



**The Bell Curve of Mature Buck Antler Scores:
When You Manage a Buck Herd, You Manage a Bell Curve of Antler Scores**
By Stuart W. Stedman

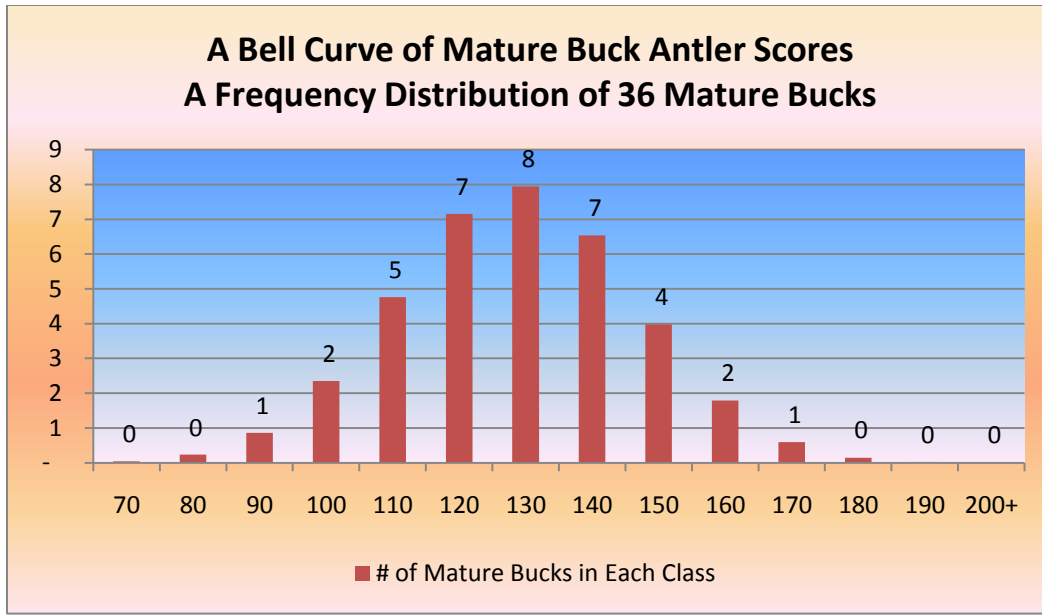
**Part I (of IV Parts):
Bell Curve Basics**

Mature buck antler scores are normally distributed—i.e. when graphed by B&C score class, they follow a bell-shaped curve. The bell curve of mature buck antler scores is a powerful tool of deer management and analysis. Specifically:

1. Antler sizes are a statistical phenomenon.
2. The bell curve predicts the antler sizes of white-tailed deer.
3. The bell curve tells us that most mature buck antlers are average. Specifically, they are clustered around the low 130s (on an unfed ranch in South Texas).
 - a. In average rainfall years on an un hunted ranch, in fact, 68% of the mature bucks score between 115 and 151 and 95% of the mature bucks score between 97 and 169.
4. The bell curve shows that outliers—really poor antlers or really great antlers—are rare.
5. Understanding the bell curve of mature buck antler scores and its implications is fundamental to a clear understanding of white-tailed deer management.
6. When you manage a buck herd, you are managing a bell curve of antler scores.

What is a Bell Curve?

A bell curve is a graph of a variable (in this case, mature buck B&C scores) that is bell-shaped in appearance. A bell curve is also called a *normal distribution*. A typical bell curve looks like this:



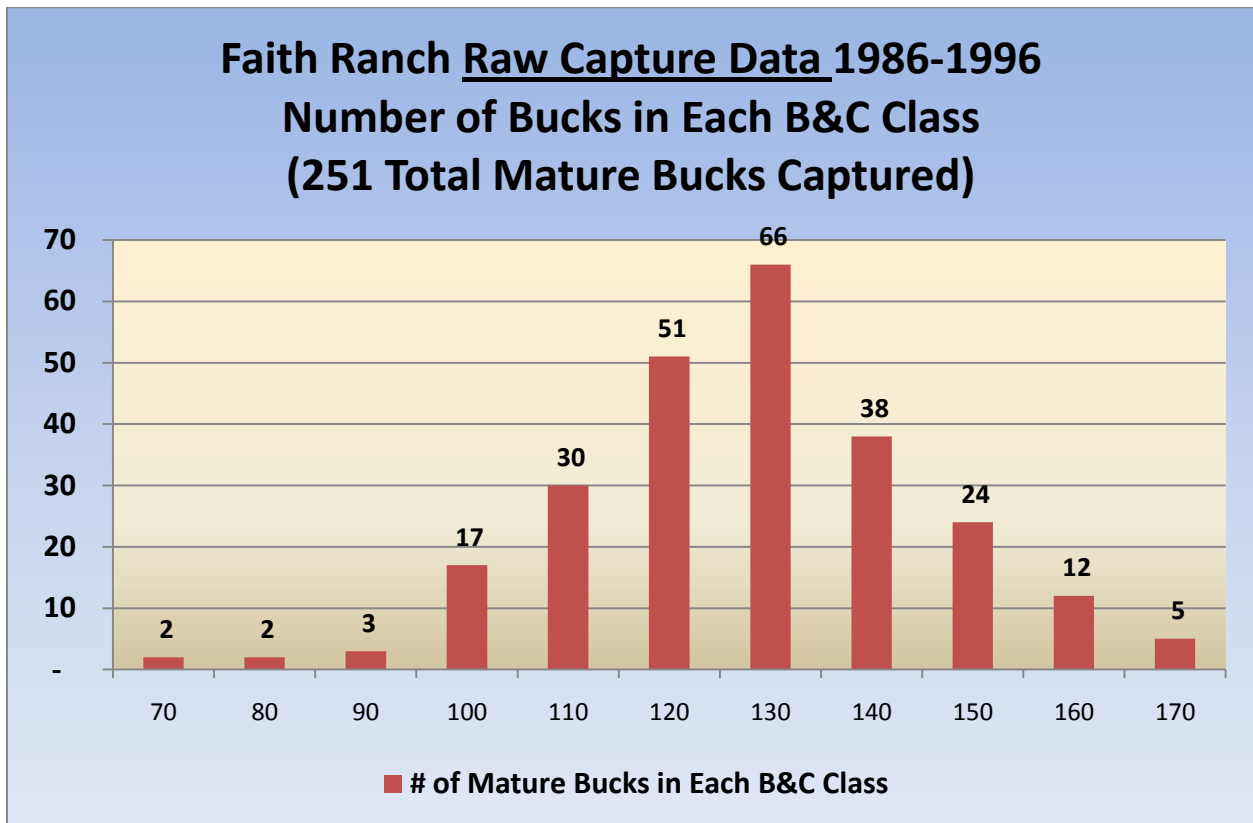
As you can see in this hypothetical deer herd, the x (horizontal)-axis shows the grouping of B&C classes in 10-point increments; the number of bucks in each B&C class is shown on the y (vertical)-axis. In the above graph, there are more 130-class bucks (8) than any other class so that bar is higher; those 130-class bucks are the average bucks in the population. And note there are few really bad (less than 100 B&C) and really good (greater than 160 B&C) bucks. Those are the outliers in this buck herd.

(Why 36 mature bucks in the above graph? Throughout this bell curve series I base the numbers on what I call the 5,000 acre "Illustrative Ranch" to make the numbers consistent as I evaluate the impact of management actions or nutritional changes on the bell curve of mature buck antler scores. The Illustrative Ranch begins (before management practices or supplemental feeding) as an un hunted, unfed 5,000 acre ranch with a density of 25 acres per adult deer (a helicopter census; actual numbers will be greater). Based on the early, un hunted Faith Ranch data, 41% of the buck herd will be 5 ½ years or older and the doe:buck ratio will be 1.25. 36 mature bucks is what you should expect on an un hunted, unfed 5,000 acre ranch with a density of 25 acres per adult deer. For those of you who want to see the math: $5,000 \text{ acres} / 25 \text{ acres per Adult Deer} = 200 \text{ Adult Deer} / (1.25 \text{ does to bucks} + 1) = 89 \text{ bucks} * 41\% \text{ mature} = 36 \text{ mature bucks.}$)

