EFFECTS OF SOIL REGION, LITTER SIZE, AND GENDER ON MORPHOMETRICS OF WHITE-TAILED DEER FAWNS

By

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Previous research documented that white-tailed deer body mass and antler size varied across physiographic regions of Mississippi. Deer from regions with greater soil fertility had greater body mass and antler size; however, this information is known only for individuals 6 months of age and older. I monitored birth mass and skeletal size of fawns produced by bred, adult, female white-tailed deer transplanted from the Delta, Thin Loess (Loess), and Lower Coastal Plain (LCP) soil regions. I evaluated the effect of soil region, litter size, and fawn gender on mass and size at birth. I found that LCP fawns and twins were lighter and shorter than loess and/or delta fawns and singletons. Males were heavier than females. Differences between regional birth dates within the pens and estimated regional birth dates based on a fetal growth curve raises questions about wide-spread application of this method of estimating deer breeding and fawning dates.

DEDICATION

There is no way I can dedicate this thesis to just one person. So many people have been with me throughout this journey. My parents, Larry and Myra Castle, and my sister Joni Castle, have been with me from the very beginning. They have always encouraged me and listened to me while I let out my frustrations. They have helped me achieve anything I desired and have been there when I needed a little guidance to go a different way. Thank you so much for all of your love and support. I would not be who I am today without all of you. The next 2 people have also been with me from the beginning. My grandparents, Hayden and June Herring, have encouraged me and been there for me any time I needed them. Granddaddy encouraged me to finish school and do something with my life up until a week before he died. They have both been an inspiration and so important in my life. Last and not least is my husband Shaun Blaylock. I met you during my first year of graduate school and we were married during the last year. I am so thankful I found you. You have been there for me since the first day I met you. Thank you so much for always being there for me and never complaining when I was gone all week and out all night trapping deer. You always encouraged me to keep going. Thank you for loving me.

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CHAPTER 1

INTRODUCTION

Soil fertility varies across soil regions in Mississippi (Pettry 1977), with apparent effects on white-tailed deer (*Odocoileus virginianus*) growth rates of adults, ultimate body mass, and antler size (Strickland and Demarais 2000). Gill (1956) reported a direct relationship between soil fertility and body mass of deer. He explained that soil fertility affects habitat quality, which in turn impacts body size. Regions with high soil fertility are generally associated with greater body mass and reproduction of deer (Strickland and Demarais 2000); however, results have been known only for individuals 6 months of age and older. Understanding how soil region affects birth mass will provide important baseline information for deer managers.

The size of a fawn at birth is correlated positively with available habitat for the dam during gestation (Verme 1963). Experiments with sheep have shown that a ewe needs a high level of nutrition to produce a large, healthy lamb (Thompson and Thompson 1948). Because most deer feti growth occurs during the last trimester of gestation, adequate nutrition must be available for the dam to produce a maximum size fawn (Verme 1963). Strickland and Demarais (2000) indicated white-tailed deer must exceed nutritional requirements to reach their maximum growth potential.

Greater fawn growth rates could be due to better nutrition during gestation and lactation (Nelson and Woolf 1985). White-tailed deer fawns that were born to does lacking adequate nutrition were smaller at birth (Verme 1963). Therefore, does and fawns must have adequate nutrition to maximize birth mass.

Multiparity and fetal gender also may influence birth mass. Verme (1963) reported that number of offspring affects birth mass and growth. Usually, multiple births result in lesser body mass. Birth mass of male and female fawns were similar, but growth rate of single males was faster than single females (Verme 1963).

Foresters use a site index to predict timber growth potential (Smith et al. 1997). Understanding causes of variation in birth mass could be beneficial in determining each soil region's potential for producing white-tailed deer. The opportunity to identify additional variables necessary to develop a site index for white-tailed deer physiologic condition and recruitment could be a valuable asset to white-tailed deer managers.

