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Photos Courtesy of Authors

Nutrition versus Genetics in Whitetail Deer Management: How Far Can Nutrition Take Us?

Interest in whitetail deer management is at an all-time high with hunters having a wide array of goals. Some hunters want more deer while others want higher "quality" deer. Regardless of their specific goals, the one topic that always arises is antlers. Antlers have intrigued hunters since the dawn of time. As early humans drew pictures of them on cave walls, it's no surprise that they are at the center of most of today's management strategies.

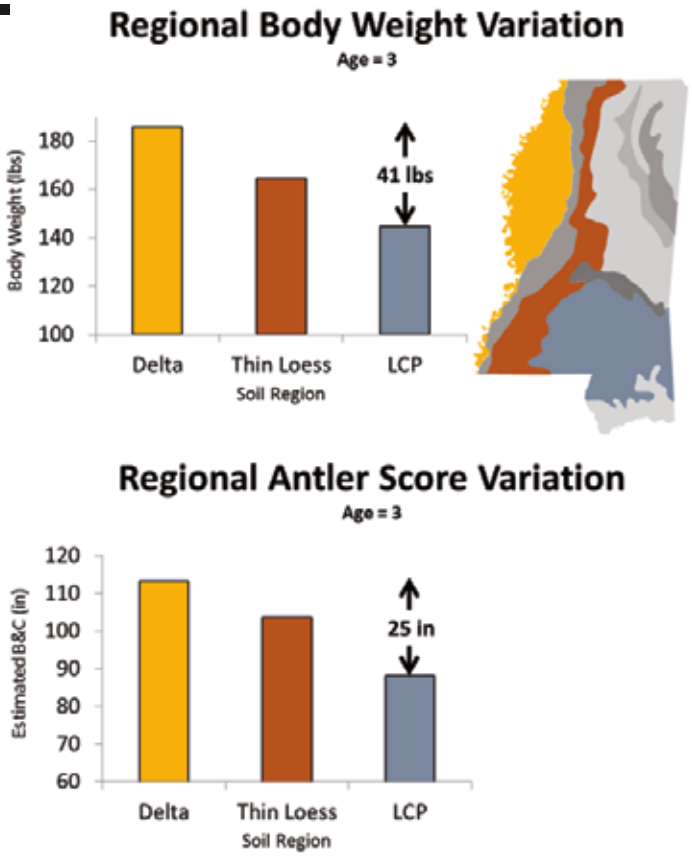
The average antler size at three years of age for a first generation LCP buck was 95 inches. Using this score as a basis for our prediction, first generation LCP bucks would score about 122 inches at six years of age.

There are many tried and true management strategies to increase antler size. For example, maintaining appropriate deer density, practicing active habitat management, and planting supplemental forages will improve nutritional quality for a deer herd. The basis for each of these strategies is maintaining a supportive nutritional carrying capacity that ensures animals fulfill their genetic potential.

Mississippi is similar to many states and provinces in that there is significant regional variation in the size of the deer. The Delta region tends to produce the state's largest bucks, while hunters harvest the smallest deer in the Lower Coastal Plain (LCP) region, and medium-sized deer in the Thin Loess region. The extent of the difference between Delta and LCP regions is remarkable, with Delta bucks averaging 41 pounds heavier and 25 inches larger than LCP bucks at three years of age (**Figure 1**).

