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SELECTION OF NEST TREE SPECIES BY RED-SHOULDERED AND BROAD-WINGED HAWKS IN TWO TEMPERATE FOREST REGIONS

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Abstract.—Characteristics of nest trees used by Broad-winged (*Buteo platypterus*) and Red-shouldered (*B. lineatus*) hawks were quantified from study areas in northeastern Wisconsin (1980–1982) and western Maryland (1978–1984). Based on comparison with random samples of trees, Broad-winged Hawks in Maryland nested in white oaks more than expected. In Wisconsin, Broad-winged Hawks selectively nested in white birch, a common tree in that region. Maryland Red-shouldered Hawks nested most often in red and white oaks, but used them in proportion to their availabilities. Both hawk species selected large nest trees, based on diameter breast height, and avoided small trees, which were the most common. Red-shouldered Hawks selected very large nest trees. These large trees were rare compared with the distribution of available trees. Within a region and for each raptor species, characteristics of nest trees did not differ by species. Our results indicated, at least for the Broad-winged Hawk, that tree species were important determinants in habitat selection at the local or regional level.

SELECCIÓN DEL ÁRBOL DE ANIDAMIENTO POR HALCONES DE LAS ESPECIES *BUTEO LINEATUS* Y *B. PLATYPTERUS*

Sinopsis.—Las características de los árboles utilizados para anidar por los halcones *Buteo platypterus* y *B. lineatus,* fue cuantificada en estudios que se llevaron a cabo en Wisconsin (1980–1982), y Maryland (1978–1984). Basado en la comparación de muestras de árboles tomadas al azar, se encontró que en Maryland, *B. platypterus* anidó más de lo esperado en árboles de roble blanco (*Quercus alba*). En Wisconsin, este halcón anidó preferentemente en *Betula papyrifera,* árbol común en la región. Por su parte la población de *B. lineatus* en Maryland, anidó con mayor frecuencia en roble rojo (*Q. rubra*) y roble blanco, utilizando esta vegetación en proporción a su disponibilidad. Ambas especies de halcones se leccionaron para anidar, árboles de gran diámentro y evitaron los árboles pequeños que resultaron ser los mas comunes. *B. lineatus,* seleccionó para anidar árboles extremadamente grandes (≥34 cm de diametro), raros dentro de la muestra estudiada. Dentro de una misma región y para cada especie de ave particular, las características de los árboles utilizados para anidar no resultaron ser diferentes por especie. Los resultados del trabajo indican, que las especies de árboles son importantes en la selección de habitat a nivel local o regional al menos para *B. platypterus.*

In addition to structural features of the habitat, floristic components of avian habitat selection are locally important for a number of insectivorous species (Franzreb 1978, Hartley 1953, Holmes and Robinson 1981, Morse 1967, Rice et al. 1984, Wiens and Rotenberry 1981). Only recently have studies compared the relative importance of plant species with that of habitat structure (Rice et al. 1984, Wiens and Rotenberry 1981). These studies and others (Franzreb 1978, Holmes and Robinson 1981, Karr

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1983) indicated that measures of plant species composition may often be at least as important as habitat structure in understanding avian habitat patterns.

The importance of plant species to small birds may be that more abundant and/or accessible food resources may be associated with certain plants (Holmes and Robinson 1981). For larger birds, such as raptors, the selectivity of certain plant species as a substrate for nests has not been studied. Tree species have characteristic growth forms (Horn 1971) that may make certain species more suitable for nest placement. In this paper we describe characteristics of nest trees chosen by Red-shouldered (*Buteo lineatus*) and Broad-winged (*B. platypterus*) hawks in two temperate forest regions. Throughout their range these raptors build nests in a variety of different tree species (Bent 1937, Burns 1911, Henny et al. 1973, Keran 1978, Matray 1974, Morris et al. 1982, Portnoy and Dodge 1979, Rosenfield 1984, Stewart 1949, Titus and Mosher 1981). Our purpose was to determine if these two hawk species selected certain trees for nesting within a region.

