

NEST SITE PREFERENCES OF RED-TAILED HAWKS IN THE HIGHLANDS OF SOUTHEASTERN NEW YORK AND NORTHERN NEW JERSEY

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Abstract.—Sixty-one Red-tailed Hawk (*Buteo jamaicensis*) nests were located in an extensively forested region of southeastern New York state and northern New Jersey. Nesting occurred almost exclusively in oak (*Quercus* spp.) forests. All nests were constructed in live deciduous trees (82% oaks), typically high in a secondary crotch within the forest canopy. Nest sites were closer than 70 random sites to forest openings and roads, which served as hunting areas. Nest sites were not closer to wetlands or other water sources than random sites, but this may result from the fact that water was plentiful in the study area. Nests were on steeper slopes and higher on the slope than random sites, but never directly on ridgetops. Thus, elevation tended to be higher and more varied for random sites. Slope aspects of nest sites were different than random sites, with the majority occurring in the southeast quadrant. Nest sites were not significantly further from human habitation than random sites, but no nesting was observed in high density suburban development.

PREFERENCIAS DE LUGAR DE ANIDAMIENTO DE *BUTEO JAMAICENSIS* EN LAS ALTURAS DEL SURESTE DE NUEVA YORK Y DEL NORTE DE NUEVA JERSEY

Resumen.—Un total de 61 nidos de *Buteo jamaicensis* fueron localizados en una zona boscosa extensa en la region sureste de Nueva York y norte de Nueva Jersey. Los anidamientos ocurrieron casi exclusivamente en bosques de cedro (*Quercus* spp.). Todos los nidos se construyeron en árboles deciduos vivos (82% cedro), típicamente altos en una cruceta secundaria dentro del dosel del bosque. Los lugares de anidamientos estaban más cercanos a claros en el bosque y carreteras que servían como áreas de caza que 70 lugares escogidos al azar. Los lugares de anidamiento no estaban más cerca de humedales u otras fuentes de agua que los lugares escogidos al azar, pero esto puede ser el resultado de que el agua es abundante en el área de estudio. Los nidos se encontraban en las pendientes más empinadas comparado a los lugares escogidos al azar, pero nunca en la cima de las colinas. Por lo tanto, la elevación tiende a ser mayor y de alcance más amplio que los lugares escogidos al azar. Las pendientes de los lugares de anidamiento fueron diferentes a los lugares escogidos al azar con la mayoría ocurriendo en el cuadrante del sureste. Los lugares de anidamiento no quedan significativamente más lejos de viviendas humanas que los lugares escogidos al azar, pero no se encontró nidos en áreas de alta densidad de desarrollo suburbano.

The Red-tailed Hawk (*Buteo jamaicensis*) is a widespread, familiar raptor of North America and its nesting ecology has been well studied (Austing 1964, Bohm 1978, Craighead and Craighead 1956, Fitch et al. 1946, Gates 1972, Gilmer et al. 1983, Hagar 1957, Johnson 1975, Luttich

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et al. 1971, Mader 1978, Orians and Kuhlman 1956, Petersen 1979, Siedensticker and Reynolds 1971, Smith and Murphy 1973). However, analysis of nesting habitat has seldom been undertaken. Howell et al. (1978) measured habitat variables at four nest sites in Ohio, and Titus and Mosher (1981) examined 13 nest sites in western Maryland. Similar studies were conducted in Iowa (Bednarz and Dinsmore 1982) and Puerto Rico (Santana C. et al. 1986). In this paper, we report on 61 nest sites from an extensively forested region that straddles southeastern New York and northern New Jersey and compare them to random sites.

STUDY AREA

The study was conducted in the Highlands, an area of rolling, granitic hills in southeastern New York and northern New Jersey (Fig. 1). This range is part of the Reading Prong, a southerly extension of the New England Uplands. The region is heavily forested and sparsely populated, especially in the north and central sections. The dominant direction of relief lies southwest to northeast and elevations vary from 507 m to nearly sea level. The study area lies in the Carolinian Life Zone (Dice 1943), but is ecotonal in character having a climax forest of northern hardwoods (Robichaud and Buell 1973). Forests are a mosaic of young and mature stands; old-growth is rare. Oaks (*Quercus* spp.) predominate in most areas. A more detailed description of this region is presented in Speiser and Bosakowski (1987).

