Demographics, Morphometrics, and Reproductive Characteristics of Eastern Cottontails (*Sylvilagus floridanus*) in Mississippi

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Eastern cottontails (*Sylvilagus floridanus*; hereafter referred to as cottontail) are an important game animal in the United States. During the 1997–98, 1998–99, and 1999–2000 harvest seasons, we characterized sex and age ratios, reproductive status, body mass, and hind foot length of harvested cottontails on Trim Cane Wildlife Management Area, Mississippi within 2 harvest regimes to better understand their population demographics and morphometrics. The area was partitioned into 2 sections with short (October–January) or long harvest regime (October–February) assigned to half of each section. Cottontail sex and age ratios did not differ among years. In February 19% of cottontails were pregnant. Most cottontails were conceived from March–June (81%) and young were born from April–July (80%). We did not detect a difference in body mass or hindfoot length between the sexes for cottontails; however, we did detect differences for body mass and hindfoot length between ages. During our study, harvest within February appeared to have little effect on cottontails. Ninety-three percent of the states within the geographic range of the cottontail allow harvest during February. Currently, there is a paucity of information on the effects of harvest on cottontails and their population status. Therefore, we recommend other states with cottontails more aggressively investigate effects of harvest on their population status.

Eastern cottontails (*Sylvilagus floridanus*; hereafter referred to as cottontail) are an important game animal in the United States (Chapman et al., 1982). Over the past several decades, cottontail habitat has deteriorated leading to declines in many areas within their geographic range (Chapman et al., 1982). Barkalow (1962) suggested cottontails in northern latitudes produce larger litters and cottontails in southern latitudes produce smaller litters, but may produce more litters annually. In Alabama, Hill (1965) observed some cottontails breeding as early as the first week in January, but usually the breeding season started in late February and continued through September (Chapman et al., 1980). In Illinois, Lord (1963) documented lower survival rate of cottontails born early in the reproductive season. In Illinois (Lord, 1963) and Ohio (Negus, 1959; Stevens, 1962), a high incidence (27–50%) of breeding by juvenile cottontails was reported. However, Pelton (1968) only observed 3% of juvenile cottontails breeding in Georgia.

Considering the importance of cottontails, its variable productivity, and the general belief in its decline in some areas it is of utmost importance for the investigation into their population dynamics. Probably the best data with less bias than surveys on rabbit parameters is from hunter bag checks (Chapman et al., 1982). Terrel (1972) commented that wildlife agencies would not be able to collect pertinent data from trapping because of the cost and labor it consumes in relation to amount of data collected. Therefore, it appears that population demographics and morphometrics can be easily and unbiasedly collected from hunter bag checks. Population demographics and morphometrics are important indicators of population changes. Petrides (1951) reported the importance of sex and age ratios in providing valuable indications of population characteristics. Therefore, our objective was to collect age ratio, sex ratio, reproductive status, body mass, and hind foot lengths

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from mandatory hunter bag checks and examine them by harvest regime across years to better understand these population demographics and morphometrics from harvested cottontails.

STUDY AREA AND METHODS

Trim Cane Wildlife Management Area (TCWMA) was located approximately 10 km north of Starkville in Oktibbeha County, Mississippi. Trim Cane Wildlife Management Area consisted of 320 hectares converted from hardwood bottomland forest to agricultural fields during the early 1970s and was farmed until 1986 (Taylor, 1996). The area naturally succeeded into primarily oldfield and hedgerow habitats.

We examined cottontail population demographics, morphometrics, and reproductive characteristics on TCWMA during the 1997–98, 1998–99, and 1999–2000 harvest seasons. Prior to the 1997–98 harvest season, cottontails had not been harvested for >8 y. The area was partitioned into 2 sections based on soil moisture, with 1 of 2 harvest regimes (short and long harvest regime) assigned randomly to half of each section. Hunters harvested cottontails from the Saturday nearest to October 15th until the end of January in the short harvest regime, whereas hunters harvested cottontails from the Saturday nearest to October 15th until the end of February in the long harvest regime.

The Mississippi Department of Wildlife, Fisheries and Parks selected weekends to hunt, selected hunters by lottery, and limited number of hunters and bag limit because of the small size of TCWMA. There were 3, 2-d weekend (Saturday and Sunday) hunts in November and 2, 2-d weekend hunts in October, December, January, and February. Two hunting parties were drawn for each weekend hunt and each party consisted of $\leq$3 hunters, with each party limited to a harvest of 6 cottontails/d, and each party assigned to a harvest regime. Annually, equal effort (hours) was applied within each hunting regime from October–January. We observed the hunts, which facilitated faster cottontail processing and the ability to precisely determine number of hours hunted in each particular harvest regime.

