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CHAPTER 13. WILDLIFE MANAGEMENT ON THE FARM

Farming is a way of life, but it must also be considered a business enterprise, specializing in the production of selected plants and animals. Plant production is enhanced by careful selection of genetic stock, and by providing a competition-reduced environment with an adequate supply of necessary nutrients. Mother nature supplies the sun, and some or all of the rain. Animal production is enhanced by careful selection of genetic stock, and by providing adequate food, cover and space. Farmers "husband" plants and animals, protecting and caring for them, giving them the highest priority for life and growth on their farms.

All farms are potential habitat for some kinds of wildlife, most farms are potential habitat for a few kinds of wildlife, and some farms are potential habitat for many kinds of wildlife. The wildlife potentials of different farms are important, because wildlife management begins with an assessment of the potential habitat for selected wildlife species, just as domestic animal production involves selection of suitable domestic species.

One important guideline to follow in the development of management practices on farms is that habitat improvement should be designed to increase indigenous populations rather than provide habitat for species that must be attracted to afarm, or stocked. This guideline seems elementary, but there are differences in the distribution of wildlife species due to variations in soil characteristics, water regimes, and nearby habitats. Thus, if there are quail in the area, habitat improvement for quail should result in more quail using the farm, and greater numbers of quail too.

"Game management is the art of making land produce sustained annual crops of wild game for recreational use."

The above statement is the very first in Aldo Leopold's classic book GAME MANAGEMENT, published in 1933. I shall alter the subject of the sentence and the objects in two prepositional phrases to make the following statement:

"Farming is the art of making land produce sustained annual crops of domestic plants and animals for business use."

Are not the above two statements in quotation marks reasonable? If so, then are we not practicing the same thing, but with different species and for different purposes? Leopold goes on to say, in the third paragraph of the first chapter of his classic book:

"Like other agricultural arts, game management produces a crop by controlling the environmental factors which hold down the natural increase, or productivity, of the seed stock."

Leopold then points out that the major differences between game management and farming are in the "degree of control" and the "seed stock" grown.

Earlier chapters in this book have contained information on the amount of control exerted by the farmer in order to maintain high yields of farm productsa major factor in decision-making in farm management. In this CHAPTER, a brief review of the basic needs of wildlife is given, followed by some specific examples of what can be done to produce sustained animal crops of wild game.

TOPIC 1. WILDLIFE REQUIREMENTS

Food, cover and space are the three basic requirements of wildlife. The requirements cannot be expressed as single values, however, since they change through time, and they are also different for different members of a population. This has been discussed in earlier CHAPTERS for domestic species, and wild species have sex- and age-related needs too. The needs of wildlife are not provided for by the wildlife manager in the same way the farmer provides for domestic stock, however. Wild species are under much less direct control; their needs are met by providing the necessary food, cover, and space, but allowing the animals free choice concerning what is used when.

Food, cover, and space resources change through time and space on the farm as a result of farming practices (see CHAPTER 11). A hayfield has heavy lush, green cover one day, and the next day when it is cut for hay the cover is reduced to stubble--leafless stems--about 3 to 4 inches high. When this happens on large acreages, nesting birds and species using the hay field for cover find themselves in an alien world, unprotected, and in need of greater security. Living in relation to the laws of the wild, they are subject to predation. They leave the hay field and move to nearby cover. Their food supply will be different, and they must adjust to these changes or die. Abandoned nests will not contribute to the population. Renesting attempts drain body resrrves from the female, and if young are produced, they must necessarily be younger when winter comes than the first-clutch offspring would have been.

Leopold's (1933) "Law of Interspersion" with regard to the distribution of cover is still a good basis for decision-making when considering the needs of wildlife. The benefits of interspersion are demonstrated in the simplest way in the schematic drawing in Figure 13-1. Note that equal acreages are present in both layouts, but in the four-square layout on the left, there are only 12 units of interior edge where different cover types meet, but in the 36 square layout on the right there are 60 units of interior edge where different cover types meet. Further, each type on the left borders only two of the three other types, but on the right each type borders all three of the other types.

