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CHAPTER 12. WILDLIFE DAMAGE, DEPREDATION AND PREDATION

Wildlife sometimes have detrimental effects on the success of farm operations. Since these effects result in both direct and indirect costs to farmers, an understanding of their impacts is important in order to promote good wildlife management on farmlands.

The CHAPTER title contains three terms representing the effects of wildlife on farm operations. Dictionary definitions of these three terms are general and somewhat repetitive. The specific definitions in the next three paragraphs provide contexts for the use of these terms.

Wildlife damage refers to the permanent damage of agricultural crops by herbivores, affecting the vigor and productivity of the crop. Deer browsing in a young apple orchard is a good example of wildlife damage.

Wildlife depredation refers to the plundering of crops that are about to be harvested. Flocks of ducks feeding in ripe grain fields is a good example of depredation.

Wildlife predation refers to the killing of livestock by carnivores. Coyotes killing sheep is a good example of predation.

Wildlife are part of the farm scene, and are usually appreciated for the enjoyment offered to the farm family. Farmers are usually willing to tolerate the effects of wildlife on their crops and livestock, providing the effects are not great enough to cause significant economic losses. Different kinds of farm operations are susceptible to different effects and economic losses. A dairy farmer, for example, is more tolerant of deer feeding in his alfalfa field than a fruit grower would be of deer in the orchard. Deer in the alfalfa field affect the farmer's dairy production unit--cows--indirectly, but deer in an orchard affect the fruit grower's production unit--trees--directly. The dairy farmer would be no more tolerant of a carnivore killing a cow than a fruit grower is of an herbivore killing a fruit tree.

TOPIC 1. WILDLIFE DAMAGE

Wildlife have the potential for causing damage to farm crops and livestock because they all share the same space. Different kinds of damage occur to different kinds of plants at various stages in their life cycles. Pheasants sometimes pull up emerging corn seedlings. Raccoons can do considerable damage in corn fields that are close to creeks, streams, and marshes as they break down the stalks to reach the ears, remove the ears from the stalks, and feed on the soft kernels. Blackbirds move in to corn fields in late summer by the thousands, eating the kernels on the tips of the cobs. Cottontail rabbits gnaw on the bark of young trees, as do voles. Gindlings of seedlings usually kills them.

Deer graze in hay fields and small grain fields, and they may also damage immature corn by taking just the corn silk off the very young, developing ear. Deer also feed on soybeans, damaging the plants by eating the leaves and sometimes selecting just the flowers. They are also attracted to vegetable crops, eating parts of the foliage. In winter and early spring, deer may browse heavily on orchards, eating the twigs, or current annual growth, from the previous growing season. Deer also graze on hayfields, especially in the spring and after each cutting when there is a new crop of tender leaves and shoots available. These are a few of many examples of wildlife using agricultural resources for food; each example results in economic loss to the farmer.

UNIT 1.1. WILDLIFE DAMAGE TO ANNUAL AND PERENNIAL CROPS

Whenever wildlife use agricultural resources as a source of food, there is a potential for damage resulting in significant economic losses. These losses may occur before the crop even germinates, while it is growing, when it is mature, and after it has been harvested.

Ring-necked pheasants will pick up seeds and germinating corn sprouts in the spring, which can become a significant economic problem in some areas (see West et al. 1969); between 2 and 3% of corn plants were pulled, amounting to about 3 bushels per acre of production.

Long-term damage to perennial crops is a serious concern to farmers. Deer damage to orchards is potentially one of the most concentrated and severe kinds of wildlife damage to a particular agricultural enterprise. When fruit trees are browsed, their productivity is directly reduced. Cottontail rabbits gnaw on the trunks and clip off the twigs of fruit trees (Caslick and Decker 1978). Deep snow enables the rabbits to reach twigs at heights of several feet some winters. Damage by herbivores to the productive unit, a tree, in an orchard is comparable to predation by a carnivore to the productive unit, a cow, in a dairy herd. The removal of a productive unit affects both short-term and long-term production.

Deer damage to orchards is particularly costly because of the long rotation of orchard trees. Newly-planted trees do not produce fruit for several years; they are an investment that must be cared for and maintained for about five years before yielding any economic return to the fruit grower. During this time, the trees are small, and most of their buds and twigs are within reach of deer. If the productive life of an apple tree is 25 years after a 5-year propagation period, then about one-sixth of the orchard acreage must be in the propagation stage when it is particularly subject to deer damage if the orchard is to be maintained over a long time period.

Another recent complicating factor in orchards is the tendency to use dwarf and semi-dwarf trees rather than the larger standard trees. The smaller trees, planted with a density up to 750 trees per acre, have a large proportion of their buds within reach of deer throughout the productive life of the tree (Figure 12-1). Thus, if deer damage is expected, production losses are also expected, and questions of the net benefits of control methods must be considered.

Figure 12-1. Dwarf and semi-dwarf apple trees (left) expose a higher proportion of the buds to deer than the larger standard trees.