My Long Relationship with the Bell Curve

In 1986, Professor Charlie DeYoung organized a random capture of bucks at the Faith Ranch as part of a long term research study that lasted 11 years. Charlie instructed the pilot to bring in the first buck he saw regardless of age or antler size. The results changed my view of deer management forever. For the first time I understood what a buck herd looked like—both antler size and age—because the random capture was unbiased by hunter selection. Significantly, Faith Ranch was essentially an un hunted ranch at the time, so the Faith Ranch data set describes what a South Texas mature buck herd looks like absent harvest and absent supplemental feed. The Faith Ranch dataset is a South Texas baseline of antler sizes.

Lo and Behold! When I analyzed the Faith Ranch random capture data, I saw that the mature buck antler scores were distributed in a bell-shaped curve. The following graph shows the **actual** number of mature bucks in each antler class captured during those 11 years.

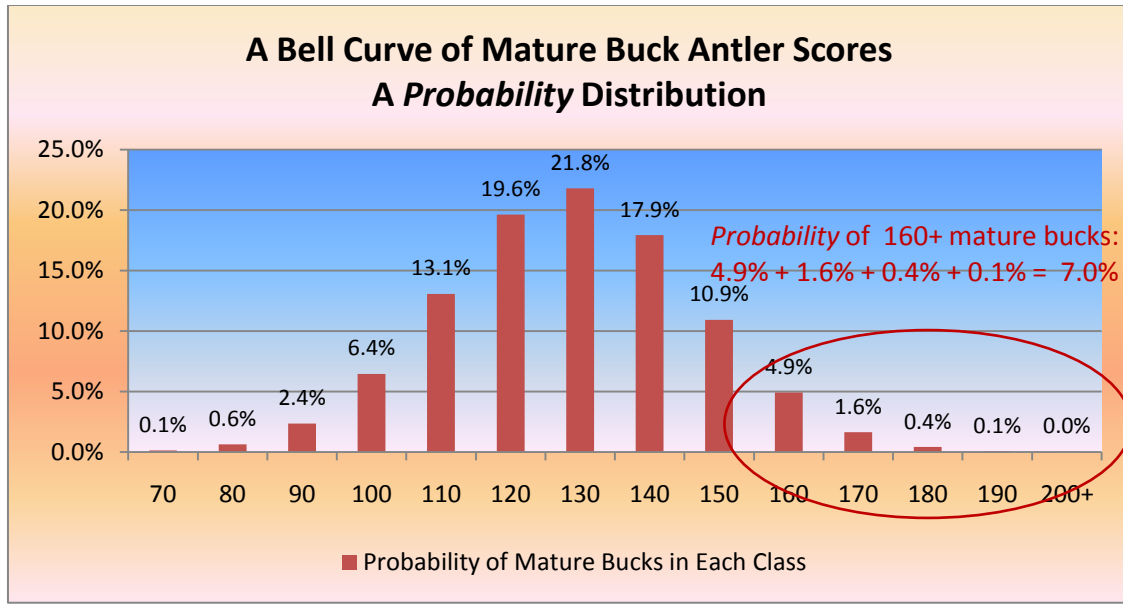


NO DOUBT: MATURE BUCK ANTLERS ARE DISTRIBUTED IN A BELL CURVE. I introduced the bell curve of mature buck antler scores in December 1993 in an article I wrote for the *Journal of the Texas Trophy Hunters*. And I have been talking about it ever since. I believe that understanding the bell curve is fundamental to thinking clearly about white-tailed deer management.

Bell Curve Basics: Probability and Frequency Distributions

I need to explain some basics about the bell curve or the *normal distribution*. These concepts will be important in later discussions of how to understand and use the bell curve. Please bear with me while I present some basic bell curve concepts.

