THE EFFECT OF ORIENTATION AND LIGHT INTENSITY ON UTILIZATION OF ARTIFICIAL WOOD DUCK NEST BOXES

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Abstract: Artificial wood duck nest boxes were surveyed during 1977 on the Bear Creek Waterfowl Management Area in west Tennessee. Box types used were wooden, metal vertical, and metal horizontal. Utilization, height, orientation and hatch success were recorded. Light intensity readings were taken on ten days. Utilization was 15% for wooden, 27 percent for metal vertical, and 0 percent for metal horizontal. Nest success in terms of percent hatch was 73.4 percent for wooden and 84.0 percent for metal vertical structures. The mean angles of utilized and unutilized boxes were not significantly different. There was no difference in light intensity between wood and metal boxes. Utilization was not dependent upon light intensity; rather visibility favored utilization.

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Wood duck *(Aix sponsa)* nest box programs have been initiated in areas where land clearing and channelization for agriculture, reservoir construction, or lumbering operations have severely depleted or eliminated natural nesting habitat-tree cavities.

The Tennessee Valley Authority initiated a nest box program at the Bear Creek Waterfowl Management Area during the winter of 1973-74. Studies of the utilization and production from other wood duck nest box programs have been reported by McLaughlin and Grice (1952), Decker (1959), and Muncy and Burbank (1975). Other investigations have observed that nest box orientation and light intensity had little effect on utilization (Grice and Rodgers 1965, Beshears 1969, McGilvery and Uhler 1971). The objective of this study is to test these observations about orientation and light with quantitative data.

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METHODS

The 557 hectare Bear Creek Waterfowl Management area in Stewart County, Tennessee, is part of the Tennessee Valley Authority's Land Between The Lakes. Stewart County is within the Highland River section of the interior low Plateau physiographic province (Fenneman 1938). The Bear Creek area is located between mile 80 and mile 86 on U.S. Army Corps of Engineers' Lake Barkley (Cumberland River) and is approximately 80 km southeast of Murray, Kentucky.

Most of the forests were logged or cleared around the turn of the century. Forested areas along the western shores were considered upland hardwood and consisted of black oak *(Quercus velutina)*, blackjack oak *(Q. marilandica)*, red oak *(Q. shumardii)*, scarlet oak *(Q. coccinea)*, and post oak *(Q. stellata)*, sourwood *(Oxydendron arborcum)*, hickories *(Carya spp.)*, dogwood *(Cornus florida)*, and a few beech *(Fagus grandifolia)*, walnut *(Juglans nigra)*, and yellow poplar *(Liriodendron tulipifera)* (U.S. Dept. Agric. 1953).

The floodplain is of the palustrine system and consists of emergent and scrub/shrub

wetlands (Cowardin, Carter, Golte, and LaRoe. 1977, U.S. Fish & Wild. Serv. Operational Draft). Portions of the area are seasonally flooded because of water level fluctuations at Barkley Dam, located at Mile 30.6. Winter pool is at 354 feet while summer pool is brought to 359 feet starting April 1.

Bear Creek is managed in cooperation with Tennessee Wildlife Resources Agency primarily for waterfowl and other wetland wildlife. Waterfowl hunting is allowed at 40 marked semipermanent blinds erected by permit holders, who are selected in a public drawing. About 40 hectares of farmland, interspersed with four draw-down impoundments, are planted yearly on a share crop basis. The draw-down impoundments are equipped with water control structures and are filled by pumping in the fall.

The field work for this study began in March of 1977. Nest inspections were made weekly throughout the nesting season, in order to document utilization and nest success. Direction of box opening was recorded and light intensity readings were taken in order to study what effects they have on the utilization of nest boxes.

Nest boxes were located along a four mi. section of the Cumberland River. There were 74 nest boxes available during the 1977 nesting season. Box types used on the management area were wooden, metal vertical, and metal horizontal. All represent the typical, artificial nesting structures used for wood ducks in eastern North America (Muncy and Burbank 1975).

The vertical wooden boxes were made from rough cut cypress and measured 25.4 x 25.4 x 55.8 cm. Entrances were 10.2 cm circular holes. The wooden boxes were bolted to 1.5 meter metal fence post which were nailed to 4.2 meter creosote treated 4 x 4 posts. A piece of metal flashing, 45.7 cm wide, was fastened around the 4 x 4's as a predator guard.

