Wood Duck Nest Site Selection in Eastern Texas

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Abstract: Nest box use, nesting success, and nesting habitat characteristics were examined on 6 study areas in eastern Texas during 1984–85. Box use averaged 29% and nesting success decreased from 82% to 64% over the 2-year study. Nest box characteristics selected by wood ducks (*Aix sponsa*) included a lower clear tree bole, orientation of the hole toward open or vegetated water, and proximity of 1 or more additional nest boxes. Habitat characteristics selected included high visibility of the box, closeness to open water, less canopy closure (%), presence of herbaceous marsh within 1 km, and presence of herbaceous wetlands (i.e., floating vascular aquatic bed, rooted vascular aquatic bed, and open water). A discriminant function analysis (DFA) model was developed for classification of nesting habitats for wood ducks in eastern Texas.

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Effective habitat and population management plans can ensure the wood duck's future as an important waterfowl species in the U.S. Gulf Coastal Plain, especially in Texas (Frentress and May 1984). Habitat features obviously influence the presence of breeding wood ducks. Because of past destruction of habitat (Hankle and Carter 1966, Anon. 1982), most of the current nesting activity occurs either in relict hardwood stands or in seasonally flooded wetlands. In the absence of adequate natural cavity production, nest boxes have proven to be an effective means of increasing wood duck production (McLaughlin and Grice 1952, Jones and Leopold 1967).

Specific criteria used by female wood ducks in selecting nesting sites are not fully understood, although food, water, and cover requirements for nesting are known (McGilvrey 1968, Drobney and Fredrickson 1979, Fredrickson 1980). With the availability of DFA models for other regions (Sousa and Farmer 1983, Lacki et

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al. 1987), the need exists to identify habitat and structural components that might increase use of artificial nest boxes by wood ducks in eastern Texas. Our objectives were to examine habitat features influencing nest site selection, and develop and test a multivariate model for nest site selection by wood ducks in the Pineywoods and Post Oak Savannah regions of Texas.

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Study Areas

Our study was conducted on wildlife management areas (WMAs) owned by International Paper Co., Inc. (IPCo.), Temple-Eastex, Inc. (TE), and the Texas Parks and Wildlife Department (TP&WD). Specific WMAs were Cherokee, Chronister and Cold Springs in Cherokee County, Salt Creek and Circle Four in Panola County, South Boggy Slough in Trinity County, and Gus Engeling in Anderson County, Texas. Most were characterized by bottomland hardwood habitat types, although Cherokee, Chronister, and South Boggy Slough also had mixed pine-hardwood habitats.

Wetland habitat types (Cowardin et al. 1979) varied with each study area. The following wetland types were represented within most study areas: broad-leaved deciduous forest (BDF), dead forest (DF), broad-leaved deciduous scrub-shrub (BDSS), dead scrub-shrub (DSS), persistent emergent (PE), non-persistent emergent (NE), open water (OW), needle-leaved deciduous forest (NDF), needle-leaved evergreen forest (NEF), needle-leaved deciduous scrub-shrub (NDSS), needle-leaved evergreen scrub-shrub (NESS), floating vascular aquatic bed (FVAB), and rooted vascular aquatic bed (RVAB) wetlands.

All study areas, except Chronister and Salt Creek WMAs, had pre-existing nest boxes. Most nest boxes were constructed of either rough-cut cypress or pine lumber. Several boxes on the Engeling WMA were plastic, designed by the Minnesota Waterfowl Association (Minneapolis, Minn.).

Methods

Existing nest box structures were located during winter 1983–84. Prior to the nesting season in 1984, boxes were repaired with predator guards securely attached and nest material (wood shavings) replaced or added. Additional boxes constructed of rough-cut pine, cypress lumber, or cypress plywood were erected in 1984 and 1985. These boxes were erected on trees, metal pipes, or wooden poles using criteria given in McGilvrey (1968). In all, 85 nesting structures were present prior to 1984, 55 boxes were added during 1984 and 69 in 1985 for a total of 209 boxes on all areas.

We examined 111 boxes during 1984. Nest boxes were monitored during March to September. A total of 75 continuous and discrete variables were measured at each box. Data collected included use (identified by presence of down, eggs or eggs shells), nest success, box dimensions, tree characteristics (if placed on tree), presence and type of predator guard, water features, canopy, understory, habitat, and visibility. Inside contents of each box were examined and noted to determine use by wood ducks or other species, along with any evidence of predation. All variables, if applicable, were collected at and adjacent to each nest box.