METHODS

From 1977 to 1980, 24 nests of the Red-tailed Hawk were found during breeding bird surveys (Speiser 1981). We located 47 additional nests from 1981 to 1987. Although we generally followed the techniques of Craighead and Craighead (1956), no effort was made to locate all nests. Most nests were found by methodically searching woodlands on foot. Particular attention was given to areas where adults frequently were seen perched or soaring, or where vigorous protesting calls were heard. Some nests also were found incidental to surveys of other raptor species (Bosakowski et al. 1987, Speiser and Bosakowski 1987). Additional nests were found by scanning forests from vistas and fire observation towers. Although some nests were seen from roads while driving through the study area, intensive car surveys (Craighead and Craighead 1956) were not specifically employed as a nest searching technique. Nearly all nests were located in March and April, prior to leaf-out.

Nine variables were measured from 61 nest sites and 70 random sites using standard 7.5 min USGS quadrangle maps. Computer-generated random coordinates were used to select the random sites. A similar number of random sites and nest sites was taken from each quadrangle map to avoid bias. Random sites were rejected if located in nonforested areas. Distances from nest sites and random sites to the nearest road, nearest forest opening (non-forested area >1 ha), nearest wetland (>0.5 ha), nearest water source (lake, pond, stream), and nearest human habitation

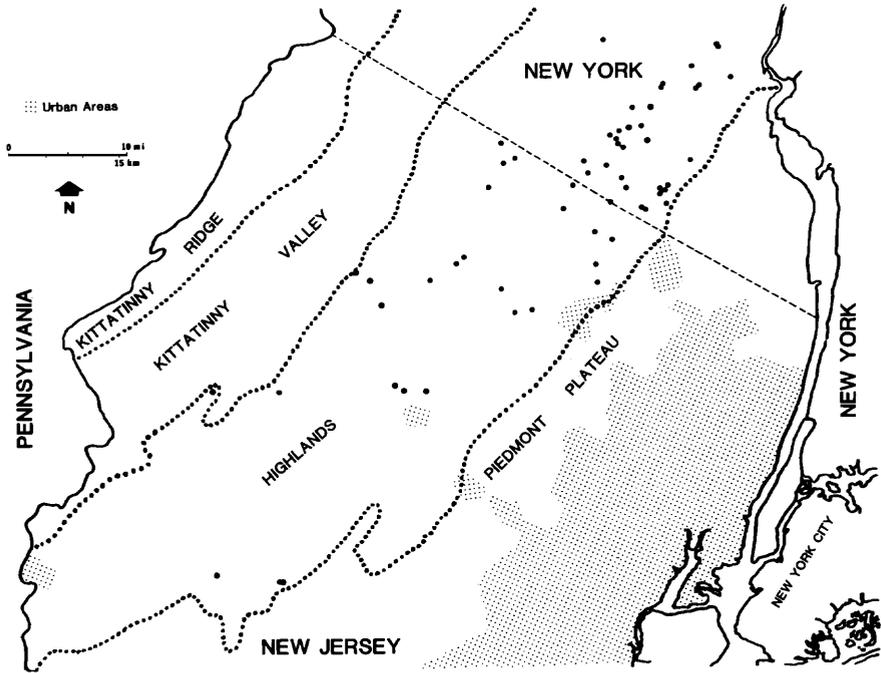


FIGURE 1. Map of all Red-tailed Hawk nests found in the Highlands during the study from 1977 to 1987. Note that the southern tip of the Highlands was less extensively searched and that nests found outside the Highlands were not used in the analysis and are not shown.

were measured from maps. Degrees of slope was figured over a 150 m baseline through the nest tree or random site. Slope aspect was determined only for sites with at least two degrees slope. Slope location was ranked into one of four categories only when slopes were longer than 180 m: 0—no slope, 1—lower slope, 2—middle slope, 3—upper slope. Elevations were taken from the quadrangle maps. Nest site data and random sites were compared statistically on the RS/1 software system (Bolt, Baranek, and Newman, Cambridge, Massachusetts). Slope aspects were compared using a Chi-square test. All other data were compared for homogeneity of variances (F -test). If variances were equal, a pooled variance t -test was applied, otherwise, an unpaired variance t -test was used.

RESULTS AND DISCUSSION

From 1977 to 1987 we found 61 nests; only 10 of which may have been the result of the same hawk(s) in subsequent years. No more than two nests were found in these traditional breeding areas. All nests were in overstory canopy trees and nest heights of a sample of 24 nests were estimated to range between 7 and 24 m above ground (Speiser 1981).

Most nests were situated high-up within the forest canopy (upper one-third of trees) which agrees with the findings of Titus and Mosher (1981). To achieve this height, nearly all nests were constructed in secondary crotches (53) whereas only six nests were built in primary crotches; two were on tree limbs away from the trunk. In contrast, the majority (58%) of 32 Northern Goshawk (*Accipiter gentilis*) nests from the same study area were built in primary crotches which resulted in nest placement at the bottom of the canopy.

