Wildlife Habitat Associations in Eastern Hemlock — Birds, Smaller Mammals, and Forest Carnivores

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Abstract

Ninety-six bird and forty-seven mammal species are associated with the hemlock type in the northeastern United States. Of these species eight bird and ten mammal species are strongly associated with the hemlock type though none of these species are limited to it. Hemlock species richness appears to be lower than in other conifer or hardwood types. Avian habitat considerations include the distribution and variety of structural habitat features throughout managed and unmanaged stands in sustainable patterns. Sawtimber hemlock stands support significantly higher bird communities than young stands. Smaller mammal habitat considerations include dense patches of coniferous regeneration, hard mast-producing inclusions, cavity trees, coarse woody debris, and wetland seeps and inclusions. Forest carnivore habitat considerations include the availability and distribution of predictable prey and suitable cover opportunities (cavity trees, coarse woody debris, wetland seeps and inclusions, and rocky ledge and well-drained den sites). Differences of ten or more inches of annual precipitation distinguish most northern New England landscapes from the majority of landscapes in the western Great Lakes region. Northern New England landscape level habitat elements include lower slope positions and imperfectly drained, excessively drained, or shallow to bedrock sites.

Introduction

Though eastern hemlock (*Tsuga canadensis*) is a well-documented habitat element in winter deer range management throughout the northeastern United States and eastern Canada (Mattfeld 1984; Huot et al. 1984; Blouch 1984; Crawford 1984; Reay et al. 1990), limited research has been conducted specifically on bird and mammal communities in hemlock stands. Roughly 96 avian and 47 mammalian species have been documented using the hemlock type in New England (DeGraaf and Rudis 1986; DeGraaf et al. 1992). Appendix 1 lists eight bird and 10 mammal species strongly associated with the hemlock type.

We review some of the more important landscape and habitat considerations regarding the hemlock type and provide some examples of avian and mammalian habitat associations in the northeastern United States and eastern Canada for birds, small mammals, and forest carnivores.

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Landscape Level Habitat Elements

Eastern hemlock occurs from the Maritime Provinces in eastern Canada to northern Georgia and west into northeastern Minnesota (Godman and Lancaster 1990). Average annual precipitation in New England ranges from 30-50 inches compared to 21-36 inches in the upper Lakes States (McNab and Avers 1994). Average annual snowfall in New England ranges from 40 to 160 inches compared to 40 to 70 inches and in some sections upwards of 250 to 400 inches along the Lake Superior shoreline (McNab and Avers 1994). This has tended to generally produce abundant hemlock regeneration on coniferous sites in New England in contrast to the difficulties faced by forest managers in the upper Lakes States to regenerate hemlock in the face of significant deer densities (Anderson and Loucks 1979; Alverson et al. 1988; Godman and Lancaster 1990; Mladenoff and Stearns 1993).

Hemlock grows on both imperfectly drained and shallow to bedrock sites as well as excessively drained sites as described by Leak (1982). Secondary successional processes on the Bartlett Experimental Forest in the White Mountains of New Hampshire continue to increase the percentage of hemlock basal area on both managed and unmanaged stands on deciduous as well as coniferous land types occurring on lower slope positions (Figure 1) (Leak and Smith 1996). Extrapolating this information across northern New England land types means there are more opportunities to manage hemlock in distinct stands, mixedwood stands, and coniferous inclusions than in the western Great Lakes region.

Hemlock volume in the northeastern United States is considerably greater in New England than the western Great Lakes region (Table 1) (Powell et al. 1993). New Hampshire timberland acreage in hemlock has increased slightly over the last 25 years from 3.2 to 3.7 percent of the total timberland acreage or 148.3 to 165.7 M acres (Cullen, personal communication). Current size-class distribution of hemlock timberland acreage is concentrated in the sawtimber size-class (120.1 M acres) and pole size-class (45.6 M acres), with almost no discernible seedling-sapling size-class acreage. New Hampshire sawtimber volume has increased over the last 25 years from 1508.3 to 2534.1 MMBF, as has growing stock volume from 596.7 to 832.9 MMCF. These numbers suggest that the hemlock resource is distributed across the New England landscape in much different patterns compared to the patterns seen in the western Great Lakes region.

