MAKING SENSE OF THE DATA: WHOSE SCIENCE IS SOUND?

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Abstract: Predator control is a particularly contentious issue, but especially so when the control of one wildlife species is proposed as a means of producing more of another for recreational purposes. When debating any issue, various "facts" and "statistics" are bantered about by the respective proponents and opponents for the purpose of persuading stakeholder opinions. Here I address some of the bones of contention related to predator management, and some of the misconceptions caused, or fueled, by the use and misuse of "facts" and "statistics."

THE ROLE OF "SOUND SCIENCE" IN DECISION, AND INDECISION, MAKING

We are a society inundated with various surveys, news reports, and other factoids designed to help us make good decisions. Whether it's the effects of salting our hamburger or controlling coyotes in Colorado to boost a mule deer (*Odocoileus hemionus*) population, we exhort science to tell us "the truth." But the truth seems to be an elusive, adaptive, and often cryptic, parameter. Mix these characteristics with politics and you're sure to have a cauldron of opinions, each clamoring to have science support their argument. Our topic for this symposium is ripe with these ingredients, and the general theme of predator control and its impacts on game species has fueled many a college lecture and campfire debate.

Several years ago I was embroiled in a controversy surrounding a school enrichment curriculum called Predators in the Classroom. One side of the controversy (there's always at least two sides to every argument) attacked the curriculum's use of vocabulary like "balance of nature" and the inclusion of people as a "predator." After such experiences, I coined a definition for "sound science." Sound science may be defined as "if the science *sounds* like it will support your respective argument, then it is by definition *sound science*; if not, it is simply somebody's misguided conjecture."

Before getting too deep into a discussion about whether predator control is or is not a useful tool for wildlife managers, a basic understanding of statistics, their uses, and perhaps more importantly their misuse, is warranted. Researchers use various statistics (e.g., means, standard deviation, correlation coefficients) to help them evaluate the response of some variable (e.g., nest success in quail) to some imposed treatment (e.g., predator control). The goal is to look objectively at two treatments and say intelligently (i.e., at least 95% of the time) whether any observed treatment response was attributable to the treatment or to merely chance. By the careful application of an appropriate study design, methods, and analyses, we strive for objectivity. Leopold and Hurst (1994) outline appropriate study designs and considerations for predator-related studies.

Let me illustrate with a simple exercise that we use at the Bobwhite Brigade to introduce the concepts of experimentation and critical thinking. Here's a simple question that begs a simple answer: who among us here today is the best shot with a .22 rifle? You may boast that you are, but I will beg to differ, just as many of our colleagues here today. So, how would you design an experiment to objectively (i.e., without bias) determine who's the best shot? Invariably someone will say set up a target and everybody shoot at it; closest one to the bull's-eye wins, right? How comfortable would you feel about just one shot? Okay, you say we'll each shoot three times and see who records the most bull's-eyes? Fine with me, I'll use my Anschutz target rifle and you use your old Stevens with iron sights and a six-pound trigger pull. Oh, did I tell you that you would shoot offhand, and I'll fire from a bench rest? I'll shoot at 8:00 a.m. before the wind gets gusty, but you will shoot at mid-afternoon when the south wind gusts at 20 mph. This exercise illustrates how our seemingly simple question can become a nightmare to decipher. Further, it underscores the need for appropriate experimental procedures and design.

Of course science as a process is totally objective and unbiased. As scientists, we adhere to a philosophy that uses observation and experimentation to seek the truth. The scientific method implores its practitioners to observe, hypothesize, test, evaluate, and re-test. But then the situation often deteriorates as findings are taken out of context, embellished, or otherwise manipulated to support one's arguments. My intent here is (1) to illustrate some examples of "sound science" and (2) how one must exercise their critical thinking skills to differentiate fact from fiction and the degrees thereof. As a prerequisite to this discussion, I offer the following (mostly anonymous) admonitions.

1) "Get the facts first, and then distort them any way you like." - Anonymous

2) "There are three kinds of lies: lies, damned lies, and statistics." - B. Disraeli

3) "He uses statistics like a drunk uses a lamp post; more for support than illumination." - Anonymous

4) "Statistics are like a bikini; what they reveal is interesting, but what they conceal is vital." - Anonymous

5) "If I hadn't believed it, I never would have seen it with my own two eyes." - Wilson's Law

6) "Where you stand on an issue usually depends upon where you sit." - Anonymous

These acknowledgments reinforce that we have a tendency to put our own particular spin on a given set of data, and thus its interpretations. As an example of how people can look at the same data, but offering different interpretations, study Figure 1 and count how many squares you see. Now ask someone next to you what their answer was. Odds are the two answers are different. The lesson is two-fold: (a) people can look at exactly the same thing, but "see" something different, and (b) things get more complex the longer you study them.