The goal of this research was to determine causes of variation in morphometrics of fawns. I monitored birth mass and skeletal size of fawns produced by bred, adult, female white-tailed deer transplanted from the wild to the Mississippi State University Rusty Dawkins Memorial Deer Unit. I evaluated effects of 3 soil regions of origin, litter size, and fetal gender on birth mass, hind foot, and total body length. I hypothesized that fawn morphometrics will be associated positively with soil fertility. Thus, Delta soil region fawns will have the heaviest birth mass and larger size followed by the Loess and LCP regions. I hypothesized that single fawns and male fawns will have a heavier birth mass and larger size than twin fawns and female fawns.

CHAPTER II

STUDY AREAS AND METHODS

STUDY AREAS

Bred adult female white-tailed deer were captured in 3 regions of Mississippi that vary in soil characteristics and potential habitat quality. These soil regions include Delta, Thin Loess (Upper Thin and Lower Thin Loess), and Lower Coastal Plain (Pettry 1977) (Fig. 1).

The Delta soil resource region covers a large part of western Mississippi. In areas suitable for deer habitat, it is considered to have the highest habitat quality for deer due to high soil fertility (Strickland and Demarais 2000). Harvested fawns averaged 23.7 kg eviscerated body mass during 1991 to 1998 (Strickland and Demarais 2000). Topography is nearly level with elevations ranging from 15.2 to 60.9 meters. The fertile Delta soil consists of rich alluvium from the Mississippi River and is one of the largest contiguous agricultural areas with a wide range of crop production. Annual precipitation in the delta ranges from 114.3 centimeters in the north to 152.4 centimeters in the south. Vegetative cover consists of small areas of hardwoods (Pettry 1977).

The Upper Thin Loess and Lower Thin Loess soil regions, located in central Mississippi, were combined for this study and are considered to have moderate