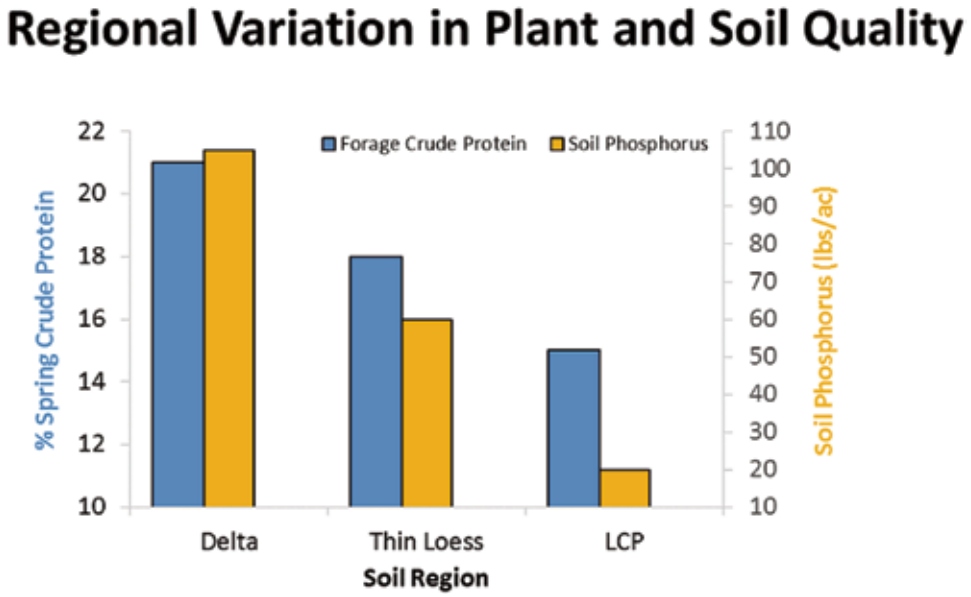
Early taxonomists recognized 15 subspecies of whitetail deer in the United States based primarily on regional morphological variation. The Boone and Crockett Club recognized this variation in 1932 with a separate trophy category for Coues' whitetail of the southwest, and interest has been expressed for further subdivisions. Mississippi is home to two subspecies, the Virginia whitetail found across most of the state, and the Osceola whitetail found in the LCP. Our significant regional differences in antler and body size lend some support to this classification. However, similar patterns of variation suggest nutrition may contribute significantly to regional variation in body and antler size.

Soil quality and land use decisions are known to impact deer growth potential by affecting the quantity and quality of available forages. Soil fertility is a complex concept, but one simple measure is the amount of phosphorus found in the soil. Greater levels of phosphorous stimulate plant growth, and actively growing plant tissue has more nutritional value than non-growing plant parts. Soil and deer forage characteristics vary across the Delta, Thin Loess, and LCP regions (**Figure 2**), with phosphorus levels in Delta soils being about twice those in Thin Loess soils and five times greater than LCP soils. A similar pattern is present in protein content of springtime deer forages, which varies from 20 percent in the Delta down to



ABOVE - FIGURE 1: Body weight and antler size of harvested bucks differ greatly by soil region in Mississippi.

BELOW - FIGURE 2. Soil fertility, as measured by amount of phosphorus, and deer forage crude protein varied with the same regional pattern as buck body weight and antler size.



15 percent in the LCP.

The Delta region is also home to large acreages of production agriculture; in order to maximize crop production, producers often add fertilizer to the soil. Although a nuisance to farmers, deer populations in the Delta benefit from soybeans in the summer and wheat in the winter. In contrast, timber production is the most common land use practice in the LCP region because the acidic, sandy soils coupled with frequent rainfall make for ideal pine growing conditions. However, a consequence of growing timber is limited deer forage production during most of the stand rotation. Forage production is limited because the forest canopy captures most of the sun's energy; little sunlight reaches the understory.

Although we demonstrated that regional differences in body and antler size are related to soil quality and land use, there was concern that smaller antlers in some regions were due to genetic limitations in antler potential. The successful deer restoration effort during the 1940s and 1950s add to the potential genetic confusion. Mississippi wildlife biologists released over 3,000 deer, some from as far away as Wisconsin and Mexico. The MSU Deer Lab has confirmed that some differences in the genetic "signatures" of current Mississippi deer populations appear related to the restocking program, but there is no evidence that Wisconsin or Mexico "genetics" are the cause of the variation in body and antler size of deer throughout the state.

