Implications of September Hunting on Wood Duck Brood Production on the Holston River in Tennessee

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Abstract: Wood duck (*Aix sponsa*) broods were counted 15 of 19 years (1973–90) using the night-float technique on a 10.8-km segment of the Holston River, eastern Tennessee. Broods were counted 9 years before and 6 years after the initiation of September hunting seasons. Mean harvest ($\bar{x}$ = 26,797, SE = 2,130) of wood ducks in Tennessee after September hunting began was 279% higher (t = 7.50, P = 0.0001, df = 14) than the mean harvest ($\bar{x}$ = 9,604, SE = 845) before September hunting. The adjusted mean number of broods ($\bar{x}$ = 7.25, SE = 1.25) observed following initiation of September hunting was significantly (F (1,8) = 16.78, P = 0.00035) less (52%) than the adjusted mean ($\bar{x}$ = 15.22, SE = 1.49) observed prior to September seasons. These results suggest a negative relationship between numbers of broods observed and September hunting.

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The welfare of wood duck populations is dependent upon the survival and fecundity of adult and yearling hens. Thirty years of wood duck banding data collected in the eastern U.S. (Bellrose et al. 1991) revealed that all adult hens and 50% of yearling hens surviving to spring return to their natal site to nest. Because most wood ducks remain on their breeding grounds through September in Tennessee (Minser 1968) and elsewhere in the South (Thompson and Baldassarre 1989), wood duck hunting regulations, particularly for September, may have a direct bearing on female survival and, therefore, on brood production the following spring.

A premigratory or "early" hunting season for wood ducks for southern states was suggested by Bowers and Martin (1975). They believed that because wood ducks in the South had higher survival rates than northern birds, that southern wood

ducks could offer additional recreational opportunities and should be managed as a separate hunt unit. Bowers and Martin (1975) cautioned, however, that early hunts in the South should be held before northern wood ducks arrived on their wintering grounds because northern wood ducks were exposed to heavy hunting pressure. The U.S. Fish and Wildlife Service (FWS) offered an experimental option in Tennessee to include wood duck hunting during the September duck hunting season which previously had been primarily for teal (*Anas discors, A. crecca*). The experimental September season was implemented by the Tennessee Wildlife Resources Agency (TWRA) in 1981 and continued through 1989. The daily bag limit for wood ducks during the 5-day mid-September hunts was 4 until 1986 when it was reduced to 2.

An examination of the impact of September hunting on the wood duck population in the Atlantic flyway by Johnson et al. (1986), indicated flyway survival rates did not change. They stated, however, that the effects on survival of local wood duck populations were unknown. Sauer et al. (1990) assessed the effect of the experimental September duck hunting season on the survival of wood ducks in Kentucky and Tennessee. They reported that the addition of the September hunting season negatively affected survival, but they concluded that it was difficult to ascertain the actual effect of hunting pressure on wood duck populations without natality information. In this report we provide information on natality and assess the impact of September hunting on a local wood duck population.

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Methods

The study area was a 10.8-km segment of the Holston River in Hawkins County, eastern Tennessee, from the town of Surgoinsville to the headwaters of John Sevier Lake. Land area in the watershed consists of 55% forests, 37% agriculture, 5% urban, and 3% other uses (Young and Dennis 1983). The river is 80–100 m wide, and is characterized by long, slow-moving pools occasionally broken by shoals. Wooded islands occur every few kilometers. Stream flow is affected by discharges from a hydroelectric dam upstream. The Holston River flows through a broad valley between parallel wooded ridges. Alluvial floodplains are normally used for agricultural production. Strips of trees are usually left between crop fields and the river, and occasionally wooded ridges extend to the river's edge or are within 100–300 m of the river. Wooded stream borders and adjacent wooded ridges serve as wood duck nesting sites (Minser 1968) and have been relatively unchanged during the last 23 years. Other than the Holston River,

aquatic habitat for waterfowl is scarce: there are no substantial wetlands along the river in our study area; consequently, waterfowl using the area are concentrated on the river.

The upper Holston River has been described as the most productive stream for aquatic macrophytic plants in North America (Young and Dennis 1983). Optimum growing conditions provided by relatively shallow, clear water charged with nutrients from waste disposal, and daily hydroelectric discharges, which provide continuous cropping of the macrophytes throughout the growing season, were suggested as factors related to high production. Bellrose et al. (1991) identified the Holston River as having the highest reported brood production of any river in North America. The high production of aquatic vegetation may be a primary reason for high numbers of wood ducks on the river (Minser 1968, Watts 1968, Hocutt and Dimmick 1971, Schacher and Minser 1988).

