Movements, Habitat Use, and Survival of Wood Duck Broods in East-central Texas

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Abstract: During 1978 and 1979, data were collected on wood duck (*Aix sponsa*) brood movements, habitat use, and survival in east-central Texas. Radio telemetry of 18 broods indicated most broods left the nesting site immediately after exiting nesting structures. Distances traveled from nesting site to brood-rearing site varied from 0.1–11.7 km. Overall, duckling survival ($N = 167$) was 8%. However, survival for 40 ducklings that reached adequate brood-rearing habitat was 48%. Duckling survival and habitat used by broods was positively correlated with an increase in wetland size, length of shoreline, percent floating and emergent vegetation, and percent flooded shrubs, and was negatively correlated with an increase in water depth and percent open water.

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Hawkins and Bellrose (1941), McLaughlin and Grice (1952), and Beshears (1974) noted that local wood duck populations may be limited by a scarcity of available nesting cavities if other ecological needs are filled. In an effort to alleviate local cavity shortages, the U.S. Biological Survey in 1937 erected >400 artificial nesting structures for wood ducks on the Chautauaqua Migratory Waterfowl Refuge in Illinois (Hawkins and Bellrose 1941, Grice and Rogers 1965). The initial success of this program prompted wood duck box placement in other areas. Thousands of nest boxes have been placed throughout much of North America (Baker 1971, Bellrose 1976). Many of these also have met with success (Klein 1955, Grice and Rogers 1965, Odum 1970, Bellrose 1976).

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However, many duck boxes have been set up by untrained personnel in areas where brood habitat in addition to nesting cavities is a limiting factor. McGilvrey (1968) described optimum brood habitat as having >4 ha flooded land and a dense cover of aquatic and emergent vegetation (only 25% open water). Wood ducks will readily nest in boxes around ponds <0.1 ha in size (Hardister 1963, Vance 1968) and with little or no available cover (Labuda 1977), i.e., with no brood habitat. It is apparent than that many artificial nesting structures have been placed at considerable distances from adequate brood-rearing habitat. This is supported by Leopold (1951), Hardister (1963), Farmer (1970), Baker (1971), and DiGiulio (1978) who found that ducklings moved to more suitable brood-rearing areas soon after hatching. Farmer (1970) found that wood duck broods moved as far as 4.2 km in shortly >24 hours after exiting nesting structures.

Ducklings hatched in areas with unsuitable brood-rearing habitat may experience a higher mortality than those hatched in an area more suitable for brood development. Farmer (1970) reported wood duck brood losses of up to 66% during movements from the nest. An analysis of studies by McGilvery (1969), Baker (1970), Brown (1972), and Ball et al. (1975) indicated preflight mortality for wood ducks to be between 47% and 59%, with up to 90% of the total mortality occurring during the first 2 weeks of life. Stoudt (1971), studying prairie nesters, and Ball et al. (1975), studying wood ducks nesting in natural cavities, showed negative correlations between brood survival and distance of overland movements. The increased mortality during travel may be due to accidents, predation, exhaustion, or scattering. The stress of such movements may be an indirect cause of increased losses if, after reaching their destination, ducklings suffer higher mortality than those not making the trip.

If broods hatched in areas of unsuitable brood habitat make long movements to suitable brood habitat and have a higher mortality than those that do not move, a reevaluation of current management practices for this species is in order. There is no reason to suspect that nesting wood ducks would choose a cavity some distance from good brood habitat if suitable cavities were available within good brood-rearing areas. Possibly then, artificial structures should be placed only within existing brood habitat or, in areas devoid of such habitat, the habitat should be improved for brood rearing before structure placement.

The purpose of this study was to evaluate wood duck production from artificial nest boxes placed in areas with little or no brood-rearing habitat. The objectives were: 1) to evaluate wood duck brood movements from nesting sites, 2) to evaluate wood duck brood survival in relation to proximity of brood-rearing habitat to nesting site, and 3) to evaluate wood duck brood survival in relation to size and characteristics of brood habitat.

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Methods

The study was conducted in Brazos and Burleson counties in east-central Texas. The study area was a 40-km section along the Brazos River and adjacent lands within 3 km of the river.

