Cavity-Nesting Bird Abundance in Thinned Versus Unthinned Massachusetts Oak Stands[1]

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ABSTRACT. Cavity-nesting birds provide significant benefits to forest communities, but timber management techniques may negatively affect cavity-nesting species by reducing the availability of suitable nest and foraging sites. We surveyed cavity-nesting birds from transects in eight Massachusetts oak stands to examine the effect of thinning with retention of snag and wildlife trees on bird use of those stands. We found no difference (P > 0.05) in number of primary- and secondary-cavity nesters detected per km among thinned and unthinned stands when snag and wildlife

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trees were retained during thinning. Our stands ranged from 13.0–51.9 ha and were surrounded by pole- and sawtimber-sized stands. Intermediate cuttings on areas of similar size can be conducted without reducing cavity-nesting bird abundance if forest managers include wildlife considerations when planning and marking stands for harvest.

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Intensive timber management has the potential to reduce cavity-nesting bird populations by reducing the availability of trees suitable for nest-hole excavation and foraging (Jackman 1974, Conner et al. 1975, Zeedyk and Evans 1975, Hardin and Evans 1977). Many studies have shown a relationship between potential nest tree (usually snag) densities and populations of cavity-nesting birds (Haapanen (1965, Scott 1979, Dickson et al. 1983, Raphael and White 1984, Zarnowitz and Manuwal 1985), resulting in management recommendations for retention of potential cavity trees during harvest operations.

Oak forests constitute the most extensive cover type group in the eastern United States. In southern New England, northern red, white, and black oaks, and their associates, comprise stands usually classified as white pine-northern red oak-red maple or white oak-black oak-northern red oak forest types (Eyre 1980). Oak forest types are often intensively managed for high-quality sawlogs. Stands are commonly thinned every 10 to 20 years, but few studies have investigated the impact of thinning on cavity-nesting birds. Trees of little or no commercial value are often removed during thinning (Conner et al. 1975, Zeedyk and Evans 1975), but removal is not always necessary. This study examined the effect of thinning on cavity-nesting bird populations when snags and wildlife trees were retained during intermediate silvicultural operations.

STUDY AREA

This study was conducted on the Quabbin Reservation, which is a municipal watershed in central Massachusetts. Stands dominated by pole- and sawtimber-sized trees occupy 89% of the area, the remainder being stands of saplings, open fields, and wetlands. Oak types dominate the forested land (36%); white pine (18%), northern hardwoods (11%), and red pine (10%) are the other important forest types.

METHODS

Inventory records were used to identify stands with >10 ha of even-aged, sawtimber-sized white pine-northern red oak-red maple forest (Eyre 1980) on relatively level terrain. We selected four thinned and four unthinned stands. Thinned stands had received as many as three intermediate cuttings prior to our study (Table 1). Silvicultural treatments generally followed guidelines for upland oaks (Roach and Gingrich 1968, Hibbs and Bentley 1983), but foresters were instructed to leave den and cavity trees whenever possible. All stands were surrounded by thinned and unthinned pole- and sawtimber-sized forestland.

Table 1. Size (ha), year of origin, and past silvicultural treatment of eight central Massachusetts oak stands surveyed for cavity-nesting birds in spring 1987 and 1988.

Stand	Size	Year of origin	Treatment
1	13.0	1919	None
2	21.8	1921	None
4	51.9	1913	None
23	28.6	1903	None[a]
5	15.5	1917	Thinned—1963, 1973 (sawlogs), 1982 (cordwood)
6	15.0	1916	Thinned—1968 (sawlogs), 1977 (cordwood)
7	20.6	1918	Thinned—1962 (sawlogs), 1981 (cordwood)
24	29.5	1910	Thinned—1986–87 (sawlogs, cordwood)

[a] One-half of stand was thinned in winter 1988; only the unthinned portion was surveyed in spring 1988.