The extent of wildlife damage to agricultural crops should be determined by objective methods that yield results which can be interpreted directly by the farmer. The calculations of Katsman and Rusch (1980) are an example for apple production. Simulated deer browsing on apple trees demonstrated expected effects on production, and regression equations were derived for predicting blossom or apple ratios from the number or percentage of the twigs snipped. Another example for deer damage to alfalfa follows.

A New York State biologist described a situation in his region where a farmer claimed that deer were doing several hundred dollars damage to his alfalfa field. Was that possible? Was it a reasonable estimate? When the question was posed to me personally, I asked the following questions.

1. The area of the state and general condition of deer there.
2. Number of deer feeding in the field regularly.
3. Duration of time (days) they were using the alfalfa field.
4. Expected reproductive rate of deer in that area.
5. Expected sex ratio of the deer in the alfalfa.

The above questions yielded enough information to:

1. Estimate the weight of deer in that area at that time of year (see Moen and Severinghaus 1981).
2. Estimate the MBLM of such a group of deer
3. Calculate metabolic costs per day.
4. Estimate metabolic costs over that time period.
5. Calculate forage required, knowing digestibility of alfalfa (see Chapter 6).
6. Convert to dollars, knowing the value of alfalfa hay.

The result? The deer could cause damage of $400-500 in the situation described. The steps taken to derive the estimate were clear and understandable to both biologist and farmer.

This procedure is indicative of the kind of logic that may be used to derive cost estimates of wildlife damage. Note that the calculation was based on animal requirements and resources needed to meet those requirements. If field surveys of alfalfa damage had also been made, documentation of both the amount of damage and the biological explanations for it would be complete. This is a new approach, however. Reed (1981:515) writes concerning mule deer:

> "Despite abundant claims of damage, little attention has been given to quantifying the net economic impact of forage eaten by mule deer."

The amount of forage required by deer may be estimated quickly with the nomogram below (Figure 13-2). It is similar to the nomogram in Figure 6-8 (page 115), except that the values for ELMD range from 0 to 10,000 kcal per day, characteristic of deer.

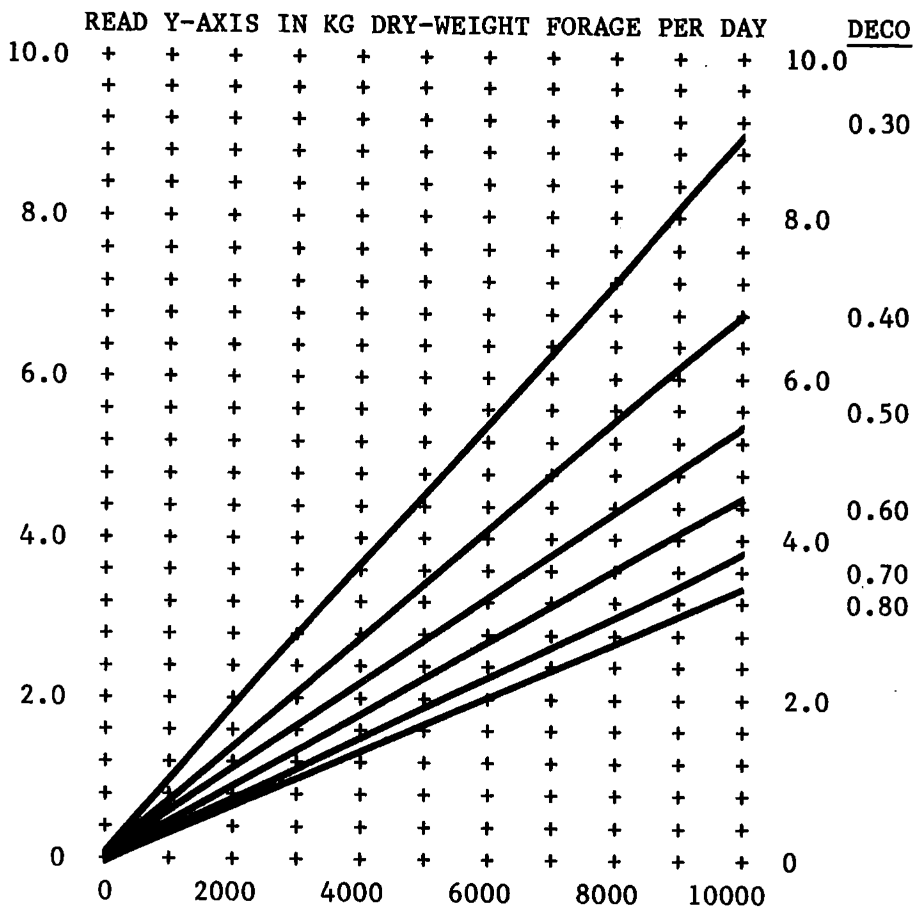

Figure 13-2. Forage intake by deer (kg per day) may be estimated quickly with this nomogram by knowing ELMD and DECO.