Artificial nesting structures for wood ducks were located on 6 small ponds southwest of College Station, Texas. The largest of these ponds was 3.2 ha and the smallest, 0.05 ha. These were predominantly steep sided, open-water ponds created by the damming of erosion-caused gullies.

In January 1978 and 1979, nest boxes, similar to those described by Bellrose (1976), were serviced and checked weekly from February through August to determine wood duck usage. Hens were captured in the nest boxes during late incubation. Each hen received a U.S. Fish and Wildlife Service leg band and a colored and numbered plastic disc nasal saddle (Max McGraw Wildl. Found., Dundee, Ill.). Radio transmitters (Wildl. Materials, Inc., Carbondale, Ill.), powered by lithium batteries with frequencies between 150 and 152 MHz and weighing approximately 22 g, also were placed on some hens (Ridlehuber 1980).

Receiving equipment included 2 24-channel receivers and 2 hand-held, 3-element yagi antennas. Effective radio range was approximately 3 km. When a radio-equipped hen could not be located from the ground, a light plane was used. Yagi antennas, attached to the wing struts (Gilmer et al. 1973), allowed reception up to 10 km.

Ducklings were web-tagged with numbered monel-metal tags before they left the nest boxes (Grice and Rogers 1965). Boxes were then continually monitored and broods were followed immediately after the exodus, and their movements were plotted on a cover map developed from recent aerial photographs. Two observers, each equipped with receiving equipment, determined movement of radio-tagged hens throughout triangulation as they moved between wetlands. Triangulation from fixed locations was used to monitor brood movements so as to minimize observer influence on movements and predation of broods. Radio contact was maintained during the first day of movement until 1) the hen and brood reached suitable brood habitat and remained there for at least 3 hours, 2) darkness precluded further movements, or 3) the brood was presumed lost to predation. Broods were relocated the second morning to determine if the brood continued to move. After the second day, broods were monitored on alternate days through the first week and thereafter twice a week through the first month.

Survival of young broods (those still with hens) was determined by locating the radioed hen on open water and visually counting the young. Because of the rolling landscape and lack of vegetation at ponds, it was usually possible to select elevated vantage points and, using either 8 × 50 binoculars or a 60X spotting scope, to observe hens and brood without disturbing them. Abandoned broods were sometimes located with the aid of a Labrador retriever.

Wetland size, depth of water, length of shoreline, and vegetative composition were measured for each pond within the study area. Attempts were made to correlate brood movements, sites used during brood rearing, and brood survival with these wetland characteristics and with wetland distance from nesting site. Habitat variables significantly ($P < 0.5$) correlated with brood movements, rearing, survival, or with distance form nesting site were identified from a matrix of product-moment correlation coefficients (Stat. Anal. System, Barr and Goodnight 1972).

Results

Movements of 20 adult wood duck hens were followed for <1 hour to 2 months. Efforts to web-tag young caused abandonment of 2 broods, and another brood was abandoned within 1 hour when an effort was made to follow a nonradio-tagged hen; thereafter, only radio-tagged birds were followed. Incomplete data were obtained for 2 radio-tagged hens that lost radios, and contact was lost with 2 hens, wearing only nasal saddles, after they left the wetland on which they nested. Complete data were available for 13 radio-tagged hens with 124 ducklings. They were followed until each brood fledged or were presumed dead.

Generally, a hen led her brood away from the nesting pond immediately after leaving the nest box. During the 2-year study, 85% of the ponds on the study area were used by broods as they moved.

Broods moved 0.05–11.7 km from nesting to brood rearing sites. These movements required >26 hours after leaving the nest box, including 2 cases where hens moved broods in excess of 11 km. The broods moved at an average rate of 0.68 km/hour (excluding time spent while brooded overnight). Some movement from nesting sites to brood-rearing sites crossed several habitats including rangelands, parklands, woodlands, roads, ponds, creeks, and a river and required overland movements of up to 2.2 km.

After reaching a suitable brood habitat, movements of all but 3 broods were confined within that area. One brood used a temporary flooded terrace along the Brazos River, but after 12 days of decreasing water levels, the brood moved to another area. Two broods moved 0.8 km from a hardwood swamp to a newly flooded terrace along the Brazos River, and, as the water receded, both broods moved back to the swamp.

