

## A REVIEW OF THE STATUS AND DISTRIBUTION OF NORTHERN GOSHAWKS IN NEW ENGLAND

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**ABSTRACT.**—The Northern Goshawk (*Accipiter gentilis*) is a resident breeder throughout much of the forested landscape of New England and a winter resident in most of New England, except possibly for extreme northern portions. Historically, goshawk numbers and distribution presumably declined as agriculture and logging grew to dominate the region in the 19<sup>th</sup> century when large parts of New England were cleared upwards of 75% of the forest cover. Goshawks likely responded to reforestation during the middle and latter decades of the 20<sup>th</sup> century. However, most biologists agree that although goshawk numbers may be stable or perhaps increasing slightly today, their true status and distribution in this six-state region is largely unknown. Goshawks in New England nest in mature regrown coniferous, deciduous, and mixed forest. From a landscape perspective, conservation, maintenance, and enhancement of mature forest, as well as early successional-stage cover, are both necessary for this species in New England. Restoration and management of these cover types would benefit not only goshawks and their prey, but also a significant portion of the region's biodiversity. Because of the extensive and intensive relationships humans have had with the New England landscape over the past three centuries, the region would make a valuable subject area for long-term monitoring and research on a wide-ranging top-level predator such as the goshawk.

**KEY WORDS:** *Northern Goshawk; Accipiter gentilis; Connecticut; distribution; Maine; Massachusetts; New Hampshire; New England; northeastern U.S.; Rhode Island; Vermont; status.*

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### UNA REVISIÓN SOBRE EL ESTADO Y LA DISTRIBUCIÓN DE *ACCIPITER GENTILIS* EN NUEVA INGLATERRA

**RESUMEN.**—*Accipiter gentilis* es un ave residente que nidifica a lo largo de la mayor parte de los bosques de la región de Nueva Inglaterra, y un residente invernal en casi toda Nueva Inglaterra con excepción posiblemente de las porciones más extremas del norte. Históricamente, los números y la distribución de *A. gentilis* presumiblemente disminuyeron a medida que la agricultura y la tala aumentaron hasta dominar la región durante el siglo XIX, cuando grandes partes de Nueva Inglaterra fueron deforestadas, transformándose más del 75% de la cobertura del bosque. Luego *A. gentilis* probablemente respondió a la reforestación a partir de mediados del siglo XX. Sin embargo, la mayoría de los biólogos coinciden con que, aunque los números de *A. gentilis* pueden permanecer estables o tal vez haber incrementando levemente en la actualidad, su verdadero estatus y distribución son básicamente desconocidos en esta región que comprende seis estados. *A. gentilis* nidifica en Nueva Inglaterra en bosques regenerados maduros de coníferas, en bosques deciduos y en bosques mixtos. Desde una perspectiva del paisaje, la conservación, mantenimiento y mejoramiento del bosque maduro y de las etapas sucesionales tempranas, son una preocupación en Nueva Inglaterra. La restauración y el manejo de estos tipos de cobertura beneficiarían no sólo a *A. gentilis* y a sus presas, sino también a una porción significativa de la biodiversidad de la región. Debido a las relaciones extensas e intensas que los humanos han tenido con el paisaje de Nueva Inglaterra a lo largo de los últimos tres siglos, la región sería un área piloto interesante y valiosa para el monitoreo y la investigación a largo plazo de un depredador tope con un área de acción amplia como *A. gentilis*.

[Traducción del equipo editorial]

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Much attention has focused on the Northern Goshawk (*Accipiter gentilis*) in the western United States west of the 100<sup>th</sup> meridian (Kennedy 1997, Crocker-Bedford 1998, DeStefano 1998, Andersen et al. 2003). However, the species is holarctic in distribution and is found in boreal and northern temperate forests in the northern hemisphere of North America and Eurasia (Squires and Reynolds 1997). In the northeastern U.S., the goshawk is found regularly throughout this region, including in all six New England states and as far south as Maryland and West Virginia (Squires and Reynolds 1997).