We recorded sex, body mass, and hind foot length for each harvested cottontail. Additionally, we noted if a male's testes were regressed or descended, and if females were anestrous or pregnant. We collected eyes from all cottontails and reproductive tracts from females and placed them in 10% formalin. We soaked eyes in formalin for 2 weeks, then extracted lenses and oven dried them at 80 °C for 7 d, and weighed them to the nearest 0.0001 g (Hill, 1966; Lord, 1963). We used the cottontail eye lens weight table computed by Hill (1966) to age cottontails (number of days). If age was $\geq$365 d, we classified the rabbit as adult. We back-dated harvested juvenile cottontails to determine month of conception and birth (Hill, 1966). We predicted age based on morphometrics using logistic regression models developed by Bond et al. (2000) for cottontails with damaged eyes due to harvest (n = 29, 18%). Bond et al. (2000) were able to accurately predict age of cottontails (79%) using body weight and hind foot length together in logistic regression equations.

We investigated changes in population structure by comparing age and sex ratios among years. Since cottontails were not harvested for 8 years prior to implementation of experimental harvest, we assumed temporal (year-to-year) changes in population structure (age and sex ratios) were attributed to effects of harvest. If we detected an effect, we tested each treatment individually to determine if the effect was attributable to either treatment. We tested for differences in population structure among years using a Mantel-Haenszel chi-square (Stokes et al., 1995). We tested for differences in body mass and hindfoot length between ages and sexes using a two-way analysis of variance on treatment and year.

RESULTS AND DISCUSSION

Hunters harvested 165 cottontails during 244 h of hunting. Cottontail harvest rate (harvest/hr) typically increased from October to February. Over 3 y, cottontail harvest rate ranged from 0.22–0.74 for the short harvest regime and 0.55–1.02 for the long harvest regime. Most cottontails were harvested in January (n = 60) and February (n = 62), whereas fewer cottontails were harvested in October (n = 2), November (n = 21), and December (n = 20).

Cottontail sex ratios (1997–98 = 46% females, 1998–99 = 51%, and 1999–2000 = 39%; χ^2_2 = 0.035, P = 0.556) did not differ among years within harvest regime and was similar to previously documented proportions from 48% (Wisconsin; Elder and Sowls, 1942) to 55% (western Maryland; Chapman et al., 1977). Age ratios (1997–98 = 64% juveniles, 1998 – 99 = 68%, and 1999–2000 = 73%; χ^2_2 = 0.69, P = 0.407) also did not differ among years. Past documented range of juvenile cottontails in the bag was 59% (Missouri; Wight, 1959) to 83% (Michigan;

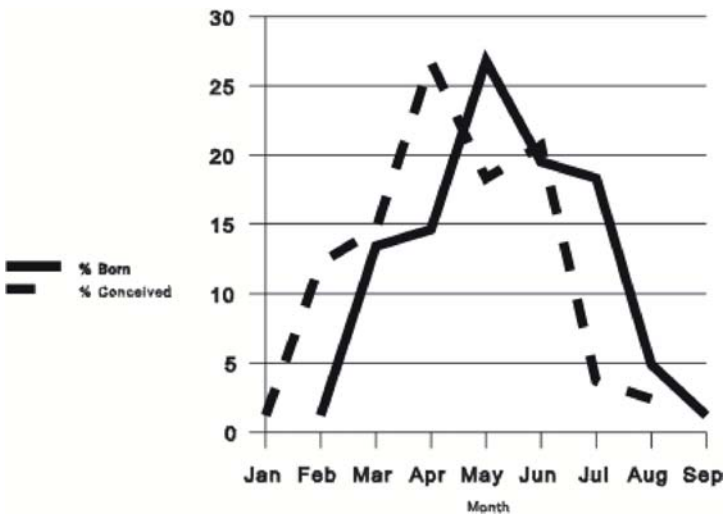

Figure 1. Percentage of harvested juvenile cottontail rabbits conceived/month (dashed line) and born/month (solid line) on Trim Cane Wildlife Management Area, Mississippi, 1997–99.

McCabe, 1981); therefore our cottontail age ratios fall well within the previously reported range of cottontail age ratios.