STUDY SITES AND METHODS

The study was conducted from 1978–1984 in Allegany and Garrett counties, western Maryland, and from 1980–1982 on the Lakewood district, Nicolet National Forest, Forest and Oconto counties, northeastern Wisconsin. The western Maryland study area was described by Titus and Mosher (1981) and lies within the Appalachian Province (Miller 1967). The area was dominated by long ridges oriented northeast to southwest. Six tree species made up 79% of the trees sampled at 100 randomly chosen 0.04 ha plots. Forty species of overstory trees were encountered in random and nest site habitat samples combined. Four of the plant associations described by Brush et al. (1980) were encountered including (1) hemlock-yellow and black birch association; (2) chestnut oak-bear oak association; (3) chestnut oak association; and (4) sugar maple-basswood (*Tilia americana*) association. Brush et al. (1980) encountered chestnut oak, red maple, and white oak in 52%, 77%, and 65%, respectively, of the plots sampled in the Appalachian Province. (Scientific names of trees listed in Table 1 are given there.) Braun (1950) described western Maryland as being within a mixed mesophytic and an oak-chestnut forest region.

The Wisconsin study area was described in detail by Titus (1984). It was located north of the tension zone (Curtis 1959), within the Superior Upland section of the hemlock-white pine (*Pinus strobus*)-northern hardwoods region as defined by Braun (1950). Seven tree species composed 83.6% of the trees sampled at 74 random plots. Forest types (% occurrence) within the Lakewood district included mixed hardwoods (26.4%), aspen (24.1%), red pine (*Pinus resinosa* [9.4%]), lowland conifer (7.3%), oak (6.0%), Jack pine (4.3%), paper birch (3.8%), and other habitat types (18.7%) (L. Swettemann, pers. comm.). The region was generally flat,

and wet areas were abundant in the form of ponds, bogs, and swamps. Curtis (1959) presented a thorough description of these plant communities.

Characteristics of active raptor nest trees were measured at the end of the nesting season. We defined an active nest as one in which at least one egg was laid. Some nests were used for more than one year by a hawk species, but only the initial sample for an individual nest tree was included in these analyses. Measurements taken at each nest tree included tree species, diameter at breast height (dbh in cm), nest height (m), and tree height (m). Nest heights were measured with a tape by a climber or with a Haga type clinometer, as also used for all tree height measurements. Percent nest height was calculated as (nest height/nest tree height) × 100.

Random sampling of forested areas was conducted on each study area to describe available nesting habitat (Titus 1984, Titus and Mosher 1981). The dbh and species of each overstory tree were tallied within 0.04 ha circular plots, a sampling procedure based on James and Shugart (1970).

Statistical analysis.—Chi-square analyses (Zar 1974) and simultaneous confidence intervals (Byers et al. 1984, Neu et al. 1974) were used to test nest tree species selection compared with the samples of trees obtained from the random plots. The null hypothesis was that for a given region each hawk species nested in the most common tree species in proportion to its occurrence. We used only randomly sampled trees as large or larger (based on dbh) than the smallest tree used by a hawk species, because many randomly sampled trees were obviously too small to support nests. Single factor fixed effects analyses of variance for unequal sample sizes were used to test for differences among nest tree species when the sample size for a nest tree species was greater than or equal to seven. Pooled or separate variance t-tests were used for two group tests. The dependent variables tested were nest height, dbh, total height of the nest tree and percent nest height.

RESULTS

Broad-winged Hawk.—Broad-winged Hawks nested in 13 tree species in western Maryland, 70% were in *Quercus* spp. (Table 1). Thirty-four percent of the Maryland nests were in white oak, which comprised only 16% of the randomly sampled trees (n = 1963). Broad-winged Hawks did not nest in trees less than 22 cm dbh, so we analyzed the occurrence of randomly sampled trees greater than or equal to 22 cm dbh (n = 797). The chi-square analysis was conducted with the 5 tree species most commonly used for nesting: white oak, red oak, chestnut oak, scarlet oak, and black cherry; all other tree species were pooled. These 5 species composed 78% of all the Maryland Broad-winged Hawk nest sites. Broad-winged Hawks in western Maryland did not use nest tree species in proportion to their occurrence ($\chi^2 = 26.3$, df = 5, $P < 0.001$). Using the Bonferroni Z-test with simultaneous confidence intervals, we found that white oak was selected more than expected ($P < 0.05$). Even though

TABLE 1. Overstory tree species occurrence and species used for nesting by Broad-winged and Red-shouldered hawks in western Maryland and northeastern Wisconsin.