Woodland	Cropland
Hayfield	Shrubland

W	C	W	C	W	C	W
H	B	H	B	H	B	H
C	W	C	W	C	W	C
B	H	B	H	B	H	B
W	C	W	C	W	C	W
H	B	H	B	H	B	H

Figure 13-1. The benefits of interspersion are illustrated by the differences in the amount of "edge" in these two layouts.

It is intuitively obvious that wildlife have many more habitat options nearby in the layout on the right than on the left in Figure 13-1. These options must be large enough to be viable, however, depending on the species. A quarter-acre woodlot is large enough for some species but not for others. The most appropriate criterion for determining minimum sizes of cover types is the behavior of the animal--the space it needs for its territory, its home range, and its propensity for travel for specific purposes such as feeding. Thus, the biology of a species--i.e., how it uses its habitat--is the important base-line information when making decisions that are intended to benefit particular wildlife species.

UNIT 1.1. FOOD

Food is present in abundance in standing ripe grain fields, but not readily available to small game birds. Then the swather comes through and lays the grain in windrows. Instantly, hundreds, even thousands of bushels become available to the birds. The combines come through the fields, cutting the grain or picking up the swathes. Then, waste grain covers the ground under the threshed straw. Food is abundant (up to several bushels per acre), and the grain stubble offers cover that protects from wind and conceals from predators. Then the tractors come with plows. The stubble is turned over, leaving exposed black soil with very little grain (less than 5% of the amount available before plowing). These changes occur on large acreages in just a day; wildlife habitats change drastically and rapidly on farms.

Gray partridge used harvested row crop habitats as a preferred winter habitat in eastern South Dakota, and Smith et al. (1982) recommended that row crop stubble should be left unplowed to preserve a preferred winter habitat and maintain food supplies.

Forage and feeds for domestic livestock were discussed on the basis of their gross, digestible, and metabolizable energy values in CHAPTER 6. It is encouraging to see wildlife food values presented in metabolizable energy values also since it is the metabolic energy derived from the food and not the weight or volume of the food that is important. Estimated waterfowl ME values in Kcal/gm dry matter of barley, wheat, and fall rye were 3.173, 3.526, and 3.336, respectiely (Sugden 1971). Metabolizable energy of bobwhite quail foods are given by Robel et al. (1979); foods rated "excellent" contained 4.3 to 4.9 Kcal/gm, "good" 3.5 to 3.9, "low" 2.7 to 3.5, and "poor" 1.4 to 2.5. Tabulations of published ME values are found in Table 13-1.

Table 13-1. Metabolizable energy in foods of game birds.

Food	ME(Kcal/gm)	Game bird	Ref.
Barley(3 varieties)	3.132-3.216	Mallards	3
Corn	3.861	Bobwhite	2
Crickets	4.882	Bobwhite	2
Dogwood	3.535	Bobwhite	2
Hawthorn,fleshy	2.185	Sharp-tailed grouse	1
Hemp	2.508	Bobwhite	2
Lespedeza, Korean	3.136	Bobwhite	2
Lespedeza, prostrate	3.415	Bobwhite	2
Lespedeza, shrub	2.693	Bobwhite	2
Locust, black	2.525	Bobwhite	2
Millet, German	3.466	Bobwhite	2
Oak, pin (acorns)	2.734-2.979	Bobwhite	2
Osage orange	3.554	Bobwhite	2
Partridgepea,showy	2.416	Bobwhite	2
Ragweed, giant	4.317	Bobwhite	2
Ragweed, western	3.878	Bobwhite	2
Rose, multiflora(hips)	2.018	Bobwhite	2
Rose, wood's	1.369	Sharp-tailed grouse	1
Rye, fall	3.336	Mallards	3
Silver buffalo berry	3.401	Sharp-tailed grouse	1
Smartweed	2.300	Bobwhite	2
Sorghum	3.508-3.706	Bobwhite	2
Sumac, smooth	1.369-1.590	Bobwhite	2
Soybean	3.776	Bobwhite	2
Switchgrass, blackwell	1.858	Bobwhite	2
Sunflower	3.649	Bobwhite	2
Thistle	2.701	Bobwhite	2
Western snowberry	4.427	Sharp-tailed grouse	1
Wheat	3.064	Bobwhite	2
Wheat (4 varieties)	3.425-3.595	Mallards	3

References:

1. Evans and Dietz 1974. JWMAA 38(4):622-629.

2. Robel et al. 1979. JWMAA 43(4):982-987.

3. Sugden 1971. JWMAA 35(4):781-785.

There is a wealth of data on the metabolizable energy of grains in the poultry science literature, and this is a source of information when data on wildlife species are unavailable.