Vegetation Characteristics

Thirty circular 0.025-ha (8.92 m radius) plots were located 20 m apart along lines through each stand. All trees (woody stems >2.5 cm diameter at breast height, dbh) were measured on each plot. Species, dbh, tree class (preferred, acceptable, rough cull, rotten cull, dead, snag, or sapling; USDA For. Serv. 1984), and presence of cavities were recorded for each tree. Saplings (woody stems 2.5–12.6 cm dbh) were classed as live or dead. Cavity function (bird, mammal, or escape), status (active or inactive), species using (if known), entrance diameter (<5 cm, 5–10 cm, >10 cm), and location (stump, trunk, broken top, or live or dead branch) were recorded (see Healy et al. 1989 for further description of methods).

Measurements of overstory and cavity characteristics were completed December 1985–June 1988. Cavities were located from the ground using binoculars after the method of Healy et al. (1989). Stem density, basal area, and average dbh were calculated for each stand.

Bird Counts

We located a transect in each stand >100 m from the stand edge. We marked each transect with numbered flags every 20 m and cleared away large woody debris so that observers could concentrate on detecting birds. Transect lengths ranged from 400 to 1220 m, depending on stand size and shape; total lengths surveyed in thinned and unthinned stands were 20.5 and 28.3 km in 1987 and 25.6 and 29.4 km in 1988.

We surveyed transects for cavity-nesting birds 8 times in each stand from 1–26 May 1987 and 10 times from 14 April–31 May 1988. Two experienced observers conducted counts when there was no precipitation and wind speed was <17 kph. Each observer surveyed two stands per morning between 0530 and 0930 hours. Observers alternated starting times and directions in which transects were

Table 2. Cavity-nesting birds (#/km) in thinned and unthinned oak stands on the Quabbin Reservation in central Massachusetts.

	1987				1988			
	Unthinned		Thinned		Unthinned		Thinned	
	x̄	SD	x̄	SD	x̄	SD	x̄	SD
Primary cavity nesters								
Downy woodpecker	0.64	(0.41)	0.56	(0.39)	1.19	(0.30)	1.14	(0.61)
Hairy woodpecker	0.32	(0.32)	0.59	(0.70)	0.60	(0.09)	0.94	(0.38)
Northern flicker	1.28	(0.62)	0.93	(0.71)	1.83	(1.13)	2.21	(0.80)
Pileated woodpecker	0.11	(0.13)	0.08	(0.16)	0.46	(0.28)	0.18	(0.18)
Unknown woodpeckers	0.43	(0.23)	0.42	(0.24)	0.66	(0.37)	0.82	(0.38)
Secondary cavity nesters								
Great crested flycatcher	1.00	(0.29)	0.88	(0.73)	0.80	(0.21)	0.69	(0.56)
Black-capped chickadee	0.67	(0.50)	1.26	(0.57)	2.14	(0.60)	3.93	(2.33)
Tufted titmouse	0.08	(0.17)			0.16	(0.26)	0.21	(0.33)
Red-breasted nuthatch	0.03	(0.06)	0.04	(0.09)	0.14	(0.17)	0.33	(0.29)
White-breasted nuthatch	0.96	(0.28)	0.76	(0.19)	1.41	(0.21)	1.14	(0.63)
Eastern bluebird	0.04	(0.08)					0.07	(0.14)
Total primary	2.79	(0.64)	2.59	(0.80)	4.74	(1.41)	5.28	(1.21)
Total secondary	2.79	(0.63)	2.93	(0.86)	4.67	(0.61)	6.37	(2.09)
All cavity nesters	5.58	(0.44)	5.52	(1.65)	9.41	(1.58)	11.65	(3.29)

walked in each stand Both observers surveyed all stands in random order. Each set of eight stands was surveyed before beginning the next set.

Observers traversed the lines at an average speed of 1 kph (6 min/100 m) and recorded all detections of cavity-nesting birds by species. Birds detected drumming or calling from beyond stand boundaries were excluded from analyses.

Analyses

We tested for differences in numbers of primary (birds which excavate their own cavities) and secondary (birds which use existing cavities) cavity-nesting birds detected per km of transect between thinned and unthinned stands and between years using a two-way analysis of variance with stand nested within treatment (Damon and Harvey 1987). We examined the effects of observers, starting times, and direction using a multi-way analysis of variance. Variances in the number of birds detected per km were similar among stands (F_{max} test, $P > 0.05$). One-way analyses of variance were used to test for differences between treatments in density; basal area; average dbh of live, snag, dead, and cavity trees; and in number of cavities.

