The Feasibility of Nightlighting for Monitoring Brood Production of Wood Ducks on Rivers

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Abstract: To determine the applicability of the nightlighting technique for monitoring wood duck (*Aix sponsa*) brood production on rivers in Tennessee, we compared results of day and night surveys on 8 rivers in spring 1990. Results of 32 day counts and 16 night counts showed that 112% more broods/km were seen at night ($\overline{X}$ = 0.55, SE = 0.022) than day ($\overline{X}$ = 0.26, SE = 0.20). The mean number of broods/km did not differ ($P < 0.05$) between replications for either night counts or day counts. There was a significant ($P = 0.01$) but weak ($R = 0.61$) relationship between the first day counts and night counts and no relationship ($P = 0.50$, R = 0.19) between the second day counts and night counts. We surveyed Tennessee Wildlife Resources Agency (TWRA) personnel ($N = 23$) who participated in night and day surveys to determine their opinions of both techniques. As a control, questionnaires also were given to 20 other TWRA personnel who had conducted only daytime surveys. All respondents felt safe conducting daytime surveys. Night workers (39%) felt that day surveys were safer than night surveys, but 61% felt there was little difference in safety between techniques. Day workers (68%) responded that day surveys were safer and 32% said there was little difference in safety between day and night surveys. Ninety-six percent of night workers and 90% of day workers said they would not reject either day or night technique due to safety concerns, and 100% of both groups said they would be willing to take part in the survey technique which proved to be most useful in monitoring wood duck trends. We believe that the nightlighting technique is a more efficient and effective management tool for monitoring wood ducks on appropriate rivers and that the technique would be readily accepted by wildlife professionals.

Proc. Annu. Conf. Southeast Assoc. Fish and Wildl. Agencies 45:167–174

Assessing the annual status of the wood duck is essential to its management. Obtaining an accurate assessment of annual changes in wood duck populations is difficult, because of its secretive nature. Many techniques for assessing annual

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changes in production of wood ducks have been tested including day float counts (Hein 1966, Mumford 1952, Steward 1958, Martin 1959), roosting flight counts (Martin 1959, Hein and Haugen 1966, Hester 1966, Minser 1968), and aerial surveys (Cottrell and Prince 1990). Trost (1989) indirectly recognized the limitations of these techniques when he referred to the wood duck as being "a species that is currently impossible to census accurately." The nightlighting method for monitoring annual changes in wood duck brood production on rivers was developed on the Holston River in eastern Tennessee (Minser and Dabney 1973). The technique proved to be more accurate and precise than day surveys for counting broods on rivers (Minser and Dabney 1973, Cottrell and Prince 1990). However, the applicability of nightlighting on other river systems throughout Tennessee has been questioned and the technique has not been adopted as a standard survey procedure. The question of safety has been of particular concern. For example, would concerns by TWRA personnel about water hazards or other night-time hazards discourage TWRA from adopting the nightlighting technique? The objective of this study was to compare the usefulness of night and day survey methods for monitoring brood production of wood ducks under a variety of conditions found on 8 rivers in Tennessee.

We acknowledge TWRA and the Institute of Agriculture, the University of Tennessee for funding this project, and the many TWRA personnel, S. Henderson, The University of Tennessee, and S. Cottrell, the Tennessee Valley Authority who helped conduct it.

Methods

The study was conducted on segments of 8 rivers, 2 in each of the TWRA's 4 administrative regions. River segments that historically were productive for wood ducks were selected by TWRA regional biologists for testing. Segments chosen from Region I were on the Buffalo and Duck Rivers, Region II—Harpeth and Red Rivers, Region III—Hiwassee and Sequatchie Rivers, and Region IV—Holston and Little Rivers (Table 1). Segments varied in length from 15.3 km to 32.8 km (x = 20.95 km).

