NB																																
	Common loon *Gavia immer*	BR																																
		BF																																
		WS																																
		WF																																

Species Using Nonforest or Aquatic Habitats Only *(continued)*

LOCAL OCCURRENCE	SPECIES	SEASONAL USE	Perch or nest: Low, exposed	Perch or nest: High, exposed	Overstory canopy: Closed forest, >70%	Overstory canopy: Partial, 31–70%	Overstory canopy: Open, <30%	Inclusions: Coniferous	Inclusions: Deciduous	Tree boles: Adjacent to water: Live, at least 18" dbh	Tree boles: Adjacent to water: Live, at least 12" dbh	Tree boles: Adjacent to water: Dead, at least 6" dbh	Tree boles: General forest: Live, hollow >24" dbh	Tree boles: General forest: Live, broken top or large limb >18" dbh	Tree boles: General forest: Live, broken top, 12–18" dbh	Tree boles: General forest: Live, columnar decay, 8–12" dbh	Tree boles: General forest: Dead and hard, 12–18" dbh	Tree boles: General forest: Dead and hard, 6–12" dbh	Tree boles: General forest: Dead and soft, less than 6" dbh	Midstory—Woody vegetation in 10–30' zone	Shrub layer: Wetland shrubs	Shrub layer: Ericaceous in 2–10' zone	Shrub layer: Mixed deciduous, coniferous vegetation in 2–10' zone	Shrub layer: Coniferous seedlings, saplings, shrubs in 2–10' zone	Shrub layer: Deciduous seedlings, saplings, shrubs in 2–10' zone	Ground cover: Upland herbaceous: >75% coverage in 0–2' zone	Ground cover: Upland herbaceous: 30–75% coverage in 0–2' zone	Ground cover: Upland herbaceous: <30% coverage in 0–2' zone	Ground cover: Emergent wetland vegetation/Bank vegetation	Ground: Sand / gravel / bare ground / sandy beach	Ground: Dead and down material	Miscellaneous: Soft mast—fruit, berries	Miscellaneous: Hard mast—nuts	Miscellaneous: Slash piles	Miscellaneous: Temporary pools
	Pied-billed grebe *Podilymbus podiceps*	BR																			■	■							■	■				
		BF																			■	■							■	■				
		WS																			■	■							■	■				
		WF																			■	■							■	■				
	Double-crested cormorant *Phalacrocorax auritus*	BR	■																															
		BF	■																															
		WS																															
		WF																																
	American bittern *Botaurus lentiginosus*	BR																				■	■				■			■	■			
		BF																				■	■							■	■			
		WS																				■	■							■	■			
		WF																				■	■							■	■			
	Least bittern *Ixobrychus exilis*	BR																				■	■				■			■	■			
		BF																				■	■							■	■			
		WS																				■	■							■	■			
		WF																				■	■							■	■			
	Great egret *Ardea alba*	BR		■																		■	■				■			■	■			
		BF																				■	■							■	■			
		WS																				■	■							■	■			
		WF																				■	■							■	■			
	Snowy egret *Egretta thula*	BR																				■	■				■			■	■			
		BF																				■	■							■	■			
		WS																				■	■							■	■			
		WF																				■	■							■	■			

Little blue heron *Egretta caerulea*	BR BF WS WF	■							■ ■ ■ ■		■ ■ ■ ■					
Cattle egret *Bubulcus ibis*	BR BF WS WF								■ ■	■ ■ ■						
Black-crowned night-heron *Nycticorax nycticorax*	BR BF WS WF	■ ■							■ ■		■ ■					
Yellow-crowned night-heron *Nyctanassa violacea*	BR BF WS WF	■							■ ■		■ ■					
Glossy ibis *Plegadis falcinellus*	BR BF WS WF	■							■ ■		■ ■					
Canada goose *Branta canadensis*	BR BF WS WF									■ ■ ■ ■	■ ■ ■ ■					
Mute swan *Cygnus olor*	BR BF WS WF										■ ■ ■ ■					
Gadwall *Anas strepera*	BR BF WS WF								■	■	■ ■					
American wigeon *Anas americana*	BR BF WS WF								■ ■		■ ■					
Mallard *Anas platyrhynchos*	BR BF WS WF								■ ■	■ ■ ■	■ ■ ■					■ ■
Blue-winged teal *Anas discors*	BR BF WS WF								■ ■		■ ■					

