THE SOIL AS THE BASIS OF WILDLIFE MANAGEMENT*

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Wildlife is a crop of the land. It is a crop just as are grass, corn, wheat, calves, pigs and other creations in the form of plants and animals under domestication. We grant readily that the size of a crop, like corn, for example, depends on the fertility of the soil growing it. We select better land for a better crop, and we fertilize a given piece of land to improve the crop from it. Unfortunately, we have not thought much about controlling the animal crop, whether domestic or wildlife, by selecting, managing, and fertilizing the soil. We have planted and transplanted both plants and animals, all too haphazardly, from one place of their generous production in suitable habitat to most any other place with little more than a simple, blind faith in the species to guarantee its own survival. We have been too reluctant to believe that the failures of such transplanting may be provoked by the infertility of the soil making the new habitat unsuitable. We speak of a certain region as "good cattle country", or "good sheep country", or "good quail country", or as a region of "fine rabbit shooting". We see the animal crop there. We see the crops of grain, the rainfall, the snows, and other environmental features, but we fail to see the underlying soil and its fertility as the basic control of what kinds of plants will grow and thereby what food for wildlife any region provides.

Wildlife struggles desperately to find the necessary calcium and phosphorus coming out of the soil to make bones, when antlers are quickly consumed by the porcupine, the pregnant squirrels, and other animals living on the highly weathered forest soils.

Courtesy Florence Page Jaques, The Snowshoe Country, The University of Minnesota Press.

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Dependence on soils seems more remote by some wildlife.

Wildlife includes many animal groups differing in their feeding habits and in the degree of dependence directly on the soil. In simpler classification, there are the carnivorous, the omnivorous and the herbivorous, which is the order as we might see them more closely connected with the soil. We have not yet studied the herbivora in sufficient detail to see how their grazing is limited to certain soil types or to specific soil areas, and how the patterns of their concentration and distribution are determined by the fertility of the soil and thereby are in accordance with the climatic forces developing it. The fact that the buffalo selected the Chernozem and Chestnut soils with their short prairie grasses, where today we grow the "hard" or the high-protein wheat and many of our cattle of good meat-producing quality, is an excellent illustration of one of the many cases where the soil pattern was in control of wildlife. That same soil pattern is likewise controlling the patterns for domestic animal and human life today.

The carnivorous animals too must fit into the pattern of the soil fertility as it provides them food. However, they are farther removed--mainly in our thinking--from the soil as the provider of their foods. Fish are highly carnivorous in the tropical seas, but of more omnivorous feeding habits in temperate waters. It is not readily appreciated that carnivorousness is such a common character of all wildlife in the humid tropics, suggesting the necessity of such habits for survival. Nor is carnivorousness connected with the fact that high rainfalls and high temperatures give exhausted soils and only forests, of which the vegetative bulk can scarcely be as nutritious as are the short grasses growing on the semi-arid, highly fertile soils capable of feeding the massive-bodied buffaloes. Carnivorousness is the predominant habit whenever the animals can't support themselves by feeding more directly on the soil and when they must therefore feed on each other. Herbivorousness, or subsistence more directly on the products of the soil, is predominant where lower rainfalls and moderate temperatures prevail and thereby provide the more fertile soils and they in turn grow the more nutritious vegetation. The climatic forces determine the kind of soil and thereby the feed, and through it are manifesting their control therefore seemingly less directly. Different animals are in specific climatic conditions more because of the food produced by the soil developed under those climatic forces than because of the comfort to animals in terms of suitable temperature and moisture.

Soil fertility is a pattern for management of any kind of wildlife.