The vertical metal cylinders were constructed from 26 gauge (0.55 mm) galvanized sheet metal. Overall length was 91 cm, with a 30.5 cm diameter and a 33 cm conical top. Nest entrances were 10.2 cm square holes. The inside, beneath the entrance, was coated with a layer of roofing tar to the level of the nesting material to aid ducklings in exiting the box. The vertical metal cylinders were mounted on either 4.2 meter 4 x 4 posts as described for the vertical wooden boxes, or on two 6-foot fence posts bolted together.

The horizontal metal cylinders were 61 x 30.5 cm and had a half moon entrance on one end. A strip of hardware cloth was riveted to the box on the inside, beneath the entrance, to aid ducklings leaving the box. All of the horizontal boxes were mounted on L-shaped 2 x 4-brackets and nailed on trees. These boxes lacked predator guards.

Prior to the nesting season, boxes were inspected and repaired. All boxes were cleaned and filled with new wood chips. Numbered metal tags (5 cm diameter) were placed on all boxes. Wooden boxes were numbered 1 - 99, vertical metal cylinders 100 - 199, and horizontal metal cylinders 200 - 299. The height, location, and direction that each box faced was recorded.

Light intensity readings were taken inside and outside of each box with a Gossen Luna Pro light meter equipped with a 36.8 cm glass fiber cable. The light meter cable was inserted into the entrance of the box and lowered to within 7.6 cm of the nest material. Outside light readings were taken with the probe parallel to the nest material and facing the direction of the box entrance. Care was taken to assure that no shadows were cast on the box while readings were taken.

Light measurements were taken over a 10-day period, April 8, 1977 to June 9, 1977. One hundred ninety-eight measurements were taken from 60 wooden and metal vertical boxes. Light intensity measurements are expressed as departures of light intensity inside the nest box from those outside the nest box. Measurements at different times and in different locations can thus be compared. Measurements were taken the first two days for metal horizontal boxes, but no further measurements were taken due to lack of utilization and small sample size (7). Metal horizontal measurements are used only for a comparison basis

and are not included in the statistical analysis.

Analysis of variance was used to test for difference in light departures between box types. Student t-tests were used to compare light departure between utilized and unutilized boxes. Comparison of use with light departure classes was by chi-square. Difference between the mean orientation angles of utilized and unutilized boxes were tested using the Watson-Williams multisample test (Zar 1974). Significance was set at the 0.05 level.

RESULTS

The first occupied nest was found on March 27, at which time it contained 16 eggs. By using an egg deposition rate of one egg per day, this nest would have contained its first egg sometime around March 3. Nest initiation continued through May 28. A total of 14 artificial nest boxes, out of a possible 74, were utilized during the 1977 season. The average clutch size for wood and metal boxes was found to be 12.8 and 11.7 eggs respectively.

Nest success, in terms of percent hatch, was found to be 73.4 percent for wooden and 84.0 percent for metal boxes. A total of 170 eggs were laid, of which 136 hatched, resulting in an overall hatchability of 80 percent.

Utilization of the three types of artificial nests was as follows: 15.2 percent for wooden, 26.5 percent for metal vertical, and 0.0 percent for metal horizontal boxes (Table 1). The perceivable preference for metal vertical boxes over wooden boxes was not significant ($P > 0.50$).

Table 1. Mean orientation angle of utilized and unutilized nest boxes, Bear Creek Waterfowl Management Area, 1977.

	Utilized		Unutilized	
Box type	No. of boxes	Mean Angle[1]	No. of Boxes	Mean Angle
Wooden Vertical	5	35	28	73
Metal Vertical	9	56	25	59
Total	14	46	53	69

[1]Mean Angle (degree) calculated according to Zar (1974).

Observations were made of the orientation of the box opening with respect to water or land (Table 1). Eleven of the utilized boxes faced open water, while only three utilized boxes did not face open water. However, 43 of the unutilized boxes faced open water and 10 did not face open water. Consequently no reference for boxes facing open water could be detected ($P > 0.75$).

Nest competition from other wildlife did not appear to be limiting on the study area. Screech owls *(Otus asio)* and mud daubers *(Specidae)* were the primary users of nest boxes, utilizing 10.1 percent and 11.6 percent respectively (Table 2). The screech owls nesting season preceded that of wood ducks and the mud daubers did not start using the boxes extensively until the end of the wood duck nesting season. Only one nest was known

Table 2. Percentage utilization of artificial nest boxes by wildlife other than wood ducks, Bear Creek Waterfowl Management Area, 1977.