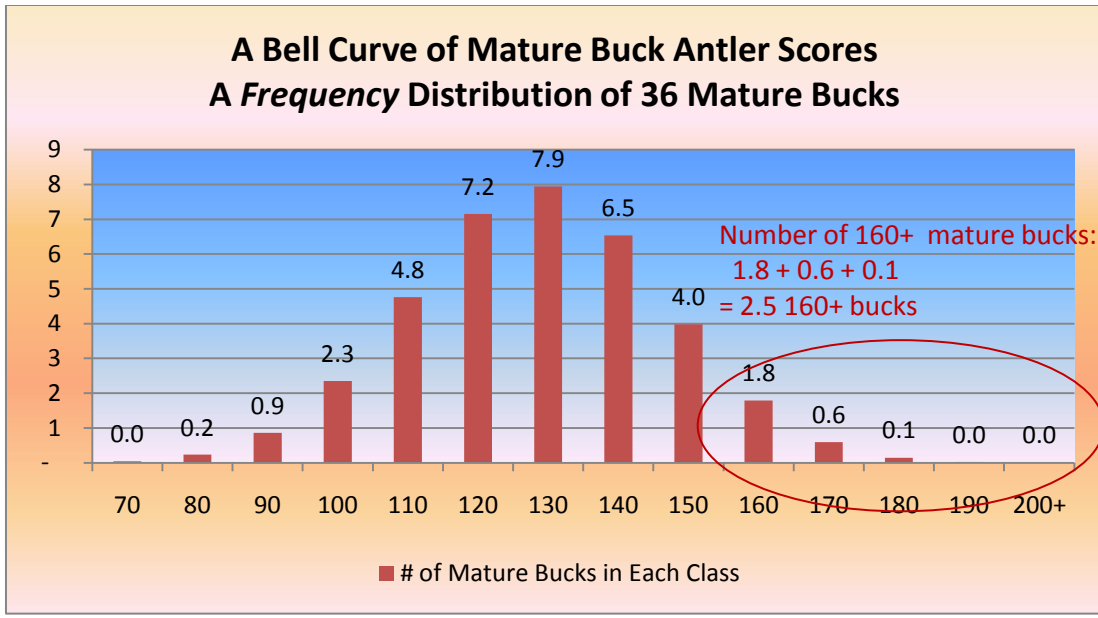
There are two ways to present a bell curve: *probability distribution* and a *frequency distribution*. The difference is solely the units for the y (vertical)-axis. A *probability* distribution shows the *probability* of the presence of mature bucks in each antler class; its y (vertical)-axis is expressed in percentages as in the following graph:



I am sure each of you has asked, “How many 160+ bucks are on my ranch?” The *probability distribution* above provides the prediction: if you know how many mature bucks you have, multiply the number of mature bucks in your herd by 7% (the estimate predicted in the *probability distribution* above) to estimate the number of 160+ bucks you will have. If a manager for example estimates that he has 36 mature bucks, he will likely have 2.5-160+ bucks (36 mature bucks * 7% probability of 160+ bucks).

How on earth can a deer herd have 2.5-160+ bucks? It cannot. But I use a decimal throughout this series to show the number of bucks in each class even though it is impossible to have 2.5-160+ class bucks. The decimals are not only necessary for the numbers to make sense, but they are a reminder that a bell curve describes statistical instead of an absolute concept.

A *frequency distribution*, on the other hand, depicts estimated numbers of bucks in each class as opposed to the probability of bucks in each class. The following graph is a *frequency distribution* and it shows the number of mature bucks in each antler class in a 36-buck herd:

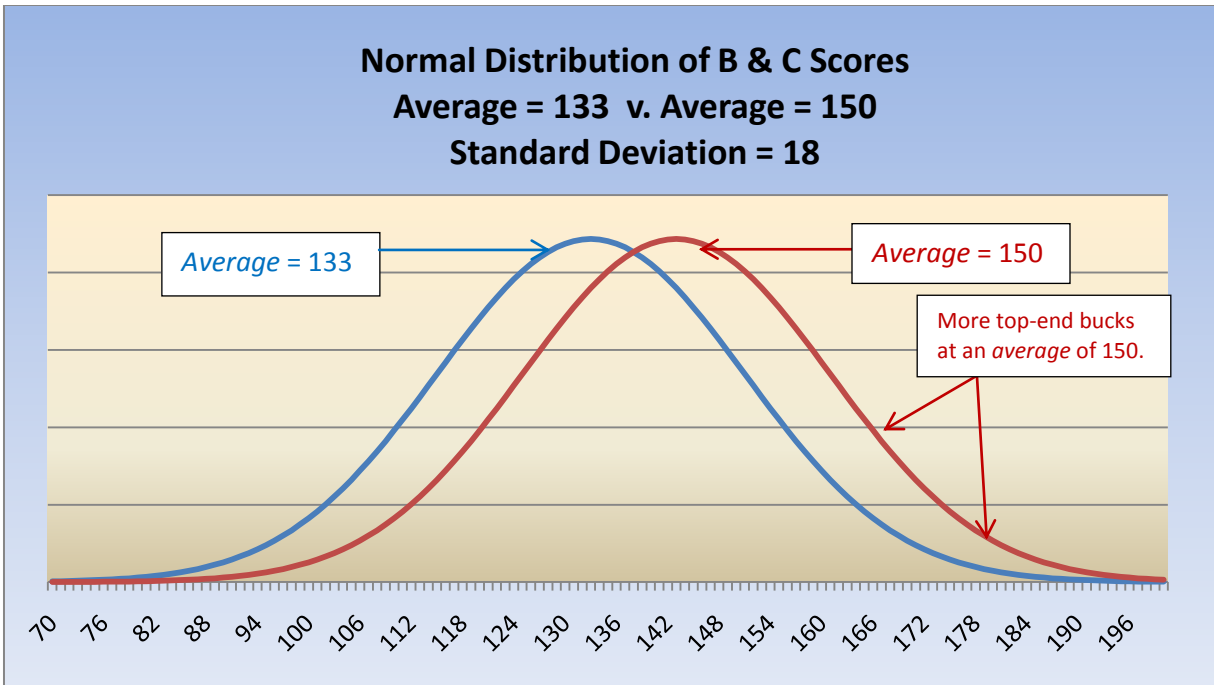


I derived the above *frequency distribution* from the preceding *probability distribution* by simply applying the probabilities of each buck class to the estimated number of mature bucks in the herd of 36 mature bucks. In Part II of this series I will show you how to create a frequency distribution of antler sizes of mature bucks in your own herd.

Bell Curve Basics: Average and Standard Deviation (Variation)

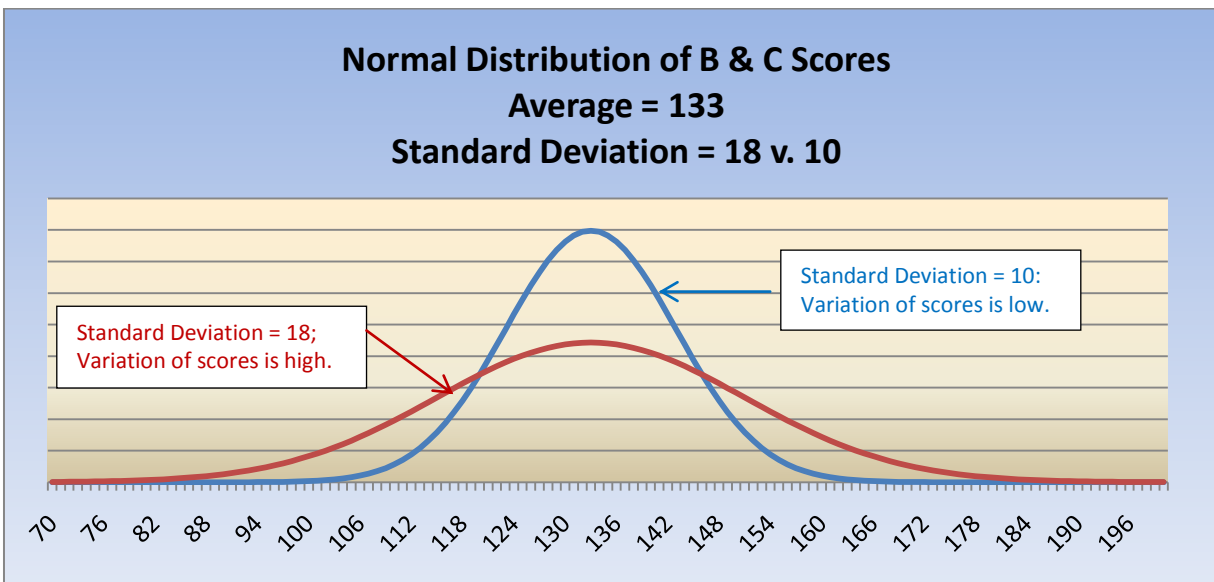
Two primary values define a bell curve: 1) the *average* (or *mean*) and 2) variation (i.e., *standard deviation*). The *average* is an arithmetical *mean* of the B&C scores of all bucks depicted in a graph. The *average* locates the bell curve along the x-axis. A higher *average* shifts a bell curve to the right; a lower *average* shifts the bell curve to the left. (As I explore in Part II of this series: great spring rains shift the bell curve to the right; drought shifts the bell curve to the left.)