Food habits of game birds in farm habitats contain many weed species in addition to the farm crops. Mourning doves in Colorado ate over 50 different native plants (Ward, 1964). Bobwhite in Missouri (Korschgren 1948), ate a total of 66 plant foods on a statewide basis, and less than 10% of them were cultivos. Note the year of publication (1948); crop management practices have changed very much in the last 30-40 years, and many of the weed seeds eaten by bobwhite are not available on present-day farms with large fields and chemical weed control.

It is imporant to discern between "important," "available," and "preferred." Foods which make up a large portion of the diet may reflect availability as much or more than importance. Studies of food habits should always be done by first sampling the foods available on the range, and when the relative abundance of a food in the diet exceeds its relative abundance on the range, the food may be said to be "preferred." Preferences may be determined under experimental conditions; 53 foods were provided penned bobwhite (Michael and Beckwith 1955), and farm crops--sorghum, wheat, lespedeza, corn and oats--ranked high.

The "importance" of a particular food for an animal should be determined on a nutritional basis. The relationship between nutrients in the food and those required by the arrival at the time of year when the food is eaten is a very important question in nutritive ecology. It is also a largely unanswered question; nutritive requirements of wild species through the annual cycle are difficult to determine.

Good wildlife habitat has sufficient amounts of foods with the carbohydrates, fats and oils, protein, vitamins, and minerals required through the annual cycle. This was recognized a long time ago; Massey (1938) discussed the roles of young shoots in the spring prior to egg-laying (vitamins), fruits (carbohydrates and organic acids) insects (protein), and grass seeds (protein) during the summer, and a sufficient supply of seeds (carbohydrates and oils) during fall and winter to carry the bobwhite quail through from one reproductive season to the next.

UNIT 1.2. COVER

Cover for wildlife on the farm needs to be divided into two categories: permanent and temporary. Permanent cover is present throughout the year, subject only to natural changes in phenology. Farm practices do not alter this cover. Temporary cover is altered in some way by farming practices during the year, and from year to year.

It is important to evaluate how cover is altered through the year, because it is not only the changes in cover that are important, but the timing of these changes. Permanent cover, such as windbreaks and shelterbelts, are subject to the phenological changes illustrated in Figure 13-2; the JDAY scale is used to represent the timing of cover changes through the annual cycle.

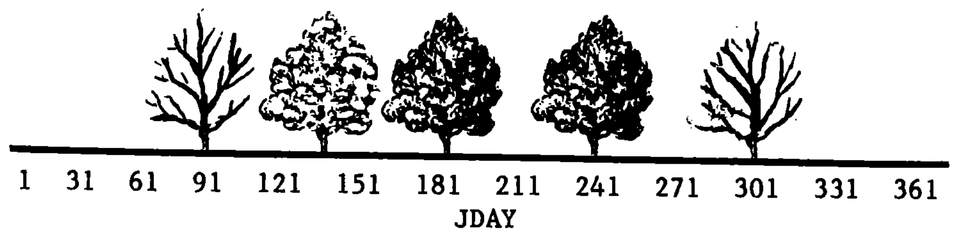

Figure 13-2. Leaf development, maturity, and fall affect the cover characteristics of windbreaks and shelterbelts.

