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Nonbreeding Bald Eagle perch habitat on the northern Chesapeake Bay.—Bald Eagle (*Haliaeetus leucocephalus*) habitat is declining throughout much of the range because of human land uses along shoreline areas (Buehler et al. 1991a), logging (Anthony and Isaacs 1989), and recreation (Chester et al. 1990). Identification of habitat for protection requires knowledge of the characteristics that define habitat suitability. Although nesting and nocturnal roost habitat have been described throughout the eagles' range (e.g., Andrew and Mosher 1982, Keister and Anthony 1983, Anthony and Isaacs 1989, Bohall Wood et al. 1989, Buehler et al. 1991b), few studies have quantified diurnal perch habitat (Stalmaster and Newman 1979, Steenhof et al. 1980, Chester et al. 1990, Caton et al. 1992). Moreover, past studies relied on visual location of perched eagles along shoreline areas, potentially biasing results toward exposed, shoreline perch sites. We used radio telemetry to avoid this potential problem.

Except for Chester et al. (1990), other studies have not examined the effects of time of day or season on eagle habitat selection. Because microclimate variables such as temperature vary by time of day and season, we investigated whether diurnal perch selection differed with respect to these periods. We also tested the hypothesis that perch habitat differed from habitat available at random on the northern Chesapeake Bay.

Study area and methods.—The study area extended along the Chesapeake Bay from the Bay Bridge at Annapolis, Maryland, to the Conowingo Dam on the Susquehanna River, encompassing 3426 km^2. The area included 2472 km of bay, river, and creek shoreline and extended inland to the head of all major tributaries except the Susquehanna and Chester rivers. It also included part of the Baltimore metropolitan area and the U.S. Army Aberdeen Proving Ground, a 350-km^2 military installation. The study area included a largely urban-suburban setting near Baltimore, coastal lowland oak-gum (*Quercus* spp.-*Liquidambar styraciflua*) forests on the Aberdeen Proving Ground, agricultural fields with scattered oak woodlots on the Eastern Shore, and upland and lowland oak-gum-hickory (*Carya* spp.) forests along the Susquehanna River valley (Brown and Brown 1972).

A total of 59 Bald Eagles were radio-tagged. Twenty-nine immatures and two adults were trapped with floating noose-fish (Cain and Hodges 1989) and padded leghold traps (Young 1983) at Aberdeen Proving Ground, Susquehanna River, and Eastern Shore trap sites. Also, we radio-tagged 28 nestlings at 8–10 weeks of age in nests throughout the northern Chesapeake region.

Eagles were equipped with 65-g radio transmitters that had solar-charged nickel-cadmium batteries (Telemetry Systems, Inc., Mequon, Wis.) and an expected life of 4–5 years. We mounted radios dorsally on eagles with a 1-cm-wide teflon ribbon harness (Bally Ribbon Mills, Bally, Pa.).

Twice weekly during daylight, from March 1986 through June 1987, we located all radio-tagged eagles on the study area from fixed-wing aircraft, once during the early morning (sunrise to 09:15) and once during the remainder of the day up to 2 h before sunset.

For each perched eagle located, we photographed the perch tree with a single-lens reflex camera and used these photographs to relocate the perch trees on the ground. We visited each tree on foot and recorded tree species, diameter at breast height (dbh), and tree height (measured by clinometer). We estimated tree accessibility to a flying eagle as the total arc (0–360°) that was unobstructed by other tree canopies for a distance of 10 m from the trunk and 3 m below the perch tree's crown. We classed perch trees as live, dead, or dead-topped. We measured the height of the surrounding canopy with a clinometer. We sampled tree density at each site by counting all trees ≥10-cm dbh in an 11.3-m radius plot (0.04 ha) centered on the perch tree.

We measured the distance from the tree to the nearest habitat edge, defined as the intersection of forest, aquatic, human-developed, wetland, or agricultural habitats. We used the U.S. Geological Survey (USGS) land use and land cover database (Anderson et al. 1976) to classify cover type at each site as developed, forested, wetland, or agricultural. We calculated the area (ha) of each habitat block containing perches using ARC/INFO computer software. We also calculated the distance from each perch to the shoreline on a computer-digitized version of the USGS 7.5 minute topographic maps.