Potential impacts of an expanding hemlock woolly adelgid (*Adelges tsugae*) population concern forest and wildlife managers over the possible loss of significant sources of winter thermal cover in a variety of site types and slope positions (Evans et al. 1996).

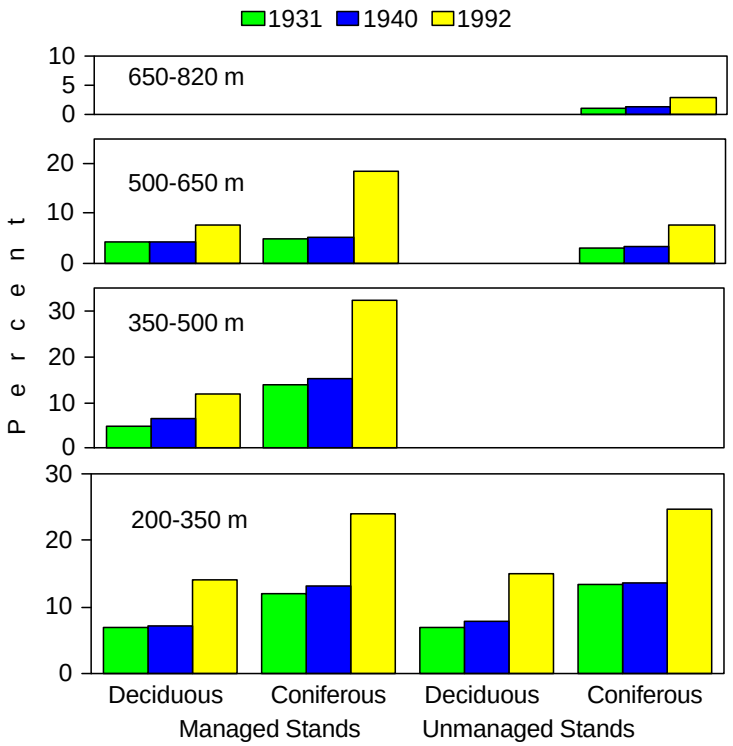

Figure 1.—Percent of hemlock basal area by deciduous and coniferous land types in managed and unmanaged stands and elevation for Bartlett Experimental Forest, New Hampshire (from Leak and Smith 1996).

Table 1.—Eastern hemlock growing stock in million of cubic feet (MMCF), board foot volume in million board feet (MMBF) and acreage of timberland in thousand acres (M acres) in the northeastern United States (from Powell et al. 1992).

Region State	Net Volume	Board Foot Volume	Timberland Acres
	(*MMCF*)	(*MMBF*)	(*M Acres*)
Northeast			
Maine	1397	3920	16987
New Hampshire	586	1594	4760
Vermont	294	1618	4429
Massachusetts	403	1157	2960
Connecticut	231	838	1768
Rhode Island	-	-	371
Totals	2912	9127	31275
North Central			
Michigan	644	2726	17442
Minnesota	-	-	14773
Wisconsin	321	1353	14921
Totals	965	4079	47136

Avian Habitat Examples

Forest habitat selection by breeding birds is mostly a function of vegetative structure (Anderson and Shugart 1974). Forest cover-type and stand size-class have been useful terms in describing the relationship of some cover type obligate species (e.g. boreal chickadee, white-winged crossbill) and size-class obligate species (e.g. magnolia warbler, blackburnian warbler), as well as species that prefer combinations of cover type and size-class (e.g. winter wren, solitary vireo) (DeGraaf and Chadwick 1987). Breeding season bird abundance in forested habitats is also strongly influenced by forest structure (e.g. structural habitat features) not necessarily well-described by forest cover type or size-class designations (DeGraaf et al. 1992; DeGraaf et al. 1998).

Structural habitat features are largely determined by the variability in canopy closure and the resulting effects on the vegetative layers beneath the forest canopy. Structural habitat features include the overstory inclusions that differ from the dominant canopy component (e.g. hardwood or mast-producing tree inclusions in a coniferous canopy), the resultant midstory and understory woody vegetation, and finally the effects of increasing light levels on the herbaceous component usually found under fairly dark ground conditions within hemlock stands. Habitat components such as cavity trees, coarse woody debris, seeps and wetland inclusions, and dry well-drained den sites are other elements influenced by overstory manipulation. Having said this, few studies describe avian use of hemlock stands in the northeastern US and eastern Canada (DeGraaf and Chadwick 1987; DeGraaf et al. 1998; Benzinger 1994a, b; Martin 1960).

