Locations and success of duck nests evaluated through discriminant analysis

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Introduction

In recent years, applications of discriminant analysis in ecological investigations have increased (e.g., Green 1971; Anderson & Shugart 1974). Klebenow (1969) used discriminant analysis to compare nest sites of Sage Grouse *Centrocercus urophasianus* with randomly selected sites. Kaminski & Prince (1977) applied the technique to contrast islands and muskrat *Ondatra zibethicus* lodges used by nesting Canada Geese *Branta canadensis* with sites not selected for nests. Most recently, Wray & Whitmore (1979) used discriminant functions to determine habitat characteristics associated with nest success of Vesper Sparrows *Pooectes gramineus*.

The objective of this paper is to provide an insight into duck nesting as a basis for management designed to maintain or improve duck production in uplands. Specifically, discriminant analysis was used to identify cover types and locations preferred by ducks for nest sites, and to identify characteristics of nest sites that are associated with nest success.

Study area and methods

This study was conducted in retired cropland, at Horicon National Wildlife Refuge, Mayville, Wisconsin. The refuge is composed of 1525 ha (18%) upland, 6834 ha (80%) wetlands, and 132 ha (2%) buildings, roads, and related facilities.

Nests were located primarily by cable-chain drag or rope dragging during May and June 1977–78. A nest was defined as a scrape or bowl that contained at least 1 egg and was in use when found. Stage of incubation and initiation dates of nests were estimated by candling and back-dating. Nests were marked with wooden laths and fates of nests were determined using the criteria of Rearden (1951). Few nests were visited more than once while in use and impacts of investigation on nest success were considered minimal (Livezey 1980). Nests in which at least 1 egg hatched were designated successful. Cover plants at nest sites were assigned by eye estimate to 1 of 5 relative-abundance classes (0–20, 21–40, 41–60, 61–80, 81–100%) and cover density was estimated with a 'density cube' modified from Jones (1968). Distances from nests to selected landmarks, detailed below, were measured with a Leitz 500-mm rangefinder or with the aid of aerial photographs and field maps.

For comparisons with nest sites, measurements at random locations in nesting fields were taken in May and again in June. These sites were marked and at each visit the composition and structure of the cover were measured as at nest sites; distances were measured at the last visit. Nests found in May and those found after 31 May were compared to random sites sampled at corresponding times. Comparisons included 15 variables: cover density; height of live cover; height of dead cover; distances to water, marsh, field edge, nearest nest, brush, and tree; and relative abundances of alfalfa *Medicago sativa*, tall grasses (primarily *Bromus inermis*, *Agropyron* spp., *Phleum pratense*, *Phalaris arundinacea*), short grasses (*Poa* spp., *Bromus tectorum*), sweet clover *Melilotus* spp., large forbs (e.g., *Ambrosia* spp., *Asclepias* spp., *Solidado* spp., *Cirsium arvense*), and small forbs (e.g., *Taraxacum officinale*, *Plantago* spp.). Distances from random sites to a nest were measured only in May when nests were most abundant, and thus were not included in late-season comparisons.

Successful nests and those destroyed by predators were contrasted to assess site characteristics that were associated with nest fate. In addition to the 15 variables used to compare nest sites with random sites, comparisons of nests also included initiation dates, numbers of persons that approached the nests, and sizes of cover blocks in which the nests were located. Initiation dates were considered because nest success varied during the nesting season in many other studies (e.g. Keith 1961). Numbers of persons that had been at nests were evaluated because preliminary analysis indicated that such disturbance may have reduced nest success (Livezey

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1980). Field size also was included because Stoudt (1969) and Nelson & Duebbert (1969) suggested that nest success was greater in large blocks of cover than in small plots.

All inter-group contrasts were made using the BIOMED program for step-wise discriminant analysis (Dixon 1975) on a UNIVAC 1110 computer at the University of Wisconsin, Madison. Discriminant analysis identifies variables that distinguish contrasted groups. The total discrimination of groups achieved is then tested by the percentage of samples that can be correctly reassigned to group by classification functions (Klecka 1975). Univariate statistics used are described in Steel & Torrie (1960).