Land adjoining each evaluated segment was comprised of forested ridges with flood plains used for cultivation or pasture. Residential properties were widely scattered along each segment. In general, all segments were composed of long, winding pools intermittently separated by rocky shoals. Swamps were nonexistent along all segments. Sloughs occurred along some segments, but were infrequent. Differing amounts of aquatic vegetation occurred in each segment.

One night survey and 2 day surveys each day for 2 consecutive days were conducted on each river. Two TWRA personnel from each administrative region assisted during day and night counts. TWRA personnel were rotated between boats for day and night counts.

Night counts began shortly after sunset following procedures described by Minser and Dabney (1973). We conducted counts in 2 4.9-m aluminum canoes, each propelled by a 3-horsepower (hp) motor, or 1 canoe and a 1 4.3-m aluminum

Table 1. Location and physical characteristics of segments of 8 rivers used to compare day and night surveys for wood duck broods in Tennessee, 20 May–16 June 1990.

River	County	Origin and termination points (river mile markers)	Length (km)	Estimated average width (m)	*N* islands	Shoreline roosting cover[a]	Source affecting water level[b]
Buffalo	Perry	Heath Canoe Rental on Highway 13 to I-40 bridge (21–11.5)	15.3	45	4	good	precipitation run-off
Duck	Humphreys	S.R. 6357 water gaging station to Highway 13 bridge (26–16)	16.1	75	2	poor	precipitation run-off
Harpeth	Cheatham	Newsom Station Rd. bridge to Kingston Spgg. rec. park (n/a)[c]	24.1	65	5	fair	precipitation run-off
Red	Montgomery	1.6 km upstream from I-24 bridge to US 79 bridge (n/a)	19.3	50	2	good	precipitation run-off
Hiwassee	Polk, McMinn	Highway 411 bridge to 22.5 river mile marker (42.5–22.5)	32.8	100	5	good	hydroelectric discharge
Sequatchie	Marion	Ketner Mill dam to mouth of Town creek	21.7	30	1	fair-good	precipitation run-off
Little	Blount	Davis ford to Highway 33 bridge (19.5–9.5)	17.4	50	16	good	precipitation run-off
Holston	Hawkins	Church Hill bridge to Surgoinsville bridge (131.5–118.5)	20.9	100	10	good	hydroelectric discharge

[a]Subjective evaluations.
[b]Major cause of water level fluctuation.
[c]Numeric river mile markers not available.

john boat propelled by a 25-hp motor. Each boat was manned by an author of this manuscript and a TWRA employee, and was equipped with 2 200,000-candlepower hand-held spotlights. One 12-volt battery in each boat provided power for the lights. The 2 boats traversed down the river abreast, maintaining a distance of 10–15 m from each bank. Motors were run continuously at low speed by the authors while TWRA observers continuously searched the shoreline for roosting broods. Although both persons in each boat had spotlights, the person in the front was primarily responsible for locating broods. The navigator assisted in searching when particularly dense roosting cover was encountered. Except for occasional navigational needs, the navigator's light remained off to conserve battery energy. Searching and spotting efforts were focused on the shoreline and immediate river bank, and intensified when dense cover was encountered, i.e., debris piles or where leafy limbs drooped into the water. Both sides of islands were surveyed when the distance between the island shoreland and mainland shoreline was narrow enough for adequate searching by 1 boat. If 1 island channel was considerably wider than the other, both boats traversed the broader channel. The same travel route was repeated during replicate surveys.

Day surveys began about .5 hour before sunrise. In the event of fog, surveys began when both banks became fully visible for 50–100 m downstream. Boats used during the day were the same as those used at night. The 2-day counts on each river were separated by a 1-hour time difference between starts. One boat was used for each day count. The boat traversed down the middle of the river and observers searched with the aid of binoculars both river banks for moving and/or stationary broods. Motors were run continuously by the authors and slowed periodically to search dense shoreline/water interface cover. Each river was first floated by day which helped familiarize workers with any navigational hazards for the upcoming night survey.