The management of wildlife is giving emphasis to feeding as the dominant factor by which the wildlife crop can be produced and preserved on lands that are marginal for domestic crops. Under its own efforts for survival in competition with man's encroachments on its range, wildlife is rapidly being pushed into its reluctantly accepted therritories that are bringing about its slow extinction. Its survival demands its submission to man's management and to his provision of foods and feeds in the habitats that will truly nourish these animals for their reproduction. Wildlife is not greatly different from domestic animal life. The soil is coming to be recognized more and more as the support via foods for all life forms now that the depletion of the fertility of our soils is marking out the areas of both crop and animal extinction and is delineating more sharply the soil areas of their survival. Land areas are being studied from a new viewpoint, now that even we of the cornbelt of the

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United States have had a few years of experience in rationing and in food shortages. A given area is no longer merely a site. Like the wild animals, we are reacting to a geographical area with concern for ourselves and for our domestic animals according as it feeds us, or as its soils produce the foods that truly nourish. The soil fertility pattern by which we seek to undergird the growth of crops and domestic animals must be viewed as the same pattern by which the management of our wildlife may be more logical and successful also. Only under the concern by man for his wildlife crop, and not in its competition with him, can our supply of game escape extinction.

Feeding overshadows breeding.

Prompted probably by the emphasis on breeding in the management of domestic animals, the breeding phase of wildlife management has raised hopes and beliefs that we can crossbreed, for example, one type of male bird or animal on another to increase the capacities for survival. The enthusiasts for the possibilities of genetics seemingly would push our domestic animals and our wildlife into many geographical areas formerly unknown to them. Such aspects as "hybrid vigor" uncovered by breeding trials lend enthusiasm. Hybrid corn, in the case of plants, has gotten more bushels or more bulk per acre. But this has happened (1) not without a seemingly more starchy grain of lower values as protein and lesser feeding power for body growth as Nebraska experiments with chicks indicate, and (2) not without exhausting the soil fertility so speedily that the special advantage of hybrid corn as more bushels per acre shrinks rapidly on successive cropping by it.

In our domestic animals, the mule has also been a similar case of hybrid vigor. But we failed to appreciate the observation that this animal slave of ours has been confined in its birth and growth to regions of highly calcareous soils or areas of low rainfall. We have accused this beast of being stubborn in its strange feeding habits when in fact is was exhibiting a self-regulatory appetite and other characters that are essential for the survival of the mule when forced to be so highly exotic as is true of it, for example, on the cotton soils of our southern states.

A few such cases of particular advantage obtained through genetics as illustrated by hybrid vigor have encouraged trials in other plants and other domestic animals. They have kept alive the hope that some helps may come therefrom to wildlife also and that marvels may be accomplished by manipulating the genes of the reproduction cells. Breeding has, of course, its potentialities. It has, for example, given increased resistance to disease. It has developed tolerations of shortages in many respects. But the toleration of starvation certainly is one character that cannot be established permanently by the most marvelous manipulations of the geneticist. Breeding may do much in determining the mating of the particular male and female cells, but after conception has once occurred, it is then that feeding takes over. It is then that the soil, which grows feeds exercises the main controls. It is essential that we see the soil and its production of feeds as the means of effective management of all wildlife, including all of its breeding variations or characteristics.

Animals search for proteins and minerals.

The problems of feeding our domestic animals point out most forcefully that many soils are giving poor feed for our farm animals and would

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be producers of poor feed for any wild animal of similar feeding habits. Whether it is feeding for milk production, for fattening, for reproduction, or even for only mainteneance, it is a necessary and common farm practice on many and extensive regions of soils to supplement the native feed crops with mineral and protein concentrates. Soil management for feed production for domestic animals has long been calling for lime applications to make possible the mineral-rich and more proteinaceous legume crops. These crops are in high demand for the young and growing animals, for the milk producers, and even for fattening without disaster. Our feeding of domestic animals is given distinctly to the struggle of providing enough of the essential minerals of soil-borne origin, and of the proteins built up of the amino acids originating only in synthesis by the plants on the more fertile soils.

Soil treatments mean more proteins and minerals in feeds.