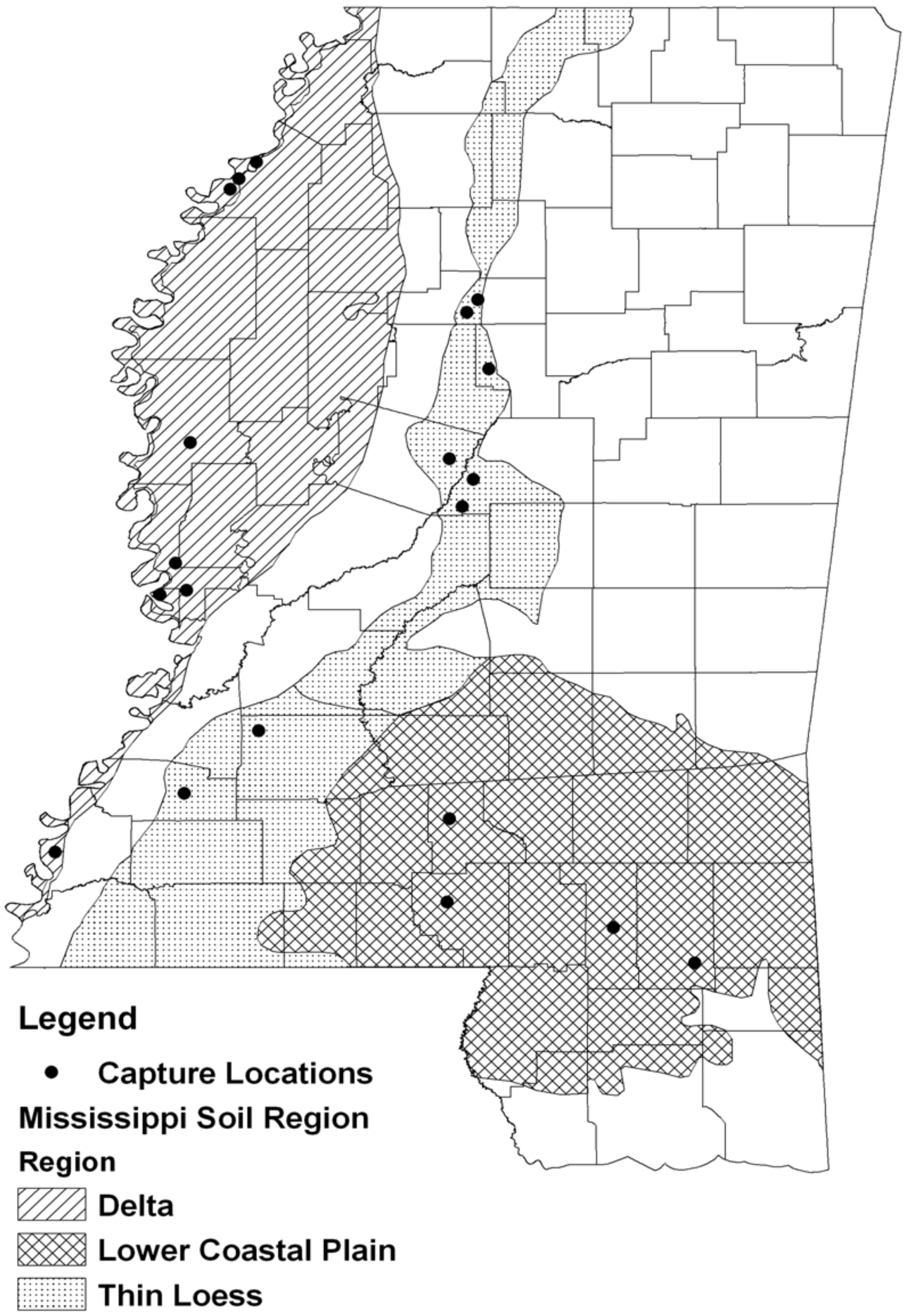

Figure 1. Soil regions of Mississippi from which adult does were captured, 2005-2006.

habitat quality for deer. Eviscerated body mass of harvested fawns averaged 21.6 kg during 1991 to 1998 (Strickland and Demarais 2000). Topography in the Loess is nearly level to sloping. Soils are silty (Pettry 1977), and soil fertility is considered to be moderate (Strickland and Demarais 2000). This soil region averages 127 to 139.7 centimeters of precipitation annually. Vegetative cover consists of primarily mixed pine and hardwoods (Pettry 1977).

The LCP soil region covers portions of southern Mississippi and is considered to have the lowest habitat quality for deer of the soil regions included in our study. Eviscerated body mass harvested fawns averaged 19.4 kg during 1991 to 1998 (Strickland and Demarais 2000). Soils are sandy and acidic with low soil fertility. Topography ranges from nearly level to steep with elevations ranging from 15.2 to 182.9 feet. The average rainfall is 139.7 to 152.4 centimeters annually. Sixty percent of this area is composed of mixed pine and hardwood forests, whereas the remaining land base is used for agricultural crops and grazing (Pettry 1977).

Adult female deer were captured by the Mississippi Department of Wildlife, Fisheries and Parks at multiple sites within each soil region. Capture sites included Wildlife Management Areas (WMAs) and Deer Management Assistance Program (DMAP) (Guynn et al. 1983) cooperators with body mass and breeding dates representative of the soil region. The Delta soil region sites included Big River Farms (10,522 ha), Buckhorn Hunting Club (1,073 ha), Burke Hunting Club (2,679.9 ha), Coahoma County Conservation League (3,480 ha), Leroy Percy State Park (725 ha), Mahannah WMA (5,129.4 ha), Steel Bayou Hunting Club (1,128 ha), and Ward Lake Hunting Club (2,589.9 ha). The Loess soil region sites included Blaylock

Property (89 ha), Deer Creek Hunting Club (2,104 ha), Deviney Property (494.7 ha), Dr. Bryant's Property (526.1 ha), Grenada Dam (313 ha), Holmes County State Park (217 ha), Hugh White State Park (534), and Riverside Hunting Club (1,083.3 ha). The LCP soil region sites included Camp Shelby (3,682.6 ha), Leaf River WMA (16,758.5 ha), Pace Hunting Club (768.9 ha), and Walker Farms (5,665.6 ha).