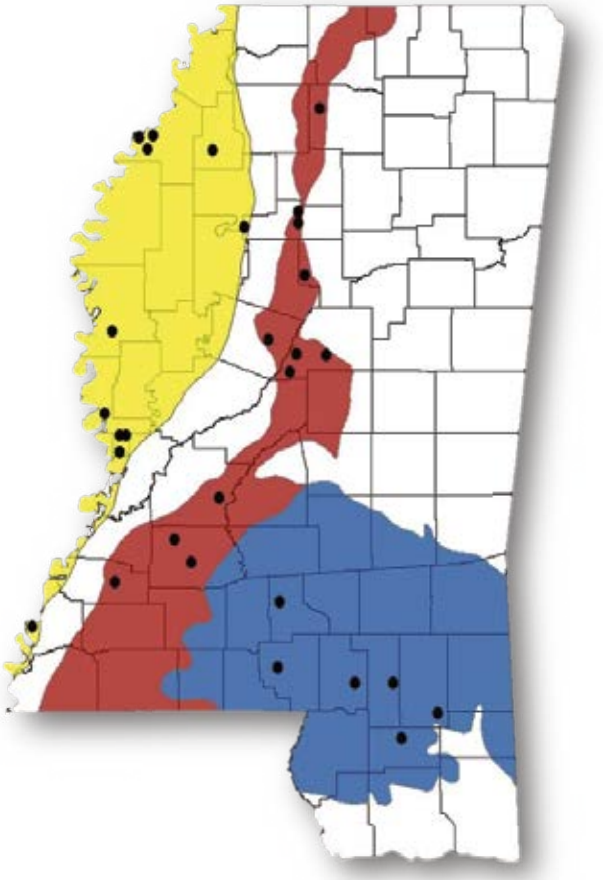
If there are actual genetic limits to body and antler size, then improved nutrition would not allow smaller deer like the Osceola subspecies living in the LCP to compensate and grow as large as Delta deer. The combination of the subspecies designation and the subtle genetic signatures remaining from past restocking efforts dictated that we take a special approach to determine if genetic limitations were involved in the extreme regional variation in body and antler size of deer across Mississippi.

IS IT GENETICS OR NUTRITION; NATURE OR NURTURE?

We needed a controlled study to determine if differences in body and antler size across Mississippi were caused by differences in genetic potential or by factors such as soil quality and land use, which are proxies of nutrition. These sources of environmental variation could be reduced to one simple factor that we could control: nutrition. We needed to obtain deer that represented the genetic variation within each of the three soil regions and raise offspring on an optimum diet.

Mississippi biologists and Deer Lab personnel captured deer from the Delta, Thin Loess, and LCP soil regions of Mississippi (**Figure 3**), and brought them back to the MSU Deer Research Unit. We captured deer from several locations within each soil region to ensure that we included the full range of genetic variation. Keeping deer in captivity allowed us to control their diet as well as their breeding, such that males were only breeding

BELOW - FIGURE 3: Capture locations of deer used in our study, (black dots). Multiple locations within each soil region insured that we adequately sampled the full range of genetic material present in each region's deer population. RIGHT: Keeping deer in captivity allowed us to control their diet as well as their breeding, such that males were only breeding females within their region.



females within their region. If body and antler sizes remained different while all deer ate the same optimum diet, then we could conclude that regional variation is caused by genetic limitations. However, if deer with historically smaller body and antler size catch up to the bigger Delta deer when fed the same diet, we can conclude that nutrition is the ultimate cause of regional variation.

GENERATIONAL RESULTS

Previous research has shown that significant environmental stressors can impact growth and survival of deer for multiple generations, a phenomenon referred to as "maternal effects." So, we planned to raise deer on optimum nutrition through two generations to account for this effect. Fawns produced by wild does but raised on optimum nutrition are first generation deer. Fawns produced by first generation deer are second generation deer.