Our soil treatments practiced most extensively are those which encourage higher concentration of minerals and proteins in the crop. Calcium put on as limestone for the formerly erroneous purpose of fighting soil acidity serves to give a higher concentration of the nutrient calcium within the crop, to bring along with itself a higher concentration of other minerals, and to synthesize more protein by means of more nitrogen taken from both the soil and the atmosphere. Phosphorus also exercises its effects on the better protein synthesis and on the more effective reproduction of the plant through a bigger seed crop. Nitrogen, too, goes as fertilizer for the building of protein in the crop and is the one element by which protein is distinguished in terms of chemical analysis. Soil treatments are not emphasizing the increased production of carbohydrates or fattening foods so much since these are crop functions performed commonly on must any soils. Soil treatments are testimony that it a far greater struggle to have plants provide sufficient minerals and proteins in themselves as feeds. Just as the deficient soils point to the plant's struggle for proteins that make for seeds and plant reproduction so our less fertile soils point to the animal and human struggle, not for carbohydrates or fuel foods of plant photosyntheses, but for the minerals, the proteins and all those complex products of the plant's biosyntheses that build bodies and encourage fecund reproduction.

Animal's selection of feed points to soil fertility.

That wild animal life in its wide roaming and discriminating selections of its feed should be limited by the soil fertility may seem difficult to believe. It is difficult since plant life above the soil and microbial life within the soil seem a weak force to bind the warm-blooded, physiologically complex behaviors of higher life to the slow, highly inorganic chemical reactions within the cold soil body. Nevertheless, the animal must depend on the soil to provide it with the dozen or more essential nutrient elements found only there where they serve as nourishment also for the microbes and where they determine what creative services the plants can perform in terms of food for wildlife and all other life. It is the differences in the activities within the soil in supplying these dozen or more nutrients that provoke the roamings and the searchings of animals as they select their food so discriminatingly. We are just coming to appreciate the fact that it is the differences in soil fertility and thereby the differences in the quality of the feeds that prompt wild animals to cover their territory and to select their feeds so wisely for their own better survival.

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Choices of grazing and other feeds by domestic and wild animals have pointed to the animal's struggle for the soil-borne minerals and the proteins encouraged by them or by minerals and nitrogen applied in fertilizers. In Pennsylvania the deer coming down from the mountains for their winter grazing choose their browse regularly in woodland areas which had been fertilized. When deer are considered a pest we forget that they may be suffering some nutrient deficiencies in consequence of their feeding on vegetation growing on very poor soil and one producing only poor wood. We forget, too, that they may find the means of remedying that deficiency by grazing the crops on our cultivated field s where fertilizers or tillage have remedied that deficiency. Soils that represent no more highly specialized plant processes than merely that of making wood even when all the soil fertility is dropped back annually in the leaves, surely cannot be supplying highly nutritious vegetation. That such is the case is suggested when the browse of deer consists only of the growing buds or tips of the shoots where the maximum concentration of life activity by the plant occurs.

Domestic animals have been observed in many instances to roam and locate a particular soil area according to the fertility of it and according to the higher concentration of protein or of mineral contents of the feed. A Missouri farmer reported that his cattle were eating first the area of barley where 200 pounds of fertilizer were applied but they left ungrazed to the very drill row that where only 100 pounds were used. An Iowa tenant farmer was startled to find his 20 head of cattle grazing on a 20-acre section of an unfenced 300-acres of stalks in the cornfield after husking. This surprise at the animal discrimination was more startling when he connected their behavior with the 70 pounds per acre of nitrogen on the 20-acre strip as special treatment in addition to the 100 pounds of fertilizer per acre on the entire field.

Plowing the soil as a means of releasing soil fertility was sufficient improvement in the feeding quality of bluegrass to make cattle graze it very closely where the land was plowed and reseeded in making waterways while they disregarded the part of the field of bluegrass left unplowed. Native prairie grasses fertilized with calcium and nitrogen in 1936 and put into one of four stacks of hay in the field annually were chosen regularly for nine successive years by cattle in their consumption first of the one particular haystack. Lespedeza hays fertilized with lime and phosphate were selected in the field by cattle and sheep.

Feeds selected are higher in nutritional values.