Much of the interest and concern for goshawks in the western U.S. is related to forest management practices, in particular the cutting of large trees and conversion of the forested landscape from late to early-seral-stage forest (DeStefano 1998). However, in the eastern U.S., woody vegetation and re-growth forest has increased to such an extent that biologists are now concerned with the lack of early-seral-stage habitats, such as grasslands and shrublands, and the loss of some forest types such as aspen (*Populus* spp.) and the species they supported (Askins 2001, Thompson and DeGraaf 2001).

The northeastern U.S., and New England in particular, have a long history of human occupation and land-use change, even before European settlement (Cronin 1983). In the 18<sup>th</sup> and 19<sup>th</sup> centuries, clearing for agriculture and timber altered the entire region (DeGraaf and Yamasaki 2001). Much of New England is reforested today, and it is unknown but unlikely that these second- or multiple-growth forests are similar—and certainly are not identical—to the original forests of 300–350 yr ago (Cogbill et al. 2002).

The primary question in the eastern U.S., one that has implications for goshawk management in the western U.S., is what is the status and distribution of Northern Goshawks in the greatly transformed landscapes of the Northeast? The objectives of this paper are to examine that question by reviewing recent accounts and expert opinion on the status of Northern Goshawks, describe the distribution of goshawks in the New England states in light of historical changes and current conditions, and attempt to assess the status of the species in this region. I then make suggestions for potential long-term, multi-state research over large landscapes in New England.

#### STUDY AREA

I restricted my review of the status and distribution of Northern Goshawks in the Northeast to New England. The six New England states (Connecticut, Rhode Island, Massachusetts, Vermont, New Hampshire, and Maine) cover ca. 163 200 km<sup>2</sup> and form an identifiable political and regional entity. This review could have also included New York, Pennsylvania, Maryland, New Jersey, and other states to the south, but New England forms a convenient and manageable region for addressing questions of status and distribution. More importantly, there are more extensive long-term records and documentation of land-use change for New England than any other region of the country (Cogbill et al. 2002, Foster 2002), in addition to well-studied, species-habitat relationships (DeGraaf and Yamasaki 2001). Nonetheless, many other parts of the Northeast share similar land-use histories with New England, and at least some of the insights and speculation provided here regarding the status and distribution of Northern Goshawks in New England will be similar for other northeastern states.

New England is diverse in vegetation, topography, climate, and other ecological factors, but in general is dominated by deciduous, mixed deciduous-coniferous, and coniferous forest as one moves from south to north (DeGraaf and Yamasaki 2001). Summers are warm and humid; winters are usually cold and snowy. Precipitation in the form of rain and snow is highly variable and based on many factors, such as latitude, elevation, and proximity to the coast, but generally ranges from 90–140 cm annually. Numerous lakes, ponds, rivers, and wetlands cover the region. Major mountain ranges include the Berkshire Mountains, which extend from western Connecticut through Massachusetts, the Taconic Mountains of Massachusetts, Green Mountains of Vermont, and White Mountains and Mahoosics of New Hampshire and Maine. The entire region was glaciated, and erosion has been a major influence on the landforms present today.

Six forest regions have been identified in New England. Major tree species that characterize some of these regions include pitch pine (*Pinus rigida*), oaks (*Quercus* spp.), eastern hemlock (*Tsuga canadensis*), eastern white pine (*Pinus strobus*), red spruce (*Picea rubens*), and balsam fir (*Abies balsamea*). These forest regions, in a general south to north distribution, are pitch pine-oak (on Cape Cod), central hardwoods-hemlock-white pine, transition hardwoods-white pine, northern hardwoods, northern hardwoods-spruce, and spruce-fir (DeGraaf and Yamasaki 2001). American beech (*Fagus grandifolia*), birches (*Betula* spp.), sugar maple (*Acer saccharum*) and several other maples, hickories (*Carya* spp.), ashes (*Fraxinus* spp.), cherries (*Prunus* spp.), and aspens are other major tree species. Disturbance to forest growth and structure is common in New England; DeGraaf and Yamasaki (2001) identify and discuss five major types of disturbances that have altered New England's forest, including windthrow, fire, exotic pests and pathogens, agriculture, and logging.