Cottontails exhibited little evidence of breeding activity (pregnant: October–January = 0%; testes descended: October–November = 0%, December = 8%, and January 27%) prior to February (pregnant = 19%; testes descended = 94%). Our results agree with studies conducted in New York (Chapman et al., 1980) and Maryland (Chapman et al., 1977). However, studies in Alabama (Barkalow, 1962) and Oregon (Trethewey and Verts, 1971) observed cottontails pregnant in January; whereas, in Connecticut (Dalke, 1942) and Wisconsin (Rongstad, 1966) cottontails were not observed pregnant until March. However, cottontails were observed pregnant year round in Texas (Bothma and Teer, 1977). Hill (1966) suggested that onset of breeding is variable between populations and even variable yearly within the same population. Temperature, severe weather, availability of succulent vegetation, and rainfall have all been suggested as primary factors for initiation of breeding in cottontails (Ecke, 1955; Wight and Conaway, 1961; Hill, 1966; Bothma and Teer, 1977). Average cottontail litter size was 2.8 (n = 5, SE = 0.37, range 2–4) and less than previously reported, likely because only visible pregnancies were observed. The previous range of mean litter sizes for cottontails was 3.1 in Georgia (Pelton and Jenkins, 1971) to 5.6 in Illinois (Ecke, 1955). We were able to estimate month of conception and birth for juvenile cottontails (n = 82) harvested. Most harvested juvenile cottontails were conceived during March–June (81%, n = 66), whereas few were conceived during January–February (13%, n = 11) and July–August (6%, n = 5; Figure 1). Most harvested juvenile cottontails were born from April–July (80%, n = 65), whereas few were born from February–March (14%, n = 12) and August–September (6%, n = 5; Figure 1).

Age and sex did not interact to affect body mass ($F_{1,144}$ = 0.18, P = 0.676) or hindfoot length ($F_{1,144}$ = 0.01, P = 0.781) for cottontails. We did not detect a difference in body mass (male: 1110 g, SE = 15.1; female: 1122 g, SE = 17.0; $F_{1,144}$ = 0.11, P = 0.742) between the sexes. The mean body mass we observed for adult male ($\bar{x}$ = 1246 g) and female ($\bar{x}$ = 1260 g) cottontails were greater for males but comparable for females reported in Maryland (males $\bar{x}$ = 1134 g, females $\bar{x}$ = 1244 g; Chapman and Morgan, 1973) and comparable for males and less than females reported in Michigan (males $\bar{x}$ = 1299 g, females $\bar{x}$ = 1441 g; Haugen, 1942). We did detect differences for body mass (adult: 1253 g, SE = 11.8; juvenile: 1050 g, SE = 10.7; $F_{1,144}$ = 128.04, P < 0.001) between ages. We observed mean body mass of juvenile male ($\bar{x}$ = 1052 g) and female ($\bar{x}$ = 1047 g) cottontails, which was comparable to Michigan (males $\bar{x}$ = 1073 g, females $\bar{x}$ = 1121 g; Haugen, 1942) and Virginia (male $\bar{x}$ = 1066 g, females $\bar{x}$ = 1037 g; Llewellyn and Handley, 1945). We did not detect a difference in hindfoot length (male: 91 mm, SE = 0.4; female: 91 mm, SE = 0.5; $F_{1,144}$ = 0.08, P = 0.781) between the sexes, however we did between ages (adult: 93 mm, SE = 0.5; juvenile: 90 mm, SE = 0.4; $F_{1,144}$ = 20.50, P <0.001).

We observed mean hind foot lengths of 93 mm (adult males and females) and 90 mm (juvenile males and females) for cottontails which were slightly less than the overall mean of 95.4 mm (90–105 mm) reported by Chapman and Morgan (1973) in Maryland, but within ranges reported for Virginia (83–110 mm; Llewellyn and Handley, 1945) and across the cottontail's geographic range (87–104; Nelson, 1909).

In conclusion, our study should add important information on cottontail demographics, morphometircs, and reproductive data from a harvested population across years. Currently, most (93%, 37/40) states within the cottontail's range allow harvest after January. Therefore, in most states harvest occurs during a portion of the breeding season. However, cottontails are highly productive producing 3–7 litters annually and average 3–5 young/litter (Chapman et al., 1980). We observed few harvested cottontails pregnant in February (19.4%) and observed few juvenile cottontails in the harvest born in February (1.2%). Considering our reduced bag limit our results are conservative. During our study, harvest within February appeared to have little effect on cottontails. Most states within the geographic range of the cottontail allow harvest during February. Currently, there is a paucity of information on the effects of harvest on cottontails and their population status. Therefore, we recommend other states with cottontails more aggressively investigate effects of harvest on their population status.

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LITERATURE CITED

Barkalow, F.S., Jr. 1962. Latitude related to reproduction in the cottontail rabbit. J. Wildl. Manage. 26:32–37.

Bond, B.T., J.L. Bowman, B.D. Leopold, L.W. Burger, Jr., and K.D. Godwin. 2000. Delineating age and species of harvested cottontail and swamp rabbits. Proc. Annu. Conf. Southeast. Assoc. Fish and Wildl. Agencies 54:330–336.