Data collected during surveys included total number of wood duck broods, age-class of broods, number of ducklings/brood, and sex and numbers of adult wood ducks. A brood was recorded as such if at least 1 duckling was observed; previous work showed that sometimes the majority of a brood may hide before all can be observed (Minser and Dabney 1973). Care was taken to avoid counting nearby ducklings of the same age-class as a separate brood. The decision to record as an additional brood was based upon age-class, behavior, and distance from the previous sighting of other broods. We used analysis of variance (PROC GLM, SAS Inst. Inc. 1985) to test for difference in counts between the 2 day surveys.

Numbers of broods for night surveys were a sum of those seen from each boat. Numbers of broods seen during day surveys were those seen per boat per replication. Both day and night survey data for each river were computed to broods/km to allow for differences in length of river segments. The number of broods/km was the dependent variable, and river, replication, and type of survey were the independent variables. We collectively analyzed the number of broods/km observed during night and during day by analysis of variance (PROC GLM, SAS Inst. Inc. 1985). We adjusted for a biased observation by reporting all mean densities as least-squares means. Statistical significance was established at $P < 0.05$.

We interviewed TWRA participants about safety aspects of the survey to determine if they would accept the nightlighting survey method. Participants were interviewed by written questionnaires immediately after the surveys and 1 year later by telephone. Telephone surveys were administered by a person other than the authors of this manuscript and who was unknown to TWRA personnel. As a control, 20 other TWRA personnel (5 each from the 4 TWRA administrative regions of Tennessee) who had previously conducted day float counts for wood ducks, but who had not conducted night counts, were given a similar telephone questionnaire in regards to safety or perceived safety. Names of participants remained anonymous on the completed questionnaires.

Results

Thirty-two day surveys and 16 nightlighting surveys for wood duck broods were conducted from 20 May–16 June 1990. Of these, 47 day and night surveys were treated as valid; 1 night survey was invalid due to excessively high water (Table 2).

More broods ($P = 0.001$) were observed during the first or earliest daytime survey than were observed during the second survey 1 hour later. Consequently, data gathered by the first boat was used to represent the day technique in comparison of day and night surveys. The mean number of broods observed/km was 112% greater during night ($\bar{X} = 0.55$, SE = 0.022) than day ($\bar{X} = 0.26$, SE = 0.020). Densities recorded during night ranged from 1.38 broods/km on the Little River to 0.12 broods/km on the Duck River. Day count densities ranged from 0.57 broods/km on the Little River to 0.06 broods/km on the Duck River. The mean number of broods/km did not differ ($P < 0.05$) between replications for either night surveys or day surveys.

A correlation analysis was conducted to determine the relationship between day counts and night counts. There was a significant ($P = 0.01$) but weak ($P = 0.61$) relationship between the first day counts and night counts and no relationship ($P = 0.50$, $R = 0.19$) between the second day counts and night counts.

Questionnaires regarding safety were completed by all 23 TWRA participants of experimental night and day surveys and by 20 other TWRA personnel who previously had conducted day but not night surveys. Although there were few differences in results of questionnaires completed immediately after the stream surveys and those completed by telephone 1 year later, only results of telephone surveys are presented because of possible bias associated with the authors being present when questionnaires were completed by TWRA personnel. One hundred percent of study and control groups felt safe during day counts, but only 87% of the study and 75% of control personnel interviewed believed night surveys were or would be safe. When asked about comparative safety of day and night surveys, 39% of the study group felt safer during day counts and 61% felt there was little difference

Table 2. Wood duck brood densities (broods/km) calculated from day and night surveys on segments of 8 rivers in Tennessee, 20 May–16 June 1990.