We used the night float census technique (Minser and Dabney 1973) for monitoring wood duck brood production from 1973 to 1975 and 1985 to 1990, because it is more accurate and precise than the daytime counts. Surveys were conducted from mid- to late June. Counts began at dark and each shoreline was searched simultaneously by a crew of 2 observers each in motor-driven canoes. We used 200,000 candlepower spotlights powered by 12-volt automobile batteries to search for roosting broods. Nighttime brood counts were conducted from 1976–81 independently by Cottrell and Prince (1990). They used 1 crew of 2 persons using spotlights to count broods on 1 bank of the river. A group of ducklings was counted as a brood if at least 3 ducklings of the same age class were seen together.

Brood survey data were analyzed using an analysis of variance in which the number of broods was the dependent variable and year and side of river were the independent variables. A main-effects-only model was used to determine adjusted mean brood production. Estimates of wood duck harvest for Tennessee (Sauer et al. 1990 and unpubl. harvest estimates, Migr. Bird Manage. Off., Laurel, Md.) before (1973–80) and after (1981–88) initiation of September hunting were tested for differences using *t*-test procedures.

Results

The adjusted mean number of broods ($\bar{x}$ = 7.25, SE = 1.25) observed during the years following the initiation of September hunting was found to be significantly less (52%) than the adjusted mean ($\bar{x}$ = 15.22, SE = 1.49) observed during the years prior to initiation of September hunting seasons (F (1,8) = 16.78, P = 0.0035; SAS, 1987). Number of broods observed ranged from a high of 3.3 broods/km before September hunting to a low of 0.6 broods/km after September hunting began (Table 1). The mean harvest ($\bar{x}$ = 26,797, SE = 2,130) of wood ducks in Tennessee after the initiation of September hunting (1981–89) was 279% higher (t = 7.50, P = 0.0001, df = 14) than the mean harvest ($\bar{x}$ = 9,604, SE = 845) before (1973–81) September hunting (Table 2).

Table 1. Wood duck broods on the Holston River, Surgoinsville Bridge to John Sevier Lake, Hawkins County, Tennessee, 1973–90.

Year	Number of broods		Total broods	Broods/km[c]
	Northside	Southside		
1973	16	13	29	2.7
1974	24	12	36	3.3
1975	14	15	29	2.7
1976	12			
1977	11			
1978	16			
1979	13			
1980	23			
1981[a]	30			
1985	16	3	19	1.8
1986[b]	6	9	15	1.4
1987	5	2	7	0.6
1988	14	3	17	1.6
1989	5	6	11	1.0
1990	13	5	18	1.7

[a] September wood duck hunts began fall 1981 (bag limit, 4).
[b] September wood duck bag limit reduced to 2 in fall 1986.
[c] Mean for 1973–75, 2.9; for 1985–90, 1.2.

Discussion

The decline in the number of wood duck broods observed after the experimental September hunting seasons began may have a result of increased wood duck mortality from September hunts. A comparison of harvest trends to brood production trends before and after September seasons began would have been useful in assessing the effect of September hunting on natality. Harvest data for wood ducks taken in Tennessee are sufficient to determine harvest trends for the state (Table 2) but not the study area (Hawkins County). Tennessee harvest data for 1981–88 include harvests for September and mid-winter hunts. Minser (1968) and Cottrell and Prince (1990) found that resident wood ducks were on the study area during September and therefore vulnerable to harvest during September hunting; however, wood ducks leave the study area by the end of October prior to the late November–December duck hunting season. If this migratory pattern occurs statewide, the increase in wood duck harvest from 1981–88 is most likely the result of the harvest of Tennessee birds within Tennessee during September seasons. Indeed, Sauer et al. (1990) documented that the number of wood ducks banded and killed in Tennessee increased substantially following the initiation of September hunting. Recovery rates of wood ducks banded within Tennessee but recovered in other states remained the same during years of September hunting as before September hunting (Sauer et al. 1990), indicating that the additional mortality was a result of wood ducks killed during September hunting in Tennessee.

Table 2. Number of wood ducks harvested in Tennessee, 1973–88.