Such hays put under test as feed for sheep were more efficient lamb producers when phosphate only or lime and phosphate together had been applied to the soils growing this feed. Lespedeza and soybean hays from soil given only phosphatic fertilizers were over 50 percent more efficient in growing body size but also in growing wool of better quality. Wool from sheep fed lespedeza hay grown on soils given only phosphate could not be scoured and carded. When scoured, it consisted of broken fibers in contrast to excellent wool that carded nicely when from sheep fed on hays grown on soil given both lime and phosphate. Such is testimony that the physiology of the sheep depends on the physiology of the plants serving as feed. It is the soil fertility that is the foundation of the physiology or function of all the life dependent on it.

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Fecundity of animals depends on soil fertility.

The reproductive processes of the animals under experiment reflected the effects of the soil treatments through the hays. Sheep fed on timothy hay grown on soil given lime were in breeding condition as one-year-olds while those fed the similar hay grown without soil treatment were not. Lespedeza hays grown similarly on the soils with different treatments registered their disturbing influence on the semen production of male rabbits. The hay from soil with no treatment serving as feed for sexually active male rabbits caused them almost to lose the capacity of semen production and induced their indifference to the female in oestrus. When returned to the feedings of lespedza hay grown on land given lime and phosphate, it required only three weeks to restore their normal male vigor and normal sexual behavior.

Breeding powers have not been linked so commonly with the quality of the feed according as that quality is dependent on the fertility of the soil. Nor have they been connected with protein contents and mineral contents of feeds as controlled by the soil fertility. It is impossible to connect animal fecundity with feed quality dependent on the fertility elements in the soil if those elements do no more than merely increase plant bulk or the carbonaceous character of it. We have long recognized that fattening feeds do not improve, but rather hinder and even destroy, breeding powers. It is not generally recognized that declining soil fertility induces changes in crop compositions; that such decline encourages carbonaceous more than protenaceous properties; and that such changed properties of feed are responsible for lower breeding powers in our domestic animals. Instead, new males are commonly purchased and artificial insemination has been called in for its multiplying power of the male in terms of numbers of females served. We have given repeated emphasis to the fact that the male is half the herd. Such emphasis on one animal as half lets us forget that breeding cannot proceed without the other half, namely the females. This over-emphasis disregards the low fecundity of the poorly nourished females whose failure to produce good egg cells in readiness for conception is not cured by merely plying them with more semen. Such trouble calls for better nutrition of the females in terms of more fertile soils. Reproduction is a matter of good nutrition of both female and male. Neither half can fulfill its share of the performance unless it is well nourished.

Ecology in terms of soil fertility must guide wildlife management.

Unfortunately, the science of soil did not precede the art of farming. Instead the former is following slowly after the latter. The various cropping successes and failures have been helps in building our knowledge of the soil. They served as postmortems to point out where the fundamentals of our soil knowledge can now guide the wiser placement of the crops of plants and likewise our crops of wildlife. The program of wildlife management in Missouri is going forward on that premise. Wildlife is no longer independent and at the top of the biotic pyramid as it was in the virgin country. It has fallen under man's dictates. It will survive only as we use our information and means to direct wisely the growing of a wildlife crop just as we direct the growing of any other crop. All these crops depend on the soil, and our management of the soil will favor or hinder the wildlife just as it favors or hinders the other crops we desire.

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In the ecological pattern of any form of life certain soil areas or regions support it more favorably than others. We have been slow to consider the soil as the factor exercising the favor in terms of the better food it provides. We were prone to magnify the rainfall, the temperature, the cover, as separate factors more than to recognize the soil as it results from the climatic forces and thereby the soil as control of growing the food and the shelter. Now that the soils in lower rainfall are recognized as producers of mineral-rich, proteinaceous feeds we can see why herbivorous feeders like buffalo and cattle grow and reproduce there on the scant prairie vegetation. Then when soils under higher rainfalls and temperatures are of low fertility and produce only forest vegetation we can see another type of wildlife that must be omnivorous and carnivorous. We can understand why such an area is the region for the fattening of cattle more than for growing them. We can understand why the wildlife there is in such grave danger of extinction, expecially when the limited areas of better soil like lowlands are under intensive arable use. If wildlife is to survive the soil must become the basis of wildlife management like it must be for any other crop management.