Box type	Screech Owl	Mud Daubers	Other	Total
Wooden vertical (33)	12.1	18.1	9.1	39.4
Metal vertical (34)	8.8	5.8		14.7
Metal horizontal (7)			28.6[1]	28.6
Total (74)	9.5	10.8	6.8	27

[1]Two out of seven contained wasp.

to have been depredated. This nest was equipped with a predator guard and was standing in three feet of water. The clutch consisted of 14 eggs on May 19, but dropped to 10 eggs by May 25, to 7 eggs on June 1 and finally contained only 5 eggs on June 6. The hen abandoned the nest sometime after June 1.

Even though nest box openings were oriented in all directions, a majority of the boxes face a northeast to easterly direction (Fig. 1). The mean angle of utilized wood and metal boxes was calculated to be 35° and 56°, while unutilized wood and metal boxes had mean

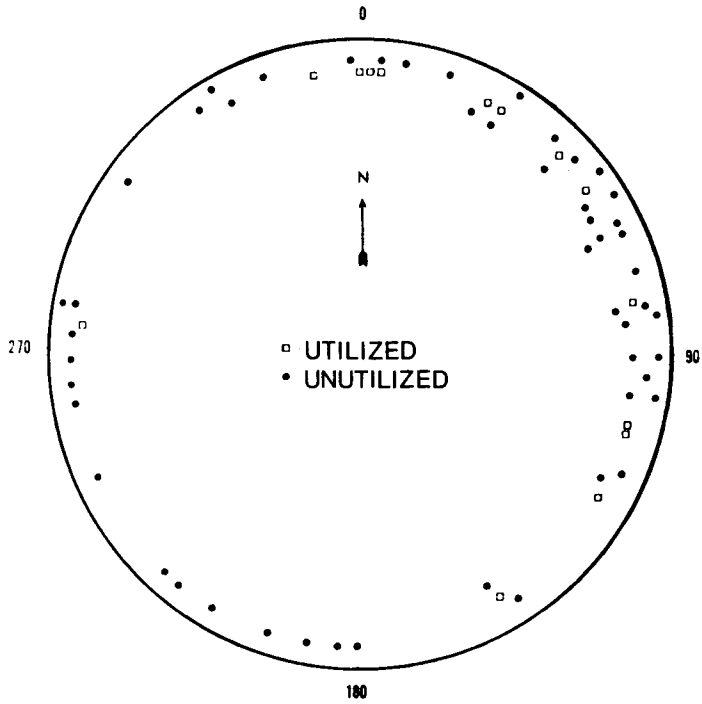

Fig. 1. Orientation of nest boxes.

angles of 73° and 59° respectively (Table 1). The mean angles for each box type were tested by the Watson-Williams test to determine if they estimate the same population mean or whether they represent distinct sample means (Zar 1974). The mean angles of utilized and unutilized boxes for both box types, were not statistically distinct ($P > 0.50$).

Analysis of variance indicated no significant difference in light departures between wood and metal boxes ($P > 0.05$). The mean light departures for both wood and metal utilized boxes were larger than for unutilized boxes (Fig. 2). The mean light departure for utilized wooden boxes was significantly different from unutilized wooden boxes ($P < 0.05$). However, utilization of wooden boxes was not dependent upon a particular light departure class ($P > 0.05$). No significance was found between utilized and unutilized metal boxes for mean light departure ($P > 0.05$). Likewise, utilization was not dependent upon a particular light departure class in metal boxes ($P > 0.05$).

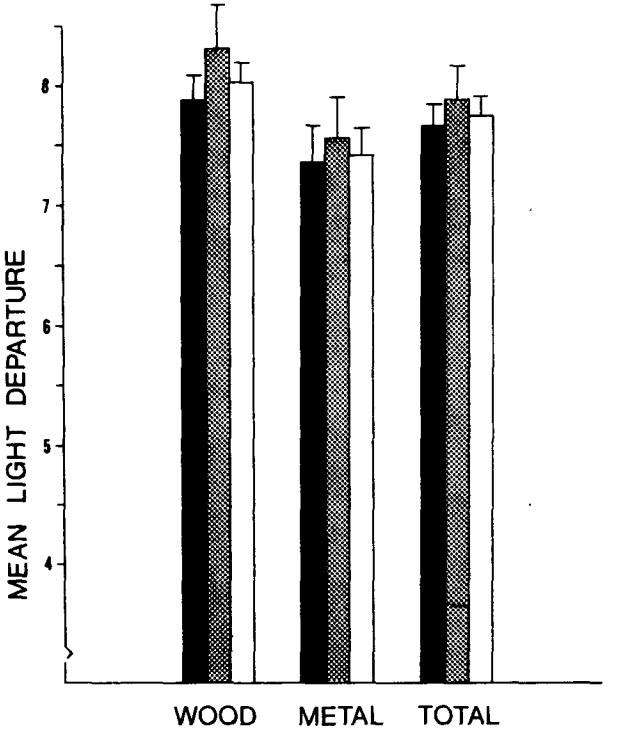

Fig. 2. Mean light departures: Black bars represent unutilized boxes, Shaded bars represent utilized boxes, Unshaded bars represent total boxes.