Results

During 1977 and 1978, 552 duck nests were located: 510 (92%), Blue-winged Teal *Anas discors*; 25 (5%), Mallard *A. platyrhynchos*; 7 (1%), Northern Shoveler *A. clypeata*; 6 (1%), Gadwall *A. strepera*; 2 (<1%), Pintail *A. acuta*; and 1 (<1%), Green-winged Teal *A. crecca*. Of these, 300 were found in May and 252 in June or early July.

Discriminant analysis of nests found in May and 345 random sites sampled in May indicated that 6 variables were important in distinguishing the 2 groups (Wilk's Lambda = 0·69; F = 44·8, Table 1). Nests were generally nearer to both water and another nest, and in denser, taller cover than random sites. Also, nests were located proportionately more in short grasses and less in alfalfa than random sites. Bluegrass *Poa* spp. was the most common short grass at all sites. Analysis of late-season nests and 339 random sites measured in June indicated similar differences between groups with 3 exceptions: distance to marsh was used to distinguish groups instead of distance to any water; cover density was no longer different between groups; and distance to another nest could not be evaluated (Wilk's Lambda = 0·89; F = 18·9, Table 1).

Both May and June nests overlapped considerably with random sites in location and cover characteristics. Classification functions correctly classified as nests or random sites only 78% and 66% of the May and June samples, respectively.

For analysis of nests by fate, 48 nests that were abandoned, damaged by investigators, or of unknown fate were excluded. Of the remaining 504 nests, only 49 (10%) were successful. Predators, primarily striped skunks *Mephitis mephitis* and raccoons *Procyon lotor*, destroyed 90% of the nests. Analysis of groups indicated that only 3 site characteristics were associated with nest success (Wilk's Lambda = 0·96; F = 5·9, Table 2): distance to water; and relative abundances of small forbs and short grasses. Successful nests were located about 63 m farther from water, and in cover composed of roughly 12% less short grasses and 4% less small forbs than nests destroyed by predators. Nests grouped by fate overlapped considerably; classification

Table 1. Comparison[1] of cover and site characteristics[2] of duck nests with randomly chosen sites at Horicon National Wildlife Refuge, 1977–1978.

Date of sample	Characteristic	Nests	Random sites	F-statistic to enter
May		n = 299	n = 345	
	Height of live cover (cm)	33 ± 1	23 ± 1	119·9
	Abundance of alfalfa (%)	11 ± 1	17 ± 1	57·2
	Abundance of short grass (%)	30 ± 2	19 ± 2	13·5
	Distance to water (m)	158 ± 8	219 ± 10	6·8
	Distance to another nest (m)	110 ± 17	420 ± 31	43·9
	Visibility of nest (%)	81 ± 1	92 ± 1	15·5
June		n = 252	n = 339	
	Height of live cover (cm)	46 ± 1	45 ± 1	6·9
	Abundance of alfalfa (%)	11 ± 1	18 ± 1	4·4
	Abundance of short grass (%)	36 ± 2	18 ± 2	43·9
	Distance to marsh (m)	184 ± 10	271 ± 13	17·9

[1] All group means differed ($P < 0·001$).
[2] Mean ± standard error.

Table 2. Comparison of cover and site characteristics[1] of duck nests grouped by fate at Horicon National Wildlife Refuge, 1977–1978.

Characteristic	Hatched (n = 49)	Preyed upon (n = 455)	*F*-statistic to enter
Distance to water (m)[2]	221 ± 25	158 ± 6	9·7
Abundance of small forbs (%)[3]	4 ± 1	8 ± 1	4·2
Abundance of short grass (%)[4]	23 ± 5	35 ± 2	3·7

[1] Mean ± standard error.
[2] Group means differ ($P < 0{\cdot}01$).
[3] Group means differ ($P < 0{\cdot}05$).
[4] Group means differ ($P < 0{\cdot}10$).

functions classified only 65% of the nests correctly.

Discussion

Comparisons of nests with random sites indicated that females selected nest sites by proximity to water and the composition and structure of cover. Selection of dense cover by females was most marked early in the season, probably because available cover was generally less well developed. Glover (1956) found that Blue-winged Teal nested mostly in clumps or tufts of vegetation early in the breeding season, but later nests were located in more homogeneous cover.