RESULTS

Birds

The most abundant primary-cavity nesters were northern flickers and downy and hairy woodpeckers; the most frequently detected secondary-cavity nesters were great crested flycatchers, black-capped chickadees, and white-breasted nuthatches (Table 2). Numbers of primary- and secondary-cavity nesters detected per km were not different between thinned and unthinned stands ($F = 1.03$; df = 1,6; $P = 0.35$), but numbers per km did differ between years ($F = 33.67$; df = 1,6; $P = 0.001$) (Table 2). There was no year × treatment interaction. We expected differences between years because the 1988 survey covered more of the active nesting period of most cavity users. We detected no effects due to time, observer, or direction ($F \leqslant 1.10$; df = 1,6; $P \geqslant 0.34$), nor any interactions between these variables and treatment ($F \leqslant 0.52$; df = 1,6; $P \geqslant 0.50$).

Cavities

Most cavities in both treatments were located in tree boles (57% unthinned, 68% thinned), and many cavities were in tree bases (36% and 19%) (Table 3). Less than 14% of cavities were found near broken tops or in live or dead branches. Most cavities had small or medium-sized entrances; only 6% in each treatment were classed as large (Table 3). Few bird-excavated cavities were located: only 21 of 302 cavities (7%) in unthinned and 16 of 176 (9%) in thinned stands. Three of 21 bird-excavated cavities in unthinned stands were in dead trees, whereas 9 of 16 thinned-stand bird-excavated cavities were in dead trees.

Table 3. Location, size, and function of cavities found in trees on 120 0.025-ha plots in four thinned and four unthinned oak stands in central Massachusetts.

	Unthinned % (n = 302)	Thinned % (n = 176)
Cavity location		
stump	36	19
trunk	57	68
broken top	3	9
live branch	2	1
dead branch	2	3
Cavity size		
small (<5 cm)	49	54
medium (5–10 cm)	45	40
large (>10 cm)	6	6
Cavity function		
bird	7	9
mammal	54	39
escape	39	52

Stand Characteristics

Oaks accounted for 56% and 67% of the basal area (BA) in thinned and unthinned stands, respectively. The combined BA of live and dead trees and snags averaged 20.3 m^2/ha in thinned stands and 25.3 m^2/ha in unthinned stands (Table 4). Unthinned stands had more live and dead stems per ha than thinned stands; however, density, basal area, and average dbh of snags and cavity trees did not differ ($P > 0.05$) with treatment (Table 4). Similar densities of snag and cavity trees in thinned and unthinned stands is evidence that operators did retain those trees where possible when thinning stands. Number of cavities in unthinned stands was not different from that in thinned stands (Table 4), but one unthinned stand contained more than twice as many cavities as any other stand. Trees with cavities made up roughly the same proportion of all trees in both treatments (4.3% unthinned, 3.9% thinned).

DISCUSSION

Snag and wildlife trees were retained during thinning in our study, and we detected no differences in cavity-nesting bird abundance between treatments. Thinnings were designed to enhance the diameter growth of crop trees by favoring dominant and codominant trees. Because smaller trees were removed, thinning reduced tree density substantially, while BA and average dbh changed proportionately less (Table 4). Canopy gaps were small enough that they closed in about 10 years; thus thinning had little effect on understory growth or the canopy profile. Thinning to B-level stocking (the lowest density to which a stand can be thinned and still be expected to grow back to fully close the canopy in a relatively short time) in these oak stands promoted the growth of dominant and codominant trees but did not dramatically change stand structure or wildlife habitat. Cavity-nesting bird populations were not affected, presumably because potential cavity trees were left standing. Species with large home ranges, such as the pileated woodpecker, may have used both thinned stands and portions of adjacent unthinned areas. Because of this we emphasize that our results apply to stands similar to those we studied and may not apply on a larger scale.