Light intensity had no effect on utilization by wood ducks which is in agreement with McGilvery and Uhler (1971). They found that wood ducks nesting at Patuxent, Maryland, were much more adaptive than starlings to changes in shape of nest box and size of entrance. However the horizontal metal boxes with half-moon entrances, that were included in their study, were not utilized by wood ducks at Bear Creek during the 1977 season. Metal horizontal boxes had a smaller mean light departure (4.96) than either wood or metal vertical boxes, which had mean values of 8.0 and 7.5 respectively. The smaller light departure would be expected since the larger entrance allows more light to enter the nest box.

Light intensities and nest box orientation were both found insignificant to nest box utilization. Considering the relationship between light intensity and nest box orientation, the direction a nest box faced did not affect utilization. Grice and Rodgers (1965) and Beshears (1969) also observed no preference for the direction a nest box faced.

DISCUSSION

The utilization of nest boxes on the Bear Creek Management area during the 1977 season presents some interesting results which warrant further study. The overall utilization of nest boxes has declined in the three years since the nest boxes were first available in 1975. On May 15, 1975, boxes were checked by TVA biologists to determine utilization. Forty of a possible seventy-six available boxes were checked on this date. Twelve out of 27 (44.4%) wooden boxes were utilized and 4 of 13 (30.0%) metal vertical boxes were used (Melis 1975, TVA unpubl. data). During the 1976 season nest boxes were checked on seven separate dates from April 13 to June 4. Seven out of 34 (20.6%) wooden boxes were utilized and 12 out of 35 (34.3%) metal boxes were utilized (Havens and Pharris 1976, MSU unpubl. data). Utilization during the 1977 season was 15.2 percent for wooden and 26.5 percent for metal vertical, both lower than in any of the two previous years. There was no utilization of metal horizontal boxes during the 3-year period. This decline in utilization is contradictory to what would be expected and what has been reported for most other nest box programs. Considering the strong homing instinct of the female wood duck, the utilization of nest boxes should increase, theoretically, following years with over 45 percent hatch success until the carrying capacity of the area is reached (Bellrose et al. 1964).

The majority of the nest boxes that were utilized, were located on the northern one-third of the management area. This habitat is characterized by several large bays with steep sloping banks. The vegetation in the area is predominantly upland hardwood forest. The southern end of the management area is a wide shallow floodplain with numerous islands. The vegetation in this area is primarily early succession species, which are common in wet soil conditions. The higher utilization on the northern end of the area may be due to the hardwood timber which is the type of habitat in which wood ducks would normally be looking for natural cavities.

Nest success in terms of hatchability was 80 percent for wood and metal boxes combined, which is comparable with 84.5 percent for the 1976 season. This percentage includes the nest in box number 149 which was abandoned after the investigator attempted to capture the hen to determine her leg band number. The hen was setting on 10 eggs when she was disturbed; she never returned to the nest. If these 10 eggs are omitted, nest success in terms of hatchability would have been 85.8 percent.

Utilization of nest boxes by other species of wildlife was limited primarily to screech owls. The owls used the boxes throughout the winter as feeding and resting stations and for nesting in early spring. No evidence of screech owl utilization was found following their nesting season. As long as boxes are cleaned out and new nesting material added every year, the investigators are of the opinion that screech owls do not seriously compete with wood ducks for nest sites and are an added benefit to a nest box program.

The orientation of nest box openings with regard to direction and whether they faced open water or land were examined and found to have no detectable effect upon utilization ($P > 0.50$). The visibility of the box and box opening appears to be a more important factor in utilization than the particular direction a box happens to face. Boxes located along the shoreline of major bays and creek channels were visible thus readily utilized.

The uneven orientation distribution of available nest boxes was unfortunate since light intensity is related to box orientation. Utilization was not found to be dependent on light intensity. Utilized wood and metal boxes did have greater mean light departures than unutilized boxes, however, this would be expected since the mean angle of utilized boxes was smaller (or more northern) than unutilized boxes.

The visibility of nest boxes, as a result of their placement, appears to be a more important factor in their utilization than orientation and light intensity. Boxes located in areas of upland hardwoods should be kept visible by trimming overhanging branches as needed.

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