Relatively short distances between nests primarily reflected the heavy use of several favoured fields near water by nesting females. Nest densities in these preferred tracts reached 7·6 nests per hectare. Crowding of nests may increase losses of nests to predators (Tinbergen *et al.* 1967; Braun *et al.* 1978), and may have contributed to the extraordinarily low nest success at Horicon during this study.

Cover and location of nests at Horicon were similar to characteristics of nest sites described in other studies. Upland-nesting ducks typically nest within 100 m of water (Glover 1956; Dzubin & Gollop 1972; Bellrose 1976). Several duck species, particularly Blue-winged Teal, commonly use bluegrass for nest cover (Bennett 1938; Krapu *et al.* 1970; Bellrose 1976).

Nests and random sites were not clearly distinguishable but some overlap of groups was expected. Undoubtedly, part of the variation in nest sites resulted from differences in preferences of nesting species (Keith 1961; Bellrose 1976), but the small samples of species other than Blue-winged Teal prevented meaningful separate analyses. Selection of dense, tall cover by females for nesting was evident at Horicon NWR even though all sampled fields had been protected from agricultural disturbance for at least 1 year. Therefore, land-use practices that remove cover in uplands reduce cover types preferred by nesting ducks, and should be controlled in areas managed for waterfowl production.

Consistent differences between successful and destroyed nests in site characteristics were few (Table 2). Poor discrimination of groups was probably caused, in part, by small numbers of successful nests available for comparisons. However, discriminant analysis indicated that proximity to water was related to low nest sucess. Possibly nests near water were more easily detected by predators than nests in higher sites because moist soil enhanced nest odours (Keith 1961; Townsend 1966). Skunks, the primary nest predator at Horicon, may have preferred to hunt near water (Keith 1961). Also, large numbers of near-water nests may concentrate predators during the nesting season.

Despite low nest success near water, comparisons of nests with random sites indicated that hens preferred to nest close to water. Dzubin & Gollop (1972) and Ball *et al.* (1975) concluded that survival of ducklings after hatching was low where broods made long overland treks to water. Proximity of nests to water at Horicon may reflect an adaptive compromise between losses of eggs and ducklings.

High relative abundances of small forbs and short grasses characterized unsuccessful nests at Horicon (Table 2). Cover at nests in short grasses was less dense than at nests in tall grasses or alfalfa ($P < 0{\cdot}5$, Newman-Keul's tests). Cover density, although greater at successful nests than at nests destroyed by predators ($P < 0{\cdot}05$, *F*-test), was not useful for discrimination of nests by fate. However, cover density at nests was positively correlated with distance to water ($r = 0{\cdot}217$, $P < 0{\cdot}001$), primarily because more dense hayfields were far from water than less dense, retired lands. This covariance reduced, in part, the usefulness of cover density for discrimination. Previous studies indicated that nest predation was lower in dense cover than in sparse vegetation (Duebbert 1969; Kirsch 1969; Schranck 1972). In contrast, other workers found no relationship between nest success and cover density or that dense cover was associated with high nest losses (e.g., Glover 1956; Keith 1961). I conclude, however, that plants which provided dense, concealing cover for nests reduced nest predation.

Discrimination of hatched and destroyed nests could undoubtedly have been improved if data on densities and searching habits of predators had been incorporated into the analyses. In areas with high nest predation, studies involving both predators and waterfowl are essential for effective management for duck production.

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Summary

Nest-site preferences and site characteristics associated with nest success for several species of ducks were evaluated using step-wise discriminant analysis of 552 duck nests and 345 random sites in uplands at Horicon National Wildlife Refuge, Wisconsin, during 1977–78. Nests generally were nearer to water and another nest, and in cover that was taller, more dense, and composed of more short grasses and less alfalfa than random sites. Successful nests averaged farther from water and were in cover composed of fewer small forbs and short grasses than nests destroyed by predators, probably because of high predator densities near water and poor concealment afforded nests by short cover species.

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A female Mallard *Anas platyrhynchos* and her brood. (*Joe B. Blossom*)