NESTING HABITAT OF CANADA GEESE IN SOUTHEASTERN MICHIGAN

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Habitat selection by birds is guided by instinctive and learned responses to stimuli from the physical environment, conspecifics, and other species within the environment (Hilden 1965). Whitmore (1975) reviewed studies that described species preferences and differences in habitat use based on certain features of the landscape and vegetation; however, most earlier studies were largely qualitative and failed to reveal which parameters were most important among several that affect habitat selection. Recent studies of passerines, employing multivariate analyses (Anderson and Shugart 1974, Cody 1968, James 1971, Sturman 1968, Whitmore 1975), have revealed differences between species-specific habitat types within particular communities. Crawford and Bolen (1976) used multiple regression analysis to correlate factors of vegetation and land-use with spring and fall population levels of Lesser Prairie Chickens (*Tympanuchus pallidicinctus*).

Little attempt has been made to quantitatively show differences within species between used and unused portions of the available habitat. Although Klebenow (1969) attempted unsuccessfully to differentiate (using discriminant function analysis) between habitat that was used and not used by Sage Grouse (*Centrocercus urophasianus*) for nesting and brood rearing, similar studies with other bird species, including waterfowl, are unavailable. This study investigates factors which separated used from unused nesting wetlands and nesting sites of Canada Geese (*Branta canadensis*) in southeastern Michigan in order to better understand nesting habitat selection by this species.

STUDY AREA, METHODS, AND ANALYSIS

The study area (9065 km^2) lies within the Huron River Valley of southeastern Lower Michigan which Hanson (1965) includes as part of the breeding range of giant Canada Geese (*B. c. maxima*). A morainic topography, resulting from the Wisconsin glacier, contains numerous kettle hole lakes and marshes. Kaminski (1975) presented a more detailed description of the study area's wetlands and vegetation.

Morphological measurements (culmen length and width, tarsus length, middle-toe length, and body weight) of molting geese (1 year and older) were made to determine subspecies identity of the Huron River Valley flock. Mean values for these measurements were similar to those documented by Hanson (1965) for giant Canada Geese (Kaminski 1975).

Between 15 April and 25 April 1974 for 8 days (08:00–16:00), we conducted a helicopter survey of the study area in order to estimate numbers of nesting Canada Geese. Quarter sections (65 ha each) were chosen as the sampling unit; the boundaries of which were easily identified from the air. Topographic maps of the study area were used to enumerate all quarter sections containing any wetland (pond, lake, river, marsh, and waste treatment lagoon) that could potentially provide nesting habitat for Canada Geese. A total of 6275 quarter sections contained at least 1 of these wetlands. A 5% sample (n = 310) was randomly selected (using a table of random numbers) and positioned on county maps by their appropriate legal description and then systematically searched for nesting geese. Ground searches of other wetlands revealed additional nests for study.

Wetlands that contained nesting geese were characterized by a shoreline development index (Reid 1961) which is based on shoreline configuration (a value of 1 denotes a perfectly round shoreline), percent residential and/or recreational shoreline occupancy, area of permanent open water, and area of emergent vegetation within the nesting quarter section. These data were obtained from aerial photos and from an inventory of Michigan's lakes prepared by Humphrys and Green (1962).