Good cover is essential if losses of game birds to predators are to remain at a reasonable level. Predation is a natural part of the ecological relationships of wildlife, however. While predator control has been demonstrated to increase fall populations of pheasants, the cost per extra chick hatched was $4.50 in 1960-64 (Chesness et al. 1968), so present costs would be on the order of $10-20.00 per chick, at least. Further, the effect of predator removal did not carry over from year to year. A far better management practice would be the establishment of permanent cover, since Chesness et al. (1968) demonstrated that predation was highest among poorly concealed nests, especially those located in fencerows. Does this suggest that fencerows with enough cover to attract ground-nesting birds but not enough cover to provide concealment of the nests are subtle death traps?

WINTER COVER

Good winter cover is necessary to provide protection from weather conditions which may cause thermal stress. The number of birds surviving the winter to breed the following spring is an important determinant of fall populations. Larger numbers of reproducing females results in a larger spread of hatching or birth dates (Figure 13-3), increasing the likelihood of higher survival rates, and numbers of young surviving. Further, below-normal body weights in late winter resulted in later egg laying by pheasants (Gates and Woehler 1968). This results in potentially higher mortality due to hay harvesting, and to later-born chicks who must of necessity be younger when winter arrives.

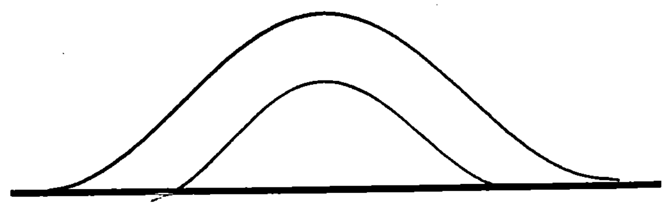

Figure 13-3. A larger breeding population results in a larger spread of hatching or birth dates.

Empirical data in Jarvis and Simpson (1978) supports the idea that better winter cover results in higher survival rates and subsequent fall populations. They suggest that survival during winter and abundance of pheasans were positively related, and the correlation between amount of land in soil bank and abundance of pheasants suggested that high survival rates of females were directly related to large blocks of uncultivated land.

NESTING COVER

Suitable nesting cover, which implies not only favorable cover for nest site selection but also for successful hatching, is a very important determinant of recruitment levels into the population. Nesting cover which favors first- nest success (Figure 13-4) results in early hatching dates nnd greater maturity by the time winter arrives, which is a benefit to the birds as they enter the period of winter stress.

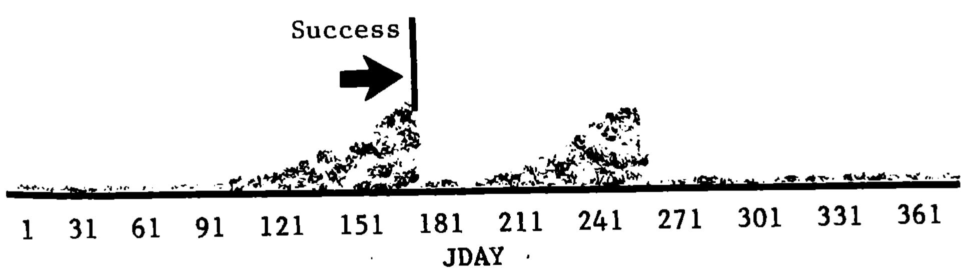

Figure 13-4, Nesting cover phenology and nesting success in farm habitats.

Home ranges of pheasants are small during the nesting period (Hanson and Progulske 1973), so interspersion of standing vegetation with hay and small grain fields is especially important at that time. Hens whose nests are abandoned or destroyed by farming operations may renest in nearby standing vegetation.

Further, brood-rearing areas were only 5-10 acres in size (Kuck et al. 1970), suggesting that a large amount of interspersion of smaller areas of different cover types may be suitable pheasant habitat.

The existence of renesting is well-entrenched in the wildlife literature (see Seubert 1952 for example) but the significance of it is less well-known, especially in regard to current farming practices. Several generalities may be made with regard to renesting.

1. The earlier incubation that nest disruption occurs, the more likely the hen will renest.

2. The earlier in the incubation period that nest disruption occurs, the shorter the renesting (time to laying of first egg in second nest) interval is.