Much of southern New England is highly urbanized, with some of the highest densities of people in the country. However, substantial portions of the region are still rural. Most of the forest land (some 120 000 km<sup>2</sup> or >70%) is privately owned by >760 000 different owners and divided into small parcels and woodlots of nonin-

dustrial-private forest (commonly abbreviated as NIPF lands), but there are large privately owned commercial timberlands in the north, particularly in Maine (Birch 1996). Federal land is much less common in the East than the West, but there are two national forests in the region: the Green Mountain National Forest in Vermont and the White Mountain National Forest in New Hampshire and Maine.

#### METHODS

I reviewed written accounts, both recent and historical, of the Northern Goshawk and related land-use changes in New England. I also summarized information reported from breeding bird atlases, which have been published for all six states. I examined long-term trends in numbers for both breeding and wintering goshawks by querying web databases for the North American Breeding Bird Survey (BBS; <http://www.mp2-pwrc.usgs.gov/bbs/>) and the National Audubon Society's Christmas Bird Counts (CBC; <http://audubon2.org/birds/cbc/hr/graph.html>). Finally, I queried local experts in each state to gather their knowledge on the status and distribution of goshawks. I defined an expert as anyone currently working as a professional biologist with a state or federal agency or a recognized non-governmental organization, who had a focus on raptors, threatened or endangered species, or forest wildlife. I asked a series of eight questions, which addressed issues related to status, distribution, population trends, habitat use, relationship to mature forest and young, early-successional forest, and prey. Questions were sent to biologists in each state and at the Green Mountain and White Mountain National Forests.

#### RESULTS

**Historical and Recent Accounts of New England Forests.** Before European settlement, the Northeast was probably a mix of forested and open habitats. Native prairie and forests cleared by Native American activities were common in southern New England, while beaver (*Castor canadensis*) meadows, periodic fires, and hurricanes created a shifting mosaic of forest and open habitats throughout the region (Cronin 1983, DeGraaf and Yamasaki 2001, Lorimer 2001, Parshall and Foster 2002). Interior and northern regions were more heavily forested than coastal sections or lands along major rivers (DeGraaf and Yamasaki 2001).

The history of New England since the time of European settlement embodies major and constant anthropogenic change (Hall et al. 2002). Foster et al. (2002) characterized these changes to the New England landscape as a continual transformation involving deforestation, intensive agriculture, farm abandonment, reforestation, and human population increase. Land was first cleared slowly for settlements and agriculture until the 1750s, after which the pace accelerated until 75% of the arable

land in central and southern New England was in pasture and crops by the first half of the 1800s (DeGraaf and Yamasaki 2001). Many of the largest trees, such as eastern white pines, were cut to provide masts for ships, first for the British navy before the Revolutionary War and then for the U.S. navy after the war (Walker 1999). Around 1910, the last major logging occurred when primarily white pines were harvested. These sites grew into hardwoods and supported large populations of Ruffed Grouse (*Bonasa umbellus*) during the 1920s and 1930s (DeGraaf and Yamasaki 2001). Today, about 65% of southern New England and >90% of northern New England are forested (DeGraaf and Yamasaki 2001). Each year the age and extent of forest in southern and central New England increases (Brooks and Birch 1988, DeGraaf and Yamasaki 2001).

Today, the evolution of the New England landscape is marked at least partially by what is no longer there. Remnants of what may be called old-growth forest make up <1% of the forests of New England (Davis 1996, Cogbill et al. 2002). Thus, the woodlands of the Northeast could be described as multiply-regrown forests of medium-sized and medium- to mature-age (40–100 yr) trees. Old-growth or virgin forest remnants remain in small and scattered amounts, but are essentially ecologically extinct, while open grasslands, shrubby habitats, or young invasive forest types have given way to altered disturbance regimes and woody plant succession (Lorimer 2001). A dominant canopy and major mast-producing tree species, the American chestnut (*Castanea dentata*), was eliminated as a canopy tree by the chestnut blight (*Cryphonectra parasitica*), introduced from Europe in the early 1900s (Paillet 2002). American chestnuts still exist in the woodlands of New England and elsewhere, but never achieve maturity and survive today only in the form of sprouts originating from trees or seedlings that were established before the arrival of the blight (Paillet 2002). The hemlock woolly adelgid (*Adelges tsugae*), an aphid-like insect from Japan, has already caused the loss of large numbers of eastern hemlock trees in southern New England, and is migrating north, threatening the existence of this long-lived, shade tolerant species (Orwig et al. 2002). Changes due to direct mortality as well as increased logging, which is occurring at a greater rate because of the threat of the loss of trees, have led to thinning canopies (Kizilinski et

al. 2002) and changes in avian communities (Tingley et al. 2002).