Williams and Nelson (1943), Miller and Collins (1953), and others suggested that Canada Goose nesting sites should be elevated to provide good visibility, afford protection, be near water, and provide a firm foundation. On the basis of these criteria, appropriate parameters were measured to evaluate the magnitude of difference between muskrat (*Ondatra zibethica*) lodges and islands selected as nesting sites, and similar unused sites. Nest site type dictated the parameters that were measured. Parameters measured on and around muskrat lodge nest sites were: (1) width of lodge top, (2) percent occurrence of cover, (3) lodge height above standing water, (4) distance from the lodge to open water, (5) average height of emergent aquatic vegetation, and (6) distance from the lodge to the nearest shoreline. The same measurements were recorded for the nearest muskrat lodge devoid of nesting Canada Geese. We assumed that the geese had a choice between the sites independent of social interactions between conspecific pairs. This assumption did not appear to be violated because of the low average density (0.08/65 ha) of nests in 1974. Data for percent occurrence of cover and height of vegetation were collected at 0.1 m intervals along transect lines (0.05 m $\times$ 10 m) extending from the base of each lodge in the 4 cardinal directions. Only vegetation (dead annuals plus live and dead perennials) that was presumed to be available to Canada Geese selecting nest sites and that intersected and/or overshadowed the transect line was counted. Parameters measured on islands used by nesting geese and islands not used were: (1) % slope at the highest point on the island, (2) density of vegetation, (3) distance from the island to the nearest shoreline, (4) island length, and (5) average height (up to 3 m) of all understory vegetation. Percent slope was measured with a Haga altimeter. Distance measurements were made with a range finder. A density board, described by DeVos and Mosby (1969), was used to estimate the density of vegetation. Four readings, corresponding to the cardinal directions, were taken within 3 m of the shore-water interface on all islands plus at the nest site on islands used by nesting Canada Geese. Replicated measurements (taken within 1 circular plot (0.03 ha) circumscribing the nest and within 1 randomly placed plot positioned adjacent to the shore on islands not used by nesting Canada Geese) were used to estimate vegetation height.

Data from nest sites were analyzed using a multivariate discriminant function analysis modified from Cooley and Lohnes (1971). The goal of discriminant function analysis is to maximize among-group variation thereby assigning individuals to a group on the basis of data peculiar to the group (Lachenbruch 1975). Green (1971) presented an excellent discussion on the statistical theory and ecological application of discriminant function analysis. In our analysis, one discriminant function was calculated because $g-1$ (g = number of groups contrasted) was less than p, the number of elements of the vector variable (Cooley and Lohnes 1971) and it accounted for 100% of the among-group variance. Variation about reported mean values is denoted by 95% confidence limits. All percent data were transformed using arcsine values (Sokal and Rohlf 1969) prior to analysis.

RESULTS AND DISCUSSION

Twenty-six active nests were located during the survey of quarter sections. We estimated there were 526 ± 231 active nests on the study area at the time of the survey. The design of the aerial survey did not exclude any wetland size class; hence quarter sections containing wetlands were surveyed in relation to their abundance. As a result, the survey concentrated on searching small wetlands (Fig. 1). Wetlands with nesting Canada Geese had shoreline development values averaging 1.4 ± 0.2 ($n = 30$). This type of shoreline configuration (nearly circular) is common to most wetlands in southeastern Michigan. Shoreline development values for nesting wetlands differed significantly ($P < 0.01$) when stratified by nest site type (muskrat lodge, island, or floating mat of vegetation) suggesting that the presence of suitable nest sites was more important to Canada Geese selecting nesting wetlands than was the shape of the shoreline. The area of emergent aquatic vegetation (predominately *Typha latifolia* and *Scirpus* spp.) within nesting quarter sections ranged from 0 to 40 ha and did not appear to directly influence habitat choice by nesting geese. Nesting wetlands having little or no emergent vegetation contained one or more islands which were virtually inaccessible to mammalian predators, alleviating the necessity for nest concealment by emergent cover. Nesting wetlands covered by more emergent vegetation usually contained muskrat lodges which were the most frequently used nest site type in the study area (Kaminski 1975). Cooper (1973) stressed the important commensal relationship between muskrats and the use of emergent cover by nesting Canada Geese at Marshy Point, Manitoba. Twelve (40%) nesting wetlands had 10% or more of their shorelines occupied residentially and/or recreationally, suggesting that Canada Geese will tolerate some human habitation when selecting nesting wetlands in southeastern Michigan. The most important factor affecting use of wetlands by nesting geese appeared to be the area of permanent open water. Ninety-two percent of all nests located during the aerial survey were situated on wetlands having 2 or more hectares of open water (Fig. 1). The greatest proportion (42%) of nesting pairs used wetlands for nesting that contained more than 25 ha of open water. This is similar to Hanson's (1965) observations that although Canada Geese demonstrate a wide adaptability for various nesting habitats, these must be available in large blocks and contain bodies of water of moderate to large size.