	Maryland				Wisconsin			
	Broad-winged Hawk		Red-shouldered Hawk		Broad-winged Hawk		Red-shouldered Hawk	
Tree species	Nest trees n = 112 (%)	% random trees dbh ≥ 22 cm	Nest trees n = 42 (%)	% random trees dbh ≥ 34 cm	Nest trees n = 34 (%)	% random trees dbh ≥ 19 cm	Nest trees n = 22 (%)	% random trees dbh ≥ 24 cm
White oak (*Quercus alba*)	38 (33.9)	(16.9)	14 (33.3)	(26.0)				
Red oak (*Q. rubra*)[a]	22 (19.6)	(27.6)	15 (35.7)	(31.8)	4 (11.8)	(18.0)	3 (13.6)	(21.2)
Chestnut oak (*Q. prinus*)	12 (10.7)	(12.8)		(8.9)				
Scarlet oak (*Q. coccinea*)	7 (6.3)	(8.4)	8 (19.0)	(6.3)				
Pignut hickory (*Carya glabra*)	2 (1.8)	(2.0)		(1.6)				
Sugar maple (*Acer saccharum*)	3 (2.7)	(4.5)		(6.8)		(5.7)	2 (9.1)	(3.7)
Red maple (*A. rubrum*)	4 (3.6)	(8.7)		(4.2)	2 (5.9)	(8.3)	1 (4.5)	(6.5)
Black locust (*Robinia pseudoacacia*)	5 (4.5)	(1.0)		(0.5)				
Black cherry (*Prunus serotina*)	8 (7.1)	(4.3)		(5.2)		(0.2)		
White ash (*Fraxinus americana*)	4 (3.6)	(0.9)	1 (2.4)	(1.0)		(0.1)		(0.2)
Black ash (*F. nigra*)							1 (4.5)	
Virginia pine (*Pinus virginiana*)	5 (4.5)	(6.5)		(0.5)				
Jack pine (*P. banksiana*)					1 (2.9)	(4.5)		(2.8)
Hemlock (*Tsuga canadensis*)	1 (0.9)					(1.3)		(2.8)
Beech (*Fagus grandifolia*)			1 (2.4)	(0.1)		(0.3)	6 (27.3)	(0.4)
Tulip (*Liriodendron tulipifera*)			2 (4.8)					
Black birch (*Betula lenta*)	1 (0.9)	(0.4)		(0.5)				
Yellow birch (*B. lutea*)					3 (8.8)	(1.4)	3 (13.6)	(2.2)
White birch (*B. papyrifera*)					16 (47.1)	(14.9)	4 (18.2)	(12.4)
Quaking aspen (*Populus tremuloides*)					6 (17.6)	(14.2)	1 (4.5)	(14.3)
Bigtooth aspen (*P. deltoides*)					1 (2.9)	(14.5)	1 (4.5)	(18.3)
Balsam poplar (*P. balsamifera*)					1 (2.9)	(0.1)		(0.2)
Dead		(0.9)	1 (2.4)	(1.6)		(1.5)		(1.4)
All other tree species		(5.1)		(5.0)		(15.0)		(13.6)

[a] In western Maryland *Q. rubra* and *Q. velutina* were considered as a single species because of similar life forms and difficulty of identification in the form of hybrids.

white oak was a common large tree on the study area, it was still selected by nesting Broad-winged Hawks. Other species of trees were used as nesting sites in about the same proportion as their occurrence ($P > 0.05$, Table 1).

In Wisconsin, 47% of the Broad-winged Hawk nests found were in white birch. White birch represented 15% of the randomly sampled trees greater than or equal to 19 cm dbh, the smallest dbh nest trees used by Wisconsin Broad-winged Hawks. White birch was selected as a nest tree more often than expected ($\chi^2 = 25.3$, df = 1, $P < 0.001$, using Yates correction).

Broad-winged Hawks also selected nest trees on the basis of size (dbh) (Fig. 1). Fifty-three percent of the Maryland Broad-winged Hawk nest trees were in the 31–45 cm dbh size classes but these size classes represented only 12% of the available trees (Fig. 1, Maryland). Fifty-nine percent of the Wisconsin Broad-winged Hawk nest trees were in the 26–35 cm dbh size classes but these size classes represented only 11% of the available trees (Fig. 1, Wisconsin).

Differences among nest tree characteristics for white, red, chestnut and scarlet oaks, and black cherry used by Maryland Broad-winged Hawks were all non-significant (ANOVA, $P > 0.09$ in all cases, Table 2). No difference was found between nest tree characteristics in white birch and quaking aspen used by Wisconsin Broad-winged Hawks (t-tests, $P > 0.20$ in all cases).