The following graph shows the impact of increasing the *average* B&C score from 133 to 150 (which a manager can feasibly do by making supplemental feed available to his herd):



Again, the *average* locates the bell curve along the horizontal axis.

The *standard deviation*, on the other hand, defines the shape of the bell curve (broad or narrow) and is a measure of the variation of individuals depicted in a bell curve. A high *standard deviation* (more variation among individuals) produces a bell curve that is shallow and broad; a low *standard deviation* (less variation among individuals) produces a bell curve that is tall and narrow.



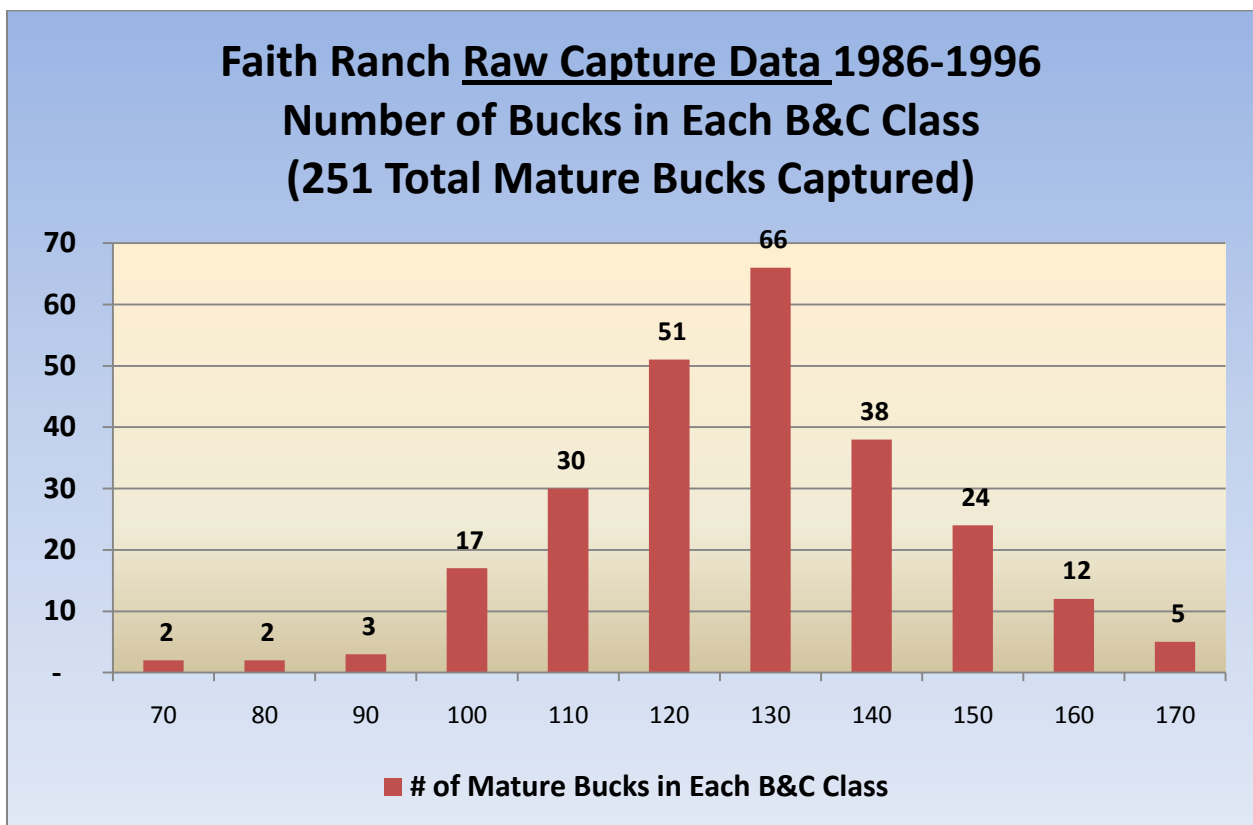
Because few randomly collected mature buck antler data sets exist, changes in *standard deviation* among deer herds is unknown and somewhat theoretical. I suspect that *standard deviation* will increase