Species Using Nonforest or Aquatic Habitats Only *(continued)*

LOCAL OCCURRENCE	SPECIES	SEASONAL USE	Perch or nest: Low, exposed	Perch or nest: High, exposed	Overstory canopy: Closed forest, >70%	Overstory canopy: Partial, 31–70%	Overstory canopy: Open, <30%	Inclusions: Deciduous	Inclusions: Coniferous	Tree boles: Adjacent to water: Live, hollow >24" dbh	Tree boles: Adjacent to water: Live, broken top or large limb >18" dbh	Tree boles: Adjacent to water: Live, at least 18" dbh	Tree boles: Adjacent to water: Live, at least 12" dbh	Tree boles: Adjacent to water: Dead, at least 6" dbh	Tree boles: General forest: Live, broken top, 12–18" dbh	Tree boles: General forest: Live, columnar decay, 8–12" dbh	Tree boles: General forest: Dead and hard, 12–18" dbh	Tree boles: General forest: Dead and hard, 6–12" dbh	Tree boles: General forest: Dead and soft, less than 6" dbh	Midstory—Woody vegetation in 10–30' zone	Shrub layer: Deciduous seedlings, saplings, shrubs in 2–10' zone	Shrub layer: Coniferous seedlings, saplings, shrubs in 2–10' zone	Shrub layer: Mixed deciduous, coniferous vegetation in 2–10' zone	Shrub layer: Ericaceous in 2–10' zone	Shrub layer: Wetland shrubs	Ground cover: Upland herbaceous: <30% coverage in 0–2' zone	Ground cover: Upland herbaceous: 30–75% coverage in 0–2' zone	Ground cover: Upland herbaceous: >75% coverage in 0–2' zone	Ground cover: Emergent wetland vegetation/Bank vegetation	Ground: Dead and down material	Ground: Sand / gravel / bare ground / sandy beach	Miscellaneous: Temporary pools	Miscellaneous: Slash piles	Miscellaneous: Hard mast—nuts	Miscellaneous: Soft mast—fruit, berries
	Northern shoveler *Anas clypeata*	BR BF WS WF																										■ ■						
	Northern pintail *Anas acuta*	BR BF WS WF																							■			■ ■	■ ■					
	Green-winged teal *Anas crecca*	BR BF WS WF																										■ ■	■ ■					
	Canvasback *Aythya valisineria*	BR BF WS WF																																
	Ring-necked duck *Aythya collaris*	BR BF WS WF																							■					■ ■				
	Bufflehead *Bucephala albeola*	BR BF WS WF																																

	Red-breasted merganser *Mergus serrator*	BR BF WS WF									■ ■					
	Osprey *Pandion haliaetus*	BR BF WS WF	■ ■	■ ■												
	Northern harrier *Circus cyaneus*	BR BF WS WF		■ ■ ■ ■									■ ■ ■ ■	■ ■ ■ ■		
	Rough-legged hawk *Buteo lagopus*	BR BF WS WF	 ■ ■	 ■ ■									■ ■ ■ ■ ■ ■			
	Gray partridge *Perdix perdix*	BR BF WS WF											■ ■ ■ ■				
	Ring-necked pheasant *Phasianus colchicus*	BR BF WS WF									■ ■ ■ ■ ■ ■ ■ ■		■ ■ ■ ■ ■ ■ ■ ■ ■ ■ ■ ■			■ ■
	King rail *Rallus elegans*	BR BF WS WF												■ ■		
	Virginia rail *Rallus limicola*	BR BF WS WF												■ ■		
	Sora *Porzana carolina*	BR BF WS WF											■ ■	■ ■		
	Common moorhen *Gallinula chloropus*	BR BF WS WF												■ ■		
	American coot *Fulica americana*	BR BF WS WF												■ ■		