Several points become very clear from these studies. Species richness (Table 2) was significantly higher in sawlog or mature stands of hemlock, northern hardwoods, and red maple than in young or pole stands of the same types (DeGraaf and Chadwick 1987). Hemlock type species richness tended to be lower than in the three other coniferous types studied (balsam fir, spruce-fir, and white pine), despite an intermediate tree dbh, low tree density, and the highest shrub density of all the forest types studied (DeGraaf and Chadwick 1987).

Several bird species, black-throated green warbler (see scientific names in Appendix 2) and winter wren, attained the highest numbers of singing males in hemlock relative to any other coniferous, hardwood, or mixedwood type or size-class. Three species, black-throated green warbler, ovenbird, and blackburnian warbler composed 27.5 percent of the total number of singing males in hemlock stands (all size-classes) in 1979-1980 survey period in the White Mountains; and composed 33.7 percent of the total in

Table 2.—Comparison of breeding bird species composition among young (pole) and mature (sawtimber) stands, White Mountains of New Hampshire and Maine, 1979-1980 (DeGraaf and Chadwick 1987).

		Hardwoods				Softwoods			
Birds	Aspen	Paper Birch	Northern Hwds	Swamp Hwds	Oak-Pine	Balsam Fir	White Pine	Spruce-Fir	Eastern Hemlock
Young stands [a]									
No. Individuals	174	144	123	122	-	124	204	148	101
No. Species	30	22	13	21	-	27	40	32	27
Mature stands [b]									
No. Individuals	-	164	167	187	177	131	165	176	169
No. Species	-	23	27	32	31	35	38	35	32

[a]Live softwoods 4-8.9 inches or live hardwoods 4-11.9 inches dbh.
[b]Live softwoods ≥ 9 inches or live hardwoods ≥ 12 inches dbh.

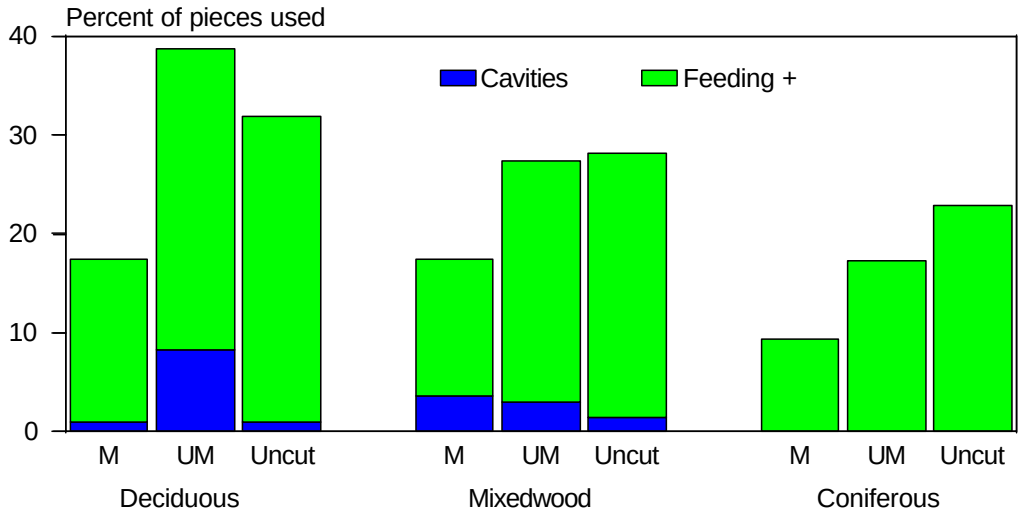

Figure 2.—Percentage of woodpecker usage in coarse woody debris by management type (M = managed, UM = unmanaged, and uncut stands), overstory composition, Bartlett Experimental Forest, New Hampshire (Yamasaki, unpublished data).