As long as forest type and structure remain unchanged, timber harvesting should have little impact on cavity-nesting bird populations. Cavity-nesting birds were more numerous in thinned Pennsylvania oakwoods when snags were retained (Stribling et

Table 4. Density (stems/ha), basal area (m^2/ha), and average dbh (cm) of live, dead, snag, and cavity trees and number of cavities/ha in mature oak stands on the Quabbin Reservation, central Massachusetts.

	Unthinned		Thinned		
	x̄	SD	x̄	SD	Probability level[a]
Density					
Live trees	1113.0	(257.6)	681.6	(134.2)	0.02
Dead trees	218.7	(74.8)	105.7	(16.4)	0.03
Snags	28.0	(9.9)	27.7	(10.9)	0.96
Cavity trees	78.3	(48.7)	42.6	(16.4)	0.21
Cavities	101.0	(64.3)	58.7	(26.4)	0.27
Basal area					
Live trees	22.6	(2.2)	18.2	(1.2)	0.01
Dead trees	1.7	(0.3)	1.1	(0.1)	0.005
Snags	0.9	(0.4)	1.0	(0.6)	0.80
Cavity trees	3.0	(2.2)	1.9	(1.2)	0.38
Average dbh					
Live trees	13.4	(2.0)	16.4	(1.9)	0.08
Dead trees	9.0	(1.8)	10.0	(0.9)	0.36
Snags	19.5	(1.1)	20.4	(3.6)	0.81
Cavity trees	19.9	(0.9)	19.4	(3.1)	0.40

[a] One-way analysis of variance; df = 1,6 for all comparisons (Damon and Harvey 1987).

al. 1990). Selection methods of regeneration had little effect on species numbers or densities in Ontario mixed woods (Welsh, D. 1987), and there were no differences in total bird densities between virgin and thinned pine forests in northern Finland (Virkkala 1987). Fuelwood cutting of dead wood in Michigan oak forest did not decrease numbers of cavity nesters, perhaps because birds used live or dead portions of live trees for nesting or because snag numbers were not limiting even after cutting (Dingledine and Haufler 1983). Cavity nesters were less abundant in Massachusetts red oak and red maple stands which were subjected to intense fuelwood cutting, possibly because fuelwood cutters selectively removed dead and dying trees when thinning stands (Chadwick et al. 1986).

Recent studies have questioned the importance of snags as nesting substrate for woodpeckers in eastern and northeastern deciduous forests (Carey 1983, Sedgwick and Knopf 1986, Welsh, C. 1987), but the importance of trees suitable for nest hole excavation and feeding is recognized. Trees most suitable for excavation have a central column of decay surrounded by sound wood (Conner et al. 1976, Conner 1978, Evans and Conner 1979, Miller et al. 1979) and often have broken tops or large branch stubs (Conner et al. 1976, Carey 1983, Sedgwick and Knopf, 1986, Runde and Capen 1987, Welsh and Capen 1991). Den and cavity trees accounted for an average of 3.8% of the basal area of live trees in 13 stands sampled by Healy et al. (1989); they concluded that saving den and cavity trees should have little impact on wood production in white pine-northern red oak-red maple stands in Massachusetts. Retaining cull trees with broken tops, branch stubs, or other signs of decay when they do not compete directly with quality crop trees should not decrease wood production either. About 20% of the cavity trees examined by Healy et al. (1989) were classed as preferred or acceptable trees that would be retained in intermediate silvicultural operations even if wildlife were not considered.

MANAGEMENT IMPLICATIONS

Management for timber and cavity-nesting birds should be compatible if forest managers plan ahead and consider the needs of cavity-using wildlife when marking stands for intermediate harvest. Thinning to B-level stocking in oak stands may have little effect on the abundance of cavity-nesting birds using those stands when a reasonable attempt is made to leave potential den and cavity trees, and retaining those trees should have little impact on wood production. If snags and other potential nest trees and foraging sites are retained during thinning and overall forest structure remains similar to that of adjacent unthinned areas, cavity-nesting bird populations should not be severely affected. □

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