3. Second clutches are usually, but not always, smaller than first ones.

Much has been written since Leopold's (1933) classic book on Game Management about the benefits of diversity in habitats for wildlife. One of the best studies quantifying that basic principle has been done by Robel (1969) who demonstrated that:

1. Bobwhite quail within 800 m of food plots used them in winter and early Spring.

2. Quail collected within 600 m of food plots had:

    a) more food in their crops,
    b) maintained higher body weights, and
    c) had more fat in their carcasses

than quail collected 900 m or more from food plots. If properly-spaced food plots provided a higher energy intake, contributed to maintaining higher body weights, and resulted in higher body fat contents, then greater survival and higher productivity must almost certainly follow.

ROOSTING COVER

Most young pheasants roosted in oats and hay in an intensively-farmed area in east-central Illinois (Warner 1979). While these two types of cover comprised only 6.4% of the land area, 43.4% of the radio-telemetry locations of broods were made in them. A similar use-level occurred in roadsides when expressed on a per area basis. Since the use of these habitats was much greater than the use of row crop--corn and soybean--habitat, the decline in hay and small grain acreages may have reached critical proportions for pheasant production. Warner (1979) states that opportunities for pheasant management in Illinois are now largely restricted to roadsides, a direct result of very intensive commercial agriculture in that state (see Table 11-1, p.244).

TOPIC 2. HABITAT MANAGEMENT FOR WILDLIFE

"Natural" provisions for wildlife on commercial farms are not compatible with current agricultural practices which tend to maximize production efficiency. Sometimes habitat is suitable but the animals are not present due to previously limited range. Then, trap and transplant programs are effective, moving breeding stock from areas with good populations to areas with good habitat but no resident populations. This practice has been proven more effective than rearing and releasing animals into natural habitat. Differences in wariness and susceptibility to predation seem to be the main causes of differences in success of trap and transplant compared to the release of animals raised in captivity.

UNIT 2.1. FOOD SOURCES

A variety of wildlife species eat crops grown on farms. The diversity of crops eaten by upland game birds and waterfowl are indicated in Table 13-2.

Table 13-2. The use of farm crops as food for upland game birds and waterfowl, based on information in Martin et al. (1951).

	WHET	OATS	BRLY	RYE	SGHM	BKWT	CORN	SYBN
UPLAND GAME BIRDS								
Bobwhite quail	W			R	S	B	C	S
Grey Partridge	W	O	B			B	C	
Mourning dove	W	O	B		S	B	C	S
Prairie chicken	W	O	B	R	S	B	C	
Ring-necked pheasant	W	O	B	R	S	B	C	S
Sharp-tailed grouse	W	O	B			B	C	S
WATERFOWL								
Black duck							C	
Canada Goose	W	O	B				C	
Mallard	W	O	B	R			C	
Pintail			B					
Teal, green-winged			B	R				
Teal, cinnamon				R				

Food plots sometimes result from poor weather conditions during harvest. Wet weather may make a low spot in a field too wet to cross with the harvester. Then it is left, and the crop remains in the field. Such little patches of corn, just a fraction of an acre in size, may be an important source of food for wildlife in the winter.

WASTE GRAINS

Waste grains, available after harvesting of farm crops, are an important source of wildlife foods. Mechanical harvesting of corn resulted in waste corn quantities from 18 to 201 pounds per acre and soybean quantities of 112 pounds per acre in Missouri (Korschgren 1960). Quantities of small grains--wheat, oats, rye, and barley--varied from 60 to over 300 pounds of important upland game bird foods per acre. Such figures indicate the potential amount of food available to wildlife, though actual quantities are reduced due to the shapes and sizes of the fields, plowing and snow cover in the winter. Harvesting methods change too; different amount are available depending on the machines used and the carefulness of the operators. In general, about 3-4% of the crop can be considered as waste after harvesting has been completed. The amount of waste grain that remains available to wildlife depends on how the harvested field is subsequently managed. Fall plowing covered up 97% of the waste corn in Texas (Baldassarre et al. 1983).