Three of the 13 broods radio-tracked away from the nest sites (2 in 1978, 1 in 1979) were presumed lost to predation within the first 24 hours after leaving the nest box. These 3 hens were located the next day on open water without broods and never were observed with broods after the first day. Six more (2 in 1978 and 4 in 1979) were lost within the first 10 days of life. The remaining 4 broods (all in 1979), which initially totaled 48 ducklings, were successful. Only 40 of the original 124 ducklings reached adequate brood habitat and 19 of these fledged for a 48% survival. The original survival from hatching to fledging for ducklings of radio-tagged hens was 0% (0 to 67) in 1978 and 19% (19 of 100) in 1979. Sixty-three percent of all ducklings were lost within 2 days after leaving the nest box, and 83% were lost within 10 days.

Only 20 wetlands were available for brood rearing in 1978, whereas 30 were available in 1979 when conditions averaged 1.7 C cooler/month and 4.9 cm wetter/month. Study ponds and wetlands within the study area were diverse in size, shape, depth, and vegetative composition (Tables 1, 2). Pond characteristics appeared to have little effect on brood movements through areas. However, wetland position in relation to hatching site and brood rearing site was an important factor in usage.

Only 5 of 20 aquatic habitats were used as brood rearing areas (occupied for at least 24 consecutive hours by the same brood) in 1978 when conditions were unfavorable because of drought. Brood use did not correlate with any of the 10 measured variables; lack of survival during 1978 precluded testing survival correlations.

Ten of 30 wetlands were used during brood rearing in 1979. In contrast to 1978, brood rearing areas in 1979 had several characters in common. Brood use was positively correlated with wetland size ($r = 0.471$), length of shoreline ($r = 0.473$), percent floating ($r = 0.282$) and emergent ($r = 0.591$) vegetation, and percent flooded shrubs ($r = 0.438$). Brood use was negatively correlated with maximum ($r = -0.489$) and average ($r = -0.403$) depth and percent open water ($r = -0.655$). Brood survival was positively correlated with wetland size ($r = 0.436$), length of shoreline ($r = 0.433$), percent of floating ($r = 0.452$) and emergent ($r = 0.600$) vegetation, and percent flooded shrubs ($r = 0.393$). Survival was negatively correleated with maximum ($r = -0.480$) and average ($r = -0.352$) depth and percent open water ($r = -0.620$).

Two wetlands provided 86% of all brood rearing days in 1979 and were the only areas in which ducklings were fledged. Distance was measured from nest box to terminal site by the most direct route and by the route traveled by broods. Broods reared ($r = 0.700$) and broods fledged ($r = 0.679$) were positively correlated with straight-line distance, as well as distance traveled, $r = 0.706$ and $r = 0.667$, respectively. However, 4 or 5 wetland characteristics that were positively correlated with brood use and survival also were positively correlated (wetland size, $r = 0.623$; shore length, $r = 0.588$; percent floating vegetation, $r = 0.531$; and percent emergent vegetation, $r = 0.788$) with straight-line distance traveled by broods from nesting site to brood rearing site. In addition, 2 of the 3 wetland characteristics that were negatively correlated with brood use and survival were negatively correlated (average water depth, $r = 0.651$; and percent open water, $r = -0.694$) with distance.

Discussion

Data suggest that increased distance traveled by broods led to increased survival. This, however, was not a cause-effect relationship. The relationship lies with the proximity of brood-rearing habitat to nesting sites. Only those broods successful at

Table 1. Characteristics and brood use of wetlands and aquatic habitats on the White Creek and Batts Ferry study areas, Brazos and Burleson counties, Texas, 1978.