Many large mammals, such as elk (*Cervus elaphus*) and caribou (*Rangifer tarandus*), have been extirpated, as have some major predators, such as wolves (*Canis lupus*) and mountain lions (*Puma concolor*; DeGraaf and Yamasaki 2001). Wolves were extirpated around 1900, and soon afterwards coyotes (*Canis latrans*) began colonizing the region from the Midwest (Parker 1995). Passenger Pigeons (*Ectopistes migratorius*), whose numbers quite possibly ranged in the billions and were likely a major prey item for goshawks and other raptors, went extinct at the turn of the 19<sup>th</sup> century (Blockstein 2002). By sheer numbers alone, their impact was a major driving force on the characteristics of eastern forests (Ellsworth and McComb 2003). During this recent history, other wildlife species have either increased their range or have become more common, such as moose (*Alces alces*), beaver, coyote, fisher (*Martes pennanti*), Wild Turkey (*Meleagris gallopavo*), Mourning Dove (*Zenaida macroura*), and others (DeGraaf and Yamasaki 2001: 13).

#### Historical Accounts for the Northern Goshawk.

In New England, nesting habitat of Northern Goshawks decreased as forests were cleared for settlement and agriculture (Bent 1937, DeGraaf and Yamasaki 2001). This was an obvious change in habitat for the goshawk, but equally important may have been the extinction of the Passenger Pigeon, which was likely important prey for goshawks (Bent 1937). Thus, the Northern Goshawk may have been a rare nesting species in New England at the turn of the 19<sup>th</sup> to the 20<sup>th</sup> century (Bevier 1994). It was called a casual species in summer (Forbush 1925–29), very rare (Bagg and Eliot 1937), and a rare and irregular winter resident (Sage et al. 1913).

In the late 1800s and early 1900s, the goshawk was a rare summer resident in northern New Hampshire (Allen 1903, Hoffman 1904, Foss 1994) and was seen in southern New Hampshire primarily as a winter visitor (Dearborn 1903, Foss 1994). The discovery (or rediscovery) of the first goshawk nest in Massachusetts has been attributed to two officials of the Harvard Forest in Petersham, central Massachusetts, in 1922–23 (Wetherbee 1945). In some winters, goshawks were reported to come out of the north in great numbers to “wreak havoc with the grouse of the county” (Wetherbee 1945: 38). Over 20 skins were reported collected from

1883–1935 (Wetherbee 1945:117–18). In 1945, Wetherbee (1945:23) reported that the “eastern” goshawk was among several species of birds that have “nested in the past but have doubtful nesting status at present.”

Since about 1955, however, there is some evidence that both numbers of nesting pairs and the range of breeding goshawks have increased steadily in New England (DeGraaf and Yamasaki 2001). For example, only three nesting records existed in Vermont before 1933, but now goshawks nest throughout northern New England (Laughlin and Kibbe 1985, DeGraaf and Yamasaki 2001). DeGraaf and Yamasaki (2001) attribute range expansion and an increase in population size to the regrowth of New England forests.

#### Recent Accounts for the Northern Goshawk.

DeGraaf and Yamasaki (2001) list the Northern Goshawk as uncommon to rare, but increasing, in New England. They state that goshawks breed throughout the New England states and winter throughout the region, except for northernmost Maine. The Northern Goshawk was one of 41 breeding bird species that DeGraaf and Yamasaki (2001) listed as having “increased significantly in abundance” in Massachusetts (Veit and Petersen 1993).

**State Accounts.** The following accounts for each of the six New England states were excerpted from the atlas of breeding birds for each state and other sources as cited.

*Connecticut.* Bevier (1994) described the goshawk as an uncommon permanent resident and migrant. Nesting concentrated in higher elevations of western Connecticut, where pairs usually occupy a territory throughout the year. They exhibit “flexible habitat selection,” nesting in tracts of mixed northern hardwoods and conifers, especially eastern hemlock and white pine, pure stands of mature white or red pine (*Pinus resinosa*) within more extensive tracts of deciduous woods, wetlands, and second-growth, deciduous stands. Nesting occurs on hillsides, frequently near wetlands and away from human disturbance. Prey brought to nests was mostly squirrels and chipmunks, grouse, songbirds, and waterfowl.