No Sep. hunting		Sep. hunting	
Year	*N*	Year	*N*
1973–74	9,945	1981–82	27,854
1974–75	8,977	1982–83	33,079
1975–76	8,241	1983–84	25,074
1976–77	8,281	1984–85	37,723
1977–78	8,329	1985–86	28,611
1978–79	15,349	1986–87[a]	23,249
1979–80	9,077	1987–88[a,b,c]	22,882
1980–81	8,635	1988–89[a,b,c]	17,220
Mean	9,604	Mean	26,979

[a] Bag limit reduced from 4 to 2 wood ducks/day.
[b] Unpublished harvest estimates, Migratory Bird Management Office, Laurel, Md.
[c] Bag: wood ducks only; teal and other species discontinued.

Intensive hunting pressure for waterfowl on our study area during September seasons may have been a primary factor in the decline of brood production. Although the Holston River in Hawkins County flows through a rural area, it is within an hour's drive of 3 metropolitan areas. Hawkins County consistently recorded the highest number of duck hunters and the greatest number of ducks killed of all counties in Tennessee's eastern region during September and regular duck seasons (Tenn. Wildl. Resour. Agency 1985; E. L. Warr, Tenn. Wildl. Resour. Agency, unpubl. data). FWS harvest estimates for Tennessee indicated that wood ducks comprised 92% of the ducks bagged during September duck season in 1981 and 60%–78% of the September duck harvest during 1982 to 1987 (J. R. Sauer, U.S. Fish and Wildl. Serv., unpubl. data). Interpretation of FWS September wood duck harvest estimates for Tennessee (J. R. Sauer, U.S. Fish and Wildl. Serv., unpubl. data) and mail surveys of Tennessee duck hunters (E. L. Warr, Tenn. Wildl. Resour. Agency, unpubl. data) indicated that wood duck harvest on the upper Holston River was substantial, possibly totaling 6%–12% of Tennessee's entire wood duck harvest in 1984–1986.

The susceptibility of female waterfowl to harvest (Hochbaum 1944, Anderson and Henny 1972) and the vulnerability of breeders to overharvest on their breeding grounds (Hochbaum 1947, Jessen 1970) has been noted previously. Adult female wood ducks in Minnesota that successfully reared broods remained on their breeding grounds longer in the fall than other females (Gilmer et al. 1977) and therefore sustained greater hunting mortality than unsuccessful hens. Gilmer et al. (1977) suggested overharvest of the population could result.

Although overharvest of wood ducks may not be widespread as a result of premigratory or early wood duck hunting seasons in the southeast (Johnson et al. 1986), the potential for overharvest on local, heavily hunted areas was documented

(Thompson and Baldassarre 1989). They found that 73% of banded female wood ducks in northern Alabama remained on their breeding area during the period when early wood duck hunting seasons were typically offered, and they warned about the potential for overharvest during premigratory hunting seasons. Survival rates of male and female wood ducks in Tennessee decreased following the initiation of September hunting seasons suggesting that the addition of September seasons had a significant effect on the wood duck population (Sauer et al. 1990). Adult females constituted an abnormally high proportion of wood ducks taken by hunters during the experimental September wood duck seasons in Kentucky in 1982–83 and concern was raised about the effect of September hunting season on recruitment (V. R. Anderson, Ky. Dep. Fish and Wildl. Resour., unpubl. rep.). Similar findings were made by an eastern Tennessee duck hunting guide who maintained records of all wood ducks taken by his hunting parties during September seasons 1981–89 (M. A. Davis Talbott, Tenn. unpubl. data). He found that 66% and 68% of wood ducks taken during September seasons in Tennessee and on the Holston River, respectively, were females (Table 3). Considering that wood duck populations are composed of 46% females (Bellrose et al. 1991), a greater harvest of females than males indicates an even greater vulnerability of females during September hunting. Analysis of 34,011 band returns of 347,471 wood ducks banded in eastern North America 1966–1984 indicated a significant negative relationship between wood duck harvest and survival (Trost 1990). In all cases, average survival rates for adult females were lower in years of high harvest rates (Trost 1990). He hypothesized that if females and young remain on their natal areas and these areas are subjected to heavy hunting pressure, then this may explain why females and young show a stronger relationship between harvest and survival rates.

A conservative approach to wood duck harvest was recommended by Trost (1990), particularly during early seasons (Thompson and Baldassarre 1989). Public hunting areas receiving heavy hunting pressure as well as breeding areas with nesting box programs were of special concern (Thompson and Baldassarre 1989). These 2 types of areas are characteristic of our study area.