Descriptive statistics (SPSS Inc. 1986) were calculated for all variables within the 1984 data set. One-way analysis of variance (ANOVA) test for continuous variables and Kruskal-Wallis test for discrete variables were used to test and eliminate many variables not showing significant differences between boxes selected and boxes not selected by wood ducks. Principal components analyses (PCA) were conducted to identify groups of variables that made up a significant proportion of the variation in box location.

We also used DFA to evaluate habitat variables for 1984 data. Variables included in the analysis were those identified by PCA or univariate analyses (Kroll 1980). Data analysis were performed on 2 groups of boxes, those occupied by wood ducks and those not occupied. Pearson correlations between significant variables and discriminant function axes were calculated to suggest relationships between each variable and the discriminant function. The magnitude of the correlation has been shown to be the best method to determine which variables are most important in discriminating between groups (Timm 1975). Results from the DFA were used to develop a multivariate model for possible nest site evaluation.

Univariate analyses, comparing 1984 and 1985 data also were conducted using ANOVA. Testing and validation of the DFA-generated model was conducted using additional nest box data collected during the 1985 nesting season.

Results and Discussion

Nest Box Use and Nesting Success

Nest box use (Table 1) varied among study areas (5% to 50%, 1984; 18% to 42%, 1985); however, overall use for all study areas (pooled) was similar for the 2 study years (29% vs. 28%, respectively). Although South Boggy Slough and Engeling WMAs showed a decrease in use rates, possibly because of the large number of boxes added to both areas prior to 1985, actual number of boxes used increased on both areas. Nesting success for all study areas decreased during 1985 season (Table 1) with the exception of South Boggy Slough WMA.

Nest Site Selection by Wood Ducks

Characteristics of nest boxes—Analyses of continuous and discrete nest box data showed several variables were significantly different for boxes that were used vs. not used (Tables 2, 3). One-way analysis of variance tests for 1984–85 pooled data showed 3 continuous nest box variables were significantly different between

Table 1. Nesting success of wood ducks for 6 eastern Texas study areas during the 1984 and 1985 seasons.

			Boxes utilized				Successful boxes[a]							
	N boxes		1984		1985		1984		1985		$\bar{X}$ clutch size		$\bar{X}$ hatch per nest	
Study	1984	1985	*N*	%	*N*	%	*N*	%	*N*	%	1984	1985	1984	1985
Cherokee	36	39	15	42	7	18	13	81	2	29	10.4	7.0	8.3	7.0
Chron-Cold Sp	15	18	6	40	5	28	6	100	2	40	9.8	13.5	8.5	13.5
Salt Creek	19	19	3	16	8	42	3	100	5	63	13.0	12.3	13.0	7.4
Circle Four	21	19	1	5	4	21	1	100	3	75	18.0	12.8	12.0	10.0
South Boggy	6	35	3	50	13	37	2	67	11	79	6.0	8.5	3.7	6.5
Engeling	21	30	6	30	8	27	5	83	7	78	9.6	12.5	9.2	9.3
Total	117	160	34	29	45	28	30	86	30	64	10.3	10.8	8.6	8.1

[a]At least 1 egg hatching per nest.

Table 2. Mean (±SE) of continuous habitat variables showing significant difference between nest boxes that were used vs. not used on 6 eastern Texas study areas, in 1984, 1985, and combined.

