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News from the Deer Research Program at the Caesar Kleberg Wildlife Research Institute

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

Summary of Part I: Bell Curve Basics

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 good understanding of the bell curve is important because a deer manager essentially manages a bell curve of antler scores when he manages bucks. The bell curve of mature antler scores is 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—Chapter A (of IV Parts): The Bell Curve as a Management Tool

I believe that all deer managers should ask the following question about any management practice: how will that action affect the bell curve of mature buck antler scores? Not only will bell curve thinking help a manager better understand deer management, but it will also force a manager to *think statistically* about his deer herd. This article explores the many ways a manager can use a bell curve to better understand deer management.

The Two Basic Bell Curve Effects: 1) Shifts (Left and Right) and 2) Size (Number of Mature Bucks)

The two most basic bell curve changes that a deer manager must understand are 1) ***shifts along the horizontal axis*** (primarily as a result of nutritional changes) and 2) ***changes in the size of the bell curve*** as a result of changes in the number of mature bucks (primarily as a result of more *buck fawns on the ground* in earlier years). I will explore those two basic concepts in greater detail.

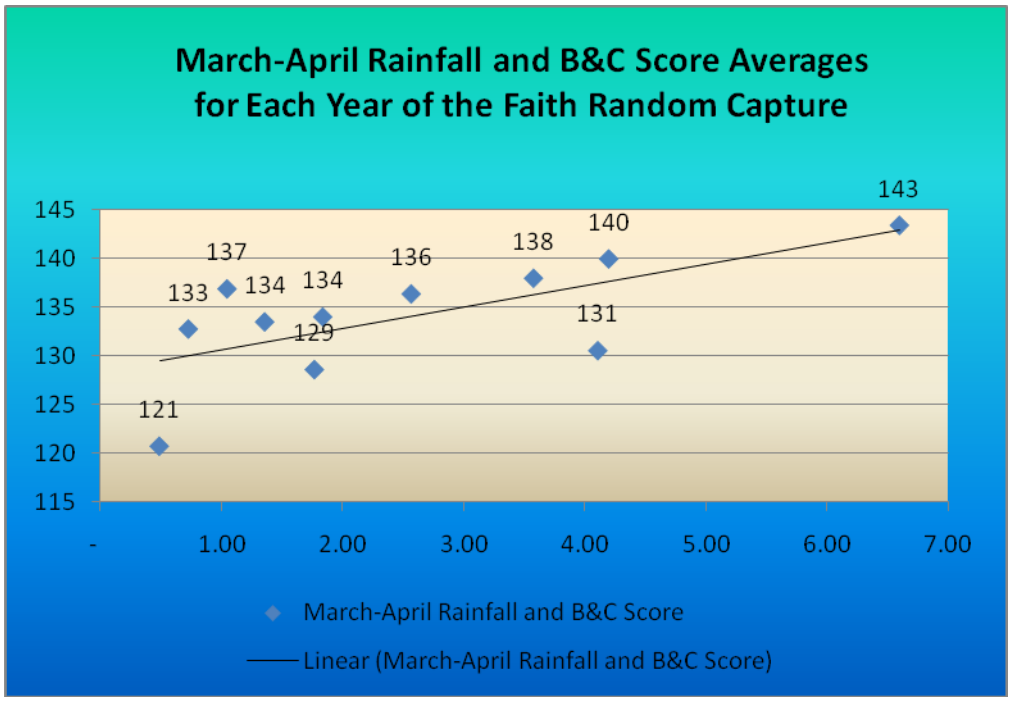
Bell Curve Shifts (Left and Right) As a Result of Nutritional Changes

In 1990, I shot a 236 Gross B&C buck. At the time Faith Ranch was low-fenced and unfed. Here's a photo of my 236:

December 21, 1990
236 3/8 Gross B&C

Naturally, I wanted to produce (and shoot!) another buck like that, so I started looking hard at the Faith Ranch random capture data for an explanation. As I mentioned in Part I of this series, my first look at the data revealed that mature buck antler scores were distributed in a bell curve. Once I saw the bell curve—with *averages* in the low 130's—I realized that I had lucked into an extreme outlier in 1990.