UNIT 1.2. CONTROL MEASURES

Wildlife damage control is best accomplished by preventive measures rather than remedial ones. Preventive measures may include management of fields and habitats in ways that direct and retain wildlife where they do not cause problems. Fences are sometimes the only way to deter them. Deer, for example, are kept out of orchards in the spring only with the considerable effort and expense of a fence. An 8-foot high woven wire fence is the best, but it is very costly to erect and maintain. Deer silhouettes showing the white flag (tail) as a warning signal have been successful in reducing car-deer collisions in Pennsylvania (Bashore 1975), but these silhouettes were not effective in keeping deer away from desired feeding sites in trials at the Wildlife Ecology Laboratory near Ithaca, N.Y. (Moen 1982). Flashing reflectors, human hair, blood, and other devices and materials have been tried as deer deterrents, with varying success. Some of these may evoke more curiosity than fear, attracting the deer rather than frightening them away.

Loud sounds, such as exploding devices that sound like gunshots have been tried and used with some success in keeping birds away from certain areas. They tend to lose their effectiveness in time as the animals find no chase, damage, or injury to be associated with the sounds.

One unique way to control red-winged blackbirds is the use of a fright-producing chemical which illicits distress cries and aerial distress displays by the affected birds (De Grazio et al. 1971). This approach, capitalizing on bird behavior rather than direct mortality as a control measure, deserves further attention, along with non-toxic repellents (Schafer and Brunton 1971).

About the only way to effectively prevent white-tailed deer damage to high-density, high-value crops such as orchards is by fencing. The pertinent question is what of kind of fence. Woven-wire fencing is very expensive to install and maintain. Electric fencing is much less expensive, but must be designed properly in order to be effective.

Vertical deer fence must be at least 8 feet high to prevent deer from jumping over. High-tensile wire fencing used for cattle pastures may be used for deer exclusion, but it must be higher than for cattle (Figure 12-3). The wire is stretched to maintain 200-250 pounds of tension, which requires large and very sturdy corner posts. Smaller line posts may be used since they serve mainly to hold up the wires (Selders et al. 1981).

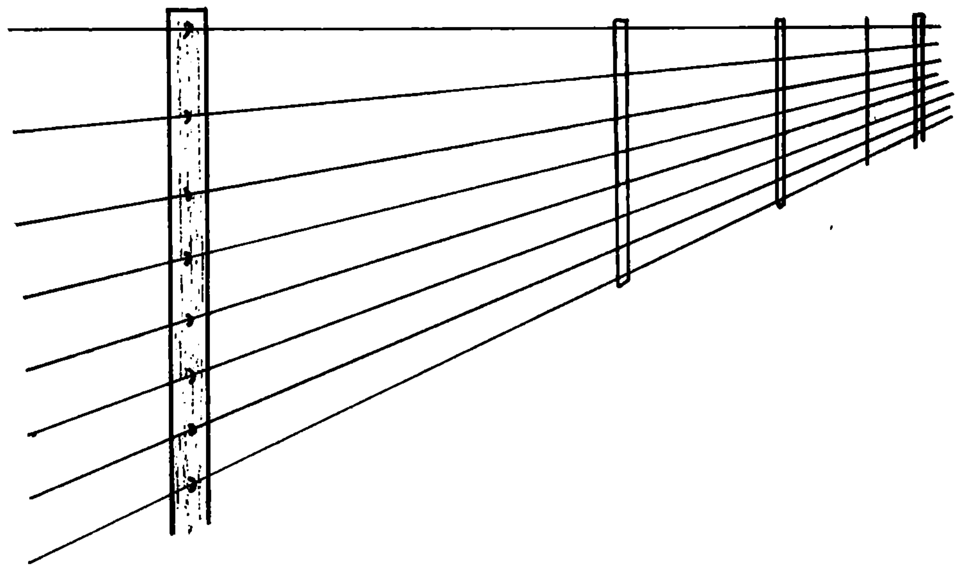

Figure 12-3. A high-tensile vertical fence which may be non-electric or electric. It must be at least 8 feet high to exclude deer.

Five designs for deer-excluding fences are listed in Table 12-1, with cost estimates. They are illustrated in Figure 12-4.

Table 12-1. Deer pressure, fence design, and cost estimates of five deer-excluding fence designs. (Data from Selders 1981* and McAninch 1982).

Deer Pressure	Fence Design	Cost Estimate ($ per foot)
Low	7-wire double, electric*	
Low-medium	3-wire low profile electric	0.35-0.40
Medium	5-wire, mesh, non-electric	to $1.00
Medium-high	7-wire, slanted, electric	0.60-0.80
High	Vertical 8-foot-high woven	2.25-3.75