After capture, deer were housed at the Mississippi State University Rusty Dawkins Memorial Deer Unit located in Starkville, Mississippi. The facility is approximately 4.0 ha in size. Within the larger facility, there are 5 pens where animals resided.

A mixture of Patriot Clover and Max Q fescue (Pennington Seed Company, Madison, GA) along with volunteers, such as bermuda grass and sedges are available as forage. Deer consumed ad libitum 20% protein (Purina Antler Max professional High energy breeder 59UB, Purina Mills, St. Louis, MO) pellets which were available in 2 feeders per pen along with one water trough.

METHODS

I obtained fawns from adult females captured from the wild during January – April 2005 and 2006 within the Delta, Loess, and LCP soil regions (Figure 1). In 2005, there were 19 does from the Delta, 17 does from the Loess, and 19 does from the LCP captured that produced fawns. In 2006, there were 12 does from the Delta, 10 does from the Loess, and 12 does from the LCP captured that produced fawns. At capture, does were aged (Severinghaus 1949), weighed, and tagged with color-coded, numbered tags (Allflex LTD, New Zealand, size large). Deer were vaccinated with

Ultra Bac 7(Pfizer Animal Health, New York, NY) for clostridium and with vibrio/Leptoferm-5 for Leptospira (Pfizer Animal Health, New York, NY). Does also were treated with Ivermectin for potential parasites and given LA-200 (Pfizer Animal Health, New York, NY) as preventive antibiotic. Does from each soil region were maintained in separate pens.

Fawns were captured within 24 hours of birth and marked, sexed, and measured. A picture of each fawn was taken to record physical features present. Fawns were tagged with one numbered, plastic color-coded ear tag (Allflex LTD, New Zealand, size medium) and one metal ear tag (Hasco Tag Company, Dayton, KY, size 681) at birth. The plastic tag was replaced with one large Allflex tag in each ear when processed at 5.5 months of age. Tattoos were placed on one ear indicating soil region, year, and birth order (eg. W5001 = LCP, 2005, Fawn #001). A single digit freeze brand (50.8 mm high, 6.4 mm face), was placed on each hindquarter indicating year of birth. The branding iron was placed in liquid nitrogen for 5 minutes. After rinsing the area with alcohol, the iron was then placed on the fawn for 31 seconds. Measurements included hind foot length, which was measured from hock to tip of longest nail (Gill 1956) and total body length, which was measured from tip of nose dorsally over brain case along vertebral column to end of last caudal vertebra (Bartush and Garner 1979). Mass was recorded to the nearest tenth of a pound and converted into kilograms. Samples of DNA were taken from a small ear notch to ensure that fawns were correctly paired with their dam. Maternity assignment was made by DNA Solutions, Oklahoma City, OK. All procedures were approved by the Mississippi State University Institutional Animal Care and Use Committee, protocol number 04-068.

I tested for the effects of soil region, fawn gender, and litter size using a 3-way mixed model analysis of variance with PROC MIXED in SAS (SAS Institute 2001). Treatments were 3 soil resource regions (Delta, Loess, and LCP), gender (male and female), and litter size (1 and 2). The experimental units were the individual fawns produced by wild-caught dams. Response variables included body mass, total body length, and hind foot length at birth. I treated the dam as a random effect. Although fawns were produced during 2005 and 2006, I assumed that there was no year effect and combined data for both years. Normality and homogeneity of variance of the residuals were tested using the Shapiro-Wilk and Levene's test and both assumptions were met. The LSMEANS PDIFF option was used to identify differences among pair wise comparisons. I considered differences in means to be significant at the alpha level of 0.05.

I tested the effect of soil region on birth date using a one-way analysis of variance with PROC ANOVA in SAS (SAS Institute 2001). The experimental units were the dams giving birth. The date a single doe gave birth was converted to Julian dates and used as the response variable. Treatments were 3 soil resource regions (Delta, Loess, and LCP). Normality and homogeneity of variance of the residuals were tested using the Shapiro-Wilk and Levene's test and both assumptions were met. I considered differences in means to be significant at the alpha level of 0.05.