Soil pattern of Missouri is the wildlife pattern.

The significance of the soil is emphasized by the fact that "a single soil type, the Clarksville stony loam, now supports 79 percent of the turkeys in Missouri. This soil, of residual limestone origin, is characteristic of the very rugged and completely dissected parts of the Ozark Plateau. Only 40 percent of it is farmed. The Clarksville gravelly loam in the same soil series supports 15 percent of the turkeys making a total of 94 percent of the birds in the state occurring on these two soil types within a single soil series. With 70 percent of the gravelly loam under cultivation, turkey populations on this second soil type in this series are on the decline". (A. Starker Leopold and Paul Dalke. Jour. of Forestry 41:428-435, 1941).

The soil fertility pattern of Missouri can well be the geographic pattern for wildlife of the state as it is and must be for domestic animal life. This has been demonstrated by feeding trials using lespedeza forage, grown on the five major areas of Missouri, brought to Columbia, and fed to rabbits (Belgain hares). The forage from the different soils grew rabbits with a wide variation in efficiency for a given feeding period. The Grundy soil (Northwest Missouri corn area) produced 637 grams gain; Lintonia (Southeast Missouri lowlands) 561 grams; Eldon (Western Missouri prairies) 505 grams; Clarksville (Ozarks) 420 grams; and Putnam only 316 grams. These soils arrange themselves in this same order, except for the Putnam, when one considers the calcium and the phosphorus of the feed retained in the rabbit body. These figures are the arrangement in order of the relative values of these soils as producers of rabbits. This is not the order in which one might arrange them for agricultural production when topography and other features commonly considered important are used in grouping them. Soils can no longer be classified in terms of productive capacities using bushels or tons per acre as the criterion. We must classify soils, not in terms of fattening power of adult animals, but in terms of a much more critical classification, namely, the capacity to reproduce and grow animals.

More fertile soils mean more wildlife.

The size of the wildlife crop can be taken as an indicator of the productivity of land just as we use a corn crop and say "this is forty bushel corn-

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land or this is fifty bushel corn ground." Using Jasper Coun[illegible]issouri, with the two prominent soil types, Gerald and Cherokee as illustrations, Mr. Wm. D. Shrader of the Federal Bureau of Plant Industry, Soil Survey Division, has taken the data of various wildlife harvests, that is quail, rabbits, opossum, skunk, muskrat, coyote, and mink, in a season and evaluated these two soils in terms of acres needed as support per animal or bird of the wildlife crop. The Gerald soils produced one animal or bird per every 16 acres while the Cherokee produced one such only on 41 acres. Both soil types are similar in most respects as commonly observed, except for the generally accepted higher productivity or more fertility of the Gerald. The wildlife crop confirms this commonly accepted difference. Thus there are plenty of reasons for believing that the soil types of the State of Missouri arranged in order of their fertility or productivity of feeds for domestic animals are likewise an arrangement of them in order of their capacity to give us a crop of wildlife. They suggest then that wildlife management for the production of this crop is premised on the soil fertility in like manner as is the production of feed crops and of our domestic animals.

Summary

In the summary the matter of wildlife management for its production is not much different than the production of domestic animals, except for the advantage of the fact that the former is not handicapped by its enclosure within the farm fences It can exercise its self-regulatory choice of feed and escape some bad management, even though it is being crowded into more and more restricted territory The soil fertility is the raw material by which we run a wildlife factory, and the product put out by it is no more numerous and no better in quality than is allowed by the stock of raw material in the soil for growing it Then, too, our management cannot exert much compulsion since Nature is slow and cannot be readily stampeded. Wildlife must grow and multiply itself in place. It cannot be multiplied by merely transplanting. Exploitation of the crop of wildlife is rapid. Rebuilding and reestablishment are slow Our soil resources have been dwindling rapidly. Their decline has been a powerful force pulling the crop of wildlife down at the same time. Wildlife management must become a party in the great cause of better soil management and in conservation of the soil, since only by that means can wildlife be on secure basis for conserving and rebuilding the object of the hunter's great desire, namely, a good crop of game.

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