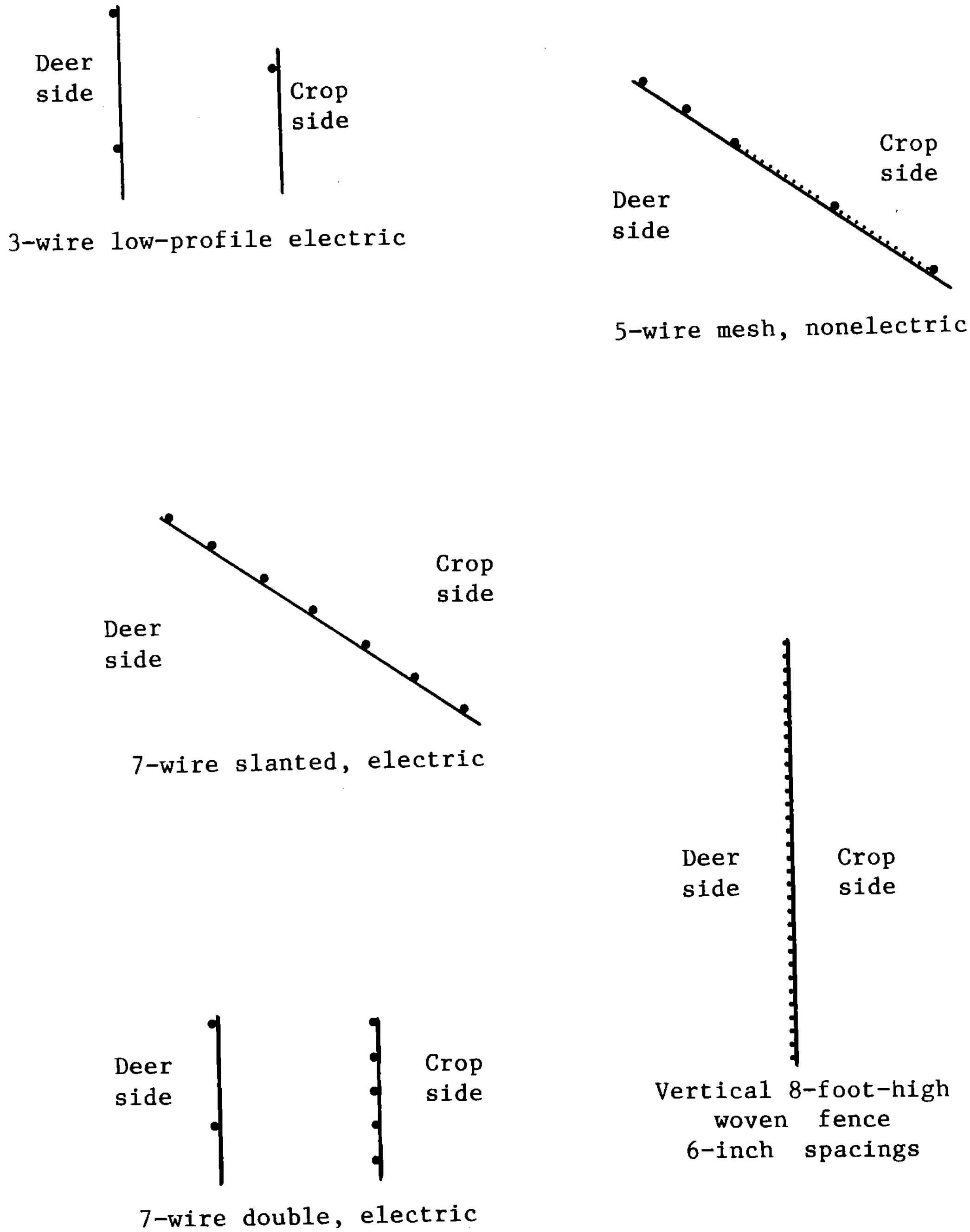

Figure 12-4. Sketches of five deer-excluding fences. See Table 12-1 for additional details.

The cost of fencing on a per-foot basis should be converted to costs per acre or costs per tree for the orchard-grower. An acre contains 43,560 square feet, and is 209 feet on each side when square. Thus, the total amount of fence needed to enclose one acre laid out square should be 836 x 0.35 upto 3.75 , which equals $293 up to $3,135 using minimum and maximum figures given in Table 12-1. Fences are not an annual expense, of course, but should last for 25 years. Thus the per year cost would be $12 to $125, PLUS maintenance.

Commercial orchards are not fenced in small one-acre squares.The distance around squares up to 10 acres in area are shown in Figure 12-5. Keep in mind that equal-sided rectangles have less perimeter than unequal-sided ones; a 10-acre area 3 times longer than it is wide has a perimeter of 3048 feet, compared to 2640 for a 10-acre square.

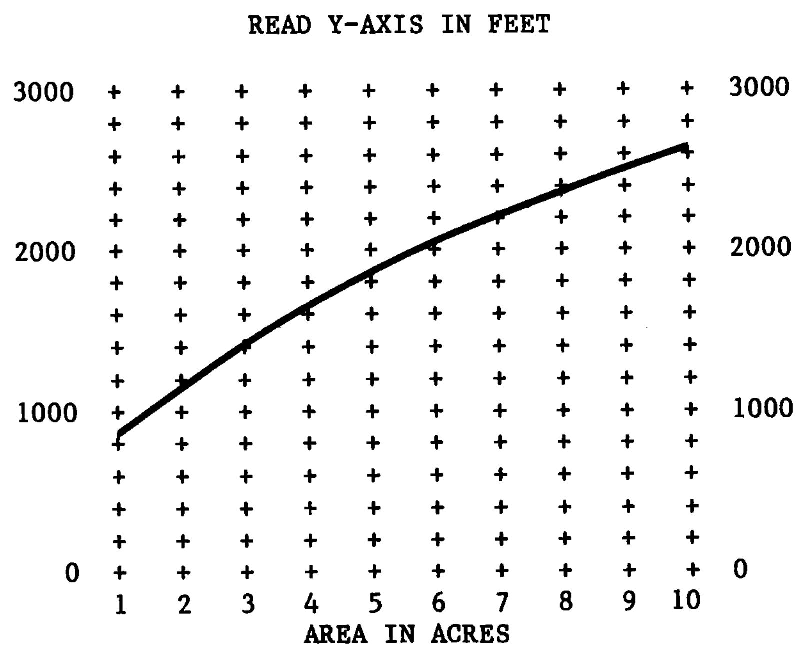

Figure 12-5. Relationships between length of the perimeter and area in acres for equal-sided rectangles.