	1984				1985				1984–85 combined			
	Used		Not used		Used		Not used		Used		Not used	
Habitat variable	$\bar{X}$	SE	$\bar{X}$	SE	$\bar{X}$	SE	$\bar{X}$	SE	$\bar{X}$	SE	$\bar{X}$	SE
Nest box characteristics												
Percent clear tree bole	27.3[a]	2.69	38.3	2.91	30.6[a]	1.96	34.6	2.59	29.0[a]	1.64	36.4	1.95
Obstruction distance (m)	7.9[a]	0.95	4.9	0.60	4.1	1.08	5.5	0.48	6.7	0.89	5.3	0.37
Distance to other box (m)	44.2[a]	9.56	27.7	3.90	64.8[a]	14.90	31.0	3.24	57.0[a]	8.98	28.1	2.37
Number of boxes seen	1.9	0.29	2.3	3.30	2.0[a]	0.43	1.5	0.21	2.5[a]	0.27	1.8	0.18
Habitat characteristics												
Distance to open water (m)	36.7[a]	5.86	114.5	14.68	57.6[a]	14.65	115.6	14.19	47.5[a]	8.57	116.3	10.33
Percent canopy closure w/in 5m	16.2	3.73	21.0	2.36	11.1[a]	2.42	18.8	1.86	13.0[a]	2.08	19.9	1.47
Visibility right (m)	23.4	1.47	21.2	1.15	24.6[a]	1.39	18.4	2.81	24.2[a]	0.99	20.0	0.69
Visibility ahead (m)	26.0	1.22	23.5	0.98	27.9[a]	1.07	24.0	0.81	27.2[a]	0.79	23.7	0.63
Visibility left (m)	21.4	1.58	21.1	1.08	24.0[a]	1.42	20.0	0.84	23.1[a]	1.04	19.8	0.67

[a] $P < 0.05$; used vs. not used nest boxes.

Table 3. Mean (±SE) of discrete habitat variables showing significant differences between nest boxes that were used vs. not used on 6 eastern Texas study areas, in 1984, 1985, and combined.

	1984				1985				1984–85 combined			
	Used		Not used		Used		Not used		Used		Not used	
Habitat variable	$\bar{X}$	SE	$\bar{X}$	SE	$\bar{X}$	SE	$\bar{X}$	SE	$\bar{X}$	SE	$\bar{X}$	SE
Nest box characteristics												
Next box material	1.7[a]	0.23	2.6	0.17	2.5	0.22	2.5	0.14	2.1	0.16	2.6	0.11
Bark texture	2.6[a]	0.38	3.5	0.23	3.0	0.40	3.2	0.24	2.8	0.27	3.4	0.17
Hole facing?	2.3	0.19	2.5	0.11	2.0[a]	0.13	2.4	0.09	2.1[a]	0.11	2.5	0.07
Other box present	1.2	0.06	1.3	0.05	1.2	0.06	1.4	0.05	1.2[a]	0.04	1.4	0.03
Box above water	1.4	0.09	1.5	0.06	1.3[a]	0.07	1.6	0.05	1.4[a]	0.05	1.5	0.04
Other box used by wood duck	1.5[a]	0.09	1.7	0.06	1.3[a]	0.08	1.8	0.05	1.4[a]	0.06	1.8	0.04
Habitat characteristics												
Woody understory	1.3	0.08	1.2	0.04	1.5[a]	0.08	1.3	0.04	1.4[a]	0.06	1.2	0.03
Invertebrates in box	1.6[a]	0.09	1.3	0.05	1.8[a]	0.06	1.3	0.04	1.7[a]	0.00	1.3	0.03
Natural pine	1.8[a]	0.07	1.4	0.06	1.2	0.06	1.4	0.05	1.5	0.06	1.4	0.04
Pine plantation	1.8[a]	0.07	1.4	0.06	1.2[a]	0.07	1.5	0.05	1.5	0.06	1.4	0.04
Clearcut	1.8	0.07	1.7	0.05	1.4[a]	0.07	1.6	0.05	1.6	0.06	1.6	0.04
Herbaceous marsh	1.2[a]	0.06	1.5	0.06	1.3	0.07	1.3	0.04	1.2[a]	0.05	1.4	0.03
Wetland type	4.2	0.70	2.9	0.35	4.3[a]	0.61	2.5	0.27	4.6[a]	0.47	2.5	0.21
Floating vascular aquatic bed wetland	1.5[a]	0.09	1.9	0.04	1.6	0.07	1.8	0.04	1.6[a]	0.06	1.8	0.03
Rooted vascular aquatic bed wetland	1.4[a]	0.09	1.8	0.05	1.5	0.08	1.7	0.04	1.4[a]	0.06	1.7	0.03
Open water wetland	1.3	0.07	1.3	0.05	1.2	0.06	1.3	0.04	1.2[a]	0.04	1.3	0.03

[a] $P < 0.05$; used vs. not used nest boxes.

the 2 groups (used vs. not used), while Kruskal-Wallis tests indicated significant differences for 4 discrete nest box variables.