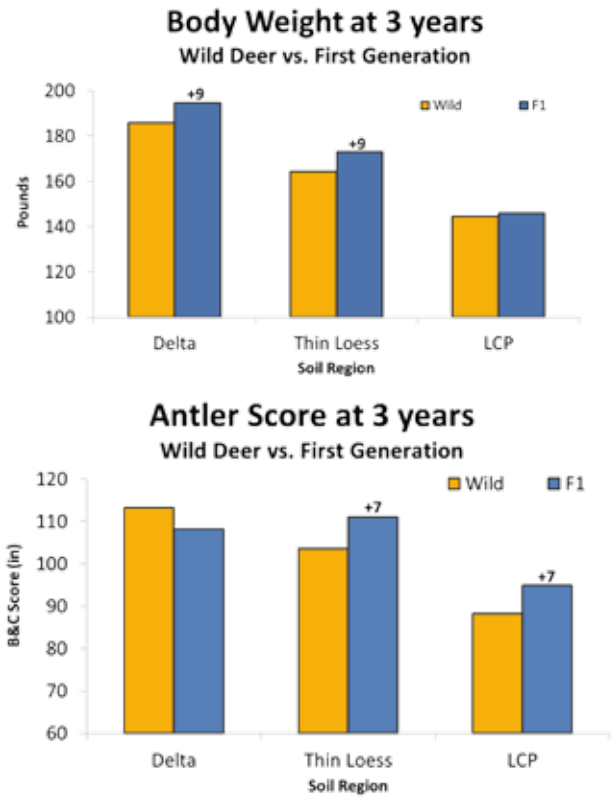
First generation bucks raised on optimum nutrition experienced a moderate increase in growth compared to their wild predecessors (**Figure 4**). Over all three regions, body and antler size increased about six percent, but the pattern was not consistent among regions. Body weight for three-year-old bucks from the Delta and Thin Loess increased by nine pounds while LCP bucks remained essentially unchanged compared to their wild counterparts roaming the nutritionally deprived region of south Mississippi. The pattern differed for antler size as the Delta was essentially unchanged while Thin Loess and LCP bucks grew seven more inches of antler compared to their wild predecessors.

Improvements in body and antler size of the second generation of all three regions were profound! As you can see in **Figure 5**, bucks from the Delta, Thin Loess, and LCP regions increased 32, 21, and 36 pounds, respectively, compared to wild bucks—that's an 18 percent increase! The second generation LCP bucks grew body weights equivalent to wild bucks from the Delta region. Antler size displayed the same trend. Bucks from the Delta, Thin Loess, and LCP regions increased 5, 11, and 28 inches, respectively, compared to their wild counterparts. The 28-inch increase for LCP bucks was an amazing 32 percent increase compared to their wild predecessors!

For logistical reasons, we had to end the study when bucks were three years old, but that's not the end of the results. We're able to predict antler size at maturity based on growth rates from our other studies. The average antler size at three years of age for a first generation LCP buck was 95 inches. Using this score as a basis for our prediction, first generation LCP bucks would score about 122 inches at six years of age. This means that after one generation of improved nutrition, average LCP bucks almost reach the minimum 125-inch requirement to be entered into the Pope and Young record book, and many of the larger animals would surpass it. The average antler score for our second generation bucks was 116 inches. Again, using this score as a basis for our prediction, second generation LCP bucks would score about 147 inches on average at six years of age!