A formula for determining the annual cost of fencing on a per tree basis, given in Caslick and Decker (1979), has been modified as follows:

$$C = ((P)*(F)*(2.06))/((A)*(d)*(10))$$

where C = annual cost in cents of protecting a tree,
P = perimeter of the area,
F = cost in cents of labor and fencing materials used,
A = area enclosed (in hectares), and
d = density of trees per hectare.

The cost per tree can then be related directly to production and gross return per tree, making it possible to estimate the net benefit of protection by fencing, similar to the calculations of net costs of dairy and beef cattle were made in CHAPTER 9.

TOPIC 2. DEPREDATION

Crop depredation is a serious problem in some areas. Blackbird depredation may be particularly severe when the corn fields are close to roost sites. Literally hundreds of thousands of blackbirds may roost in marshes in the fall as broods from the surrounding area flock together before migrating. These flocks will fly out as a black cloud into a cornfield and feed, with thousands of birds descending on a single field at one time.

Depredation by trampling by waterfowl is another form of loss that may be severe under certain conditions. Grain that is in swathes or windrows before being combined is particularly susceptible to trampling by field-feeding ducks and geese. The birds fly out of the marsh on feeding flights, land in the grain fields, feed on the grain, walk on it, and defecate on it. If wet weather prevents harvest, the depredation can become very severe as migrating flocks build up in certain areas and the economic loss to a few individual farmers great.

UNIT 2.1. DEPREDATION ON GRAINS

Red-winged Blackbirds are well-known for liking corn in the "milk stage," when the kernels are filling out but not yet dented and hard. Then, blackbirds feed by landing on the stalks, picking the husks open and feeding on the kernels on the ends of the cobs. The birds move from cob to cob, spoiling 5 to 10% of the kernels. Corn was the most abundant component of their diet in Ontario from July 21-September 3, with the amount of corn damage dependent on the stage of maturity of the corn (Gartshore et al. 1982.)

Alternate sources of food, such as weeds, did not affect the amount of damage to the corn as it was such an abundant and convenient food source. Blackbird use of cornfield habitats increased from the end of July to the end of August, and then decreased in the premigration and migration period in September and October (Johnson and Caslick 1982). Roosts of 3.5 million birds were reported by these authors in upstate New York.

The amount of depredation, expressed in bushels of grain and therefore dollar loss, is often difficult to determine. The approach described by De Grazio et al. (1969) for appraising blackbird damage to corn is an excellent example of the kinds of methods that should be developed. They sampled ears of corn to determine the relationship between length of the cob and weight of the kernels. Regression equations were derived and a table generated with the numerical values; sample data are shown in Table 12-2.

Table 12-2. Sample data (weight in gms) indicating how the table in De Grazio et al. (1969) may be used to estimate the amount of corn lost to blackbird depredation.

Length of corn on ear (inches)	Length of damage (inches)			
	1	3	5	7
5	7.9	42.8	81.4	-
7	8.5	44.8	87.6	128.6
9	7.0	43.1	91.1	143.2
11	6.4	44.3	97.3	160.1

Damage assessments may be made as follows:

1. Record the number and the total lengths of damaged ears, and the length of damage on each.

2. Estimate weight in grams from Table 12-2.

3. Convert grams to bushels (one bushel of shelled corn weighs 25.4 kg).

The amount of damaged corn may be divided by the expected production to determine the fraction of the expected crop destroyed by blackbird damage.

UNIT 2.2. DEPREDATION ON HAY

Depredation on hay is a problem associated with elk and mule deer management in western states. Elk often do extensive damage to haystacks on farms and ranches as the hay becomes a readily available source of food during winter concentration. Such concentrations are characteristic of elk, which migrate from their summer range at higher elevations down to lower elevations in the winter. Since farms and ranches are found in the valleys, they become susceptible to elk damage at a time when the supply of natural foods is low. Elk become quite tame too, and are willing to associate closely with farming activities at that time. Haystacks are best protected by high mesh fences (Murie 1951).

Mule deer are also a significant cause of depredation in the western states. Since they are migratory like elk, large winter concentrations occur, with the potential to cause significant economic losses to haystacks and other agricultural products. The amount of damage depends to a large extent on weather and snow conditions, and the availability of natural forage. It is important to realize that migratory herds of both mule deer and elk concentrate at low elevations where agricultural enterprises occur, so the potential for damage remains as long as the populations are high.