*Rhode Island.* Enser (1992) reported that historical nesting was unknown. Northern Goshawks may now be the most common nesting Accipiter in Rhode Island, but there are still very few known nests (ca. eight confirmed or possible occurrences in the early 1990s). This species became reestab-

lished in the mid-1950s. They usually breed in isolated areas of coniferous forest, particularly mature stands of hemlock and white pine and also deciduous woodlots.

**Massachusetts.** Veit and Petersen (1993) listed the goshawk as one of 41 breeding bird species whose numbers have increased significantly since the 1950s, based on Griscom and Snyder's (1955) accounts. The current status is given as an uncommon resident and migrant on the mainland and a rare migrant on the islands of Nantucket and Martha's Vineyard. In 1995, nesting was restricted to western Massachusetts, but now occurs regularly throughout the state, except for Cape Cod and the Islands. Goshawk numbers fluctuate annually, but have been increasing steadily since the mid-1950s, both during the breeding season and in winter.

**Vermont.** Laughlin and Kibbe (1985) reported that goshawks were found almost statewide, but were largely confined to areas with medium to high relief (e.g., in the Champlain Lowlands along Lake Champlain). All but one record were from the hilly eastern and southern portions of that region.

**New Hampshire.** Foss (1994) described the goshawk as much more common in southern New Hampshire in recent decades, while the Cooper's (*Accipiter cooperii*) and Sharp-shinned (*A. striatus*) hawks seem to have made only modest recoveries since the use of DDT was banned in the early 1970s. The goshawk breeds throughout the state, typically in higher elevations, and often nests in deciduous trees, especially white birch (*Betula papyrifera*), red maple (*Acer rubrum*), and black birch (*B. lenta*), but occasionally in white pine. Prey items include grouse, crows, waterfowl, small birds, hares, squirrels, and chipmunks.

**Maine.** Adamus (1987) reported that the goshawk was somewhat common in the central and southern parts of the state, but less so further north. Confirmed nesting records exist for coastal regions and southern and central Maine. Probable breeding records exist throughout Maine, including the north-central region and along the Canadian border. Goshawks are generally absent in northern Maine during winter (DeGraaf and Yamasaki 2001).

**Breeding Bird Surveys and Christmas Bird Counts.** Both breeding (from BBS data) and winter (from CBC data) distribution maps show the goshawk present throughout all of New England, but in both cases the number of observations of indi-

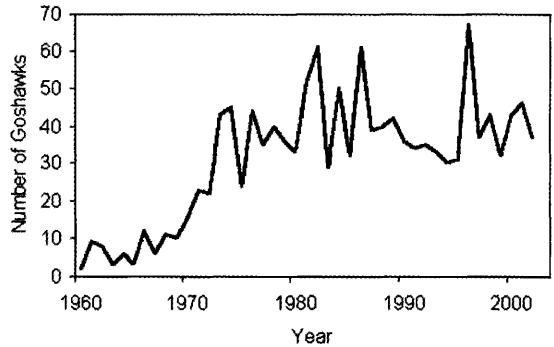


Fig. 1. During the Christmas Bird Count in New England from 1959–60 to 2002–03, counts of Northern Goshawks have shown a long-term increasing trend. Data compiled from National Audubon Society, Inc. web site Christmas Bird Count home page (<http://www.audubon.org/bird/cbc/>) for Connecticut, Rhode Island, Massachusetts, Vermont, New Hampshire, and Maine.

vidual birds is <1 per route (Sauer et al. 2003). In spite of extremely low densities, long-term CBC data show a concurrent long-term increase in sightings of goshawks, but a slight decrease in number of birds observed per unit effort (Fig. 1).

**Expert Opinions.** Several biologists responded to my questions about goshawks in their state. Not unexpectedly, the distribution of Northern Goshawks in most New England states is somewhat easier to determine, and thus better known, than population status or trends. Breeding bird surveys probably best indicate the distribution of nesting pairs. In general, goshawks can be found in forested areas throughout New England, although densities could be expected to vary among regions (C. Gaughan, S. Melvin, S. Parren, and T. Hodgman pers. comm.). In short, most biologists described the goshawk as uncommon but present, and given naturally low densities of this species, well distributed in forested habitat.