	Characteristics										Brood use			
				Depth[a]			% Vegetated							
Wetland	*N* boxes	Size (ha)	Shore length (m)	Max.	Ave.	% Open water	Floating	Emergent	Shrubs	Trees	Hatching[b]	Transit[c]	Rearing[d]	*N* fledged
White Creek														
PH[e]	0	0.01	47	1	1	77	10	13	0	0		1	0	0
SP	0	0.02	62	3	2	90	5	5	0	0		0	0	0
RS	1	0.04	82	3	2	98	1	1	0	0	1	0	0	0
RG	1	0.08	168	3	2	86	4	10	0	0	1	0	0	0
PE	0	0.10	172	3	1	97	1	2	0	0		1	0	0
FT	0	0.13	178	4	2	70	5	10	10	5		1	2	0
RH	1	0.14	207	3	2	94	4	1	1	0	0	2	0	0
FN	0	0.15	211	3	2	88	6	0	0	0			0	20
PC	0	0.19	258	3	2	100	Tr[f]	Tr	0	0		0	0	0
CE	0	0.27	236	3	3	100	0	0	0	0		1	0	0
CW	0	0.31	353	4	3	100	0	0	0	0		0	0	0
FS	0	0.37	263	4	3	76	10	7	5	2		1	1	0
FP	0	0.65	779	4	3	92	1	3	3	1		1	7	0
PW	0	0.69	848	4	3	98	Tr	1	0	1		1	0	0
RB	10	1.9	1,274	4	4	89	6	3	1	1	9	0	0	0
FJ	8	2.9	2,204	4	4	100	Tr	Tr	Tr	0	3	1	0	0
PB	0	2.9	2,224	4	4	93	5	2	0	0		0	1	0
Batts Ferry														
GS	0	0.07	136	3	1	94	3	3	0	0		0	0	0
GR	0	0.08	123	3	1	60	5	5	25	5		0	0	0
GM	0	0.35	234	4	3	100	0	Tr	Tr	Tr		0	0	0
GB	10	1.5	1,163	4	3	97	1	2	0	0	1	0	0	0

[a] 1 = <0.5m, 2 = 0.5–1.0 m, 3 = >1.0–2 m, 4 = >2.0 m.
[b] Measured only on ponds having nest boxes.
[c] Number of times used by a brood in moving from 1 area to another; does not include initial movements from pond with nest box.
[d] Measured in brood days.
[e] Letters denote wetlands on study area (from Ridlehuber 1980).
[f] Tr = trace.

Batts Ferry														
GS	0	0.09	160	3	2	94	3	3	0	0		1	0	0
GR	0	0.10	145	3	2	60	5	5	25	5		0	0	0
GM	0	0.41	260	4	3	100	0	Tr	Tr	Tr		0	0	0
GB	10	1.3	1,292	4	3	97	1	2	0	0	2	0	0	0
WS[e]	0	2.5	1,177	3	1	10	Tr	5	20	65		2	1	0
AT[e]	0	4.0	2,649	3	1	30	0	0	10	60		2	14	0
SS[e]	0	5.4	2,530	1	1	3	27	16	27	27		2	97	2

[a] 1 = <0.5m, 2 = 0.5–1.0 m, 3 = >1.0–2 m, 4 = >2.0 m.
[b] Measured only on ponds having nest boxes.
[c] Number of times used by a brood in moving from 1 area to another; does not include initial movements from pond with nest box.
[d] Measured in brood days.
[e] Not available for brood use in 1978
[f] Letters denote wetlands on study area (from Ridlehuber 1980).
[g] Tr = trace.

Table 2. Characteristics and brood use of wetlands and aquatic habitats on the White Creek and Batts Ferry study areas, Brazos and Burleson counties, Texas, 1979.