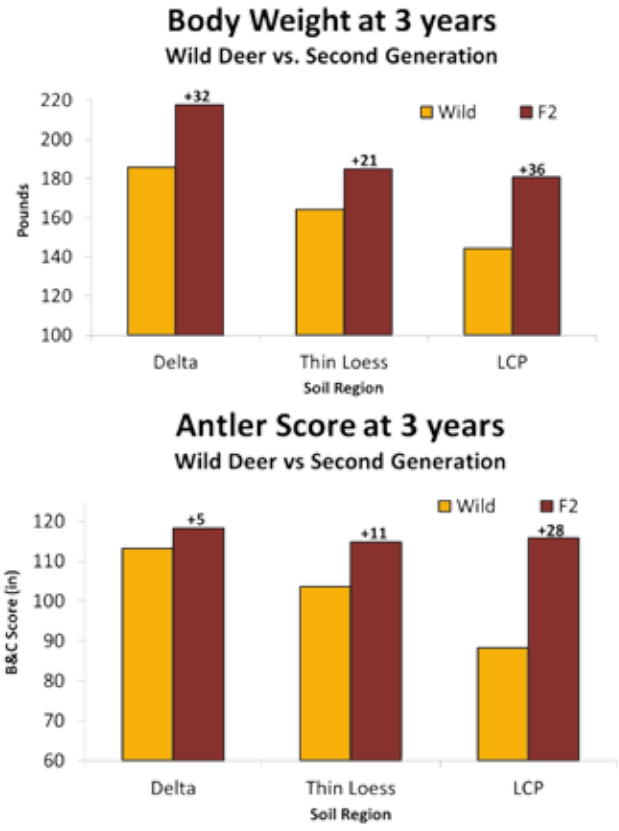
NUTRITION AND TIME ARE KEY

We documented some amazing results. First and foremost, ***you are what you eat—and also what your mother and grandmother ate too***! Our results clearly show that smaller deer in the LCP region of Mississippi that are



ABOVE - FIGURE 4: First generation bucks with genetics representative of three soil regions and raised on high-quality nutrition grew bodies and antlers about 6% larger than bucks harvested from the wild.

BELOW - FIGURE 5: Second generation bucks (F2) with genetics representative of three soil regions and raised on high-quality nutrition grew bodies and antlers about 20% larger than bucks harvested from the wild.



similar to the Osceola whitetail deer are not genetically doomed to have smaller bodies and antlers; they are simply a product of their environment. Once nutrition was improved, LCP bucks displayed their true genetic potential, but it took time.

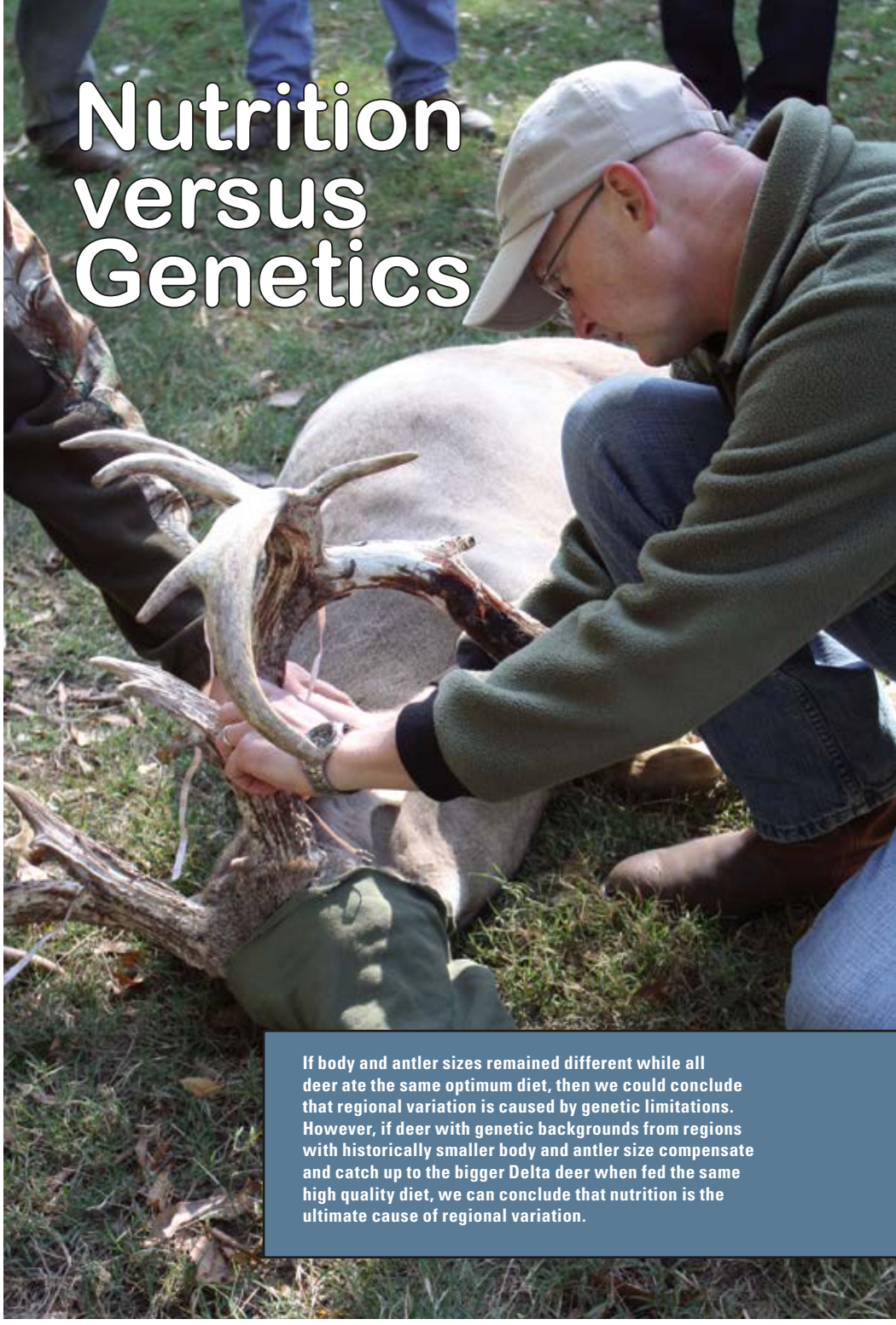
Buck responses took two generations to compensate because the nutritional improvements had to overcome long-standing morphological adjustments to previous habitats that were mediated by their mothers, or what's called "maternal effects." Simply put, maternal effects can be thought of as a mother communicating information about the quality of the environment that she is experiencing with her in-utero offspring.