But as I bored into the data more closely, I realized something else: the *averages* of the randomly captured mature bucks shifted from year to year in response to rainfall conditions in March and April. In fact, the Faith Ranch average mature buck B&C score shifted from an *average* of 133, to a low of 121, to a high of 143. The following chart is a scatterplot that shows the relationship between March-April rainfall and mature buck B&C score (R-squared = 0.45).

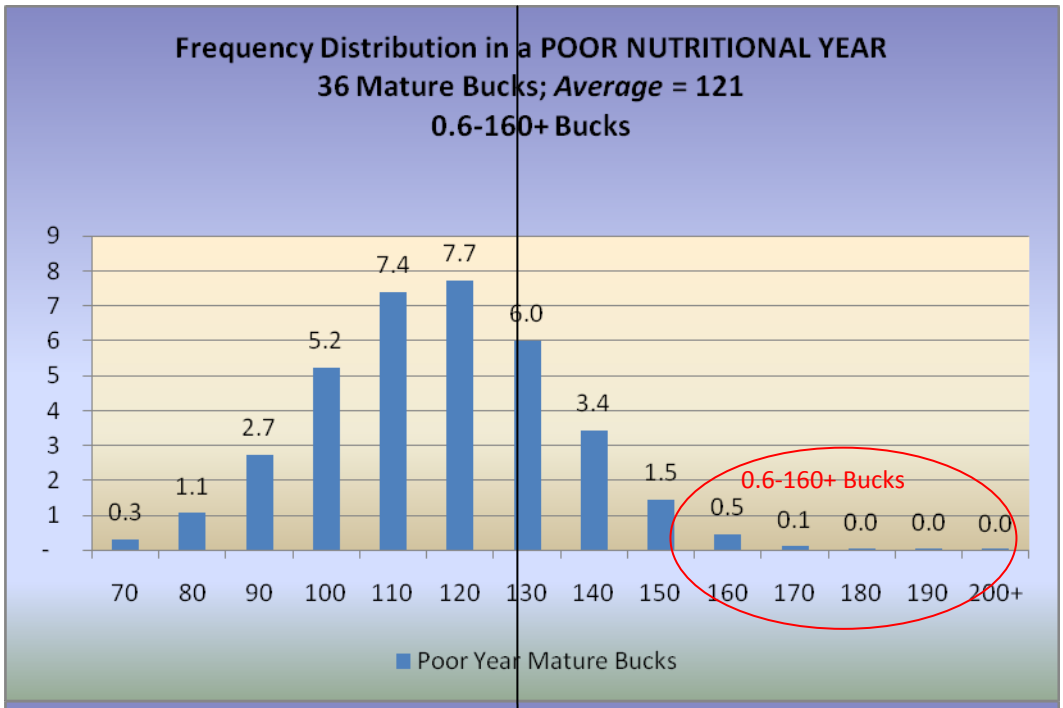


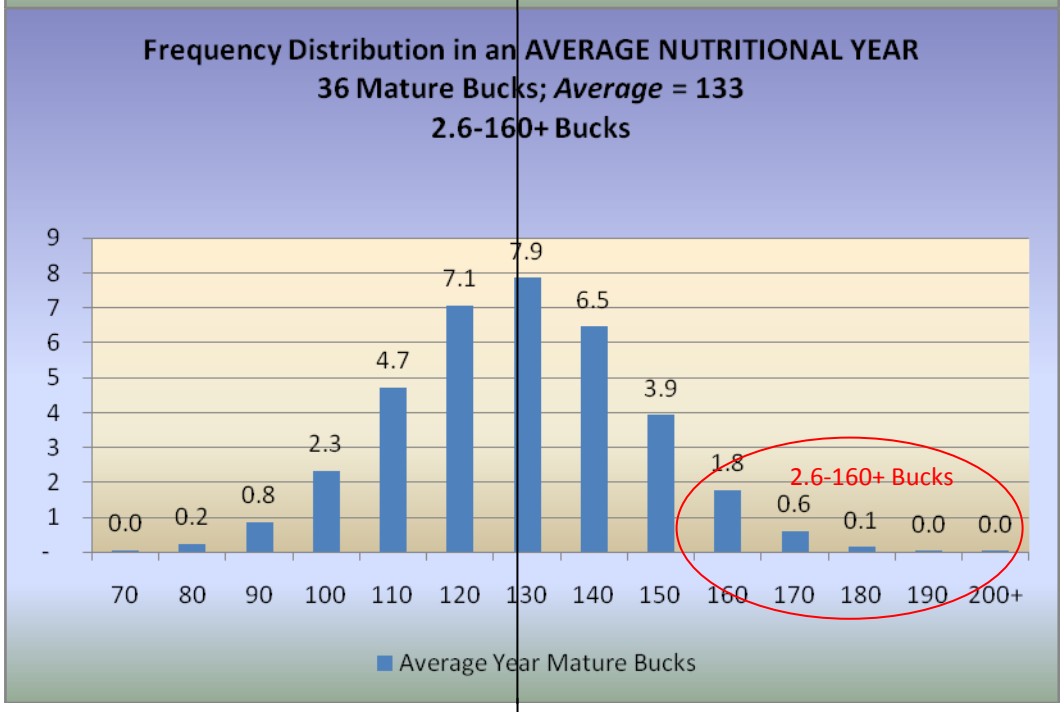
The Impact of Shifts in Averages as a Result of Nutrition

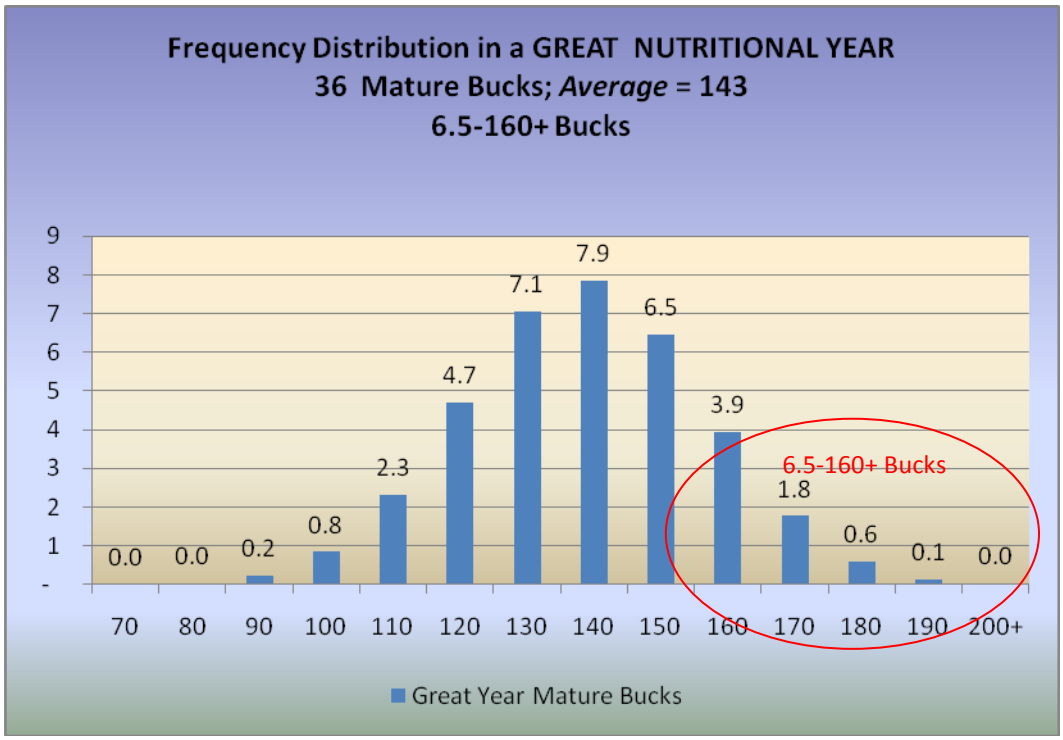
These changes in B&C score *averages* as a result of rainfall are dramatic: from a low of 121 to a high of 143. These *averages* have a significant impact on the position of the bell curve of mature buck B&C scores along the horizontal axis and a HUGE impact of the probability of producing large-antlered bucks. The following three graphs show the impact of March-April rainfall on the position of the bell curve on the horizontal axis. I added a vertical line through the 130 class bar to show the dramatic nature of the bell curve shifts. Each graph below assumes a mature buck herd of 36 bucks in these frequency distributions.