We divided the study-area shoreline into 2472 1-km sections and, using a random-numbers table, selected 178 sections. For each section selected, we randomly selected a distance between 0 and 1000 m along the section shoreline to define a point for comparison with eagle-selected sites. We chose the tree ≥20-cm dbh that was closest to each randomly selected shoreline point and measured the same characteristics that we measured for each perch tree.

We assigned perch trees to early morning leaf-on (sunrise–09:15, May–October), midday leaf-on (09:16–2 h before sunset, May–October), early morning leaf-off (sunrise–09:15, November–April) and midday leaf-off (09:16–2 h before sunset, November–April) classes, based on the date and time the tree was observed in use. We used Kruskal-Wallis tests to compare continuous variables among all classes of perch and randomly chosen trees, because variables were non-normally distributed. If the Kruskal-Wallis test resulted in the rejection of the null hypothesis ($P < 0.05$), we used Wilcoxon rank-sum tests to make pair-wise comparisons. We found no significant differences among perch tree classes in pair-wise comparisons ($0.06 < P < 0.98$) for all variables measured except for tree density. We pooled data, therefore, from all perch tree classes and compared all perch trees with randomly chosen trees. We used χ^2 analyses to compare the frequencies of discrete variables among perch trees and randomly chosen trees. We determined relative habitat preference based on Neu et al.'s (1974) approach.

Results.—We identified 220 Bald Eagle perch trees on the northern Chesapeake Bay (Table 1). Perch trees, on average, were larger in diameter, taller, extended farther above the canopy, and had greater accessibility than did randomly chosen trees ($P < 0.001$). Perch trees occurred in stands with greater canopy heights, were slightly farther from the edge, and occurred in stands with fewer trees per ha than did stands with randomly chosen trees ($P \leq 0.05$). Perch sites and randomly chosen sites were both relatively close to water ($P = 0.07$).

Eagles selected perches more often than expected in forested cover types, when compared to available sites, and eagles avoided human-developed types when compared to available

TABLE 1

CHARACTERISTICS OF BALD EAGLE PERCH TREES (N = 220) AND RANDOMLY CHOSEN SHORELINE TREES (N = 178), NORTHERN CHESAPEAKE BAY, MARYLAND

Variable	Perch trees			Randomly chosen trees			P value
	$\bar{x}$	SE	Range	$\bar{x}$	SE	Range	
Diameter (cm)	56.8	1.5	19.5–132.5	34.5	1.0	20.0–84.5	<0.001
Height (m)	19.1	0.4	6.1–38.1	12.4	0.3	4.6–31.7	<0.001
Canopy height (m)	16.1	0.5	0–30.8	12.8	0.4	0–25.6	<0.001
Height above canopy (m)	3.0	0.4	−14.3–27.7	−0.4	0.4	−18.3–21.3	<0.001
Access (degrees)	262	6.0	0–360	223	7	0–360	<0.001
Trees per ha	554	34	25–5000	659	38	50–3750	<0.01
Distance to edge (m)	5	1	0–250	3	1	0–100	0.05
Distance to water (m)	46	7	0–704	34	4	0–553	0.07

TABLE 2

COVER TYPE, SPECIES COMPOSITION, AND CONDITION OF BALD EAGLE PERCH TREES (N = 220) AND RANDOMLY CHOSEN TREES (N = 178), NORTHERN CHESAPEAKE BAY, MARYLAND

	Perch trees		Randomly chosen trees		
Variable	$\hat{p}$[a]	95% CI	$\hat{p}$[a]	95% CI	Selection
Cover type					
Developed	4.1	0.8–7.4	19.7	12.2–27.2	−
Farmland	28.7	21.1–36.3	41.6	32.4–50.8	0
Forest	49.1	40.7–57.5	24.7	16.6–32.8	+
Wetland	18.2	11.7–24.7	14.0	7.5–20.5	0
Tree species					
Black locust	13.2	7.5–18.9	10.7	4.9–16.5	0
Oak spp.	22.3	15.3–29.3	22.5	14.7–30.3	0
Sweet gum	23.6	16.4–30.8	7.9	2.8–13.0	+
Yellow poplar	8.6	3.9–13.3	1.7	0.0–4.1	0
Other	32.3	24.4–40.2	57.3	48.0–66.6	−
Condition					
Live	50.0	41.6–58.4	92.7	87.8–97.6	−
Dead-topped	25.0	17.7–32.3	2.8	0.0–5.9	+
Dead	25.0	17.7–32.3	4.5	0.6–8.4	+