Wood ducks are particularly vulnerable to hunting due to the characteristics of both the wood duck and river in our study area. Waterfowl hunting on the Holston

Table 3. Numbers and sexes of wood ducks killed in Tennessee and on the Holston River during September seasons by certain hunters, 1981–89.[a]

	Males		Females	
Location	*N*	%	*N*	%
Statewide	76	34	147	66
Holston River	32	32	69	69

[a] Unpublished data of M. A. Davis, Talbott, Tenn.

River in Hawkins County traditionally has been popular among hunters in northeastern Tennessee, and the Holston is the principal duck hunting area in Hawkins County. Lack of adjoining wetlands to the Holston River results in few escape options for wood ducks using the river. Additionally, typical wood duck behavior of repeatedly flushing and landing downstream in front of people in boats (Stewart 1958, Minser 1968) before eventually flying back upstream presents a float hunter with repeated opportunities to harvest from the same group of birds. Numerous hunters floating the same segment of river increase wood duck vulnerability to hunting mortality. Wood ducks inhabiting streams are believed to be more vulnerable to hunting than those inhabiting extensive swamps because of the relative ease of hunter access to streams (Bellrose et al. 1991) and because wood ducks are the primary duck available during September (Minser 1968) hunting seasons.

Wood duck vulnerability was compounded during the September hunting season which allowed harvest of wood ducks on their natal area. In hindsight, the 4-bag limit on wood ducks during the first 5 years of experimental September hunting was neither conservative nor prudent. Even though the bag limit was reduced to 2 in 1986, recovery of the wood duck population on our area may take some time. Our data indicated that as of 1990 numbers of broods have not recovered 4 years following the 50% reduction in the September wood duck bag limit. Hunting mortality of wood ducks is considered additive (Trost 1990) and concentrated hunting pressure, even at reduced bag limits, may continue to suppress the population. The failure of wood ducks to readily expand their populations to available habitat, even with no hunting, partly explains the reason for their long (60-year) recovery period in North America during the early to mid-1900s (Bellrose et al. 1991). This weak pioneering trait also could further slow population recovery on our study area if local breeders are heavily harvested during September.

The drought of the mid-1980s possibly had a negative effect on wood duck recruitment (R. E. Trost, S.C. Coop. Fish and Wildl. Res. Unit, Clemson Univ. pers. commun.) and may explain the decreases in brood production which we observed. Dried-up wetlands, used for nesting by wood ducks, would likely result in lower recruitment. Our study area is a river with water discharges made daily from an upstream hydroelectric dam, thus water was not limiting. We believe that wood duck brood habitat on our study area was not significantly affected by the drought.

Another suggested cause for the decline in brood production was the discontinuation of the wood duck nesting box program on the Holston. Nesting boxes (N = 94) were erected on the study area by TVA and others in the early 1970s (Muncy and Burbank 1975), but maintenance was discontinued in the late 1970s (Cottrell et al. 1989). Next box availability declined 25% by 1981 (Cottrell et al. 1989), and some believe that the decline in nesting boxes could have been the reason for decreased brood production. However, the adjusted mean brood production ($\bar{x}$ = 15.67, SE 1.77) observed during years of nest box maintenance (1973–75) was not significantly different from the adjusted mean ($\bar{x}$ = 15.00, SE 2.05) observed after maintenance ceased (1976–81), but before September hunting began. Also, daytime

float counts for wood duck broods were conducted in 1967 (Minser 1968) before nest boxes were erected. Although daytime counts represent a minimal number, results of 1967 counts were higher than any of 8 experimental daytime counts conducted on the same river segment in 1973 (Minser and Dabney 1973). These data indicate that brood production was likely as great or greater before nesting boxes were erected than after the box program began and that natural cavities may not have been in short supply before or after 1970. Use of nest boxes documented by Muncey and Burbank (1975) and Cottrell et al. (1989) may have represented a temporary shift of nesting from natural cavities to boxes.

Harvest rates for wood ducks in Tennessee increased significantly and wood duck survival and brood production decreased in the years after the initiation of September wood duck hunting. We believe that mortality that resulted from September hunting contributed substantially to the decline in the number of broods we observed on our study area. Concentrated duck hunting which occurs on the Holston River apparently is not characteristic of other rivers in Tennessee. Impact of September hunting on these rivers would likely be less.

Management Implications

Because of the concentrated duck hunting on the Holston River, consideration should be given to managing the Holston as a special unit. If brood production and subsequent population levels are not maintained at desired levels under current hunting regulations, further reduction of the daily bag limit or suspension of September hunting on the Holston River should be considered. These findings emphasize the danger of harvesting local populations of wood ducks on their breeding areas during September. We recommend that monitoring of brood production using the night float technique be continued as an index to population welfare.