Species Using Nonforest or Aquatic Habitats Only *(continued)*

LOCAL OCCURRENCE	SPECIES	SEASONAL USE	Perch or nest: Low, exposed	Perch or nest: High, exposed	Overstory canopy: Closed forest, >70%	Overstory canopy: Partial, 31–70%	Overstory canopy: Open, <30%	Inclusions: Coniferous	Inclusions: Deciduous	Tree boles: Adjacent to water: Live, at least 18" dbh	Tree boles: Adjacent to water: Live, at least 12" dbh	Tree boles: Adjacent to water: Dead, at least 6" dbh	Tree boles: General forest: Live, hollow >24" dbh	Tree boles: General forest: Live, broken top or large limb >18" dbh	Tree boles: General forest: Live, broken top, 12–18" dbh	Tree boles: General forest: Live, columnar decay, 8–12" dbh	Tree boles: General forest: Dead and hard, 12–18" dbh	Tree boles: General forest: Dead and hard, 6–12" dbh	Tree boles: General forest: Dead and soft, less than 6" dbh	Midstory—Woody vegetation in 10–30' zone	Shrub layer: Wetland shrubs	Shrub layer: Ericaceous in 2–10' zone	Shrub layer: Mixed deciduous, coniferous vegetation in 2–10' zone	Shrub layer: Coniferous seedlings, saplings, shrubs in 2–10' zone	Shrub layer: Deciduous seedlings, saplings, shrubs in 2–10' zone	Ground cover: Upland herbaceous: >75% coverage in 0–2' zone	Ground cover: Upland herbaceous: 30–75% coverage in 0–2' zone	Ground cover: Upland herbaceous: <30% coverage in 0–2' zone	Ground cover: Emergent wetland vegetation/Bank vegetation	Ground: Sand / gravel / bare ground / sandy beach	Ground: Dead and down material	Miscellaneous: Soft mast—fruit, berries	Miscellaneous: Hard mast—nuts	Miscellaneous: Slash piles	Miscellaneous: Temporary pools
	Killdeer *Charadrius vociferus*	BR					■																					■	■					
		BF					■																					■	■					
		WS					■																					■	■					
		WF					■																					■	■					
	Willet *Catoptrophorus semipalmatus*	BR																									■	■		■	■			
		BF																									■	■		■	■			
		WS																									■	■		■	■			
		WF																									■	■		■	■			
	Spotted sandpiper *Actitis macularia*	BR																									■	■		■	■			
		BF																									■	■		■	■			
		WS																									■	■		■	■			
		WF																									■	■		■	■			
	Upland sandpiper *Bartramia longicauda*	BR	■																								■	■		■	■			
		BF	■																								■	■		■	■			
		WS	■																								■	■		■	■			
		WF	■																								■	■		■	■			
	Common snipe *Gallinago gallinago*	BR	■																			■	■							■	■			
		BF	■																			■	■	■	■			■	■	■	■			
		WS	■																			■	■	■	■			■	■	■	■			
		WF	■																			■	■	■	■			■	■	■	■			
	Ring-billed gull *Larus delawarensis*	BR																												■				
		BF																												■				
		WS																												■				
		WF																												■				

	Herring gull *Larus argentatus*	BR BF WS WF									■ ■ ■ ■ ■ ■		■	
	Great black-backed gull *Larus marinus*	BR BF WS WF												
	Common tern *Sterna hirundo*	BR BF WS WF									■		■	
	Black tern *Chlidonias niger*	BR BF WS WF										■ ■		
	Rock dove *Columba livia*	BR BF WS WF									■ ■		■	■
	Barn owl *Tyto alba*	BR BF WS WF						■ ■			■ ■ ■			
	Snowy owl *Nyctea scandiaca*	BR BF WS WF		■ ■							■ ■ ■ ■ ■ ■	■ ■		
	Short-eared owl *Asio flammeus*	BR BF WS WF								■ ■ ■ ■	■ ■ ■ ■ ■ ■ ■ ■ ■ ■ ■ ■	■ ■ ■ ■		
	Chimney swift *Chaetura pelagica*	BR BF WS WF						■		■	■			
	Belted kingfisher *Ceryle alcyon*	BR BF WS WF	■ ■										■	
	Fish crow *Corvus ossifragus*	BR BF WS WF		■ ■ ■ ■						■ ■ ■ ■		■ ■ ■ ■		

