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Doe to Buck Ratios: How important are they?

In the March 2008 issue of *Deer and Deer Hunting*, James Slinsky cited the work of C.W. Severinghaus and stated that the maximum ratio of does to bucks possible in a deer herd is 3:1, even when considering the extreme case that 100% of the does survive and 100% of the antlered bucks are killed during the previous hunting season. The author is certainly correct in stating that the ratio will always come out 3:1 with these assumptions, no matter what the starting ratio is, as long as you assume that all the does are being bred and the fawns are surviving at a rate of 1 per doe. Table 1 shows an example of the application of theses conditions in an Excel spreadsheet. Data are entered into the colored boxes and the algorithm determines the herd dynamics over the next 10 years. Even when the herd starts out with a ratio of 1 buck for every 10 does, the ratio becomes 3:1 after the first year of breeding and remains at that limit. Even though this is true, there are reasonable conditions under which data entered into the same model produce much higher ratios of does to bucks. Below I present 2 scenarios that could lead to skewed ratios in the real world.

Table 1. Algorithm projecting herd dynamics for 10 years. Outcomes are pre-hunt. Button buck survival is determined after fawn survival. In the example below. The button bucks represent 50% of the doe population.

Adult buck survival	0.0%	Adult doe survival	100.0%	Button buck survival	100.0%	Fawn survival/doe	1

Year	Bucks	Does	Buck fawns	Doe fawns	New Deer	Does/bucks	Total deer	Gain or loss of deer from starting herd	Percent of original herd
1	10	100	0	0		10.00	110		100%
2	50	150	50	50	100	3.00	200	90	182%
3	75	225	75	75	150	3.00	300	190	273%
4	113	338	113	113	225	3.00	450	340	409%
5	169	506	169	169	338	3.00	675	565	614%
6	253	759	253	253	506	3.00	1013	903	920%
7	380	1139	380	380	759	3.00	1519	1409	1381%
8	570	1709	570	570	1139	3.00	2278	2168	2071%
9	854	2563	854	854	1709	3.00	3417	3307	3107%
10	**1281**	**3844**	**1281**	**1281**	**2563**	**3.00**	**5126**	**5016**	**4659.80%**

Scenario 1: High fawn mortality. If instead of 1 fawn per doe, only 0.4 fawns per doe survive, there is a dramatic increase in the ratio of does per buck. The ratio then becomes 6 does per buck. Figure 1 shows how fawn recruitment affects the doe to buck ratio. This clearly is a case that could be realistic in certain regions of the country where there is high fawn mortality. Whereas the limit of 3:1 is true in cases where there is high fawn survival, it is not invariably true in cases where there is high fawn mortality.

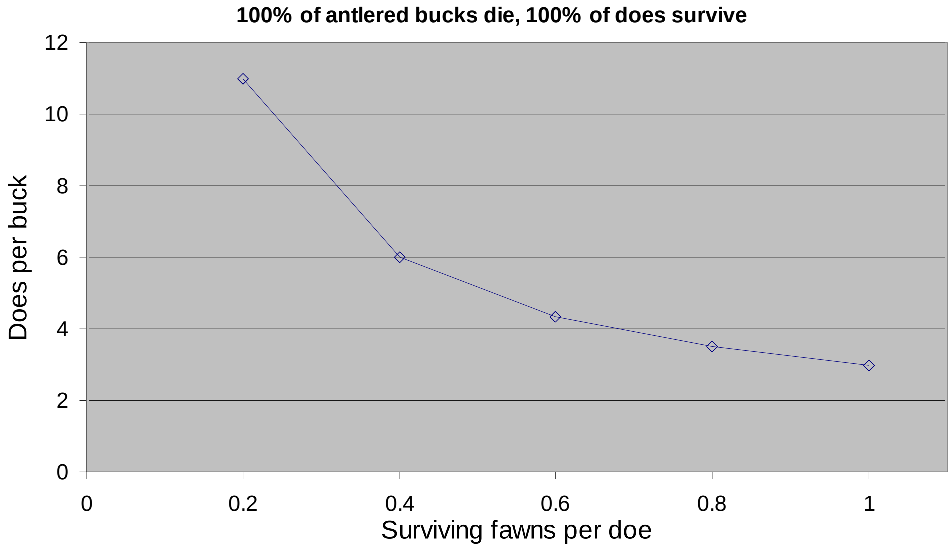

Figure 1. Low survival of fawns results in increased doe to buck ratios.

Scenario 2: High button buck mortality. If button bucks are selectively killed, even when 1 fawn per year survives, the ratio becomes quickly skewed. Figure 2 shows how selective mortality of button bucks affects the doe to buck ratio. Notice that, when 50% of the surviving fawns are bucks, the ratio of does to bucks is 3:1, but in the case where only 40% of the surviving fawns are bucks, the ratio rises to 4 does per buck, and so forth. This is of possible concern in areas with high antlerless deer permits. Many hunters cannot distinguish a button buck from an adult doe, or they do not care. Button bucks tend to travel alone and therefore lack the protection of an adult doe. Even if they are with a doe, they often scurry ahead of the group to get to a food source. They are especially vulnerable to hunters. It is not unrealistic to surmise that, in areas with many doe permits, there might be a preferential mortality of button bucks. I suspect very few hunters proudly take their button buck to the check station to be counted.