Red-shouldered Hawk.—Six tree species (one nest site was in a dead red oak) were used for nesting by Maryland Red-shouldered Hawks (Table 1). Sixty-nine percent of the nests were either in red or white oak, which composed 37% of all randomly sampled trees in Maryland. Red and white oaks composed 58% of the randomly sampled trees greater than or equal to 34 cm dbh ($n = 292$). There was no selection by Maryland Red-shouldered Hawks for red or white oak, nor for all other tree species pooled ($\chi^2 = 2.3$, df = 2, $0.25 < P < 0.5$). Beech was most commonly used as a nest tree by Red-shouldered Hawks in Wisconsin even though it was encountered in only 0.4% of the randomly sampled trees ($n = 509$ randomly sampled trees $\geq$ 34 cm dbh) of suitable size (Table 1). No chi-square test was conducted due to the small sample size.

Red-shouldered Hawks clearly selected trees on the basis of size in both regions (Fig. 2, Maryland; 2, Wisconsin). Only 4% of the randomly sampled trees in Maryland had a dbh greater than 40 cm, with 90% of the nest trees being larger than this. Less than 1% of the randomly sampled trees in Wisconsin had a dbh greater than 40 cm, with 63% of the Red-shouldered Hawk nest trees exceeding this dbh.

As with the Broad-winged Hawk nest trees, characteristics of Red-shouldered Hawk nest trees appeared similar among various tree species. No differences were found among nest tree characteristics in white, red, or scarlet oaks for Maryland Red-shouldered Hawks (ANOVA, $P > 0.4$ in all cases).