State biologists recognize that information on population trends is lacking. Some have stated that, although it is commonly reported that goshawk numbers may be increasing because of widespread reforestation, there are no definitive data to support this proposal. Goshawk numbers may have decreased in northern Maine during the 1960s through 1980s because of widespread spruce budworm (*Choristoneura fumiferana*) infestations and subsequent increased tree mortality and salvage harvests; however, numbers there may have stabilized in the last decade (T. Hodgman pers.

comm.). It appears that goshawks have expanded south in New Hampshire, suggesting that numbers have increased in the southern part of the state in recent years (C. Gaughan pers. comm.).

Biologists from the Green and White Mountain National Forests provided responses similar to those of state biologists regarding the status and distribution of Northern Goshawks on their areas (C. Grove and M. Yamasaki pers. comm.). Goshawks are distributed throughout most or all of both Vermont's Green Mountain and New Hampshire and Maine's White Mountain National Forests, certainly as breeders and probably as winter residents, although some birds may be winter migrants from the north. Goshawks are not common, but neither are they considered rare; the term "uncommon breeder" might best describe their status on national forest lands within New England. Forest biologists believe that goshawk numbers are probably stable at some undetermined level, and may even be increasing as suggested by state breeding bird atlas accounts, but again caution that data are lacking and opinions on population trends are speculative. On both the Green and White Mountain National Forests, goshawks nest in mature stands of white pine or mixed spruce-fir and hardwoods. Given the land-use history of New England, many of these stands are essentially regrown mature forest of 80–100 yr. Often there are forest openings, such as roads, trails, and upland openings nearby, but usually nests are away from high levels of human activity. Some additional generalizations of nest sites include gentler slopes at lower elevations (e.g., below 450 m). The Northern Goshawk was listed as a Regional Forester Sensitive Species in 2003 on some national forests in the northern portions of the U.S. Forest Service's Region 9, but not on either the Green or White Mountain National Forest (M. Yamasaki pers. comm.).

#### DISCUSSION

Foster et al. (2002) characterized six major trajectories of change in the long-term dynamics of wildlife populations in the northeast: (1) many large mammals and birds that declined historically have increased recently, (2) open-land species went from low to high abundance with land clearing, but are in decline today, (3) some species were extirpated, (4) some species have expanded their ranges into the northeast, (5) introduced non-natives have proliferated, and (6) some persistent

species did not exhibit major long-term trends. Likewise, DeGraaf and Yamasaki (2001) identified three major trends in New England's wildlife in the last several decades: (1) forest species are increasing, (2) grassland and shrubland species are declining, and (3) many southern birds are spreading northward into the region. In addition, a few species like Common Ravens (*Corvus corax*) and moose have extended their range southward.

At least some of these statements apply directly or indirectly to the Northern Goshawk in New England. The goshawk was apparently one of those forest species that has increased in numbers in the last half century. This was probable given that at least three quarters of New England's forests were cleared for agriculture and high-graded for timber. The number and distribution of goshawks could have been expected to decline significantly with the amount of forest clearing that occurred in the 18<sup>th</sup> and 19<sup>th</sup> centuries. With reforestation occurring during the middle decades of the 20<sup>th</sup> century, the distribution and number of goshawks likely increased. This presumed long-term decline followed by an increase in numbers of goshawks must be viewed in the proper temporal scale: in decades, if not centuries, of change. More difficult to decipher is whether or not goshawk distribution and numbers are increasing today. Some evidence indicates that this is the case, but empirical data are extremely limited to nonexistent. Thus, it is difficult to speculate on recent (say, the last 20–30 yr) population trends without more definitive data. However, long-term efforts, such as the Christmas Bird Count, indicated a possible increase, or at least stabilization, of goshawk numbers in the region (Fig. 1).