As wildlife professionals, we measure the "worth" of our wares by publishing in "refereed" journals. A manuscript is subjected to anonymous reviews by (usually) three peers who challenge your methods, analyses, and interpretations. If it fails substantially any of these measures, it is unacceptable for publication in the professional journal. The system isn't perfect, but it does work well. The manuscripts presented here at this symposium may or may not have undergone such rigorous reviews, and I encourage you to challenge the author(s) on their statements (including mine). Such is the way of science.

SOME COMMON SOURCES OF CONFUSION

Researchers try to minimize the effects of "extraneous" variables, i.e., those they are not interested in, by setting up controlled experiments. In a classical animal science experiment, one might use a number of steers of similar breeding (e.g., 30 angus steers) to test the effect of protein supplementation on average daily gain. An experimental design might place five steers in each of six different pens. The steers would be assigned randomly to one of the pens, and then three of the pens would be selected randomly to receive the "treatment" and the other three pens would serve as experimental "controls." Experimental diets would be similar except that one ration would be 12% crude protein and the other only 7% crude protein. To the degree possible, all other variables would be standardized (i.e., held constant across all replicates). At the conclusion of the trial, any differences observed in average daily gains should be attributable to the treatment.

In a perfect world, experiments relative to predator control would follow a similar protocol. However, in field ecology experiments, one rarely has the level of control over all variables as the animal scientist studying weight gains in a feedlot. Typically you are trying to monitor a response that involves a nocturnal, elusive prey and or predator species. Additionally, a suite of environmental variables may affect your experiment. And it's usually expensive to increase one's sample size of radio-marked bobwhites (*Colinus virginianus*) or coyotes (*Canis latrans*) to obtain the degree of accuracy you desire in whatever measurements are being recorded.

Some common problems associated with field experiments, including predator-prey studies, include (a) confounding variables, (b) spurious correlations, and (c) extrapolating beyond the context of one's study.

Confounding variables

When several variables are intertwined to such a degree that the scientist cannot separate the effects of Variable A from Variable Z, the results are "confounded." Consider the classic example of the Kaibab Plateau deer herd in Arizona. In 1906, Theodore Roosevelt proclaimed the Kaibab Plateau a federal game refuge for the sake of the mule deer herd. The Kaibab was closed to all hunting. Additionally, a predator control campaign was initiated that removed 20 wolves (*Canis lupus*), 781 mountain lions (*Puma concolor*), 4,889 coyotes and 554 bobcats (*Felis rufus*) from 1906 to 1931 (Rasmussen 1941). The deer herd increased from an estimated 3,000 head in 1907 to a reported 100,000 head about

1924 (Figure 2; the numbers are disputable; see Burk 1973). A catastrophic die-off occurred about 1924 and the deer herd plummeted to pretreatment levels because of a depleted range. This incident is used in several ecology textbooks (e.g., Kormondy 1969) as the classical effect of "messing with Mother Nature" relative to controlling predators, and then subsequently releasing a deer herd that ultimately destroys its range.

While the popular interpretation of the Kaibab Plateau is to illustrate how predators kept the deer herd trimmed to fit the range's carrying capacity, other authors have attacked the interpretation (Caughley 1970, Burk 1973). Caughley (1970) stated that the "data on the Kaibab deer herd . . . are unreliable and inconsistent, and the factors that may have resulted in an upsurge of deer are hopelessly confounded." Confounded because in addition to the predator removal, some 195,000 sheep also were removed from the range during the early years. Thus, how does one discern the population effects caused by removing predators from that of removing a competitor for forage?

One of my favorites is the case study of deer populations increasing over most of west Texas in the early 1960s. Most observers would be quick to credit the screwworm eradication program as the "treatment" that allowed deer numbers to multiply. But other factors were at play as well, including a targeted coyote control program using toxicants like strychnine and Compound 1080, a drought-induced destocking of livestock from much of the range, the breaking of the drought in 1957 and resultant forb flush, increased emphasis on law enforcement, and what I suspect was a reluctance of hunters to allow hunting of the to-that-point low deer numbers. Which of these factors was *not* involved, at least to some extent?

Why have raccoons (*Procyon lotor*) and other "mesomammals" apparently blossomed so over the last 15 years? Again, the intuitive response is the demise of the fur market in about 1986. But I can list three other factors that have surely contributed to the "release" including (a) emphasis on deer management, i.e., supplemental feeding, (b) increasingly fragmented landscape, and (c) increased number of farm ponds. All of these phenomena afford mechanisms for raccoons to exploit and increase in density.