(Why 36 mature bucks? 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 unhunted, 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, unhunted 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 unhunted, 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 acres/ 25 acres per Adult Deer = 200 Adult Deer/ (1.25 does to bucks + 1) = 89 bucks * 41% mature = 36 mature bucks.)

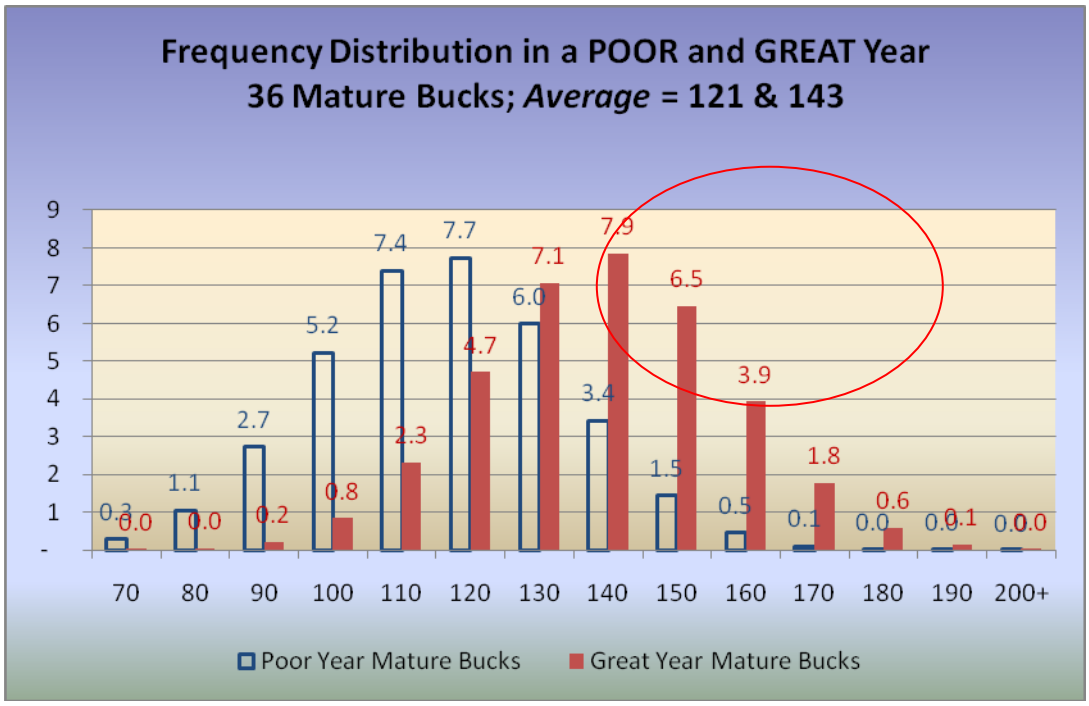
Below are the graphs that show the right-left shifts in the bell curve in response to spring rainfall. Note that I use a decimal to show the number of bucks in each class even though it is impossible to have, say, 7.7-120 class bucks. The decimals are not only necessary for the numbers to make sense, but they are a reminder that a bell curve describes a statistical instead of an absolute concept.