TOPIC 3. PREDATION

Predation on both domestic and wild species has been a controversial subject for many years. An often-held notion is that predation is simple subtraction, and if it didn't occur, there would be that many more animals in a population. Ecological relationships are not quite that simple, however.

One of the points discussed in CHAPTER 13 is that a diversity of habitat types is good for wildlife, including both predator and prey. Leopold (1933) wrote about this when farming methods and agricultural technologies were nothing like those used today, and diverse habitats were the rule rather than the exception.

Habitat diversity will be discussed in the next CHAPTER, but it may be pointed out here that habitat diversity may make predators less efficient. Experimental evidence for that conclusion is sparse because of a lack of controlled studies. Bowman and Harris (1980) demonstrated that racoons spent more time searching and the number of randomly-placed bobwhite dummy nests found per unit time decreased as spatial heterogeneity (habitat diversity) increased. Experience reduced search time. Such has results are of interest to farmers and wildlife biologists as farm habitats are becoming less heterogeneous, with more specialized enterprises and large areas of land used for single enterprises.

UNIT 3.1. PREDATION ON LIVESTOCK

Predation on livestock has always been an emotional issue, and will continue to be so as long as predators use domestic livestock as part of their food base. The amounts of predator losses are dependent on the habitat characteristics for wildlife and the management techniques used by farmers.

How significant are livestock losses to predators? Summer sheep losses in Montana totalled 3.7% of the grazing population (576/15707), with about 34% of the losses due to black bear, 15% to grizzly bear, and 6% to coyote predation. The other losses were attributed to diseases, poison plants, and poor herding techniques (Johnson and Griffel 1982).

There has been controversy over the years concerning the identity of individual predators which cause livestock losses. Radio-tracking has make it possible to study the movements and behavior of individual animals, and has made it much easier to gather specific data on individuals in studies of mortality. While 8 coyote family groups lived within 5 km of a turkey farm in Nebraska, only 3 of 19 coyotes were thought to be responsible for turkey losses (Althoff and Gipson 1981).

Robel et al. (1981) suggest control of individual coyotes as an effective way to reduce predator losses. They also suggest several sheep management techniques that will reduce sheep losses to predation under farm-flock conditions. These suggestions include night confinement, day and night confinement, installation of mercury-vapor lamps over corrals, and erection of predator-proof fences around corrals. Unfortunately, none of these were evaluated on a net cost basis. If the amount and type of fencing required were given, the number of lights required, the number of sheep and the costs of confinement in terms of both feed and labor were given, then current prices could be used to evaluate the net cost in relation to observed losses to predators of less than 1%. The average number of losses per producer was less than 5 sheep out of an average flock size for the study period of 445 (calculated from data in Robel et al. 1981). This percent loss is less than the 3% and 1% reported by Schaefer et al. (1981) for losses to coyotes and dogs, respectively, in Iowa.

An extensive radio-tracking study of red fox in east-central Minnesota showed that fox territories often conformed to natural physical boundaries (Sargent 1972), which suggests that some farms will be more prone to predation losses than others as a result of physical features which provide more suitable fox territories. Is there not considerable potential for rating agricultural areas and individual farms for their predator potential? Such an evaluation system is needed as predator control moves from a general, widespread philosophy to a species- and individual-specific management technique. This is a move in the right direction, and one which would benefit from more detailed knowledge of predator, prey, habitat characteristics, and management techniques.

UNIT 3.2. PREDATION ON WILDLIFE

Predation on wildlife has been an emotional issue over the years, just as predation on livestock has been. The general trend in thinking has gone from one extreme to the other; from thinking that predator control would be of distinct benefit to wildlife populations to thinking that predators have little effect on wildlife populations. Actually, these two extremes are not directly comparable. It seems, from the evidence accumulated over the years, that predator control is not an effective way to increase wildlife populations, but that predators often do affect wildlife populations. This apparent paradox needs to be explained further.

Large-scale but low-level predator control has little or no impact on predator populations and their prey bases. If anything, it is probably beneficial to the predator populations by reducing competition for prey. Small scale but high-level predator control is effective in reducing predator populations. The effectiveness of such reduction in predators is reflected in short-term periods of higher wildlife productivity.

Balser et al. (1968) demonstrated that 60% more ducklings were produced on the part of the Aggassiz National Wildlife Refuge in northwestern Minnesota where intensive predator control was practiced compared to the no-predator-control part of the refuge. The authors recommend, however, that several aspects of predator control practices be given careful consideration before establishing predator control policy.

> ". . . until more is known, reduction of predators to increase waterfowl nesting success should be limited to intensively managed production areas where substantial nest losses are demonstrated."

Farms do not meet the criterion of "intensively managed production areas" for wildlife. They are just such areas for domestic livestock, and predator control may be desired on farms that are subject to high losses from predators.

Chessness et al. (1968) compared pheasant nesting success on trapped and untrapped areas in Minnesota, and demonstrated that hatching success improved on the trapped area over a 3-year period, reaching 36% in the Third year. Some readers are undoubtedly surprised at that low value--36%--even with intensive predator control. On the untrapped area, hatching success remained at about 16% each year.