Literature Cited

Anderson, D. R. and C. J. Henry. 1972. Population ecology of the mallard. I. A review of previous studies and the distribution and migration form breeding areas. U.S. Fish and Wildl. Serv. Resour. Publ. 105. 166pp.

Bellrose, F. C., D. J. Holm, and R. C. Crompton. 1991. Unique wood duck; its biology, ecology and management. Wildl. Manage. Inst. In press.

Bowers, E. F. and F. W. Martin. 1975. Managing wood ducks by population units. Trans. North Am. Wildl. and Nat. Resour. Conf. 40:300–324.

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. A. Frederickson, G. V. Burger, S. P. Havera, D. A. Graber, R. E. Kirby, and P. S. Taylor, eds., Proc. 1988 North Am. Wood Duck Symp., St. Louis, Mo.

———, ———, and P. I. Padding. 1989. Nest success, duckling survival and brood habitat selection of wood ducks in a Tennessee riverine system. Pages 191–198 *in* L. A. Frederickson, G. V. Burger, S. P. Havera, D. A. Graber, R. E. Kirby, and P. S. Taylor, eds., Proc. 1988 North Am. Wood Duck Symp., St. Louis, Mo.

Gilmer, D. S., R. E. Kirby, I. J. Ball, and J. H. Riechmann. 1977. Post-breeding activities of mallards and wood ducks in north-central Minnesota. J. Wildl. Manage. 41:345–359.

Hochbaum, H. A. 1944. The canvasback on a prairie marsh. Am. Wildl. Inst., Washington, D.C. 201pp.

———. 1947. The effect of concentrated hunting pressure on waterfowl breeding stock. Trans. North Am. Wildl. and Nat. Resour. Conf. 12:53–64.

Hocutt, G. E. and R. W. Dimmick. 1971. Summer food habits of juvenile wood ducks in East Tennessee. J. Wildl. Manage. 31:221–228.

Jessen, R. L. 1970. Mallard population trends and hunting losses in Minnesota. J. Wildl. Manage. 34:93–105.

Johnson, F. A., J. E. Hines, F. Montalbano III, and J. D. Nichols. 1986. Effects of liberalized harvest regulations on wood ducks in the Atlantic Flyway. Wildl. Soc. Bul. 14:383–388.

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. 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.

Muncy, J. A. and J. H. Burbank. 1975. Comparative use of three types of wood duck nest boxes. Proc. Annu. Conf. Southeast. Assoc. Fish and Wildl. Agencies 29:493–500.

SAS Institute Ins. 1987 User's Guide: Statistics, version 6. edition. Cary, N.C. 1028pp.

Sauer, J. R., J. S. Lawrence, E. L. Warr, G. W. Cook, and V. R. Anderson. 1990. Experimental wood duck hunting seasons and the survival of wood ducks in Kentucky and Tennessee. Pages 357–360 *in* L. H. Fredrickson, 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.

Schacher, W. H. and W. G. Minser. 1988. An evaluation of a wood duck nesting program in Eastern Tennessee. Proc. Annu. Conf. Southeast. Assoc. Fish and Wildl. Agencies 42:337–342.

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

Tennessee Wildlife Resources Agency. 1985. Tennessee's early duck season experiment 1981–1983. Tech. Rep. 85–2. PCAN0064/200. Nashville, Tenn. 24pp.

Thompson, J. D. and G. H. Baldassarre. 1989. Post-breeding dispersal by wood ducks in Northern Alabama with reference to early hunting seasons. The Wildl. Soc. Bul. 17:142–146.

Trost, R. E. 1990. The relationship between harvest and survival rates of wood ducks in eastern North America, 1966–84. Pages 367–370 *in* L. H. Fredrickson, 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.

Watts, D. E. 1968. An evaluation of some components of wood duck habitat on John Sevier Lake, Hawkins County, Tennessee. M. S. Thesis. Univ. Tenn., Knoxville. 75pp.

Young, R. C. and W. M. Dennis, 1983. Productivity of the aquatic macrophyte community of the Holston River: Implications to hypolimnetic oxygen depletions of Cherokee Reservoir. Tenn. Valley Authority (TVA) Div. Air and Water Resour., Muscle Shoals, Ala. TVA/ONR/WR–83/12. 34pp.