A problem has been observed when Canada geese feed on soybean seeds in large amounts, such as might occur when the geese arrive at a new nesting location during migration with an abundant supply of soybeans. The geese then eat large quantities of soybeans, drink water, and the imbibition of water results in the beans swelling greatly, causing impaction and pressure necrosis resulting in death in 4 to 16 hours (Durant 1956). An overly-abundant food supply proves harmful in this case; about 1% of the goose population was affected in Missouri.

Some references to the frequence and volume of grains and weeds consumed by wildlife are given in Table 13-3. The list indicates the variety of species feeding on farm habitat foods. Many additional species are listed by the authors; this list is restricted to those in which the food occurred in the diet with a frequency or volume of 10% or more.

Table 13-3. Plants found on farms, wildlife species feeding on them with a frequency or volumetric rate of 10% or more, and journal references.

PLANT	ANIMAL	REFERENCE*		
Barley	Fox squirrel	Yeager	1959	JWMAA 23:102
Buckwheat	Red-winged blac/	Matt et al.	1972	JWMAA 36:983
Clovers	Bobwhite	Baldwin & Hendley	1946	JWMAA 10:142
	Prairie chicken	Kobriger	1965	JWMAA 29:788
	Sharptailed grouse	Kobiger	1965	JWMAA 29:788
	White-tailed deer	Nixon,McClain & R/	1970	JWMAA 34:870
Corn	Black Duck	McGilvrey	1966	JWMAA 30:577
	Bobwhite	Wright	1941	JWMAA 5:279
	Bobwhite	Korschgren	1948	JWMAA 12: 46
	Bobwhite	Robel et al.	1974	JWMAA 38:653
	Fox squirrel	Yeager	1959	JWMAA 23: 02
	Mourning Dove	Hanson & Kossack	1957	JWMAA 21:169
	Mourning dove	Korshgran	1958	JWMAA 22: 9
	Mourning dove	Beckwith	1959	JWMAA 23:351
	Muskrat	Arata	1959	JWMAA 23:177
	Pheasant	Fried	1940	JWMAA 4: 27
	Pheasant	Wright	1941	JWMAA 5:279
	Pheasant	Harper & Labisky	1964	JWMAA 28:722
	Pintail	McGilvrey	1966	JWMAA 30:577
	Prairie chicken	Kobriger	1965	JWMAA 29:788
	Red-winged blackb/	Hintz & Dyer	1970	JWMAA 34:789
	Red-winged blackb/	Matt et al.	1972	JWMAA 36:983
	Reeves Pheasant	Korschgren & Cha/	1970	JWMAA 34:274
	Waterfowl	Shields & Benham	1969	JWMAA 33:811
	White-tailed deer	Korschgren	1962	JWMAA 26:164
	White-tailed deer	Robel and Watt	1970	JWMAA 34:210
	White-tailed deer	Nixon, McClain &/	1970	JWMAA 34:870
	Whooping cranes	Shields & Benham	1969	JWMAA 33:811
	Wood duck	McGilvrey	1966	JWMAA 30:193
Foxtail	Mourning dove	Hanson & Kossack	1957	JWMAA 21:169
Lespedezas	Bobwhite	Davison	1942	JWMAA 6:97
	Bobwhite	Korschgren	1948	JWMAA 12:46
	White-tailed deer	Korschgren	1962	JWMAA 26:164