CHAPTER III

RESULTS AND DISCUSSION

RESULTS

Eighty-nine wild-caught, pregnant, adult, females produced fawns during 2005 and 2006 (Table 1). I processed 52 LCP, 41 Loess, and 51 Delta fawns at birth, but 2 Loess fawns (2 male singletons) were not measured for total body length and one Delta fawn (1 female singleton) was not measured for hind foot and total body length.

Soil physiographic region (origin of wild-caught dams) influenced physical measurements of fawns born in captivity (Table 2). Birth mass differed among soil regions ($F_{2,39} = 3.51$, $P \leq 0.040$). Lower Coastal Plain fawns weighed 0.4 kg < those from the Loess. Hind foot length at birth differed among regions ($F_{2,39} = 5.80$, $P \leq 0.006$). Lower Coastal Plain fawns measured 13.3 mm < than the Loess and 12.1 mm < than the Delta. Total body length at birth differed among regions ($F_{2,39} = 7.21$, $P \leq 0.002$). Lower Coastal Plain fawns were 42.8 mm < than the Loess and 34.9 mm < than Delta fawns.

I tested the effect of litter size at birth using 46 singletons and 87 twins (Table 3). Birth mass differed between singletons and twins ($F_{1,39} = 5,62$, $P \leq 0.023$). Hind

Table 1. Sources, number that produced fawns, and mean body mass of adult female white-tailed deer captured from the Lower Coastal Plain (LCP), Thin Loess (Loess), and Delta soil regions of Mississippi, 2005-2006.

Site	Hectares	Soil Region	County	Number of Deer	Mean Body Mass (kg)
Big River Farms [a]	10,522	Delta	Adams	5	54.7
Buckhorn Hunting Club	1,073	Delta	Issaquena	1	40.4
Burkes Hunting Club [a]	2,680	Delta	Coahoma	4	48.3
Coahoma County Conservation League [a]	3,480	Delta	Coahoma	1	56.7
Leroy Percy State Park	725	Delta	Washington	1	40.8
Mahannah Wildlife Management Area	5,129	Delta	Issaquena	11	54.2
Steel Bayou Hunting Club	1,128	Delta	Issaquena	4	50.6
Ward Lake Hunting Club [a]	2,590	Delta	Coahoma	4	59.5
Blaylock Property	89	Loess	Montgomery	1	36.3
Deer Creek Hunting Club	2,104	Loess	Jefferson	2	51.0
Deviney Property	404	Loess	Copiah	7	53.8
Dr. Bryant's Property	526	Loess	Attala	1	54.4
Grenada Dam	313	Loess	Grenada	6	51.2
Holmes County State Park	217	Loess	Holmes	1	53.1
Hugh White State Park	534	Loess	Grenada	6	38.0
Riverside Hunting Club	1,083	Loess	Attala	3	40.1
Camp Shelby	3,683	LCP	Forrest	22	40.4
Leaf River Wildlife Management Area	16,759	LCP	Perry	3	42.0
Pace Hunting Club	769	LCP	Jeff Davis	2	40.8
Walker Farms	5,666	LCP	Marion	3	44.8

[a] Capture site is located within the batture area.

Table 2. Least squares means physical characteristics at birth for white-tailed deer born to wild-captured dams from the Lower Coastal Plain (LCP), Thin Loess (Loess), and Delta soil regions of Mississippi, 2005-2006.

	LCP			Loess			Delta				
Variable	*n*	Mean	SE	*n*	Mean	SE	*n*	Mean	SE	$F_{2,39}$	P
Birth											
Mass (kg) [1]	52	2.3A	0.1	41	2.7B	0.1	51	2.6AB	0.1	3.51	0.040
Hind Foot Length (mm) [1]	52	211.5A	3.0	41	224.8B	3.2	50	223.6B	2.9	5.80	0.006
Total Body Length (mm) [1]	52	585.4A	8.3	39	628.2B	8.7	50	620.3B	8.0	7.21	0.002

[1]Means with different letters within a row differ ($P \leq 0.05$).

foot length differed between singletons and twins ($F_{1,39} = 4.16$, $P \leq 0.048$). Twins weighed 0.3 kg less and were 7.2 mm shorter than singletons.