as averages increase because of greater nutrition but this is an area that demands further research and an examination of other datasets (including datasets of captive herds).

In sum, the *average* locates the bell curve along the x (horizontal)-axis; the *standard deviation* defines its shape (and the variation around the *average*).

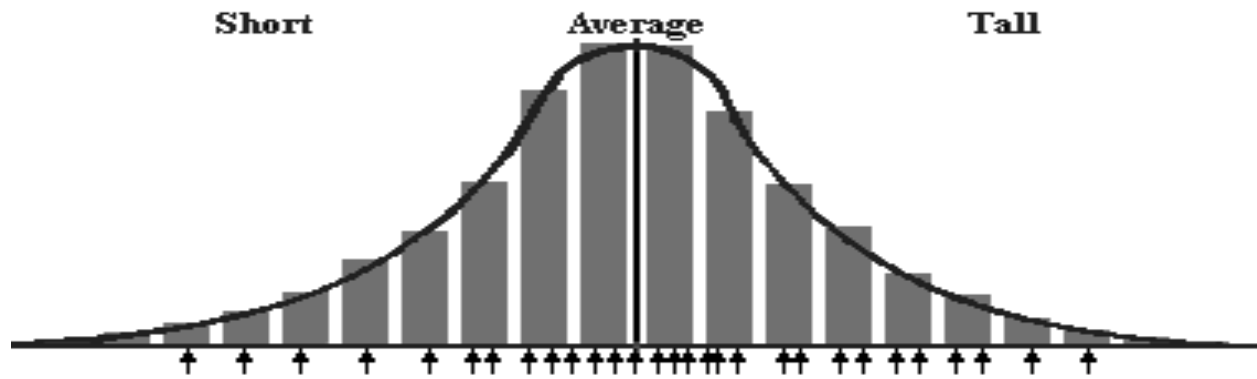
The Bell Curve: A Reminder Why It is Critical to Deer Management

Now before you delete this email because your eyes have glazed over, remember that antler size is absolutely, positively distributed in the shape of a bell curve. When you manage a buck herd, you are managing a bell curve of mature buck antler scores. It's just that simple. As a reminder of the importance of the bell curve, I show again the actual Faith Ranch random capture data in the graph below:



Averages and Outliers: Why Nature Produces Both

Most continuous, measurable traits in nature are distributed normally—or in a bell-shaped curve. Human height, human IQ, fat production in cattle, crop yields, number of leaves in trees, the pitch of a human's voice are all examples of continuous, measurable traits in nature that tend to be distributed normally. Below is a distribution of the height of American men—a classic bell curve.



The distribution of the height of American men

Graph:														
Height	5'3"	5'4"	5'5"	5'6"	5'7"	5'8"	5'9"	5'10"	5'11"	6'	6'1"	6'2"	6'3"	6'4"
Count	1	3	4	6	7	12	17	17	12	7	6	4	3	1

Most American men are 5'9" to 5'10"; those are average heights. The very few extremely tall or extremely short are the outliers. As I have shown, antler scores of bucks follow a similar pattern.