	Day				Night	
River	Day 1		Day 2		Night 1	Night 2
	Rep 1	Rep 2	Rep 3	Rep 4	Rep 1	Rep 2
Buffalo	0.26(4)[a]	0.06(1)	0.20(3)	0.26(4)	0.46(7)	0.52(8)
Duck	0.06(1)	0.06(1)	0.06(1)	0(0)	0.12(2)	0.25(4)
Harpeth	0.29(7)	0.04(1)	0.25(6)	0.17(4)	0.21(5)	0.33(8)
Red	0.21(4)	0.05(1)	0.47(9)	0.47(9)	b	0.31(6)
Hiwassee	0.12(4)	0.06(2)	0.12(4)	0.03(1)	0.61(20)	0.52(17)
Sequatchie	0.37(8)	0.28(6)	0.14(3)	0.14(3)	0.32(7)	0.41(9)
Little	0.57(10)	0.17(3)	0.57(10)	0.34(6)	1.32(23)	1.44(25)
Holston	0.24(5)	0.14(3)	0.29(6)	0.05(1)	1.10(23)	1.00(21)
$\bar{x}$ all rivers	0.26(5.4)	0.10(2.2)	0.26(5.2)	.18(3.5)	.59(12.3)	.60(12.2)

[a]Number of broods observed along entire segment.
[b]Counts not recorded because of excessively high water.

in safety between day and night counts. Seventy percent of those who had never conducted night counts believed day counts would be safer and 30% thought there would be little difference in safety between day and night counts. Participants were asked if concern over safety would cause them to not recommend the use of day counts, not recommend the use of night counts, or not reject the use of either day or night counts. Ninety-six percent of the experimental group and 90% of the control said they would not reject either method due to safety concerns. All participants responded they would be willing to take part in whichever technique proved to be the most useful in monitoring annual trends in wood duck populations.

Discussion

Our results on the use of nightlighting counts for monitoring wood duck brood production were similar to results reported for the Holston River (Minser and Dabney 1973, Cottrell and Prince 1990). More than twice as many broods were seen at night and so the nightlighting method is believed to provide a better estimate of reproductive success and is likely more sensitive to annual changes of local wood duck production on rivers. Numbers of broods seen during day counts from one day to the next were more consistent than in past studies (Minser and Dabney 1973), but because the numbers seen were less than half of those seen at night, day surveys would be less sensitive in monitoring significant changes in brood production. We attributed differences in numbers of broods observed on the 2-day counts made on the same day on each river to 1) a disturbance factor caused by the first boat and 2) the later observation period of the second count when broods are less active, or 3) a combination of 1 and 2. These factors may allude to some of the primary reasons why daytime stream brood surveys have proven to be inconsistent (Minser and Dabney 1973) and unreliable in reflecting annual population trends on rivers (Moser and Graber 1990). Conditions under which daytime counts are made constantly change and are sometimes unpredictable. Light intensity, temperature, fog, human disturbances, and especially brood activity change as morning hours pass. All these factors may affect brood availability for counting and result in surveys which do not reflect brood production. At night, survey conditions are more stable. During darkness, broods roost at water's edge, are stationary and are more available for counting; fog and human disturbances are rarely a problem. As a result, we believe nightlighting surveys provide more accurate estimates of brood production and give managers more reliable information upon which to make decisions. Nightlighting data may be of particular need to states holding September hunting seasons for wood ducks where reliable data is needed for monitoring reproductive status or, in other states, for routine annual assessment of brood production on appropriate rivers.

The question has been asked about the possibility of adjusting old or new results of day brood surveys to correct for differences in low numbers of broods seen during day compared to night counts. Unfortunately, due to the weak or total lack of correlation of day and night surveys in this study and the inprecision of daytime surveys in other studies (Cottrell and Prince 1990, Minser and Dabney 1973), adjustment of daytime data is not possible. Meaningful conclusions about annual changes in brood production therefore cannot be made from daytime brood surveys.