1991-1992 survey period. The five most abundant species (the above three species plus black-capped chickadee and solitary vireo) composed 38.3 percent of the total number of singing males in hemlock stands in the 1979-1980 survey period; and composed 46.4 percent of the total in the 1991-1992 survey period (DeGraaf, unpublished data). Similarly black-throated green warbler, blackburnian warbler, solitary vireo, winter wren plus the red-breasted nuthatch showed significant associations with hemlock in New Hampshire, New Jersey, the western Great Lakes region, and southeastern Ontario (Holmes and Robinson 1981; Benzinger 1994a, b; Howe and Mossman 1995; Martin 1960).

During the non-breeding season and throughout winter, eastern hemlock, as individual trees, inclusions, and stands, provide an important seed source for pine siskin, goldfinch, red crossbill, white-winged crossbill, evening grosbeak, as well as for numerous small mammals like red squirrel (DeGraaf and Rudis 1986; Howe and Mossman 1995).

Other important avian hemlock habitat associations include ruffed grouse, yellow-bellied sapsucker, great horned owl, and a number of overwintering forest birds for a variety of reasons. Ruffed grouse habitat management guidelines often addressed the importance of hemlock stands, inclusions, and single trees as high quality fall and winter roosting locations (Edminster 1947; Jordan and Sharp 1967). Conversely, the importance of residual conifers in providing goshawk and great horned owl hunting perches in regenerating hardwood and aspen stands was recognized in the western Great Lakes region by Gullion and Svoboda (1972).

Affinities for hemlock tree boles by foraging and cavity dwelling primary excavators like the yellow-bellied sapsucker

and pileated woodpecker have been recognized by Rushmore (1969) and others. The relationship between yellow-bellied sapsuckers, hemlock ring shake, and the proximity of suitable aspen nesting trees has been recognized Shigo (1963; personal communication). Hemlock tends to be long-lived, develops a number of potential cavity sites and perhaps a higher level of cavity-dwelling and foraging use by an array of woodpeckers, smaller mammals, and forest carnivores. Coarse woody debris found under mixedwood (e.g. mostly hardwood-hemlock) overstory conditions on the Bartlett Experimental Forest shows a higher percentage of woodpecker use than coarse woody debris under more coniferous (e.g. red spruce and balsam fir) overstory conditions (Figure 2) (Yamasaki, unpublished data).

Hemlock in hardwood and mixedwood, as well as in mixed conifer stands can influence usage of these stands by raptors such as the great horned owl, long-eared owl, and barred owl (DeGraaf and Rudis 1986). Great horned owls were observed using larger forested stands with scattered hemlocks more than red-tailed hawks in central New York (Hagar 1957).

Smaller Mammal Habitat Examples

Of the 32 species of insectivores, hares, and rodents that inhabit northeastern forest habitats, roughly 23 species use the hemlock type (DeGraaf et al. 1992). Five species having some preference for hemlock include snowshoe hare, red squirrel, deer mouse, southern red-backed vole, and porcupine (DeGraaf et al. 1991). Limited information exists on any of the nine forest bat species use of the hemlock type.

The deer mouse and southern red-backed vole are two of six species (including masked shrew, short-tailed shrew, white-footed mouse, and woodland jumping mouse) that comprise 92 percent or more of the annual sampling effort in the White Mountains (Yamasaki, unpublished data). Annual small mammal abundance and species richness can fluctuate dramatically due to food availability (e.g. prior year's mast crop) and winter severity (e.g. frozen ground with no snow cover) among other variables. Important structural habitat features to smaller mammal communities include a range of overstory canopy closures. The resulting effects on the midcanopy and shrub layers, and perhaps the patterns of coarse woody debris contribute to the subsequent accessibility of prey by both avian and mammalian predators such as northern goshawk, barred and great horned owls, and typical forest carnivores like fisher, raccoon, red fox, and bobcat (DeGraaf et al. 1992; Powell et al. 1997a, b).