Frequency Distribution in a POOR NUTRITIONAL YEAR
36 Mature Bucks; *Average* = 121
0.6-160+ Bucks
9
8
7
6
5
4
3
2
1
-
0.3
1.1
2.7
5.2
7.4
7.7
6.0
3.4
1.5
0.5
0.1
0.0
0.0
0.0
0.6-160+ Bucks
70
80
90
100
110
120
130
140
150
160
170
180
190
200+
Poor Year Mature Bucks


Frequency Distribution in an AVERAGE NUTRITIONAL YEAR
36 Mature Bucks; *Average* = 133
2.6-160+ Bucks
9
8
7
6
5
4
3
2
1
-
0.0
0.2
0.8
2.3
4.7
7.1
7.9
6.5
3.9
1.8
0.6
0.1
0.0
0.0
2.6-160+ Bucks
70
80
90
100
110
120
130
140
150
160
170
180
190
200+
Average Year Mature Bucks



The impact of these nutritional bell curve shifts is HUGE! A poor year would produce 0.6-160+ bucks on a 5,000 acre ranch; an average year would produce 2.6-160+ bucks; and a great nutritional year would probably have 6.5-160+ bucks on 5,000 acres. The following *frequency distribution* compares the bell curves of a poor nutritional year with a great one on the same graph:



Nutritional shifts in the bell curve of mature buck antler scores are an important concept to understand. A manager cannot do anything about spring rainfall, but a manager can make supplemental feed available to his deer herd. SUPPLEMENTAL FEEDING, IF DONE DILIGENTLY AND FOR A LONG ENOUGH TIME, CAN SHIFT THE BELL CURVE TO THE RIGHT. This bell curve shift to the right as a result of supplemental feed is one of the two powerful benefits of supplemental feeding. Supplemental feeding also increases the number of *buck fawns on the ground*—which will increase the SIZE of the bell curve of mature buck antler scores.

Changes in the Size of the Bell Curve (i.e. changes in the number of mature bucks)

As I explain in part I of this series, a *frequency distribution* of mature buck antler sizes shows the *number* of mature bucks in each particular antler class. *Frequency distributions* demonstrate the second important management principle of bell curve analysis: as you add more mature bucks to a buck herd, the bell curve gets bigger. The bigger the bell curve of mature buck antler scores, the more 160+ bucks you will have. And how do you increase the number of mature bucks? You increase the number of does (your fawn factory) which puts more *buck fawns on the ground*.