Two important conclusions were reached from their study. One, the cost of predator control was $4.50 per extra chick hatched in 1960-64 (probably 10 times that now), and two, the effect of predator removal did not carry over from one year to the next. Predators have the biological potential to rebound quickly from low populations, due to the number of transient individuals who may travel long distances looking for available territories and their high reproductive potential.

A key phrase in the evaluations of Chessness et al. (1968) of the effectiveness of predator control is "per extra chick hatched." This needs to be explained further and understood fully in order to put predator control, or any management practice, into perspective. The cost of predator control was not divided by the total number of pheasant chicks hatched on the predator-controlled area, but rather by the difference between the number hatched on the predator-controlled area compared to the area with no predator control. This gives a true measure of the cost of predator control in relation to the benefits derived from it--in this case the benefit being measured by the extra number of chicks hatched. The same logic must be applied to determine the net benefit of animal-damage control or livestock-predation control. It is the net increase in production that is important.

It has been customary to think of predation in a one-on-one way, such as "fox predation on pheasants." Larger considerations are more desirable, and help put predation into perspective. Sargent (1978) evaluated diets, feeding rates, growth rates, and denning periods of red fox litters, and pointed out the large prey demands at that time. His concluding paragraph (page 526) begins with an important perspective:

> "It is common practice to equate a small percentage of a particular prey in a predator's diet to a small impact on the prey population. These calculations for red foxes suggest, however, that because of large prey demands, a small percentage of duck in the foxes' diet can be of consequence to particular (duck) populations."

Important directions for future work may be gained from the above statement. Predators and their prey must be studied in the larger ecological context rather than as one-on-one relationships. Also, metabolizable energy rather than food habits, number of prey, percents of diet, etc., need to be evaluated over time periods of biological significance, such as denning periods.

What is the metabolic energy requirement of a red fox? Caloric intake cannot be compared directly to other species because of differences in body sizes, diet components, and diet digestibility and assimilation efficiencies. A study of red fox bioenergetics (Vogtsberger and Barrett 1973) provides some facts about growing pups that may be used to calculate the multiple of base-line metabolism (MBLM, see Chapter 6) and make comparisons with other species. These facts include:

1. Average ingestion = 223 Kcal/kg body wt/day,
2. Assimilation efficiency = 91%, and
3. Weights given ranged from 2.5 to 4.2 kg.

Using the formula described in CHAPTER 6 for calculating base-line metabolism--MBLM = ELMD/BLM--the following calculation may be made for a 2.5 kg pup:.

MBLM = (223)*(0.91)*(2.5)/(70)*(2.5**0.75) = 3.65

and for a 4.2 kg pup:

MBLM = (223)*(0.91)*(4.2)/(70)*(4.2**0.75) = 4.15

How do these values of MBLM--3.65 to 4.15--compare to those of other species? They are similar to high-producing free-ranging beef cattle and sheep, white-tailed deer (Moen 1981) and to hard working horses (see CHAPTER 6). The relatively small amount of energy partitioned into growth of fox pups suggests that a large amount is partitioned into maintenance and activity. Sargeant (1978) refers to "much play" of pups and adults as "highly active." Thus an MBLM of about 4.0 may be readily explained by more activity and less tissue production characteristic of a carnivore compared to relatively less activity and more tissue production characteristic of an herbivore. The compensating effects of activity in relation to production are interesting in relation to an MBLM of 4.0, which I consider a reasonable upper limit for free-ranging animals. A value of 5.0 may be used if one wants to be sure that peak energy requirements are not being underestimated.

TOPIC 4. THE CONCEPT OF COST SHARING

Should individual farmers be subject to periodic heavy losses incurred by wildlife, such as depredation by migrating waterfowl? Such losses are different from the rather stable and small quantity of background costs that come with the support of resident wildlife. Concentrations of ducks and geese often result from the establishment of wildlife refuges that encourage such concentrations. Farms in areas where refuges are established may suddenly be faced with depredation problems, and it is unreasonable to expect farmers to contribute a significant portion of their crops to the public's wildlife. If the farms were there before the refuge, the "first-use" principle should be applied, providing the farmers who are subjected to losses as a result of establishment of a refuge the protection and economic recovery necessary.

On the other hand, if an established refuge borders some land that is later developed for farming and becomes subject to depredation, the "first-use" principle applies to the refuge.

It is important to establish refuges and management areas with first-use considerations in mind, because wildlife resources are too valuable to be used as instruments of destruction, hard feelings, and lawsuits. The farmer's perspectives need to be respected and considered when planning and implementing wildlife practices. How much better it is to encourage farmer and landowner participation in the improvement of wildlife habitat, providing incentives as necessary, rather than finding wildlife resources restricted to refuges, which are at most only islands in a larger area of farmland.

UNIT 4.1. DIRECT AND INDIRECT PUBLIC ASSISTANCE

Public assistance to farmers suffering the effects of wildlife depredation may be made directly through compensatory payments, or indirectly through preventive measures. Both kinds of assistance have been provided in the U.S., often in association with other soil and water conservation programs.