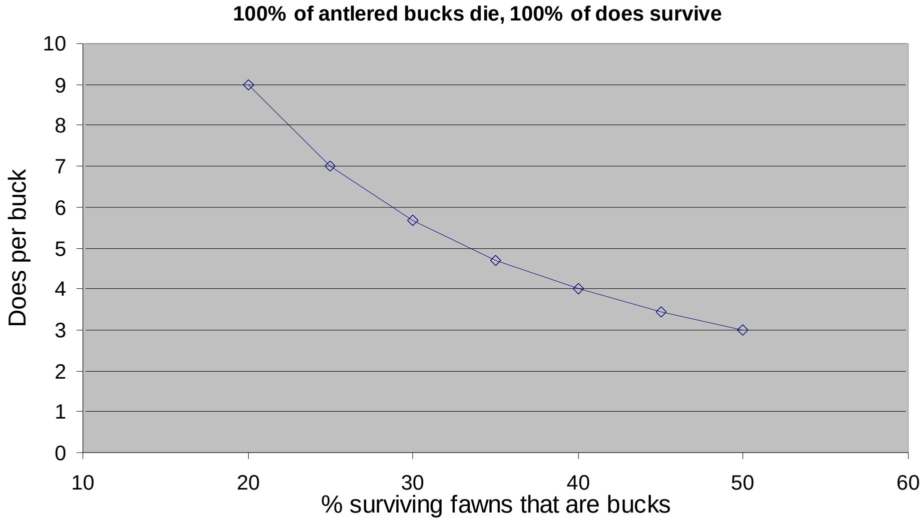

Figure 2. Selective loss of button bucks results in high doe to buck ratios.

The models shown above are extreme cases in which 100% of bucks die and 100% of does survive. However, adding even a modest buck survival of 20%, and doe mortality of 20%, the ratio changes from 6 does per buck to 4 does per buck when the fawn survival is 0.4 fawns per doe. So, the real world presents limits on how far skewed the doe to buck ratios can be, just as the previous article suggested.

Real-world conditions. Can models like the one shown here be used to determine the critical factors needed to achieve a balanced population? I think the answer is yes. As an example, I took the numbers for the 2006 deer herd in my home state of Michigan and applied them to the model. Table 2 shows the outcome if the mortality rates for the Michigan herd were to be projected forward for 10 years. While some might quibble with the exact numbers used, it is more important to see the impact of mortality rates on the growth and distribution of the herd. Note that the Michigan DNR believes the ratio in Michigan prior to the 2006 hunt was 1.9 does per buck. Many hunters would take exception to this, but I think that the modeling suggests that these are probably good estimates. The mathematics simply does not allow the ratio to get skewed very much as long as there is some buck survival and doe mortality.

Table 2. Application of model using numbers from the 2006 deer harvest in Michigan.

Adult buck survival	28.0%	Adult doe survival	74.0%	Button buck survival	100.0%	Fawn survival/doe	0.75

Year	Bucks	Does	Buck fawns	Doe fawns	New Deer	Does/bucks	Total deer	Gain or loss of deer from starting herd	Percent of original herd
1	364138	691862	280000	280000		1.90	1616000		100%
2	361407	771426	259448	259448	518897	2.13	1132833	1132633	70%
3	390479	860140	289285	289285	578570	2.20	1250619	1250419	77%
4	431887	959056	322553	322553	645105	2.22	1390943	1390743	86%
5	480574	1069348	359646	359646	719292	2.23	1549922	1549722	96%
6	535566	1192323	401005	401005	802011	2.23	1727889	1727689	107%
7	597080	1329440	447121	447121	894242	2.23	1926519	1926319	119%
8	665722	1482325	498540	498540	997080	2.23	2148048	2147848	133%
9	742274	1652793	555872	555872	1111744	2.23	2395067	2394867	148%
10	827634	1842864	619797	619797	1239595	2.23	2670498	2670298	165%

Notice that the herd grows by only 65% over 10 years. This may seem like out of control growth but consider the impact that small changes in the herd composition can have. For example, if doe and fawn mortality are only 5% higher, the herd growth is only 4% over 10 years instead of 65%. However, if the mortality of does is decreased by 5%, then instead of growing by 65%, the herd grows by 153% over 10 years time. If instead of changing doe or fawn mortality, the survival rate of bucks is doubled from 29% to 58%, the herd increases only from 65% growth to 94%. These examples illustrate the tremendous sensitivity of the herd to selective mortality of does, which illustrates as well the tremendous difficulties a state agency has controlling the population of such a large herd. These issues are made much more complicated by the fact that in many states, there are diverse environments to deal with, as well as economic and social divides like farming country vs. northern woodlands. Natural mortality based on winter conditions, or from small differences in harvest from year to year can significantly impact the herd size over several years based on it's impact on doe and fawn mortality.

