APPLICABILITY OF BASIC PHYSIOLOGY AND NUTRITION RESEARCH TO PRACTICAL WILDLIFE MANAGEMENT[1]

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ABSTRACT

Past emphasis on wildlife research with immediate applicability has resulted in good management progress with minimum effort. However, this emphasis may now be impeding management progress. Most of the "easy" answers may be known already. Wildlife scientists and managers should recognize the need for basic physiological and nutritional research to improve future management procedures. Examples are given of recent knowledge concerning wild species that have been obtained through such basic research, the possible implications of this knowledge, and the need for more "in depth" research on the biology and ecology of the species with which we work.

INTRODUCTION

One might logically ask "Why does a wildlife scientist or manager need an understanding of physiology and nutrition?" After all, wildlifers have existed for many years with little emphasis on these areas. Further, we often hear that the wildlife manager is a "land manager," a habitat manipulator. Most wildlifers, when asked, will declare that they are interested in "ecology" or "management" — not such basic sciences as physiology or nutrition. I would like to argue that one needs a basic understanding of the physiology and nutrition of the animals with which he is concerned if he is to be a really good manager or ecologist. I would also argue that more rapid progress in management procedures can be made in the future if more emphasis is placed on such basic areas as physiology and nutrition.

Wildlife management has been defined by Giles (1971:1) as "the science and art of *changing* [emphasis mine] the characteristics and interactions of habitats, wild animal populations and men in order to achieve specific human goals by means of the wildlife resource." Wildlife ecology can be defined as a branch of science concerned with the interrelationship of wild mammals and birds and their environments. Going one step farther, physiology, nutrition and population dynamics can be looked upon as speciality areas of wildlife ecology. All are, in reality, subsciences or divisions of wildlife ecology. Many schools have recognized the importance of a knowledge of population dynamics in wildlife management and have graduate or upper level courses in this speciality area. Wildlife physiology and nutrition have not gained such recognition, however, and relatively few wildlifers have had specific course-work in these areas (at least from an applied wildlife standpoint).

A part of the definition of wildlife management as given by Giles was the manipulation of populations and habitats to meet specific human goals. A thorough knowledge of physiological and nutritional adaptations of wild animals will enable the wildlife manager to make decisions concerning wildlife populations and habitats (i.e., manipulate, manage) on a sounder basis. The benefits of this knowledge can be either direct or indirect, i.e., the knowledge may be applied as a new technique (as in the use of physiological indices) or may simply be useful as background information for decision making.

Now let us draw some analogies between medical science, animal science and wildlife science. What are the goals of medical research? In simplest terms these are to prevent and/or cure illnesses or malfunctions of the human body. What are the goals of the animal sciences? The biological goal of the animal sciences is to produce bigger and better farm animals more efficiently.

Now, to paraphrase Giles, the biological goal of wildlife management is to manipulate wildlife populations. The speciality area of wildlife population dynamics, defined as the study of numerical and structural changes in populations, greatly assists the manager in achieving this goal. The place of physiology in this process can be depicted as in Figure 1. The speciality area of physiology or physiological ecology has to do with mechanisms and interactions of normal body processes with the environment which lead to natality and/or mortality and thereby determine the size and structure of wildlife populations. Knowledge in this area, which used to the manager's advantage, can be a very valuable asset in manipulating wildlife populations.

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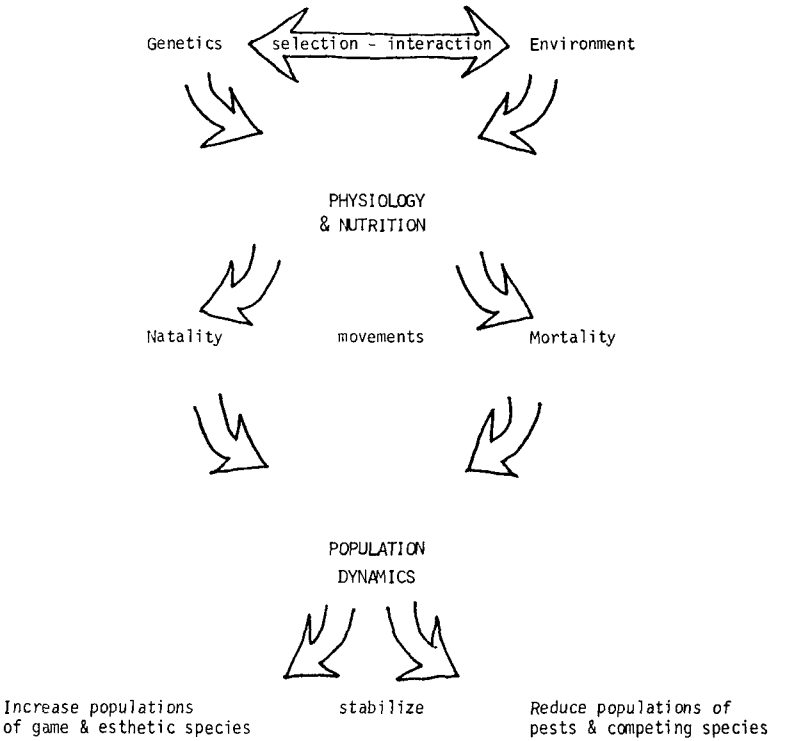

Figure 1. Schematic diagram showing key position of physiology and nutrition in pathway to attaining biological goals of wildlife management.