The status of Northern Goshawks is certainly tied to the distribution and condition of mature forest. However, the recent decline of some early-successional-stage species, such as grouse and lagomorphs (Rusch et al. 2000, Litvaitis 2001, Fuller and DeStefano 2003), may influence goshawk distribution and reproduction (Doyle and Smith 1994). Historically, the extirpation of some species, particularly the Passenger Pigeon, have likely altered the suite of available prey species for goshawks, while the expansion of some species, such as some passerines, in New England may provide new prey. Regardless, ubiquitous and intensive anthropogenic change has characterized, and will continue to influence, the region's landscape, vegetation, and wildlife. DeGraaf and Yamasaki (2001:

3) summarized this by stating, "Most species have likely had very different distributions through time. In 50 or 100 years, both the species present and their distributions will be different." This is likely the case for the Northern Goshawk.

The characteristics of topography and forest cover reportedly used by goshawks in New England show similar patterns to other parts of the species' range in North America. Nesting occurs in mature coniferous, deciduous, and mixed forest, typically on gentle rather than steep terrain, in proximity to some forest openings, but mostly away from well-used roads and human habitation. Similar patterns in nesting cover have been reported for other northeastern states (outside of New England). In New Jersey and New York, goshawks selected extensive mature forested areas for nesting, particularly in mixed hardwood-coniferous stands with greater numbers of large trees (>20 cm Diameter Breast Height) and high tree basal area (Allen 1978, Speiser and Bosakowski 1987, Bosakowski and Speiser 1994). Hemlock, pine, and cedar (*Chamaecyparis thyoides*) dominated nest sites, while oaks were less prevalent, although nests were usually in deciduous hardwood trees. Nests were present on gentle slopes or flat terrain, away from southern exposures, small forest tracts, paved roads, and human habitation.

Kenward (1996) speculated that goshawks in North America may face more competition from Red-tailed Hawks (*Buteo jamaicensis*), Red-shouldered Hawks (*B. lineatus*), and Great Horned Owls (*Bubo virginianus*) than goshawks face in Europe with similar raptor species. Red-tailed and Red-shouldered hawks are found throughout New England, except for northernmost Maine for the Red-shouldered Hawk, and are regular breeders (DeGraaf and Yamasaki 2001). Red-shouldered Hawks inhabit mature deciduous-coniferous forest, while Red-tailed Hawks are found in more open habitats (DeGraaf and Yamasaki 2001). Great Horned Owls are uncommon, but widespread, and are found year-round throughout all of New England, occurring in all types of cover (DeGraaf and Yamasaki 2001). Although little is known about the interactions among these raptor species, given the potential for aggressive interactions (Crannell and DeStefano 1992, Rohner and Doyle 1992), this may be an important local influence on the distribution of goshawks in some parts of the region. Broad-scale loss of hemlocks and the conditions of forest cover and canopy closure they create could also

have important and related consequences for several wildlife species, including goshawks.

#### NEW ENGLAND: A "NATURAL EXPERIMENT"

Keane and Morrison (1994), in the first symposium on the ecology and management of Northern Goshawks, stressed the importance of identifying effects of scale and biological organization in ecological studies. In the same symposium, Graham et al. (1994) recommended that management of goshawks take place in large tracts of forest, which should be viewed as sustainable ecological units rather than smaller tracts or individual goshawk home ranges. Of the potential spatial scales that can be addressed, most forest wildlife biologists stressed the importance of, and need for, studies at large landscape levels (DeStefano 2002).

New England would offer an interesting opportunity to examine how goshawks have responded to a changing landscape. Widespread intensive land clearing and logging have given way to extensive reforestation of second- or multi-growth forest, embodying changes that have taken place over the last 2–3 centuries. Today, small, rare, and widely-dispersed patches of old-growth or virgin forest, altered disturbance regimes including reduced timber harvest, dominant mid-aged forest, loss of early-successional-stage cover, and increases in human densities and development offer an opportunity to see how goshawks have dealt with these changes in the northeast. This investigation would also offer insights into similar developing trends in the western U.S. Well distributed and coordinated monitoring of goshawk populations on randomly selected forested areas in New England, perhaps stratified by state, forest cover type, or ecological region, would be an appropriate approach. Surveys for goshawks could also include other forest raptors and major prey species, given recent emphasis away from single-species approaches and toward biodiversity (DeStefano 2002). However, the extent and effort required would be large, given the large spatial and temporal scales involved.

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