Moral of the story is to beware of confounding factors. They are everywhere around us and cloud our ability to identify single causal factors.

Spurious correlations

One of the most common pitfalls we step into is the inability to separate relationships that are "causal" (i.e., a "cause and effect" relationship exists) from those that are simply "correlated" (i.e., they vary together). Consider the relationship depicted in Figure 3 (adapted from Brennan 1991), which illustrates a relationship between bobwhite abundance in the southeastern United States and what I refer to the moment as "Factor A." Study the graph, then answer the following questions.

1) Does an increase in "Factor A" cause the bobwhite population to decline?

2) Would you recommend controlling "Factor A" if your goal was to increase bobwhite numbers? What if such control

would be politically incorrect; would you still lobby for it as a quail enthusiast?

3) What do you think "Factor A" really represents?
- (a) raccoon numbers
- (b) fire ant numbers
- (c) hunting license sales
- (d) hunting lease costs
- (e) Quail Unlimited membership

The correct answer is (e) Quail Unlimited membership! This illustrates that two variables may be highly correlated (either positively or negatively) and yet have little biological significance.

Similarly I could plot the number of churches in a city against the number of murders that occur in that city and have a high correlation coefficient. Can I deduce then that an increase in churches causes a higher murder rate? Of course not. Population size is the independent variable that is driving both the number of churches and homicides.

Extrapolation

One of the standard caveats learned by any student of statistics (especially correlation analyses) is to never "extrapolate beyond the range of your data." Extrapolation means stretching whatever inferences may be gained from your analysis to points (or contexts) beyond which your respective data set applied.

For example, Frost (2000) removed approximately 1 mesomammal per 12 acres (mostly raccoons) from 600-acre study areas over a 30-day period just prior to the 1998 and 1999 nesting seasons in Tom Green County, Texas. Despite the removal of this number of potential predators, survival of radio-marked bobwhites and fate of artificial quail nests were similar on both trapped and nontrapped sites. So what do you conclude from such studies? That predator control failed to yield the desired result of more quail? Be careful about how you interpret your findings, especially as you use the phrase "predator control". Scent stations indicated that, at this scale and level of trapping (200 trap nights per acre), mesomammal abundance was not reduced even in the short-term. Thus no "control" was achieved, so one could hardly anticipate a treatment response in terms of increased quail or nest survival.

Interpreting effects of predator control

Connolly (1978) listed 31 studies where predators were implicated in controlling or limiting ungulate populations in North America, and 27 other studies where they did not. Connolly summarized that "a sufficiently selective review of the literature can reinforce any desired view on the subject of predation."

The question that sparked this symposium was what impact predators (i.e., especially coyotes) would have on deer populations in the Edwards Plateau "once the coyotes have killed off all the sheep." In other words, would (could) coyotes suppress deer populations? While other authors will likely address this question, my take on the matter is this: deer numbers would decline somewhat but still remain fairly high. One has to look only at the Rio Grande Plains or the Rolling Plains to see that relatively high populations (perhaps two to five coyotes per square mile) can coexist with a healthy deer population. In fact, it would be interesting to graph coyote densities on the X-axis and the number of Boone and Crockett trophy bucks from a particular county on the Y-axis and see what kind of relationship exists. And would such a relation be simply correlated, or causal?

Once you get stimulated to study the "squaradigms" that surround predator management, there are a number of interesting relationships upon which to ponder. How do raccoons and coyotes vary? Coyotes and quail? Feral hogs and quail? Just remember that (a) even if everyone looks at exactly the same data, people will see different things and (b) the more you study what appears to be a simple question, it will inevitably become more complex.