The 8 rivers we surveyed offered few navigational hazards in conducting night counts; however, some required more care than others. The Buffalo and Little rivers were rather narrow with some sharp turns and shoals which required extra concentration and skill to navigate successfully. Although we encountered few navigational hazards at night, there was little doubt that the degree of difficulty was greater and attention to navigation was more demanding at night than in day. To reduce hazards and to increase success of night counts, we recommend the following: 1) the navigator(s) should be familiar with the stream survey area before attempting to float at night; 2) select stream segments that do not have hazards, e.g., sections with severe shoals, shoots, log-jams, and hairpin turns. Sections with slower moving water are probably better wood duck habitat: 3) conduct counts during normal river flow. Do not conduct surveys in high water due to reduced ability to see broods hidden in flooded vegetation and due to increased navigational hazards. Low flows may impede navigation, resulting in excessive noise and interrupted brood searching: 4) use only personnel who are comfortable with the night technique.

TWRA personnel asked whether 1 boat could be used for the night survey instead of 2: using 1 boat in the middle of the river and 2 spotlights, 1 to shine each bank, would reduce the need of manpower and equipment by 50%. This can be done on rivers with a width of ≤ 50 m. When observers get farther than 20–25 m from the bank, the chances of missing roosting broods increase. We have successfully used 1 boat for night surveys in subsequent work.

We conclude that the nightlighting survey on appropriate rivers is a more efficient and accurate technique for estimating production of wood duck broods than daytime surveys. If safety precautions are made in selection and floating of rivers, the nightlighting technique should become an accepted management tool for wildlife professionals.

Literature Cited

Cottrell, S.D. and H.H. Prince. 1990. A comparison of wood duck survey techniques on the Holston River in east Tennessee. Pages 219–224 *in* L.H. Frederickson, G.V. Burger, S.P. Havera, D.A. Graber, R.E. Kirby, and T.S. Taylor, eds. Proc. 1988 North Am. Wood Duck Symp. St. Louis, Mo.

Hein, D. 1966. Float counts vs. flight counts as indices to abundance of nesting wood ducks. J. Wildl. Manage. 30:13–16.

——— and A.O. Haugen. 1966. Autumn roosting flight counts: an index to wood duck abundance. J. Wildl. Manage. 30:657–668.

Hester, F.E. 1966. The value of roost counts as a population index for wood ducks. Pages 183–192 *in* L.R. John, ed. Wood duck management and research: a symposium. Wildl. Manage. Inst., Washington, D.C.

Martin, E.M. 1959. River float and roosting flight counts as indices to numbers of wood ducks. M.S. Thesis, Iowa State Univ. Ames. 114pp.

Minser, W.G. 1968. Seasonal abundance and distribution of the wood duck, *Aix sponsa,* on the upper Holston River in east Tennessee. M.S. Thesis, The Univ. Tenn., Knoxville. 80pp.

——— and J.M. Dabney. 1973. A comparison of day and night float counts for wood duck broods on the Holston River in east Tennessee. Proc. Annu. Conf. Southeast Assoc. Game and Fish Comm. 27:311–315.

Moser, J.J. and D.A. Graber. 1990. Stream brood surveys as indicators of wood duck production. Pages 205–208 *in* L.H. Fredericson, G.V. Burger, S.P. Havera, D.A. Garber, R.E. Kirby, and T.S. Taylor, eds. Proc. 1988 North Am. Wood Duck Symp., St. Louis, Mo.

Mumford, R.E. 1952. A study of wood duck populations on Indiana streams. M.S. Thesis, Purdue Univ., Lafayette, Ind. 42pp.

SAS Institute, Inc. 1985. SAS User's guide: statistics. 1985 ed. SAS Inst., Inc., Cary, N.C. 956pp.

Stewart, P.A. 1958. Some wood duck census methods and their evaluation. Release 209, Ohio Coop. Wildl. Res. Unit. Ohio State Univ., Columbus. 13pp. (memeo).

Trost, R.E. 1989. The relationship between harvest and survival rates of wood ducks in eastern North America, 1966–84. Pages 252–255 *in* L.H. Frederickson, G.V. Burger, S.P. Havera, D.A. Graber, R.E. Kirby, and T.S. Taylor, eds. Proc. 1988 North Am. Wood Duck Symp., St. Louis, Mo.