I tested the effect of gender at birth using 66 males and 67 females (Table 3). Birth mass differed between males and females ($F_{1,39} = 7.65$, $P \leq 0.009$). Males were 0.3 kg heavier than females. There was a gender and litter size interaction for mean total body length ($F_{1,39} = 7.74$, $P \leq 0.008$). Single males were longer than single females, twin males, and twin females.

Fawning dates of wild-caught dams were compared using 32 Delta, 28 Loess, and 31 LCP birth events. Birth date differed among soil regions ($F_{2,88} = 37.48$, $P \leq 0.001$). Mean birth date for the Delta soil region was July 12 with a range of June 14 to August 10. Mean birth date for the Loess soil region was July 29 with a range of June 30 to September 23. Mean birth date for the LCP soil region was August 15 with a range of July 22 to September 21.

Table 3. Least squares means physical characteristics at birth by gender and litter size for white-tailed deer born to wild-captured dams from the Lower Coastal Plain, Thin Loess, and Delta soil regions of Mississippi, 2005-2006.

	Gender								Litter Size							
	Male			Female					Single			Twins				
Variable	*n*	Mean	SE	*n*	Mean	SE	$F_{1,39}$	*p*	*n*	Mean	SE	*n*	Mean	SE	$F_{1,39}$	*p*
Birth																
Mass (kg)	66	2.6	<0.1	67	2.3	<0.1	7.65	0.009	46	2.6	<0.1	87	2.3	<0.1	5.62	0.023
Hind Foot Length (mm)	66	223.0	2.4	66	217.0	2.3	4.01	0.052	45	223.6	2.6	87	216.4	2.4	4.16	0.048
Total Body Length (mm)[1]	64	618.3	6.6	66	604.3	6.3			45	623.5	7.2	85	599.1	6.5		

[1]Gender*Litter Size interaction ($F_{1,39}$ = 7.74) ($P \leq 0.008$); single males (mean = 642.6A, SE = 10.8), single females (mean = 604.5B, SE = 9.8), twin males (mean = 594.0B, SE = 7.8), twin females (mean = 604.2B, SE = 8.2). Means with different letters differ significantly ($P \leq 0.05$).

DISCUSSION

Birth mass of white-tailed deer within Mississippi is equivalent to other regions within the species' range. Birth mass ranges from 1.8 kg to 3.6 kg at birth; variation is attributed to region, habitat quality, and habitat type (Sauer 1984). The 2.3 to 2.7 kg fawn birth mass I report for the 3 soil regions of Mississippi, are within the mid-range of Sauer's (1984) values. Neonate fawns from northern Michigan weighed 2.9 kg with a range of 0.9 kg to 4.6 kg (Verme 1963). Similar results were found by Nelson and Woolf (1985), with fawns from Illinois weighing 2.9 kg with a range of 2.5 kg to 3.3 kg. Fawns produced by does captured in the Loess soil region were only 0.2 kg less than the mean mass of fawns from Michigan and Illinois.

There is a relationship between birth mass and adult body mass. Schultz and Johnson (1995) reported a direct correlation between birth mass and body mass of adult males; however, birth mass explained only about 30% of the variation in mass at 1.5 years of age. Festa-Bianchet et al. (2000) reported that mass during early development is correlated with adult mass of bighorn sheep. Studies in red deer have also shown correlations between birth and adult mass (Clutton-Brock et al. 1988). It is possible that birth mass does not show as much regional variation as older animals. Body mass varies from 27 kg for Florida key deer to 136 kg for deer from northern regions (Demarais et al. 2000).

Because birth mass of white-tailed deer is similar among regions of North America, despite wide variation in adult size, birth mass may be limited by uterine space. Research in pigs has shown that there is a maximum litter size that a uterus can support. Sows with longer uterine horns provide a larger uterine environment, which allows larger litters and more total birth mass (Geisert and Schmitt 2002). It is possible that deer have a similar limiting uterine capacity and variation in body mass is not expressed until older ages.