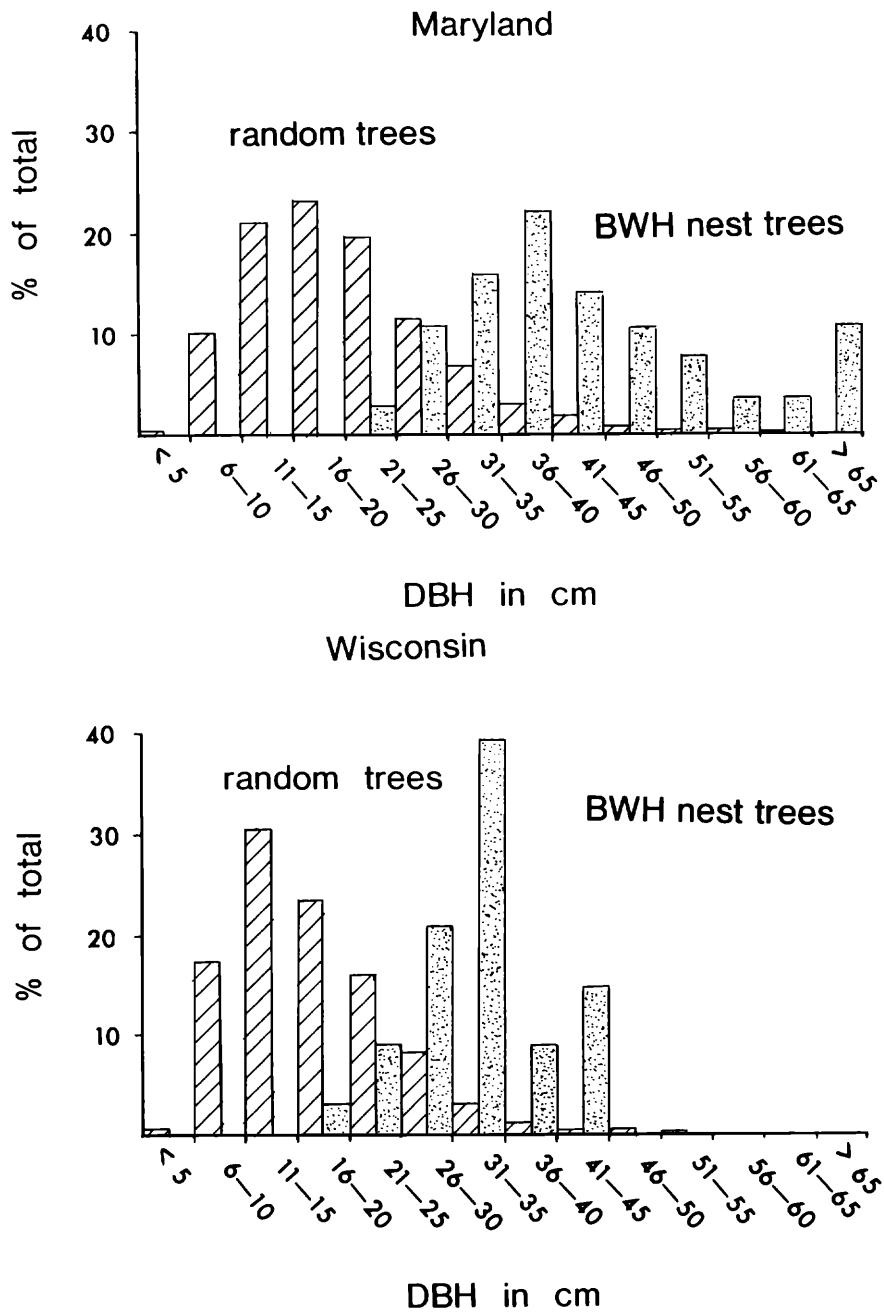

FIGURE 1. Size class distribution of random trees and Broad-winged Hawk (BWH) nest trees in western Maryland and northeastern Wisconsin.

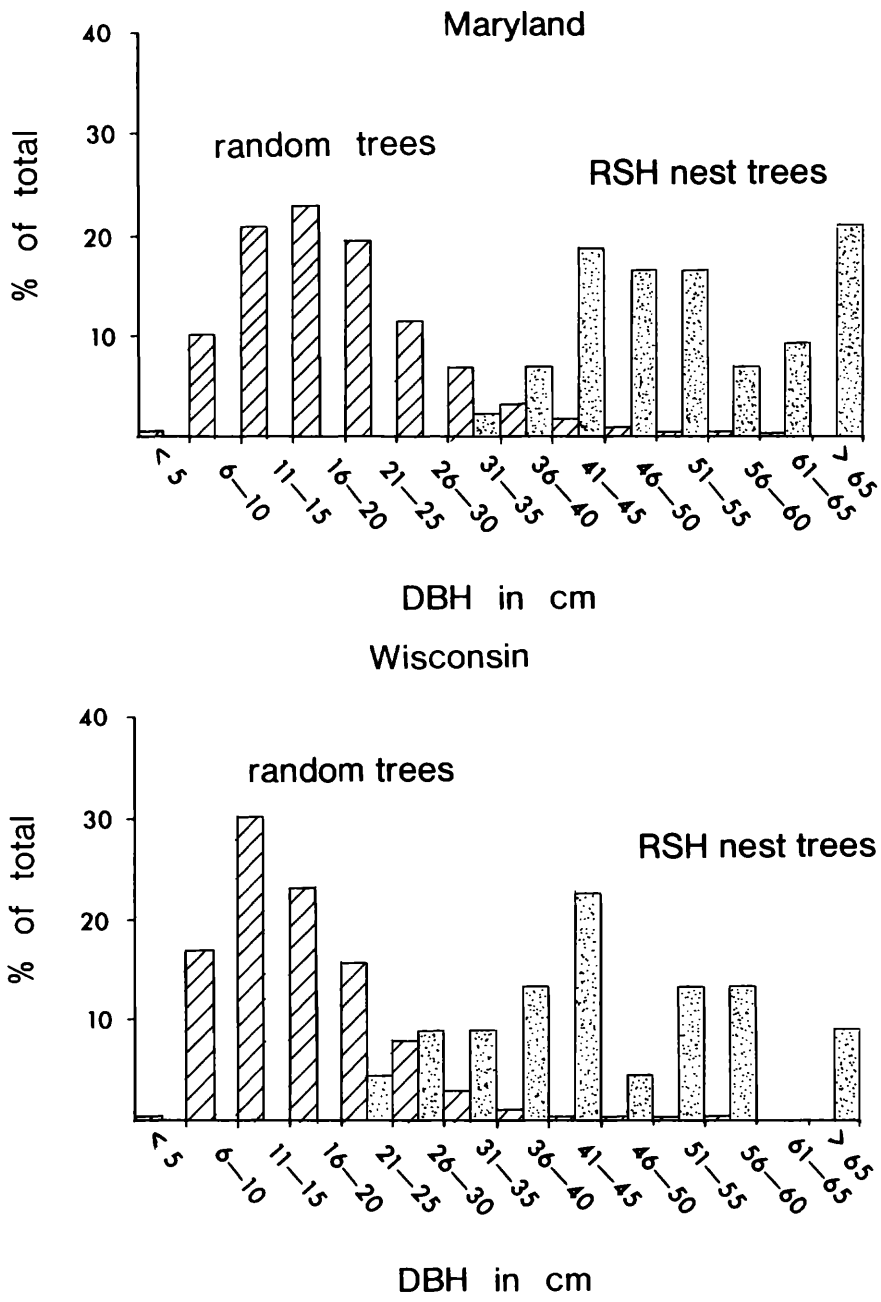

FIGURE 2. Size class distribution of random trees and Red-shouldered Hawk (RSH) nest trees in western Maryland and northeastern Wisconsin.