Traditionally, wildlifers have manipulated environment and then counted numbers of animals and sometimes determined natality and mortality rates. We have largely (but not completely, of course) ignored that vast area in between as shown on the accompanying diagram, i.e., physiology. This may be so primarily because wildlife departments have been understaffed and scientists poorly funded in the past. We had to be very general because we couldn't afford to be specific. But — times are changing. If our field is to progress rapidly, we all cannot be oriented towards changing the environment and then censusing populations to see "what happened." We need to think more in terms of a team approach to problem solving. There is much to learn in between — physiological and nutritional mechanisms that may interact in various ways and which may enhance tremendously our manipulatory powers over wildlife populations.

The following are some questions to ponder which greater emphasis on physiological and nutritional ecology may help us answer:

1. Can we at present or in the future alter environment to change mortality and natality of wildlife populations to suit our will?
2. What effect does man's interference have on natality and mortality of wildlife populations? (For example, his presence, contaminants, clear cuts, dogs, etc.) Can we predict this? What *basic* physiological knowledge is needed to obtain answers to the above?
3. What are the major environmental factors which alter natality or mortality of wild animals? Do significant interactions exist? (Example — Do nutrition and population density interact to regulate natality?)
4. Can we block or stimulate certain physiological pathways with certain environmental chemicals? [Example — Can we regulate (increase or decrease) fertility with synthetic hormones?]

5. Can physiological characteristics of wildlife be used to evaluate the quality of the environment (enzyme levels, blood urea nitrogen, cholesterol — i.e. physiological indices)?
6. Can we predict rabies outbreaks, or irruptions of mice or rats via a monitoring of physiological characteristics?
7. Can we hold pest species at low population levels?
8. Can we reduce crop damage through the use of repellants,via habitat manipulation or through use of chemosterilants?
9. What are the physiological pathways (mechanisms) involved?
10. What additional physiological and nutritional knowledge is needed to help solve these problems?

This paper will not provide answers to all the above questions but hopefully will stimulate you to think of the great potential which physiology research on wild animals has for the field of wildlife management. The study of applied wildlife physiology (or physiological ecology if your prefer) is really just getting underway. There are few trained physiologists in the wildlife field and there is much to learn about basic functions and responses of wild species.

As wildlifers, we all need to get more scientific and basic in our approach to ecological research. We need to:

1. Define problem areas of wildlife ecology.
2. Set up hypotheses to test, produce differences experimentally.

Often it is necessary to ask: *Can* a specific environmental factor alter reproduction or mortality? To what extent can it? How does it? Let's look at a specific question in depth. What environmental factors control white-tailed deer numbers in the Southeast?

One might list the following:

1. Hunting (both legal and illegal)
2. Dogs
3. Nutrition
4. Population density
5. Contaminants
6. Disease
7. Cover

Of these 2, 3, 4, 5, 6, and 7 have physiological aspects. Now let's take two of these (nutrition and dogs) and look at them in more detail.

Nutrition is a word not commonly used by the average wildlife manager. The general term "habitat" is more common, and although it is used primarily to mean food or nutrition in the case of deer in the Southeast at least, in reality, it includes the two vastly different environmental factors of food and cover.

But nutrition can also be broken down further into carbohydrates and fats (energy sources), protein, minerals and vitamins. So, if we say nutrition controls deer numbers in the Southeast, do we mean that all components of nutrition are responsible? This is improbable and it would appear that the wildlifer needs to go from the general term "habitat" to the more specific term "nutrition" to the even more specific terms of "energy" or "protein" or "vitamins."

So we've divided nutrition into its several components. Now let's ask "when" is nutrition acting to regulate deer numbers. It is unlikely that it is acting throughout the year. Is it limiting in the spring, summer, fall or winter or during a combination of 2 or more of these? Does anyone know? Has it been investigated on a seasonal basis?

But we're not through yet! Let's ask "how" does nutrition affect deer numbers? Through starvation? Probably not in the Southeast. Through effects on disease susceptibility? Maybe — but there is currently little data in this area. Through effects on reproduction? This is probable since we do know that reproductive rates of deer are generally lower in the Southeast than in the Midwest and North.

Then it seems appropriate to ask "What aspect of the reproductive process is affected?" The following are possibilities:

1. The proportion of fawns breeding
2. The number of ova shed/adult
3. Fertilization
4. Embryonic survival
5. Postnatal survival

Few would say we know the answers to all of the questions posed above. Yet, if we had the answers we could work toward managing deer herds more effectively in the Southeast by manipulating habitat

to provide the needed nutrient or nutrients at the appropriate times. How do we get the answers we need? What approaches are available to us?