The doe controls the population growth because of the biological fact that bucks can breed multiple does in a season, and does can come into estrous 2 or even 3 times during a season, depending on their location. Therefore, a herd with 6 does per buck is likely to produce the same number of fawns as a herd with 1 doe per buck. Changing the number of bucks in the herd has little impact on the growth of the population. And it has little impact on the ratio of does to bucks.

The myth of the high doe to buck ratio. To illustrate the futility of focusing on ratios, consider this. Using the model, if the doe kill in the Michigan example were increased by 10% (an extremely difficult prospect) the number of does per buck would change from

2.2 to 2.0. If instead, the buck survival rate were 10% higher, the ratio would only change from 2.2 to 2.13. Large changes in either the rate of doe killing or buck killing have a minimal impact on ratios. Contrast this with the earlier examples that show that small changes in doe and fawn survival have a massive impact on herd size.

We hunters focus on the ratio, because from our perspective it is badly skewed. Most hunters see many more does than bucks. But, many hunters do most of their observing during the gun hunting season. They carefully avoid disturbing their hunting areas prior to opening day, and do most of their observing after opening day. Their perception of the pre-hunt herd health is badly skewed by the fact that many bucks are killed on opening day and most other bucks become nocturnal. Does are seen more often because they have fawns that need to be cared for. How many times have we all seen a poor nervous wreck of a doe trying to catch up to her incorrigible little button buck that goes where he wants when he wants, and like many young 20-something men, feels impervious to harm, even when shotguns are exploding over his head. An additional factor is that, at least in my experience in the farming country of southern Michigan, hunters do not distinguish does from fawns. When a family member or friend tells me of his day, he may say, I saw 12 does today. In all likelihood, he saw 4-6 does and 6-8 fawns. Because the fawns have lost their spots and are nearly as large as their mothers, they have lost their identity as a fawn. If the hunter is not distinguishing adult does from fawns, then he will come up with a very flawed ratio.

Good doe to buck ratios do not signify a healthy herd. One of the problems with the kind of model shown here is that it says nothing about the quality of the herd. In the extreme case where 100% of the bucks are killed, and the ratio is 3:1 or less, the ratio is not completely out of control, but all the available bucks are only 1.5 years old. Most hunters would agree this is not conducive to a high quality hunting environment. In the model, 2 does per buck can be achieved with a 100% buck kill and a 50% doe kill every year (1 fawn per doe survival rate). I think we can all agree, that even though this ratio sounds good, the quality of the deer hunt under such conditions would be relatively low as well. These considerations lead to the conclusion that, for most herds, especially in states like Michigan, worrying about the ratios is probably a waste of time and effort. The real problems most of us face are overpopulation of deer, and under representation of mature bucks. These problems have little (if anything) to do with doe to buck ratios. That is because in most real world situations, the doe to buck ratios are really not wildly out of control, they just seem that way.

The model presented here leads me to 3 conclusions. First, we must be sensitive to the fact that in some areas because of poor fawn survival or preferential killing of young bucks, that the doe to buck ratios could be skewed. Importantly, these are probably very isolated conditions in which buck and fawn mortality is high, and doe mortality is low. Even moderate survival of bucks and mortality of does overcomes this problem. Second, the size of the herd is dependent on the mortality of does. It is critically important to harvest antlerless deer in order to prevent overpopulation. However, it is equally critical to do so without impacting the number of button bucks that make it through the hunting season. A first priority should be to provide incentives and education to hunters on the value of hunting does, and the negative impact of the inability to distinguish button bucks from does. Third, buck to doe ratios do not necessarily have any relationship to age classes of bucks. It would not make sense to try to manage to a ratio if the herd is comprised mainly of immature bucks. In fact, that is the problem we face presently. The deer herds in heavily hunted states like Michigan do not have doe to buck ratios that are badly skewed. However, they may have mature buck to total buck ratios that are unacceptable. To achieve better mature buck ratios, we need to provide incentives and education for hunters to recognize young bucks, and let them live to be older. First and foremost, we should shift our attention from buck to doe ratios, and focus on mature buck to total buck ratios instead, as well as continuing to focus on population control.

Addendum. All mathematical models have limitations that require a certain degree of skepticism. Note that in the model used here, the ratios come to a limit and remain at the same ratio for all ensuing years. This is of course not realistic. It occurs because the model uses the initial parameters from the current year for all subsequent years. Similarly, the method of button buck analysis has limitations. The model first determines overall fawn survival and then applies a percentage of button bucks that survive. Because it is a percentage of all fawns, the doe fawn survival rises proportionately with the buck fawn mortality. Nonetheless, this does not change the dynamic of the model, just the numbers that are derived. The conclusions are not altered. A model that uses 100% survival for does is similarly limited. It does not take into account mortality from ageing that will naturally occur in the populations, and therefore, again, the actual numbers are not correct, yet the trends are valid. Moreover, such extreme models allow us to see the limits of possibility. Even in such an extreme case, it can show us that nature applies mathematical limits on sex ratios based on the reproductive nature of the animal. Finally, the numbers from the Michigan DNR are of course estimates based on many different assumptions. What is most interesting about modeling is that it really doesn't matter what the exact numbers are that you put in. The dynamics produced by changing the numbers is what is important.