Wetland	Characteristics										Brood use			
	N boxes	Size (ha)	Shore length (m)	Depth[a]		% Open water	% Vegetated							
				Max.	Ave.		Floating	Emergent	Shrubs	Trees	Hatching[b]	Transit[c]	Rearing[d]	*N* fledged
White Creek														
PH[f]	0	0.02	59	2	1	77	10	13	0	0		0	0	0
SP	0	0.03	73	3	2	90	5	5	0	0		0	0	0
RS	1	0.05	91	3	3	98	1	1	0	0	1	1	0	0
FO[e]	0	0.05	110	2	1	11	83	3	3	0		1	2	0
RG	1	0.09	196	4	3	86	4	10	0	0	1	0	0	0
PE	0	0.12	202	3	2	97	1	2	0	0		0	0	0
PW[e]	0	0.16	170	2	1	20	Tr[g]	Tr	35	45		0	4	0
FT	0	0.16	198	4	3	70	5	10	10	5		0	0	0
FN	0	0.18	230	4	3	88	6	6	0	0		1	0	0
RH	1	0.18	248	4	3	94	4	1	1	0	0	1	0	0
RD[e]	0	0.22	220	2	1	98	2	0	0	0		0	0	0
PC	0	0.24	303	4	3	100	Tr	Tr	0	0		1	0	0
CE	0	0.30	248	4	4	100	0	0	0	0		0	0	0
CW	0	0.35	372	4	4	100	0	0	0	0		0	0	0
FS	0	0.41	277	4	4	76	10	7	5	2		0	0	0
LS[e]	0	0.58	1,100	2	1	10	0	5	15	70		2	6	0
FP	0	0.72	820	4	4	92	1	3	3	1		0	0	0
PW	0	0.74	893	4	4	98	Tr	1	0	1		1	0	0
RB	10	2.1	1.341	4	4	89	6	3	1	1	5	0	1	0
FJ	9	3.2	2.320	4	4	100	Tr	Tr	Tr	Tr	2	1	0	0
PB	0	3.2	2,341	4	4	93	5	2	0	0		0	1	0
GT[e]	0	3.3	1,733	3	1	30	0	5	15	50		2	3	0
LM[e]	0	5.7	3,440	3	1	12	14	61	12	1		0	104	2

traveling long distances were successful in finding adequate brood rearing habitat. If the distance involved was great, the broods were less likely to successfully reach adequate habitat. Ball et al. (1975) observed that broods undertaking overland moves >0.8 km suffered greater mortality than did broods that were reared closer to nest sites.

Maximum straight-line distance (5.1 km) moved from the nesting site to brood rearing areas was greater than those observed by Young (1967), Vance (1968), Farmer (1970), Baker (1971), Hepp and Hair (1977); they reported maximum straight-line distances of 1.2, 4.2, 3.5, 3.2, and 2.1 km, respectively. Stewart (1958) and Harduster (1963) reported a maximum total distance moved by wood duck broods from nesting site to brood-rearing site to be 2.6 and 5.6 km, respectively. Broods on our site traveled a maximum of 11.7 km between nest site and brood-rearing areas.

The high (63%) mortality of ducklings during the first 2 days after leaving a nest box, as observed in our study, indicated this was a critical time for wood duck brood survival. Brood mortality calculated from 7 wood duck studies summarized by Hepp (1977) suggested a mean survival of 32% to 68% during the first 6 weeks of life. A lengthy move through inferior brood habitat and use of inferior brood habitat contributed to high brood mortality during our study. The differences in survival rates between 1978 and 1979 can be directly attributed to the differences in weather conditions. Cooler temperatures and increased rainfall in 1979 resulted in additional wetlands for wood duck brood use. All wetlands used to successfully rear wood duck broods were temporary. In years with average or below average rainfall, these would not be available for wood duck brood usage or would be dry during at least part of the brood rearing season.

Habitats successfully used in brood rearing during this study were >4 ha, shallowly flooded with an interspersion of flooded timber and shrubs, emergent and floating vegetation, and open water. They were not unlike brood rearing areas as described by Mumford (1952), McGilvrey (1968), Vance (1968), and Hepp (1977). In our study, brood survival to flight stage for ducklings that reached adequate brood-rearing habitat was 48% even though broods had to travel excessive distances to reach suitable habitat.

The use of wetlands by wood duck broods and brood survival increased with an increase in wetland size, length of shoreline, percent floating and emergent vegetation, and percent flooded shrubs. The use of wetlands by broods and brood survival decreased with an increase in maximum and average depth of water and percent of open water. Long distances between nesting sites and adequate brood rearing sites reduce the chance for survival for wood duck ducklings. Distances >2 km are probably detrimental. Nest boxes on areas devoid of brood habitat and >2 km from adequate brood-rearing habitat should be re-placed closer to the existing brood habitat. Temporary wetlands should not be depended upon to provide brood-rearing habitat if they are likely to be dry during any part of the brood-rearing season.

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