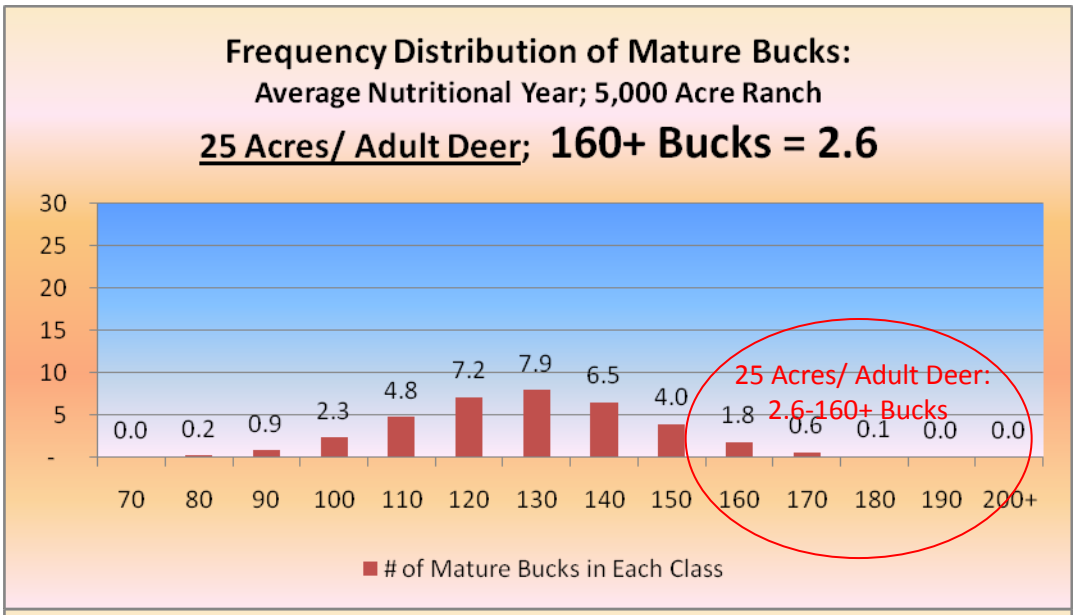
To illustrate the impact of changes in deer density on the number of mature bucks, I assume a 5,000 acre Illustrative Ranch at 3 deer densities: 25, 12.5, and 8.3 acres per adult deer. I assume (based on data from an unhunted Faith Ranch) that 41% of the bucks will be mature (5 ½ years and older) and that no bucks are culled before reaching maturity. The number of mature bucks in each of the 3 deer density scenarios is as follows:

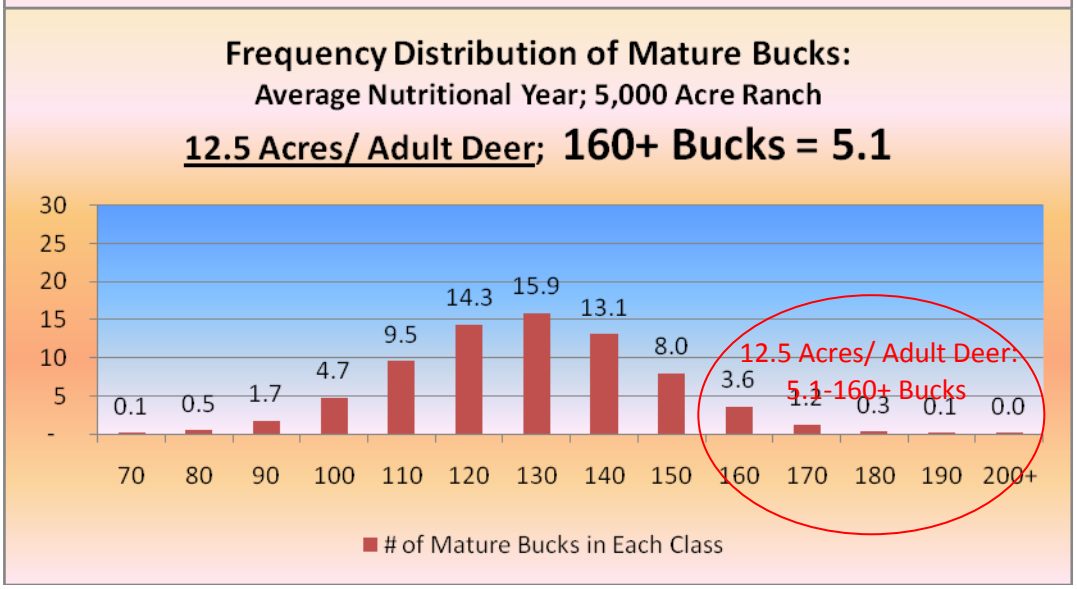
5,000 Acre Illustrative Ranch: Impact of Deer Density on Number of Mature Bucks	
Acres per Adult Deer	Number of Mature Bucks
25.0	36
12.5	73
8.3	109