Red-tailed Hawks built nests in 10 different species of live trees with the majority in oaks (82%). We found 32 nests in *Quercus rubra* (52.5%), 10 in *Q. prinus* (16.4%), four in *Q. velutina* (6.6%), four in *Q. alba* (6.6%), three in *Liriodendron tulipifera* (4.9%), two in *Acer saccharum* (3.3%), and one each in *A. rubrum*, *Fraxinus americana*, *Q. coccinea*, and one unknown. Although several studies in the eastern United States have also shown an exclusive use of deciduous trees for nest trees (Hagar 1957, Orians and Kuhlman 1956), Red-tailed Hawks will occasionally use conifers (Bent 1937, Titus and Mosher 1981) and man-made towers (Brett 1987) for nesting. Two nests reported for the Highlands, but not part of our study, were in a Norway Spruce (*Picea abies*) (Paul Jehebar, pers. comm.) and an abandoned 55 m construction tower (Piccatinny Arsenal, U.S. Army, ARDEC personnel). Trees appear to be important substrates for nesting even in sparsely forested portions of western North America. Knight et al. (1982) found Red-tailed Hawks nesting exclusively in riverine forestland along the Columbia River whereas cliffs were avoided. Moreover, Houston and Bechard (1983) documented the increase of nesting Red-tailed Hawks following the expansion of trees into the prairie regions of Saskatchewan.

Nearly all nest sites in this study were located in oak-dominated stands, which comprised most available forests. Stands of hemlock (*Tsuga canadensis*)-pine (*Pinus* spp.) and northern hardwoods, were usually avoided by Red-tailed Hawks. We do not believe that nests were significantly overlooked in conifers because the nests are large and the hawks are usually conspicuous vocally and visually when we walked near an active nest. Hagar (1957) also noted that Red-tailed Hawks nested less frequently in areas with scattered hemlocks than did Great Horned Owls (*Bubo virginianus*).

Nest sites were significantly closer to forest openings and roads (Table 1) which supported our observations that Red-tailed Hawks rarely nested deep within the interior of contiguous forest cover. This result was not surprising since these hawks are known to occur at high breeding densities in regions where most of the forest has been cleared for agriculture (Craighead and Craighead 1956, Hagar 1957, Luttich et al. 1971, Orians and Kuhlman 1956). In Maryland, Titus and Mosher (1981) did not find 13 nests to differ significantly from random sites with regard to proximity of forest openings, but the maximum range for nest sites (550 m) was half that obtained for random sites. Also, their mean of 233 m should not be considered a long distance given that Red-tailed Hawks

TABLE 1. Nest site variables measured at Red-tailed Hawk nests and random sites. Values are means \pm SD with range in parentheses.

Variable	Nest sites (n = 61)	Random sites (n = 70)	F-test P value	t-test P value
Distance opening (m)	155.9 \pm 134.03 (6-610)	238.1 \pm 210.00 (0-850)	0.002	0.008
Distance road (m)	182.2 \pm 141.48 (2-610)	247.7 \pm 248.86 (0-1200)	0.0002	0.062
Distance wetland (m)	545.2 \pm 552.05 (6-2300)	564.8 \pm 541.07 (0-2600)	0.869	0.841
Distance water (m)	239.7 \pm 193.78 (6-945)	250.8 \pm 210.88 (10-900)	0.748	0.749
Distance human hab (m)	777.3 \pm 517.08 (60-2300)	730.1 \pm 516.46 (50-2360)	0.988	0.603
Slope (degrees)	13.9 \pm 6.38 (0-25)	8.7 \pm 5.84 (0-28)	0.480	0.0001
Slope location (0-3)	1.61 \pm 1.07 (0-3)	1.14 \pm 1.12 (0-3)	0.714	0.017
Elevation (m)	249.0 \pm 59.60 (135-366)	273.1 \pm 84.16 (70-420)	0.007	0.059

can have nesting season ranges over 3 km in width (Craighead and Craighead 1956). Bednarz and Dinsmore (1982) found 26 Red-tailed Hawk nest sites to have over a 3-fold increase in the amount of non-forested upland hunting habitat when compared to Red-shouldered Hawk (*Buteo lineatus*) nest sites. Specifically, the type of forest openings associated with the nests (within 150 m) in our study were: highways and roads 46%, wetlands 21%, large field (>2.5 ha) 15%, pipeline and transmission slash 13%, or lake and rivers 5%. The tendency to nest near openings probably explains why nest sites were typically found closer to roads than random sites. Roads are apparently viewed as forest openings by the hawks as we have repeatedly observed territorial adults hunting on the grassy shoulders and median strips of highways.