The difference between selected nest sites and ones not used by Canada Geese was evaluated using a discriminant function analysis. A multivariate analysis of variance yielded a highly significant ($P < 0.001$) discrimination

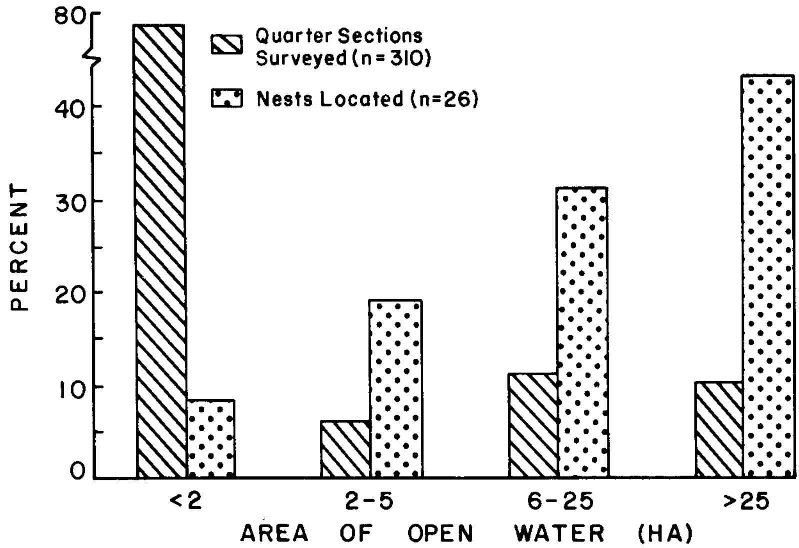

FIG. 1. Percentages of Canada Goose nests in relation to the area of open water associated with nesting wetlands in 1974.

between both categories of muskrat lodge and island sites. Width of muskrat lodge top had the highest scaled eigenvector coefficient (Table 1) indicating it was most influential in separating lodges used by nesting geese compared to ones not used. All lodges used by nesting Canada Geese exceeded 1 m in top width while only 2 met this criterion in the unused category. Rienecker (1971) observed that Canada Geese more readily accepted artificial nesting structures having large (0.9 m–1.2 m) platforms. Although percent occurrence of cover, surrounding muskrat lodges, was not significantly different ($P > 0.05$) among lodges with goose nests, percent occurrence of cover was significantly different ($P < 0.05$) among lodges not used by nesting geese. This suggests that Canada Geese selected muskrat lodges for nest sites that were surrounded by a similar amount of cover. Although percent occurrence of cover ranked second in discriminatory ability (Table 1), it contributed similarly to the discriminant function along with lodge height above standing water and distance from the lodge to open water. These 4 parameters are probably important cues used by Canada Geese in selecting muskrat lodges as nest sites and should be measured when field evaluating lodges as potential nest sites for this species. Discriminant scores for all muskrat lodges were computed using a grand mean of 50 (S.D. = 10). Histograms of these scores depict the relative difference between muskrat lodges used and not used by

TABLE 1

MEAN (95% C.I.) AND SCALED EIGENVECTOR COEFFICIENTS FOR PARAMETERS MEASURED ON AND AROUND MUSKRAT LODGES USED AND NOT USED BY CANADA GEESE AS NESTING SITES IN 1974

Parameter	Used lodges (n = 23)	Unused (n = 23)	Scaled eigenvector coefficient[1]
Width of lodge top (m)	1.6 (1.4– 1.8)	0.88 (0.80–0.96)	-2.535
% occurrence of cover	35.1 (32.4–39.4)	30.2 (25.0–35.5)	-0.786
Lodge height above water (m)	0.34 (0.30–0.38)	0.27 (0.21–0.33)	-0.718
Distance from lodge to open water (m)	17.5 (9.6–25.4)	25.7 (5.7–45.7)	+0.556
Average height of vegetation (m)	0.82 (0.75–0.89)	0.80 (0.70–0.90)	-0.294
Distance from lodge to nearest shoreline (m)	58.7 (39.3–78.1)	58.9 (39.0–78.8)	-0.289

Root of $W^{-1}A = 1.046$
Wilk's lambda = 0.489; df = 6,39; F = 6.79; ($P < 0.001$)

[1] The largest absolute value is most important.

nesting Canada Geese (Fig. 2). Although lodges within the 46–55 range could not be clearly assigned to 1 of the 2 groups with much confidence, each distribution is comparatively distinct with used lodges occupying the lower ranges of discriminant scores. The minimal overlap between the distributions suggests that those lodges selected by nesting geese were superior nesting sites.