It appeared that placement and use of additional nest boxes near existing boxes, especially in marsh habitats, had a positive impact on production. Although, if breeding pairs exceed available nest cavities, nest interference may lead to inefficient reproduction (Jones and Leopold 1967). Some authors (Bellrose 1976) suggested that wood ducks are very social, often preferring to nest near other wood ducks. In fact, nest site territoriality is unknown for this species. Rothbart (1979) reported that batteries of "apartment" type nest boxes were used readily, but he suggested hens might become confused in returning to nest boxes.

There also were significant preferences for boxes located over or adjacent to water, either open or vegetated. These observations, coupled with those of McLaughlin and Grice (1952), suggested use rates can be increased by locating boxes near or over water, within sight of the flight path.

Characteristics of habitats—Analyses of continuous and discrete habitat variables resulted in significant differences for 5 continuous and 10 discrete habitat variables (Tables 2, 3). The significance of box visibility and a relatively open canopy confirmed the importance of open habitats (i.e., herbaceous marsh, FVAB, RVAB, and OW). These data indicate that boxes placed in open areas in or near water may receive higher use than poorly visible boxes placed some distance from water.

The negative effects of cover types such as natural pine, pine plantation, and clearcut within 1 km of box supported well-defined preferences for wetland types (i.e., flooded timber and herbaceous areas). Wetland types including FVAB, RVAB, and OW showed significant differences between boxes that were used vs. not used. Selection for these wetland types, along with nearness of herbaceous marsh, indicated importance of herbaceous wetland in wood duck nesting habitats.

Model formation and validation—Nest box and habitat variables (from 1984 data), for which significant differences occurred (Tables 2, 3), were used to develop a discriminant function model. A significant DFA resulted, and correctly classified 75.2% of boxes. Based on Pearson correlation importance rankings (Table 4), previous univariate observations were substantiated. The following model was developed using classification coefficients, to determine the discriminant score (Y) of each case:

$$\begin{aligned} Y = {} & 1.638\text{FLOATAQ} - 1.286\text{NATPINE} + \\ & 0.003\text{DISTOPEN} + 1.016\text{OTHER} - \\ & 0.670\text{WOODY} - 0.016\text{CANOPY3} + \\ & 0.010\text{VISI3} - 2.037. \end{aligned}$$

Significant loading of distance to open water (positive correlation) and presence of natural pine within 1 km (negative correlation) indicate the preference of nesting wood ducks for herbaceous marsh with open water nearby, in the absence of pine forest. The 1984 DFA model correctly classified 64.4% of the boxes using 1985 data. Hence, we feel that the model is a useful tool in evaluating habitat for nest box placement in eastern Texas.

Table 4. Classification coefficients, correlations between variables, and discriminant function and percentage of cases correctly identified for a DFA ($P < 0.05$) on utilized and non-utilized wood duck boxes for 1984. FLOATAQ = floating vascular aquatic bed wetland for immediate area (1 = yes, 2 = no), NATPINE = natural pine for immediate area (1 = yes, 2 = no), DISTOPEN = distance to open water (m), OTHER = other box present (1 = yes, 2 = no), WOODY = woody understory within 3 m (1 = yes, 2 = no), CANOPY3 = canopy closure (%) within 5–20 m, and VISI3 = 50% visibility distance (m) to left of box.

Variable	Classification coefficients	Correlation between variables and functions
FLOATAQ	1.63779	0.67263
NATPINE	−1.28592	−0.52150
DISTOPEN	0.00227	0.46697
OTHER	1.01642	0.24371
WOODY	−0.66966	−0.21361
CANOPY3	−0.01607	0.09253
VISI3	0.00972	−0.02171
	Utilized box group mean	−1.03213
	Non-utilized box group mean	0.42280
	Percent correctly classified	75.2%

Correct application of the model could result in more effective nest box placement in eastern Texas wetland habitats. Further validation and model refinement should be conducted, however, to improve efficacy of the classification model. Should a manager use the DFA model for habitat classification purposes, we recommend the following procedures. Measurements of the variables presented in Table 4 should be taken. Then, multiply each habitat variable measured by the appropriate discriminant coefficient in the equation and sum the products. A value <-0.22695 indicates possible suitability for nest box placement (Kroll and Whiting 1977).

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