Soil fertility has a linear relationship with physical condition and productivity of many wildlife species (Crawford 1950). Habitat quality is affected by soil fertility which influences growth patterns of white-tailed deer (Leberg et al. 1992). The relationship between regional soil fertility and growth of deer was supported by differences I found in fawn birth mass and size in Mississippi. Lighter and smaller fawns produced by does captured in the LCP compared to the Delta and Loess soil regions supports patterns reported by Strickland and Demarais (2000). They found that body mass and antler size was less for deer in the LCP than from other regions. The Delta was thought to have the greatest quality soil and habitat in the state based on greater body mass and antler size, followed by the Loess; however, I found no differences in mass and skeletal size at birth between these regions. The quality of some native plants was higher in the Upper Thick Loess than the Delta and it has been hypothesized that abundance of agriculture crops accounted for higher body weights in the Delta (P. D. Jones, Mississippi State University, unpublished data). It is possible that deer populations from the Delta and Loess soil regions have the genetic potential to produce equivalent-sized deer, but expression of this potential may depend on available nutrition.

Data from population health checks performed by the Mississippi Department of Wildlife, Fisheries and Parks estimate fawning dates as July 6, July 11, and August 6 for the Delta, Loess, and LCP, respectively (C. W. Dacus, Mississippi Department of Wildlife, Fisheries and Parks, unpublished data) based on a fetal growth scale (Hamilton et al. 1985). Although average birth dates within the pens followed a similar pattern with does from the Delta fawning earliest, and does from the LCP fawning latest, average values from the pens were 6 to 18 days later than the agency's regional estimates. The discrepancy in birth dates between the pens and health checks could be due to sample composition because the regional estimates represent data from more populations within each of the regions. However, a similar result is observed when restricting analyses to comparable counties. The consistency of the later birth dates supports a second explanation that the fetal scale (Hamilton et al. 1985) may not accurately estimate fetal age under all circumstances in Mississippi.

The fetal scale is based on deer from South Carolina with fetuses at 189+ days of age (i.e., term) weighing 2.7 to 3.2 kg with a forehead-rump length of 458 to 492 mm. Birth mass from my study averaged 2.3 to 2.7 kg with a forehead-rump length of 391 to 426 mm (A. C. Blaylock, Mississippi State University, unpublished data). Similar values for near-term fetuses collected from each of these soil regions in Mississippi, averaged 2.2 to 2.5 kg with a forehead-rump length of 396.4 to 430.8 mm (A. C. Blaylock, Mississippi State University, unpublished data).

The differences in fetal size between South Carolina and Mississippi may be the source of discrepancy between the fawning dates in our pens and estimated fawning dates in the wild. Near term fetuses and neonatal fawns from Mississippi were smaller than the South Carolina fetuses (Hamilton et al. 1985), which could potentially underestimate fetal age and thus over-estimate birth date. However, actual birth dates in our pens were later than estimated birth dates estimated for their respective regions, indicating that the fetal scale is over estimating fetal age. One possible explanation is that gestation length differed between the Mississippi and South Carolina populations.

Verme (1963) found that number of offspring produced by the dam influences birth mass and that single fawns are approximately 0.2 kg heavier at birth than twins. Black-tailed deer singletons weighed 0.4 kg more than twins (Mueller and Sadleir 1980). The 0.3 kg heavier singletons I reported is similar to Verme (1963) and Mueller and Sadleir (1980). In contrast, Knowlton et al. (1979) found no effect of litter sizes on fetal measurements made prior to birth.

My research suggests there are differences in birth mass between males and females. Bartush and Garner (1979) reported similar results for wild-captured fawns in Oklahoma, but not until 6 days of age. Roseberry and Klimstra (1975) also found differences between males and females in body mass and hind foot length at all ages. In contrast, Verme (1963) found that single female fawns were slightly heavier than single male fawns, but that males in twin groups were a half pound larger than females. Nelson and Woolf (1985) also found no difference in mass and skeletal size among gender.