Wetlands often resemble large forest openings, but the small percentage of nests (21%) located near them (<1 km) did not produce a significant difference from random sites. Proximity to a water source other than a wetland (lake, pond, stream) also was not significantly different. Water is apparently abundant in the study area (mean distance to water for random sites was 250 m) such that the lack of statistical significance does not necessarily preclude its importance to nesting Red-tailed Hawks. However, other studies have also failed to show a positive association of Red-tailed Hawk nests with water (Bednarz and Dinsmore 1982, Titus and Mosher 1981).

Nest sites were on significantly steeper slopes than random sites and higher up on the slope than random sites. Titus and Mosher (1981) and Bednarz and Dinsmore (1982) reported that Red-tailed Hawks nested

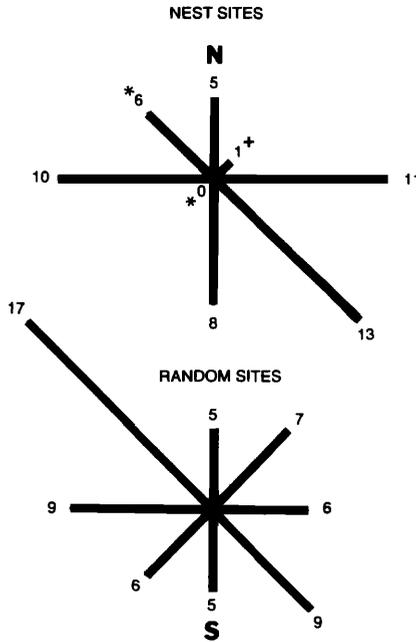


FIGURE 2. Slope aspect distributions of Red-tailed Hawk nest sites versus random sites ($\chi^2 = 17.9$, $df = 6$, $P = 0.006$). * indicates a significantly different proportion than random sites (Fisher Exact Test, 2-tailed, $P < 0.05$, + $P = 0.07$).

on steeper slopes compared to random sites or Red-shouldered Hawk nests, respectively. Santana C. et al. (1986) reviewed five explanations for this strategy: (1) unobstructed access to the nest, (2) wide views to detect predators at a distance, (3) wide views to detect territorial intruders, (4) visible nest as a territorial marker, and (5) watch nest for predators while hunting in territory. As an additional benefit, we suggest that (6) flight energetics are more favorable on steeper slopes for larger soaring raptors (e.g., Cathartid vultures). When we approached active nests, the hawks usually escaped by inconspicuously gliding downhill on set wings, whereas nests on flat terrain required more wing-flapping for escape flights, more likely revealing the location of the nest. Thus, nest openness or visibility may be an artifact of trees staggered at various altitudes of steep slopes. All of these proposed benefits appear to drive selection towards the highest, most exposed site possible, yet it must be realized that there are negative selection pressures, such as predation and physical exposure, which counterbalance the ultimate choice. It follows then that in our study, Red-tailed Hawks most often nested between lower and middle slopes (mean = 1.6), seldom near the top of a slope, and never directly on a ridgetop. The avoidance of upper slopes and ridge tops is also reflected in our elevation data, which showed that nest sites tended

to be at lower elevations and had a significantly narrower range than random sites. In addition to avoiding exposure to the elements and predators, the hawks may also be avoiding the stunted forest growth which is typical of dry, rocky ridgetops in our study area.

Slope aspects were significantly different for nest sites (Fig. 2) with the southwest direction being completely avoided, the northwest and northeast directions being under-represented, and the majority of nests occurring in the southeast quadrat. Bednarz and Dinsmore (1982) also found a complete avoidance of the southwest direction, but overall found no significant difference from random, probably because of the relatively flat terrain of Iowa. Titus and Mosher (1981) found a significant preference of eastern exposures in their sample of 13 nests. We speculate that southeastern exposures are favored to maximize insolation to the nest on cold mornings, as well as to reduce excessive heat stress in the afternoons, thus buffering daily temperature extremes. Conversely, southwest exposures tend to exaggerate daily temperature extremes in our study area compared to southeast or eastern exposures (data of Ross 1958).

Nest site proximity to human habitation was not significantly different than random sites. This result agrees with our field observations that Red-tailed Hawks will sometimes nest in woodlands adjacent to low density rural housing where human activity is slight. Of interest, Bednarz and Dinsmore (1982) found Red-tailed Hawks nesting significantly closer to buildings than Red-shouldered Hawks. Although we consider the Red-tailed Hawk to be one of the least sensitive large raptors to human activity, no nests were found in close proximity to high-density suburban housing developments.

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