Species Using Nonforest or Aquatic Habitats Only *(continued)*

LOCAL OCCURRENCE	SPECIES	SEASONAL USE	Perch or nest: Low, exposed	Perch or nest: High, exposed	Overstory canopy: Closed forest, >70%	Overstory canopy: Partial, 31–70%	Overstory canopy: Open, <30%	Inclusions: Coniferous	Inclusions: Deciduous	Tree boles: Adjacent to water: Live, at least 18" dbh	Tree boles: Adjacent to water: Live, at least 12" dbh	Tree boles: Adjacent to water: Dead, at least 6" dbh	Tree boles: General forest: Live, hollow >24" dbh	Tree boles: General forest: Live, broken top or large limb >18" dbh	Tree boles: General forest: Live, broken top, 12–18" dbh	Tree boles: General forest: Live, columnar decay, 8–12" dbh	Tree boles: General forest: Dead and hard, 12–18" dbh	Tree boles: General forest: Dead and hard, 6–12" dbh	Tree boles: General forest: Dead and soft, less than 6" dbh	Midstory—Woody vegetation in 10–30' zone	Shrub layer: Deciduous seedlings, saplings, shrubs in 2–10' zone	Shrub layer: Coniferous seedlings, saplings, shrubs in 2–10' zone	Shrub layer: Mixed deciduous, coniferous vegetation in 2–10' zone	Shrub layer: Ericaceous in 2–10' zone	Shrub layer: Wetland shrubs	Ground cover: Upland herbaceous: <30% coverage in 0–2' zone	Ground cover: Upland herbaceous: 30–75% coverage in 0–2' zone	Ground cover: Upland herbaceous: >75% coverage in 0–2' zone	Ground cover: Emergent wetland vegetation/Bank vegetation	Ground: Dead and down material	Ground: Sand / gravel / bare ground / sandy beach	Miscellaneous: Temporary pools	Miscellaneous: Slash piles	Miscellaneous: Hard mast—nuts	Miscellaneous: Soft mast—fruit, berries
	Horned lark *Eremophila alpestris*	BR																								■	■	■			■			
		BF																								■	■	■			■			
		WS																								■	■	■			■			
		WF																								■	■	■			■			
	Sedge wren *Cistothorus platensis*	BR																							■									
		BF																							■									
		WS																							■									
		WF																							■									
	Marsh wren *Cistothorus palustris*	BR																													■			
		BF																													■			
		WS																													■			
		WF																													■			
	European starling *Sturnus vulgaris*	BR												■			■	■																
		BF			■																							■	■	■					
		WS					■							■			■	■										■	■	■					
		WF					■																					■	■	■					
	American pipit *Anthus rubescens*	BR																							■									
		BF																							■									
		WS																																
		WF																																
	Vesper sparrow *Pooecetes gramineus*	BR	■																									■	■	■			■		
		BF	■																									■	■	■			■		
		WS	■																									■	■	■			■		
		WF	■																									■	■	■			■		

	Savannah sparrow *Passerculus sandwichensis*	BR BF WS WF										■ ■ ■ ■	■ ■ ■ ■	■ ■ ■ ■			
	Grasshopper sparrow *Ammodramus savannarum*	BR BF WS WF	■ ■									■ ■	■ ■	■ ■			
	Lapland longspur *Calcarius lapponicus*	BR BF WS WF										■ ■				■ ■	
	Snow bunting *Plectrophenax nivalis*	BR BF WS WF										■ ■				■ ■	
	Bobolink *Dolichonyx oryzivorus*	BR BF WS WF											■ ■	■ ■			
	Eastern meadowlark *Sturnella magna*	BR BF WS WF	■ ■ ■ ■										■ ■ ■ ■				
	House sparrow *Passer domesticus*	BR BF WS WF										■ ■ ■ ■	■ ■ ■ ■	■ ■ ■ ■			■
	Black-tailed jackrabbit *Lepus californicus*	BR BF WS WF										■ ■ ■ ■	■ ■ ■ ■				
	Muskrat *Ondatra zibethicus*	BR BF WS WF													■ ■ ■ ■		
	Norway rat *Rattus norvegicus*	BR BF WS WF		■ ■ ■ ■								■ ■	■ ■				■ ■ ■ ■
	House mouse *Mus musculus*	BR BF WS WF		■ ■ ■ ■								■ ■	■ ■	■ ■ ■			■ ■ ■ ■

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