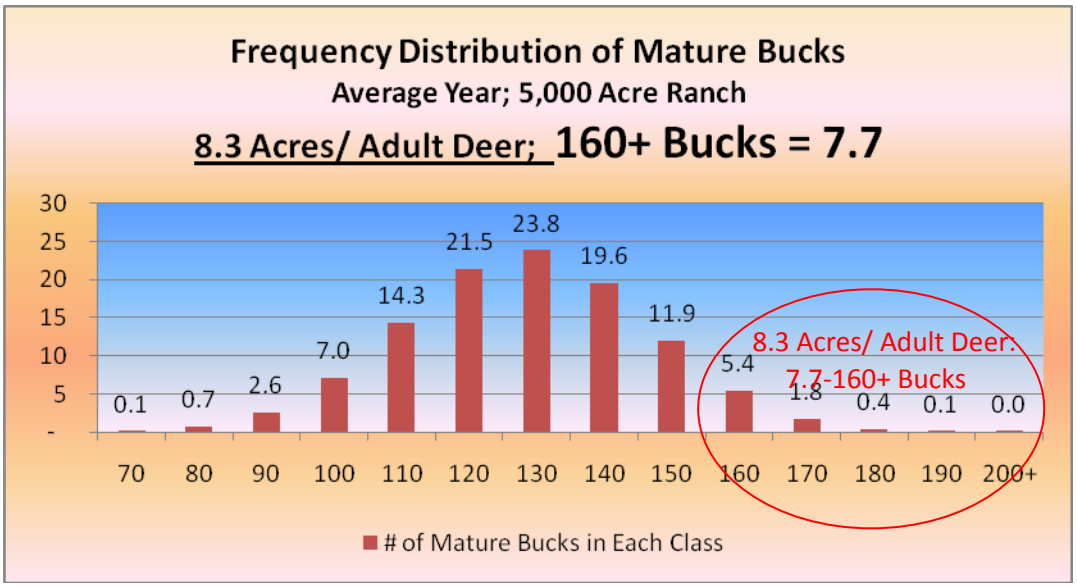
Note that the number of mature bucks doubles from 25 acres/ adult deer to 12.5 acres and triples from 25 acres/ adult to 8.3. This makes sense because 12.5 acres is twice the density of 25.0 and 8.3 acres is 3 times the density of 25.0. The number of 160+ bucks likewise increases proportionally with density. The following table shows the probable number of 160+ bucks:

5,000 Acre Illustrative Ranch: Number of 160+ Bucks at 3 Different Densities			
Acres per Adult Deer	Number of Mature Bucks	Average Year % of 160+ Mature Bucks	Number of 160+ Bucks
25.0	36	7.0%	2.6
12.5	73	7.0%	5.1
8.3	109	7.0%	7.8

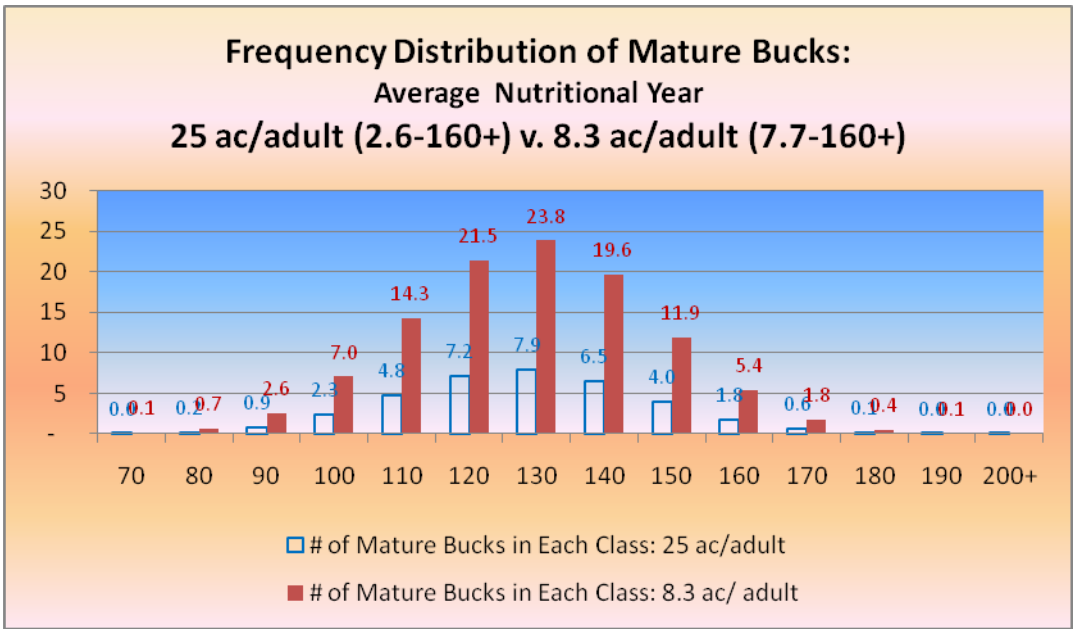
Although the table presents the numerical effect of increasing deer density on 160+ bucks, a bell curve shows this impact in dramatic fashion:


Frequency Distribution of Mature Bucks:
Average Nutritional Year; 5,000 Acre Ranch
25 Acres/ Adult Deer; 160+ Bucks = 2.6
30
25
20
15
10
5
-
0.0
0.2
0.9
2.3
4.8
7.2
7.9
6.5
4.0
1.8
0.6
0.1
0.0
0.0
70
80
90
100
110
120
130
140
150
160
170
180
190
200+
25 Acres/ Adult Deer:
2.6-160+ Bucks
# of Mature Bucks in Each Class


Frequency Distribution of Mature Bucks:
Average Nutritional Year; 5,000 Acre Ranch
12.5 Acres/ Adult Deer; 160+ Bucks = 5.1
30
25
20
15
10
5
-
0.1
0.5
1.7
4.7
9.5
14.3
15.9
13.1
8.0
3.6
1.2
0.3
0.1
0.0
70
80
90
100
110
120
130
140
150
160
170
180
190
200+
12.5 Acres/ Adult Deer:
5.1-160+ Bucks
# of Mature Bucks in Each Class



The bottom line is simple: by increasing the number of mature bucks, the bell curve gets bigger. The number of 160+ bucks doubles from 25 acres/ adult to 12.5 acres and triples the number from 25 acres/ adult to 8.3 acres. The bell curve allows a manager to visualize that change. The following graph, for instance, combines the Low Density and High Density bell curves:



I realize I have presented lots of numbers and lots of graphs. But think about the hunting experience on a 5,000 acre ranch or lease in an average nutritional year. An unfed 5,000 acre ranch with a typical density of 1 adult deer per 25 acres would produce 2.6-160+ bucks in an average year. With supplemental feeding and time to allow consistent fawn crops to become mature, that same 5,000 acre ranch could produce 7.7-160+ bucks in an average year. The hunting experience on each would be night and day. Size matters.

The effect of increased density on the number of 160+ bucks is simple, mathematical, and dramatic. But is there a limit on the number of deer a South Texas ranch could support? If not 1 adult deer per 8.3 acres, why not 1 to 4.2 acres? Or 1 to 2.1 acres? A couple of comments. First, the only way a manager can achieve a density of 8.3 acres per adult deer is through intense supplemental feeding; the vagaries of South Texas rainfall will not allow a herd to grow that large without supplemental feed. Second, I am not sure researchers have defined the limits of deer density on supplemental feed. I know there is a limit, and I know there is a "density sweet spot" (Dan Friedkin's wonderful metaphor) that will maximize antler size. Not too hot, not too cold. But I also know that the power of numbers (i.e. larger bell curves) in producing trophy bucks is dramatic and compelling. The density issue is complex and well beyond the scope of this bell curve series. I do know a limit exists. But with diligent and concentrated supplemental feeding, I am confident that a density of 8.3 acres per adult deer is comfortable and does not come close to going beyond the density sweet spot.