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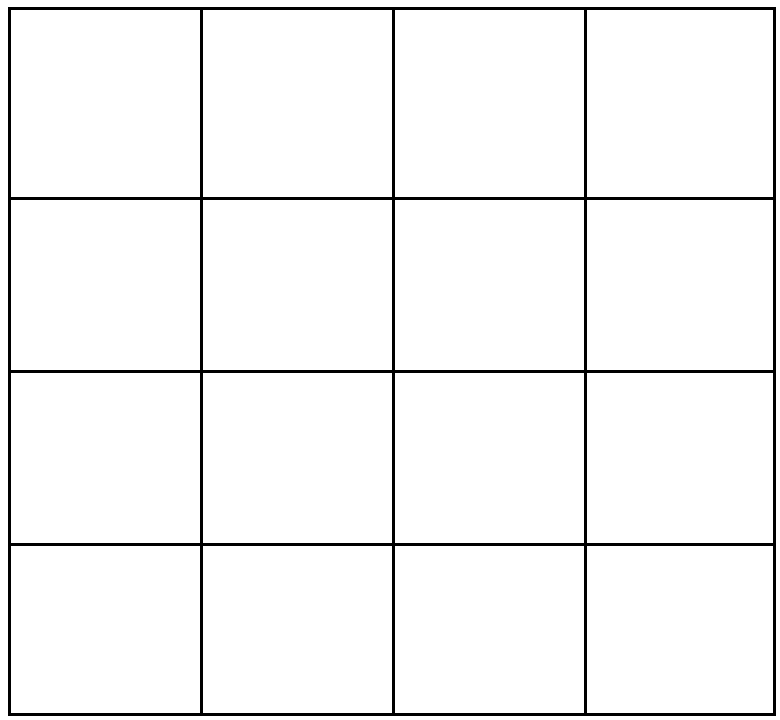

Figure 1. "Squaradigms" as they relate to predator management. Count the number of squares you see in this figure. Is it the same number that your neighbors see? Why or why not?

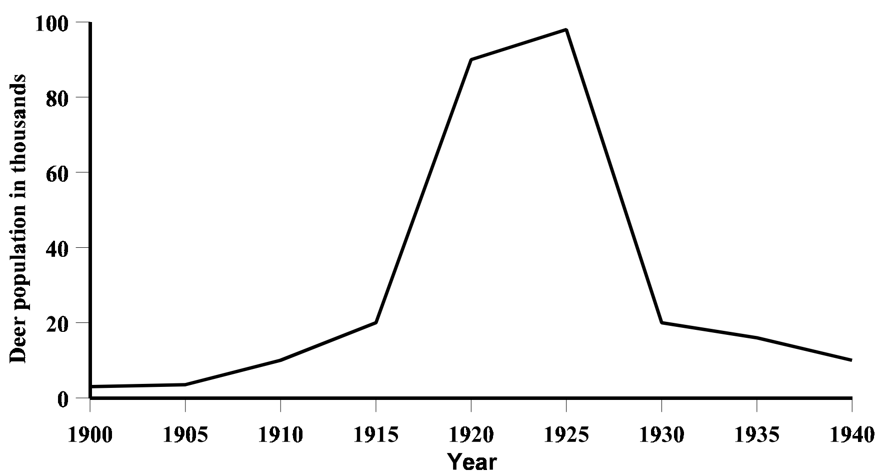

Figure 2. Deer population trends on the Kaibab Plateau, Arizona (from Rasmussen 1941).

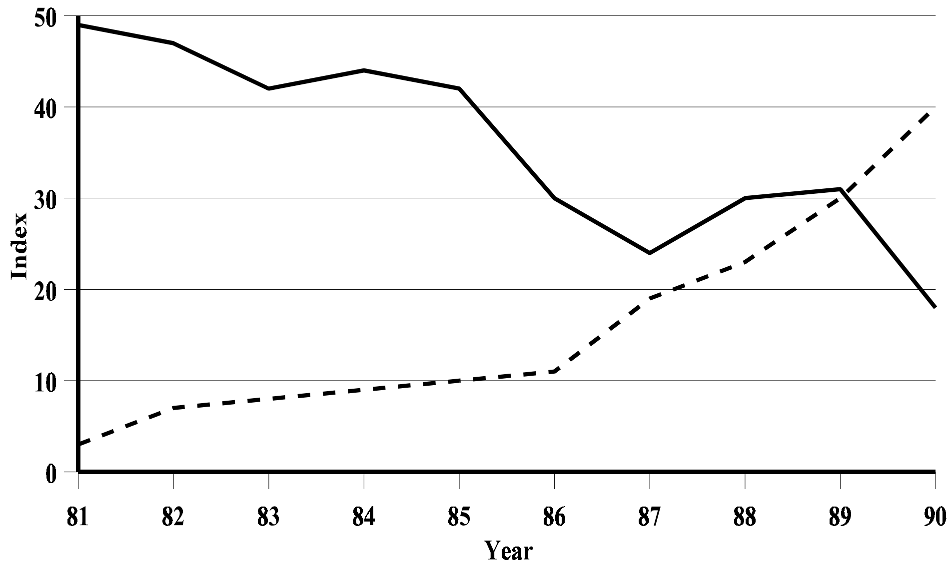

Figure 3. Bobwhite abundance in the southeastern U.S. (solid line) versus “Factor A” (dashed line). Adapted from Brennan (1991).