One example of direct assistance to farmers that greatly benefited wildlife was the soil bank program of 20 years ago. Farmers were paid on a per- acre basis to take land out of crop production and put it in long-term soil-building cover crops. Thus sweet clover (*Melilotus* spp.) and other legumes were planted on large numbers of acres, and the higher nesting success reported for "retired cropland" (see CHAPTER 11) is a reflection of wildlife benefits accrued.

Large concentrations of wintering waterfowl in southern states resulted in depredation levels sufficiently great to establish legislation in 1948 which provided monies for the purchase of national wildlife refuges to be managed specifically for wintering waterfowl (Salyer and Gillett 1964). These kinds of preventive measures serve as indirect assistance to farmers who would otherwise suffer economic losss due to depredation, while providing public land for the enjoyment of the waterfowl and other wildlife. These long-term values were realized only as the land was purchased, thereby displacing farmers, which may not necessarily be the preference of the farm family. This brings up questions of the rights of individuals in relation to those of the state, and of public benefits. The most reasonable way to proceed with such programs is by legally establishing sources of funds to be used over a period of years for land acquisition. Then, wildlife management programs are built on mutual cooperation rather than power and misunderstanding. Effects of the latter often persist for a generation or more.

One form of indirect assistance that has been proven biologically for renewable resources such as wildlife, and for domestic species as well, is the annual harvesting of the surplus production. All livestock farmers know that, if they did not harvest their livestock herds in proportion to the annual production, the herds would increase in size to the point where the farm's resources could no longer support them. The same principle applies to many wild species, though it is much more difficult for various public groups to agree on the definitions of annual production, surplus, and methods of harvest.

Population control is not as simple as removing a certain number of animals from a larger number of animals. Elkwhich concentrate in a valley in the winter come from a much larger area of summer range. The winter range may be overpopulated, and the summer range underpopulated. How many animals should be removed? Or to what extent should effective protection measures be instituted on the winter range? I shall not answer these questions, but I will offer an academic and professional challenge to biologists and managers faced with such questions, regardless of species.

The challenge is this. Time is a most important dimension in ecology. How much information can you assemble and synthesize about the species of interest over successive annual cycles? Such information should include behavior patterns, physiological rhythms, changes in nutrient requirements, changes in nutrients available, reproductive rates for different age classes, population changes over time . . . and much more. Only after the above considerations are defined as exhaustively as possible are we in the most ideal position to make judgments concerning the necessity and net effect of particular decisions and management actions. The challenge is too big to meet perfectly, but striving to be perfect will bring us closer to perfection.

UNIT 4.2. PRIVATE ASSISTANCE

Private assistance to those who own or control large areas of wildlife habitat, such as farmers, has some desirable characteristics. Private assistance may be much more direct than public assistance, and more of the dollars provided go directly for management practices. The closeness of the source of income to its effect on the land has some benefits which routing of tax or other monies through the federal or state governments and then eventually back to a conservation program does not have.

What are sources of private assistance? Individuals, groups, private companies . . . all could be part of a conservation movement unlike anything ever experienced before if we as a nation had the desire to provide aesthetically-pleasing, quality wildlife habitat while maintaining necessary levels of food production. Farmers caught in the "cost-price squeeze" will of necessity try to produce more in order to maintain net income. If the public would recognize how low current food prices are relative to prices of other commodities and be willing to pay more for food and for greater habitat diversity, wildlife habitat would surely be improved.

The driving force behind conservation programs should be the benefits accruing to the natural resources. The interrelationships between wildlife and their habitats need to be understood in order to recognize these benefits, because they are not necessarily in direct proportion to the dollars spent on conservation programs. Doing the right thing is very important, but that is possible and only done when basic ecological relationships are understood, not from textbook experience, but from close association with the land and natural resources.

A large proportion of the population does not come into direct contact with the natural resources supporting agriculture and wildlife conservation. Berry (1977) takes issue with statements about people being spared the "drudgery" of being involved in their own food production, pointing out that such sparing results in loss of responsibility, pride, and quality in life, and a concommitant reduction in overall health. It is interesting that the United States has pro-ecology and anti-agriculture segments in its population while its people throw out as garbage an amount of food equal to the net income of the nation's farmers! If we would, collectively, see soil, water, air, plants, and animals as resources to be used and cared for in respectful ways, public and private assistance for their conservation would be ample.

TOPIC 5. SUMMARY

Wildlife on the farm obviously do not come free. They are an integral part of the farm scene. They provide enjoyment and recreation to the farm family, but they also have the potential to represent a substantial economic cost. Realistic cost analyses might well consider an alternative proposed by T. Moen (1982) that is applicable not only to coyotes but to many other species of wildlife as well:

> ". . . possibly better management of the coyote could be achieved by <u>less</u> management of the coyote and <u>more</u> management of the sheep."

Implementation of this alternative requires more public assistance in the management of domestic livestock, but this is very likely the only alternative if we are to have abundant wildlife populations and viable agricultural enterprises.

Familiarity with not only wildlife biology and ecological theory but also with the theory and practice of farming, especially the annual cycle of farm operations, will increase the understanding of farmers and wildlife biologists for each other. If society as a whole understood the dependence of all life on natural resources, improved habitat conditions for wildlife while maintaining necessary food production levels are both realistic goals.

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