One likely mechanism for expression of maternal effects is a relatively new concept called epigenetics, where gene activity can be switched off and on based on repeated patterns. For example, the first generation bucks were raised on the same optimal diet as the second generation bucks, but their mothers had passed along a signal to their genes that said, "don't grow as big as you can because even though the environment has improved, it's not normal and it may be too risky to grow a large body and antlers." This allows for certain genes that code for growth to remain "switched off," and prevents investment in a larger body and antler size in response to a temporary resource. Thus it keeps animals from growing larger in a particularly good year, only to sustain themselves when forage quality returns to "normal." However, by the second generation, these genetic switches likely were turning on, signaling to genes in offspring that it is now safe to grow larger because the environment my mother experienced has improved and is now the norm.

Maternal effects can also be thought of as the mother "inheriting" her environment. If a mother inherits a high quality environment, she will pass it along to her fawns. The same will occur if she inherits a low-quality environment. There's even research in mice that suggests the males contribute "switching" information via his sperm, so it's not all left up to mom.

A second important result was exhibited by deer with genetics representative of the Delta region. Those study animals came from the region that we considered to be the "Gold Standard" for

Nutrition versus Genetics



If body and antler sizes remained different while all deer ate the same optimum diet, then we could conclude that regional variation is caused by genetic limitations. However, if deer with genetic backgrounds from regions with historically smaller body and antler size compensate and catch up to the bigger Delta deer when fed the same high quality diet, we can conclude that nutrition is the ultimate cause of regional variation.

body and antler growth by whitetail deer in Mississippi. Yet, we observed a 32 pound increase in body weight and a five inch increase in antler score. These results suggest that even deer in the Delta are not attaining their full potential in the wild. Limited resources wouldn't allow us to continue this project beyond two generations.

So we may never know how large Mississippi's whitetails can grow when optimum nutrition is provided for many generations. We promote proper habitat management for free-ranging deer and hope that many generations will be grown on such improved landscapes. But, one thing is for certain, the Mississippi State University Deer Lab will continue to work with wildlife biologists to identify and address research topics of importance to proper management of our wonderful deer resource. ■