Other important structural habitat features include the overstory inclusions that differ from the dominant canopy component (e.g. mast-producing tree inclusions in a coniferous canopy), patches of regenerating and midstory hemlock and other woody regeneration, and finally the effects of increasing light levels on the herbaceous component usually found under fairly dark ground conditions within hemlock stands. Preliminary data inspection for relationships between the most commonly trapped small mammal species in the White Mountains and increasing coniferous basal area suggests a positive relationship for southern red-backed vole and perhaps white-footed mouse, an inverse relationship for woodland jumping mouse and short-tailed shrew, and no apparent relationship for deer mouse and masked shrew (Yamasaki, unpublished data). Cavity trees, both live and dead, provide summer roosting opportunities for forest bats; the hoary bat is known to roost in coniferous foliage (DeGraaf and Rudis 1986).

Snowshoe hare use very dense coniferous (including hemlock) understories in winter (O'Donoghue 1983; Litvaitis 1985; Monthey 1986) that are often found in regenerating patches in mixedwood and coniferous stands. Significant snowshoe hare predators include fisher, bobcat, and northern goshawk.

Species like gray squirrel, eastern chipmunk, and northern flying squirrel also use hemlock stands and inclusions, especially when hard mast-producing trees such as beech (*Fagus grandifolia*) and oak (*Quercus* spp.) are present in the overstory even though hemlock is not their preferred habitat (DeGraaf et al. 1992).

The porcupine-hemlock habitat relationship is a complex one. Porcupines often find suitable foraging sites and denning sites in both large diameter cavity trees and large down hollow logs, and rocky ledges in hemlock stands and inclusions often in wintering deer areas (Dodge 1982; Griesemer et al. 1994). Porcupines cut branches from the tops of the trees; the branches fall to the ground and often are consumed by deer. White-tailed deer and porcupine seem to have a symbiotic relationship with mature hemlock in the winter.

Forest Carnivore Habitat Examples

Thirteen of 14 wide-ranging carnivore species that inhabit forest habitats in New England use the hemlock type (DeGraaf et al. 1992). Four species, red fox, black bear, marten, and bobcat appear to have some seasonal preference for the hemlock type (Harrison et al. 1989; Elowe 1984; Strickland and Douglas 1987; DeGraaf and Rudis 1986). For red fox this may be partly attributed to the spatial relationship of hemlock and other softwoods to lower slope positions and riparian (e.g. lakeshore, stream, and river) habitats, as well as coyote avoidance (Voigt and Earle 1983).

Black bear are known to forage in wetland seeps, swales, and riparian drainages in the spring for ephemeral herbaceous forage (e.g. skunk cabbage, various sedges, grasses, and tubers) present in these habitat conditions (Elowe 1984). Female black bear use softwood riparian areas in Maine when hard mast crops are marginal (Schooley 1990). Vander Haegen and DeGraaf (1996) found black bear travelling softwood tributary buffer zones between forested watersheds. Coarse woody debris is a source of grubs and ants especially in the spring and large hollow

trees and logs, and slash piles can be winter den sites (DeGraaf and Rudis 1986).

Fisher use the hemlock type extensively in New England (Kelly 1977). Hemlock and mixedwood stands and inclusions were selected by female fishers as spring-early summer den sites at greater rates than hemlock was available in central New England (Powell et al. 1997a). This seasonal pattern of use is similar but not as strong as winter fisher use of available hemlock in the western Great Lakes region (Thomasma et al. 1994). This may be due in part, to the diffuse pattern of hemlock and other softwood occurrence and distribution in New England.

Fisher and bobcat are opportunistic foragers, hunting in regenerating and mature mixedwood and softwood areas with abundant prey bases (e.g. snowshoe hare, cottontails, red, gray, and flying squirrels, voles and mice, and even raccoon and dead deer) (Giuliano et al. 1989; Arthur et al. 1989; Powell et al. 1997b; Litvaitis et al 1986). Some speculate that female fisher also select denning sites in areas supporting wintering deer populations, as reliable sources of food (e.g. deer carcasses) during kit rearing activities (Kelly 1977). Female fisher can move their kits up to four times per litter (Powell et al. 1997a), so higher densities of maternal den trees in hemlock and other coniferous stands and inclusions may be warranted for fisher, raccoon, marten, and other mammal cavity-dwellers, as well as a significant coarse woody debris component. Talus piles, rocky ledge sites, and well-drained den sites used by bobcat also are often found in places where the hemlock type occurs (McCord and Cardoza 1982).