I contend that most wildlife problems can best be solved by a combination of field and laboratory research. By laboratory research I mean controlled studies on confined animals whether it be inside a building or in an outdoor enclosure. Both these types of research (field and laboratory) have shortcomings. Field work is often difficult to interpret because of its uncontrolled nature. Too often many environmental factors change simultaneously and therefore are confounded. Laboratory experiments, on the other hand, can always be criticized as being "unnatural". This is a valid criticism, but they *can* be well controlled, and taken together with field experiments, they will, in my opinion, give us the concrete data which we need to evaluate the effects of environmental variables on wildlife populations. Going back to our original question concerning the effects of nutrition on deer populations in the Southeast, the following approaches to getting specific answers are possible.

1. Field Studies
   a. Measure food availability and food quality at various times of the year — this can be done by "habitat" surveys, food habits analysis, etc.
   b. Compare condition, reproductive rates, parasite load, etc. between different areas and attempt to relate to specific differences in nutrient intake.
2. Laboratory Studies
   a. Impose different nutritional regimes on penned deer — measure condition, reproductive rates, lactating ability, etc.
   b. Study digestibility of various forages.
   c. Investigate adaptive mechanisms to different nutritional regimes (such as nitrogen recycling on low protein diets).

Many will recognize that substantial progress in research has been made in many of these areas in the past few years. However, it is hoped that by enumerating some of these needs that more of us will gain an appreciation for this type of work and its potential for the practicing manager.

A second example is the question of what effects free running dogs have on deer populations. Available evidence indicates there are few direct kills, but many believe that continuous running of deer may be detrimental to their health and reproduction. Let's look at some possible areas of physiology that might be affected.

(1) Does the stress of being chased weaken deer to the point where disease or inclement weather can cause death?
(2) Is reproduction impaired?
   a. lower conception rates?
   b. embryo survival impaired? (Work in domestic sheep (Ulberg and Sheean 1973) has shown that a 1 to 2° F rise in body temperature can increase early embryonic mortality.)
   c. lactation depressed with subsequent fawn loss?

Possible approaches to this problem are as follows:

1. Field Studies
   a. Measure extent of dog harassment by radio telemetry.
   b. Set up areas and chase as often as possible and compare reproduction, population structure, etc. with unchased area. Might also take physiological measurements such as body temperature, plasma corticoid levels, bone marrow fat, ovulation rate if deer can be killed during or after chase.
2. Laboratory Studies
   a. Harass penned deer with dogs during critical times of reproductive process i.e. immediately after conception and around time of parturition. Monitor body temperatures, plasma, corticoid levels and effects on reproduction.

Let's now look at a few areas in which "basic research" has contributed to the solving of our management problems. Controlled studies have recently shown that many wildlife species reduce voluntary food consumption during the winter months. This has been shown for deer (Long et al. 1965, Fowler et al. 1967, and Kirkpatrick et al. 1975) and squirrels (Montgomery et al. 1975) and is probably true for many other game species as well. What are the practical implications of this knowledge? Winter may *not* be the time of greatest nutritional deficiency in these species as we had previously expected. There is little need to "manage" areas for greater food production if food is already adequate or in surplus.

Also for many years wildlifers have been concerned about protein content of deer forages and its relationship to reproduction. Recent work on ruminants (Memon et al. 1969) and deer in particular

(Abler et al. 1975) indicates that the energy level of the diet may be much more important in regulating reproduction than protein (Murphy and Coates 1966). Since the two are normally closely correlated in forages we probably won't go too far wrong in managing for protein in our forages and in fact protein may be just as important as energy at *certain* stages of the reproductive process — for example, during late pregnancy and early lactation.

In the area of environmental contaminants we wildlifers have barely scratched the surface. Most papers in the literature deal with residue levels of various contaminants in wildlife species (and these are needed). But, what physiological effects do these contaminants have on our wild species? The Missouri group has done some good work along these lines but more is needed. Basic work on enzyme levels and disease susceptibility after contaminant exposure is very scant. Recent work at Patuxent by Dieter (1975) indicates that blood enzymes may be a "potentially valuable technique to monitor the presence of contaminants in wild populations."

And speaking of monitoring, much remains to be learned regarding the use of physiological indices in evaluating condition and habitats of many species. Blood urea nitrogen, mandibular fat levels, cholesterol levels, all show promise of being useful in intensively managed deer populations.

In conclusion, medical and animal scientists recognized long ago the need for and utility of basic physiological and nutritional research on humans and domestic animals, respectively. Wildlife managers have been slow in recognizing the comparable potential of basic research in these areas on important wildlife species. The time has come in terms of staffing and funding in which wildlife agencies can afford to — and must if our field is to progress rapidly — place more emphasis on basic research.

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