Bothma, J. du P., and J.G. Teer. 1977. Reproduction and productivity in South Texas cottontail rabbits. Mammalia 41:253–281.

Chapman, J.A., A.L. Harman, and D.E. Samuel. 1977. Reproductive and physiological cycles in the cottontail complex in western Maryland and nearby West Virginia. Wildl. Monograph 56:1–54.

Chapman, J.A., J.G. Hockman, and M.M. Ojeda. 1980. *Sylvilagus floridanus*. Mammal. Sp. 136:1–8.

Chapman, J.A., J.G. Hockman, and W.R. Edwards. 1982. Cottontails. Pages 83–123 *in* J.A. Chapman and G.A. Feldhamer, eds. Wild Mammal of North America: Biology, Management, and Economics. John Hopkins University Press. Baltimore, MD.

Chapman, J.A., and R.P. Morgan. 1973. Systematic status of the cottontail complex in western Maryland and nearby West Virginia. Wildl. Monograph 36:1–54.

Dalke, P.D. 1942. The cottontail rabbits in Connecticut. Bull. Conn. Geolological Natur. Hist. Surv. 65:1–97.

Ecke, D.H. 1955. The reproductive cycle of the Mearns cottontail in Illinois. Am. Midl. Nat. 53:294–311.

Elder, W.H., and L.K. Sowls. 1942. Body weight and sex ratio of cottontail rabbits. J. Wildl. Manage. 6:203–207.

Haugen, A.O. 1942. Life history studies of the cottontail rabbit in southwestern Michigan. Am. Midl. Nat. 28:204–244.

Hill, E.P. 1965. Some effects of weather on cottontail reproduction in Alabama. Proc. Annu. Conf. Southeast. Assoc. Game and Fish Comm. 19:48–57.

Hill, E.P. 1966. A cottontail rabbit lens growth curve from Alabama. Proc. Annu. Conf. Southeast. Assoc. Game and Fish Comm 20:50–56.

Llewellyn, L.M., and C.O. Handley. 1945. The cottontail rabbits of Virginia. J. Mammal. 26:379–390.

Lord, R.D., Jr. 1963. The cottontail rabbit in Illinois. Illinois Department of Conservation and Illinois Natural History Survery, Southern Illinois University Press, Carbondale, Illinois Technical Bulletin No. 3. 94 pp.

McCabe, R.A. 1981. The cottontail rabbit hunted for recreation and control. Proc. World Lagomorph Conf. 1:899–906.

Negus, N.C. 1959. Breeding of subadult cottontail rabbits in Ohio. J. Wildl. Manage. 23:451– 452.

Nelson, E.W. 1909. The rabbits of North America. N. Am. Fauna 29:1–314.

Pelton, M.R. 1968. A contribution to the biology and management of the cottontail rabbits (*Sylvilagus floridanus mallarus*) in Georgia. PhD. Dissertation, University of Georgia, Athens. 160 pp.

Pelton, M.R., and J.H. Jenkins. 1971. Productivity of Georgia cottontails. Proc. Annu. Conf. Southeast. Assoc. Game and Fish Comm. 25:261–268.

Petrides, G.A. 1951. The determination of sex and age ratios in the cottontail rabbit. Am. Midl. Nat. 46:312–336.

Rongstad, O.J. 1966. Biology of penned cottontail rabbits. J. Wildl. Manage. 30:312–319.

Stevens, V.C. 1962. Regional variations in productivity and reproductive physiology of the cottontail in Ohio. Trans. N. Am. Wildl. Nat. Resour. Conf. 27:243–253.

Stokes, M.E., C.S. Davis, and G.G. Koch. 1995. Categorical data analysis using the SAS system. SAS Institute, Cary, North Carolina. 648pp.

Taylor, J.D. II. 1996. Northern bobwhite habitat use and reproductive success in managed oldfield habitats in Mississippi. MS Thesis. Mississippi State University, Mississippi State. 103 pp.

Terrel, T.L. 1972. The swamp rabbit (*Sylvilagus aquaticus*) in Indiana. Am. Midl. Nat. 57:283–295.

Trethewey, D.E., and B.J. Verts. 1971. Reproduction in eastern cottontail rabbits in western Oregon. Am. Midl. Nat. 56:463–476.

Wight, H.M. 1959. Eleven years of rabbit population data in Missouri. J. Wildl. Manage. 23:34–39.

Wight, H.M., and C.H. Conaway. 1961. Weather influences on the onset of breeding in Missouri cottontails. J. Wildl. Manage. 25:87–89.