Summary

Hemlock seems to be an important component of the habitat requirements of a number of avian and mammalian species. As we have seen from the many adelgid-related presentations in this symposium, concerns over the future of eastern hemlock habitat in New England pose many more questions on the potential effects to a broader range of wildlife species than just for white-tailed deer. A disruption of the patterns of hemlock cover through the region could have some significant effects on future species occurrence and distribution patterns.

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Appendix 1.

Bird and mammal species strongly associated with eastern hemlock habitats in the northeastern United States (adapted from DeGraaf et al. 1992).

	Structural Habitat Features								
Species	Closed conifer canopy	Dens / tree cavities	Dense understory / thickets	Wetland inclusions / seeps	Down woody debris	Mast	Rock ledges/ talus	Well-drained den sites	Forest clearings nearby
Birds									
Great Horned Owl		X							
Long-eared Owl	X		X	X					X
Northern Saw-whet Owl		X							X
Blue-headed or Solitary Vireo	X								
Blue Jay						X			
Red-breasted Nuthatch		X							
Hermit Thrush			X						
Black-throated Green Warbler			X						
Mammals									
Snowshoe Hare			X						
Red Squirrel	X								
Deer Mouse					X	X			
Southern Red-backed Vole				X	X	X			
Porcupine		X					X		
Red Fox								X	X
Black Bear				X	X	X	X		
Marten		X			X				
Bobcat			X				X		
White-tailed Deer	X		X			X			

Appendix 2.

Common and Scientific Names of Bird and Mammal Species Using Hemlock Mentioned in this Paper.

Common Name	Scientific Name
Birds	
Northern Goshawk	*Accipiter gentilis*
Red-tailed Hawk	*Buteo jamaicensis*
Ruffed Grouse	*Bonasa umbellus*
Great Horned Owl	*Bubo virginianus*
Barred Owl	*Strix varia*
Long-eared Owl	*Asio otus*
Northern Saw-whet Owl	*Aegolius acadicus*
Yellow-bellied Sapsucker	*Sphyrapicus varius*
Pileated Woodpecker	*Dryocopus pileatus*
Blue-headed or Solitary Vireo	*Vireo solitarius*
Blue Jay	*Cyanocitta cristata*
Black-capped Chickadee	*Poecile atricapillus*
Red-breasted Nuthatch	*Sitta canadensis*
Winter Wren	*Troglodytes troglodytes*
Golden-crowned Kinglet	*Regulus satrapa*
Ruby-crowned Kinglet	*Regulus calendula*
Hermit Thrush	*Catharus guttatus*
Magnolia Warbler	*Dendroica magnolia*
Black-throated Green Warbler	*Dendroica virens*
Blackburnian Warbler	*Dendroica fusca*
Ovenbird	*Seiurus aurocapillus*
Red Crossbill	*Loxia curvirostra*
White-winged Crossbill	*Loxia leucoptera*
Pine Siskin	*Carduelis pinus*
American Goldfinch	*Carduelis tristis*
Evening Grosbeak	*Coccothraustes vespertinus*
Mammals	
Masked Shrew	*Sorex cinereus*
Short-tailed Shrew	*Blarina brevicauda*
Hoary Bat	*Lasiurus cinereus*
Cottontails	*Sylvilagus* sp.
Snowshoe Hare	*Lepus americanus*
Eastern Chipmunk	*Tamias striatus*
Gray Squirrel	*Sciurus carolinensis*
Red Squirrel	*Tamiasciurus hudsonicus*
Northern Flying Squirrel	*Glaucomys sabrinus*
Deer Mouse	*Peromyscus maniculatus*
White-footed Mouse	*Peromyscus leucopus*
Southern Red-backed Vole	*Clethrionomys gapperi*
Woodland Jumping Mouse	*Napaeozapus insignis*
Porcupine	*Erethizon dorsatum*
Coyote	*Canis latrans*
Red Fox	*Vulpes vulpes*
Black Bear	*Ursus americanus*
Raccoon	*Procyon lotor*
Marten	*Martes americana*
Fisher	*Martes pennanti*
Bobcat	*Lynx rufus*
White-tailed Deer	*Odocoileus virginianus*