Five parameters were measured on islands used and not used by nesting

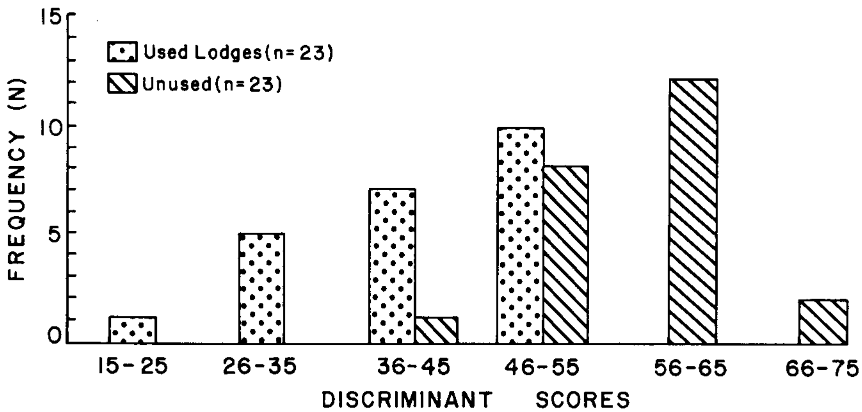

FIG. 2. Histograms of discriminant scores from parameters measured on and around muskrat lodges used and not used by Canada Geese as nesting sites in 1974.

TABLE 2

MEAN (95% C.I.) AND SCALED EIGENVECTOR COEFFICIENTS FOR PARAMETERS MEASURED ON ISLANDS USED AND NOT USED BY CANADA GEESE AS NESTING SITES IN 1974

Parameter	Used islands (n = 37)	Unused (n = 37)	Scaled eigenvector coefficient[1]
Island relief (% slope)	15.7 (13.4–18.1)	8.4 (6.2–10.9)	+24.352
Island vegetation density (%)	45.7 (36.1–55.3)	62.9 (53.3–72.0)	-16.607
Vegetation density at nest site (%)[2]	17.1 (11.8–23.1)	——	——
Distance from island to nearest shoreline (m)	73.2 (61.1–85.3)	61.4 (45.1–77.7)	+11.788
Island length (m)	65.9 (39.0–92.8)	85.1 (50.8–119.4)	-11.501
Average height of vegetation (m)	1.7 (1.5– 1.9)	2.0 (1.6– 2.4)	-10.836

Root of $W^{-1}A = 0.439$
Wilk's lambda = 0.695; df = 5,68; F = 5.96; ($P < 0.001$)

[1] The largest absolute value is most important.
[2] Not included in discriminant function analysis.

Canada Geese (Table 2). Percent slope of island relief had the highest relative power for discrimination being 7% greater on the average for islands used by nesting geese compared to unused islands. Hanson and Eberhardt (1971) observed that Canada Geese did not use islands that had low profiles for nesting in the Columbia River of Washington. Islands having more relief not only facilitate nest vigilance but render nests less vulnerable to fluctuating water levels. The density of vegetation was significantly lower ($P < 0.01$) on all islands used by nesting geese compared to islands not used. Furthermore, the density of vegetation at the immediate nest site was significantly lower ($P < 0.01$) than the average vegetation density on the remaining area of the nesting island. Sherwood (1968) reported that most Canada Geese nesting at the Seney National Wildlife Refuge in northern Michigan selected islands that were free of dense, high brush which enhanced visibility and accumulated less snow. Barry (1962), Cooper (1973), and Ryder (1967) observed that snow cover on the breeding grounds delayed nest initiation in Atlantic Brant (*Branta bernicla*), Canada Geese, and Ross' Geese (*Chen rossii*) respectively; because suitable nest sites were not available. Although all variables contributed cumulatively to the discriminant function, distance from the island to the nearest shoreline, island length, and the height of vegetation differed slightly in their order of magnitude (Table 2) suggesting a reduced contribution to the separation. Percent slope of island relief and the density of island vegetation were the most important parameters, among those measured, affecting island use by nesting Canada Geese. Increasing island relief and thinning dense stands of vegetation should improve the