Why are such traits as antler size and human height distributed in a bell-shaped curve? Simple:

1. The averages represent the traits in a population that are the most successful in the current environment. Most individuals are average.
2. Outliers are few because outlying traits create disadvantages to an individual. Small antlered mature bucks or small humans might have difficulty competing for mates (perhaps not true for humans now but most likely true 10,000 years ago). Although large-antlered bucks or tall humans might create advantages for those individuals, great energy (mostly nutrition) is required to produce those big traits. The energy required can become a disadvantage that negatively affects survival in certain conditions.
3. The presence of outliers is vital to a population's ability to survive environmental changes. In times of great nutritional stress, for instance, smaller antlered bucks or shorter humans would have probably had great advantages over larger individuals that consumed more nutrients to produce those large characteristics. Conversely, in times of nutritional bounty larger antlered bucks or taller humans might have greater breeding success.
4. In sum, the bell curve is Nature's way of rewarding the most successful members of a population—the averages—while creating the diversity required to handle environmental changes.

Outliers: Implications

The predominance of average individuals is a powerful force in nature. Nature tends to punish extreme outliers. With respect to deer, fighting the bell curve—and Nature's continual efforts to reward the averages—is very difficult to do. Yet deer managers want more trophies, and they particularly want to produce extremely large-antlered whitetails—or outliers. But the quest for outliers runs up against a powerful tenet in nature: "Nature abhors outliers as much as she does a vacuum."

Although nature tends to punish large outliers by creating nutritional demands on those individuals that are difficult to satisfy, super-extreme outliers have another problem: a potential lack of *fitness* for their

environment. Take the basketball player Yao Ming, a 7' 5" giant. The following table shows what a super-extreme outlier Yao Ming is and how far on the right tail of the bell curve Yao is:



Some very famous very tall guys		
	Players	US population this tall
3σ	Michael Jordan 6'6", Kobe Bryant 6'7"	130,000
4σ	Larry Bird 6'9", Karl Malone 6'9"	3,200
5σ	Shaquille O'Neal 7'1", Wilt Chamberlain 7'1", Kareem Abdul-Jabbar 7'2"	28
6σ	Yao Ming 7'5"	2 in the world

Although Yao's height gave him incredible advantages on the basketball court, it created a *fitness* problem for him: his feet could not support his frame. After a number of injuries to his feet, Yao retired from basketball.

Outliers: Breeder Bucks and Fitness

The following slide shows two extreme outliers at the Faith Ranch: a 50 point deformed buck and the 236 I shot in 1990. These images provide a visual to describe outliers on the bell curve of antler scores.

OUTLIERS



50 or so B&C



236 B&C

The two Faith Ranch bucks in the slide above are certainly extreme outliers, but they possessed *fitness* that allowed them to survive until maturity. But I do wonder (though I do not know) whether the bucks in the following slide could compete for does or even survive outside of a deer breeding pen:



My suspicion is that a majority of bucks in the above photos could not in fact survive or compete for mates in a wild deer herd. I do not know that, but I think I'm looking at something akin to Yao and his feet: a *fitness* problem.

But what about the offspring of such bucks that are released into the wild as fawns. Can they survive and compete for mates? Will their antlers look similarly to their sires at maturity or will the stress of the wild reduce antler size? Research is needed to see what happens to the offspring of these extreme outliers. This area is one of the great unknown areas in white-tailed deer management today. And it is relevant because a number of deer managers are adding deer from deer breeders to their herds in wild pastures of South Texas.

Summary of Part I

Mature buck antlers are distributed in a bell curve. The *average* locates the bell curve along the horizontal axis; the *standard deviation* (a measure of variation) defines its shape. A solid understanding of the bell curve is important because a deer manager essentially manages a bell curve of antler scores when he manages bucks. That antlers are distributed in a bell curve makes sense because it's Nature's way of rewarding the most successful individuals in a population—the averages—while maintaining a few non-average individuals that can thrive if the environment changes. Finally, even though the goal of

most deer managers is to produce large-antlered outliers, outliers are statistically rare and extreme outliers risk lack of *fitness* in an environment.

Part II of this Bell Curve Series will describe how a manager can use the bell curve to better understand the management of the white-tailed deer.