[a] $\hat{p}$ = proportion of trees in a given class of cover type, tree species, or condition.

sites (Table 2). Perch trees occurred in forest blocks larger in size than forests available along the shoreline ($\bar{x}$ = 1685 and 873 ha, respectively, $P = 0.02$). Eagles selected perches in sweet gums more than expected, based on availability, whereas eagles selected "other" tree species less than expected when compared to randomly chosen trees (Table 2). Oaks, black locusts (*Robinia pseudoacacia*), and yellow poplars (*Liriodendron tulipifera*) also were frequently used as perches, but not at rates greater than that expected, based on availability. Most perch trees were live, but eagles used a greater percent of dead or dead-topped trees than expected, based on availability (Table 2).

Discussion.—Eagles selected larger and more accessible trees for perching than what was available at random, similar to eagle behavior recorded elsewhere (e.g., McEwan and Hirth 1979, Stalmaster and Newman 1979, Steenhof et al. 1980, Keister and Anthony 1983, Anthony and Isaacs 1989, Chester et al. 1990). Unlike Chester et al.'s (1990) results for North Carolina, however, we found no structural differences between perches used in May–October and perches used during November–April. We also found no time of day effects. Because suitable conifers are nearly absent from the northern Chesapeake, eagles may not show the selection patterns Chester et al. (1990) found in mixed pine-hardwood forests in North Carolina (i.e., eagles selected pine perches after 11:00 during the leaf-on period). Other differences (e.g., eagles in North Carolina perched lower in the tree after 11:00) may be related to microclimate differences between the two areas. Eagles in North Carolina may seek shade during the heat of the day, whereas temperatures on the Chesapeake may not be hot enough to produce this behavior, except during the warmest days in summer. In addition, our analysis may have missed some of these effects by averaging conditions over the entire leaf-off and leaf-on periods. Using similar seasonal definitions, however, we documented seasonal differences in roost habitat selection related to microclimate on the northern Chesapeake (Buehler et al. 1991b, c).

Most previous eagle habitat studies relied on visually locating eagles to identify used habitat and thus potentially biased results toward trees with more exposed perches. Because our results were similar to those from other studies, if a technique bias exists, it may not be significant, at least for the variables we measured. The key shortcoming of using surveys in which only shorelines can be observed is the inability to discover used inland habitats. On the northern Chesapeake, 11% of all diurnal radio-tagged eagle use occurred inland >80 m (range = 91–704 m). This disadvantage may be partly offset in areas with steep terrain where hillsides or mountainsides are still visible from the shoreline (Caton et al. 1992).

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Annual variation in the timing of breeding of the Monk Parakeet in relation to climatic factors.—The timing of breeding of a species is regarded as adaptive. According to Lack (1950), natural selection normally favors those individuals rearing offspring during the season that maximizes productivity and/or minimizes mortality.

Most birds have evolved a hereditary response to environmental changes (proximate factors, sensu Baker 1938) that predicts the favorable season well in advance. The variation in day length, at middle and high latitudes, is the primary signal to induce the basic physiological and behavioral preparations for breeding (Lack 1950, Immelmann 1971, Murton and Westwood 1977). However, additional factors are generally required to adjust the onset of egg laying to slight variations in ecological conditions (Immelmann 1971).

The Monk Parakeet (*Myiopsitta monachus*) has a breeding season restricted to spring and summer. The mean date of onset of laying has been found to vary among years within a 19-day range from late October to mid November (Navarro et al., unpubl. data). The regularity in timing of breeding suggests that the increasing day-length may be the basic environmental cue controlling this species' breeding season. However, the year-to-year variation indicates that other factors also may influence the onset of breeding in the Monk Parakeet.

This paper is focused on the role of proximate factors (other than photoperiod) that may induce slight annual shifts in the timing of breeding in the Monk Parakeet. We used correlation analysis to investigate the potential effects of rainfall and temperature on the date of initiation of egg laying.

Study area and methods.—The information presented here was collected during a long-term study of the breeding biology of the Monk Parakeet, conducted in a 610-ha area located