CHAPTER IV

MANAGEMENT RECOMMENDATIONS

Information on birth mass could provide important health status information for the dam as well as condition of surrounding habitat; however, there is little data available on birth mass of fawns born in the wild (Nelson and Woolf 1985). Few published results exist for birth mass of fawns born to captive, healthy, well-fed does (Mueller and Sadleir 1980). Birth mass of males is related directly to body mass at adult ages (Schultz and Johnson 1995). Birth mass could give baseline data for comparison of animals under varying environmental conditions (Mueller and Sadleir 1980). Additionally, male birth mass could serve as a benchmark for growth, survival, and reproductive success at maturity (Schultz and Johnson 1995). The regional differences I found at birth could provide baseline data for wildlife managers in Mississippi.

My results have raised questions concerning the accuracy of the South Carolina fetal growth scale (Hamilton et al. 1985) for Mississippi deer populations. Discrepancies between predicted fawning dates and actual birth dates are indicative of a problem. Fetal age using this method has been assumed to be correct independent of soil region of fetal origin, gender of the fetus, and litter size. Future research should determine the possible confounding effects of soil region, gender, and litter size. The development of a fetal scale for Mississippi could be a valuable asset for wildlife managers, as there are approximately 30 to 40 health checks done a year in Mississippi in which the fetal scale is used (L. E. Castle, Mississippi Department of Wildlife, Fisheries and Parks, unpublished data). Data from fetal scales are used to estimate mean conception dates and detect changes in breeding and fawning seasons. This information can be used to adjust season structure and an accurate fetal scale is needed to determine any changes that occur.

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APPENDIX A

TABLES OF PHYSICAL CHARACTERISTICS AT BIRTH BY LITTER SIZE AND GENDER SEPARATED BY REGIONS

Table A1. Least square mean physical characteristics at birth by litter size for white-tailed deer born to wild-captured dams from the Lower Coastal Plain (LCP), Thin Loess (Loess) , and Delta soil regions of Mississippi, 2005-2006.

	LCP						Loess						Delta					
	Single			Twins			Single			Twins			Single			Twins		
Variable	*n*	Mean	SE	n	Mean	SE	*n*	Mean	SE	n	Mean	SE	*n*	Mean	SE	n	Mean	SE
Birth																		
Mass (kg)[1]	13	2.4	0.2	34	2.2	0.1	14	2.7	0.2	26	2.6	0.2	17	2.9A	0.2	29	2.2B	0.1
Hind Foot Length (mm)	13	213.2	4.7	34	209.9	3.8	13	226.5	4.5	26	223.2	4.5	16	231.2	4.2	29	216.2	4.0
Total Body Length (mm) [1]	13	591.4	13.1	34	579.4	10.4	14	636.8	12.7	24	619.6	12.2	16	642.3A	11.8	29	598.3B	10.9

[1] Means within soil region with different letters differ (*P* < 0.05).

Table A2. Least square mean physical characteristics at birth by gender for white-tailed deer born to wild-captured dams from the Lower Coastal Plain (LCP), Thin Loess (Loess), and Delta soil regions of Mississippi, 2005-2006.

	LCP						Loess						Delta					
	Male			Female			Male			Female			Male			Female		
Variable	*n*	Mean	SE	n	Mean	SE	*n*	Mean	SE	n	Mean	SE	*n*	Mean	SE	n	Mean	SE
Birth																		
Mass (kg)[1]	20	2.5A	0.1	27	2.1B	0.1	22	2.8	0.1	18	2.5	0.1	24	2.7	0.1	22	2.5	0.1
Hind Foot Length (mm)[1]	20	216.3A	3.8	27	206.8B	3.9	22	226.2	4.2	18	223.5	4.0	24	226.6	3.9	22	220.8	3.5
Total Body Length (mm)	20	594.3	10.8	27	576.5	11.0	20	630.5	11.8	18	625.9	11.4	24	630.1	10.6	21	610.6	10.1

[1] Means within soil region with different letters differ ($P < 0.05$).