TABLE 2. Characteristics of common nest trees (mean ± SD) used by Broad-winged Hawks in western Maryland and northeastern Wisconsin.

Tree species	*n*	Nest height (m)	dbh (cm)	Nest tree height (m)	% nest height
Western Maryland					
White oak	38	14.1 ± 3.0	44 ± 11	24.3 ± 3.2	57 ± 9
Red oak	22	15.8 ± 2.7	47 ± 14	25.3 ± 2.6	63 ± 10
Chestnut oak	12	15.4 ± 3.4	45 ± 12	24.1 ± 2.9	64 ± 12
Scarlet oak	7	14.2 ± 2.2	33 ± 6	22.9 ± 3.4	62 ± 6
Black cherry	8	14.8 ± 1.5	44 ± 6	23.6 ± 1.8	63 ± 7
Black locust	5	18.3 ± 3.2	41 ± 10	25.3 ± 3.1	72 ± 5
Virginia pine	5	14.2 ± 3.0	29 ± 7	19.5 ± 4.2	73 ± 7
All samples	112	14.8 ± 3.2	44 ± 14	24.0 ± 3.4	62 ± 10
Northeastern Wisconsin					
White birch	16	10.0 ± 2.9	32 ± 5	22.3 ± 2.8	45 ± 11
Quaking aspen	6	10.8 ± 2.1	36 ± 10	21.3 ± 3.2	51 ± 11
Red oak	4	10.0 ± 1.2	34 ± 7	22.3 ± 3.1	45 ± 4
All samples	34	10.4 ± 2.6	34 ± 8	22.0 ± 2.7	47 ± 10

DISCUSSION

Broad-winged Hawks did not choose nest trees at random. White oak and white birch were chosen above their local availabilities in Maryland and Wisconsin, respectively. Red-shouldered Hawks nested in large red or white oaks in Maryland in about the same proportion as their occurrence. These tree species were often the only large suitable nest trees because old growth forest stands in western Maryland were dominated by white and/or red oak. Red-shouldered Hawks usually nested in large trees which were rare compared with the total number of trees in the forest, so nest tree choices were probably limited.

Raptors probably key in on the accessibility of a crotch to which they can fly and its ability to support a nest. The importance of a given tree species to a hawk is likely a function of architectural configuration for nest construction. The architecture of a tree is its overall structure, or growth form, and this approach to forest measurement is time consuming (Oosterhuis et al. 1982). In our study, we recorded tree species, which on average have typical growth forms or architectures. Noting where the nest was built in the tree, we found that Broad-winged Hawk nests were most often located in the main crotch of a tree (61%, $n = 90$) and supported by three or four branches (83%, $n = 120$). Red-shouldered Hawks constructed larger nests than Broad-winged Hawks and nearly always nested in the main crotch (88%, $n = 43$) supported by 3 or 4 branches (86%, $n = 51$). Aside from the importance of tree species architecture for nest placement, Newton et al. (1981) found nest success to be higher for Red Kite (*Milvus milvus*) nests in beech (*Fagus silvatica*) than other tree species. More studies relating nest success to habitat structure and floristics are needed.

The implications of tree species selection by nesting raptors may be important to forest managers. We have previously shown that structural features of the vegetation and physiography were correlated with raptor nest site selection (Titus and Mosher 1981). We may also be able to predict habitats selected in one region with data from another region (Mosher et al. 1986). Additionally, this study indicated that certain tree species may be important regionally for nesting. Forest managers may find it easier to manage for a group of tree species than for specific structural habitat features since tree species composition varies between regions.

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NOTES AND NEWS

The Colony Registry Program of the newly formed **Purple Martin Conservation Association** seeks the help of all persons in locating and registering Purple Martin colonies throughout all of North America in preparation for several projects designed to help this man-dependent species experiencing long-term declines within parts of its breeding range. If you know of someone who has a martin colony or is trying to attract one, or if you are interested in starting a colony yourself, please write to the P.M.C.A. You can further assist by looking for martin houses or gourds in peoples' yards during your travels. If you locate some, please try to obtain the mailing addresses from either the street & house numbers, rural mailboxes, phone books, or by stopping to inquire. Please send addresses to: PURPLE MARTIN CONSERVATION ASSOCIATION, *Institute for Research & Community Services, Edinboro University of Pennsylvania, Edinboro, PA 16444.*