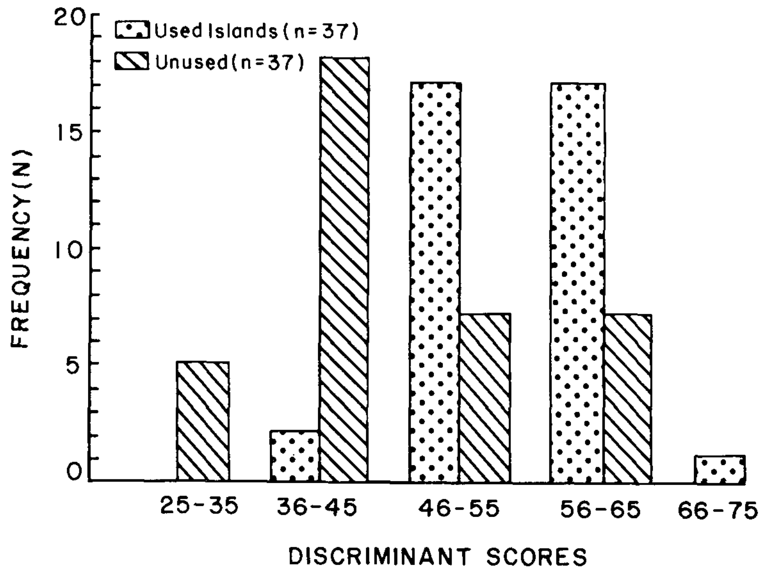

FIG. 3. Histograms of discriminant scores from parameters measured on islands used and not used by Canada Geese as nesting sites in 1974.

suitability of islands for nesting in southeastern Michigan. Discriminant scores, forming frequency distributions (Fig. 3), from both island groups show the greatest overlap in the 46–65 range making it difficult to accurately predict if an island having a score within this range will be used by nesting Canada Geese in southeastern Michigan. The less distinct separation between these frequency distributions may reflect the preference that Canada Geese show for insular nest sites throughout their breeding range.

Although an absolute separation was not obtained in either case, the analyses show that certain physiognomic characteristics delineated selected nest sites from sites not chosen. Those parameters, most significant in the discrimination, were probably important proximate cues (Hilden 1965) affecting site selection by Canada Geese. Klopfer and Hailman (1965) stated that if a bird species recognizes and distinguishes between suitable and unsuitable habitats, its reproductive efficiency could be enhanced. This should theoretically contribute to the fitness of reproducing individuals.

Information obtained in this study is valuable for predicting potential nest site availability, for providing guidelines in the manipulation of habitat, and for the effective construction and positioning of artificial nesting structures for Canada Geese. Experimental manipulation of nest site quality along with the density of breeding pairs as they affect site selection would be a logical advancement of this study. Similar research with other species whose nest sites lend themselves to discriminant function analysis would augment our understanding of factors affecting species-specific nest site selection and provide an opportunity to evaluate their strategies of habitat selection.

SUMMARY

Nesting habitat of Canada Geese in southeastern Michigan is described. Most nesting pairs (92%) preferred wetlands that contained 2 or more hectares of open water. Data were collected from both muskrat lodges and islands used and not used by Canada Geese as nesting sites. These data were analyzed using a discriminant function analysis to determine which factors best separated used from unused nesting sites. Top width of muskrat lodges and percent slope of island relief along with the density of island vegetation were most important in the discrimination. This approach provides a quantitative technique for evaluating the potential availability of nesting habitat along with revealing species-specific nest site preferences.

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