TABLE 13-3 IS CONTINUED ON THE NEXT PAGE

TABLE 13-3, CONTINUED FROM PREVIOUS PAGE

PLANT	ANIMAL	REFERENCE*		
Oats	Pheasant	Fried	1940	JWMAA 4: 27
	Red-winged blackb/	Matt et al.	1972	JWMAA 36:983
	White-tailed deer	Nixon,McClain &/	1970	JWMAA 34:870
Ragweeds	Bobwhite	Baldwin & Hendley	1946	JWMAA 10:142
	Bobwhite	Korachgren	1948	JWMAA 12: 46
	Bobwhite	Robel	1969	JWMAA 36:983
	Bobwhite	Robel et al.	1974	JWMAA 38:653
	Red-winged blackb/	Mott et al.	1972	JWMAA 36:983
Sorghum	Bobwhite	Korschgren	1948	JWMAA 12: 46
	Bobwhite	Robel	1969	JWMAA 33:237
	Bobwhite	Robel et al.	1974	JWMAA 38:653
	Mourning dove	Dillon	1961	JWMAA 25:334
	Prairie chicken	Jones	1963	JWMAA 27:757
	Reeves Pheasant	Korschgren and Ch/	1970	JWMAA 34:274
	White-tailed deer	Robel and Watt	1970	JWMAA 34:210
	Whooping Crane	Shields and Benh/	1969	JWMAA 33:811
Soybeans	Bobwhite	Baldwin & Hendley	1946	JWMAA 10:142
	White-tailed deer	Nixon,McClain & R/	1970	JWMAA 34:274
Wheat	Bobwhite	Robel	1969	JWMAA 33:237
	Bobwhite quail	Klimstra & Scott	1973	JWMAA 37:492
	Canada Geese	Shields & Benham	1969	JWMAA 33:811
	Fox squirrel	Yeager	1959	JWMAA 23:102
	Mourning dove	Ward	1964	JWMAA 28:152
	Mourning dove	Korschgren	1958	JWMAA 22: 9
	Mourning dove	Hanson & Kossack	1957	JWMAA 21:169
	Pintail ducks	Krapn	1974	JWMAA 38:408
	Red-winged blackb/	Hintz & Dyer	1970	JWMAA 34:789
	Red-winged blackb/	Mott et al.	1972	JWMAA 36:983
	Sandhill cranes	Shields & Benham	1969	JWMAA 33:811
	White-tailed deer	Robel and Watt	1970	JWMAA 34:210
	White-tailed deer	Nixon,McClain & R/	1970	JWMAA 34:870
	Whooping cranes	Shields & Benham	1969	JWMAA 33:811

*JWMAA is code name for J. Wildl. Manage. See CHAPTER 13, TOPIC 4.

UNIT 2.2. COVER MANAGEMENT

What can farmers do to enhance the wildlife cover on their land? As a general rule, the more cover, the better, if it has the right qualities. A large stand of closely-spaced pines or spruces may provide very dense cover, but such cover is not good for wildlife species found on farms.

Cover must have functions appropriate to the species expected to use it. Some of these functions are dependent on the optical density of the cover, some on its physical density, and some on its thermal characteristics (Moen 1973). Several examples of the functions of cover are given next.

Cover implies protection. Animals need protection from weather factors, from predators, and even from other members of their own species. Protection from weather factors involves primarily the physical density of the cover. Ground cover, for example, offers resistance to the movement of air, so wind speeds are lower over the ground when it is covered with vegetation than when it is bare. The vertical wind profiles described in CHAPTER 7 illustrate that cover may be limited to obstructions to air flow. A jack rabbit resting behind a rock may find considerable protection from the wind in an otherwise barren landscape .

On a larger scale, windbreaks and shelterbelts provide barriers to wind, and their physical characteristics, especially height and density, determine their effects on air flow. Studies in a wind tunnel at the Wildlife Ecology Laboratory, Cornell University showed that the relative effects of lower barriers extended further downwind relative to height but not as far in absolute distance. This is illustrated in Figures 13-5 and 13-6, based on data in Moen (1974).

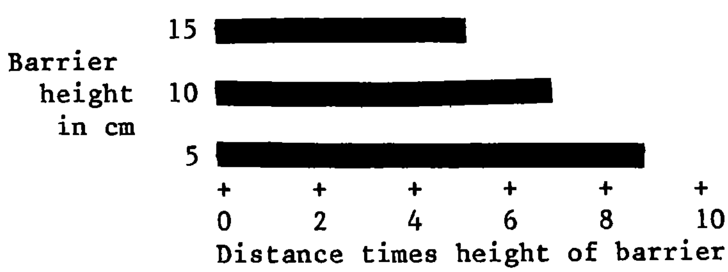

Figure 13-5. The effects of solid barriers 5, 10, and 15 cm high high extended downwind for distances 9, 7, and 5 times the heights of the three barriers respectively.

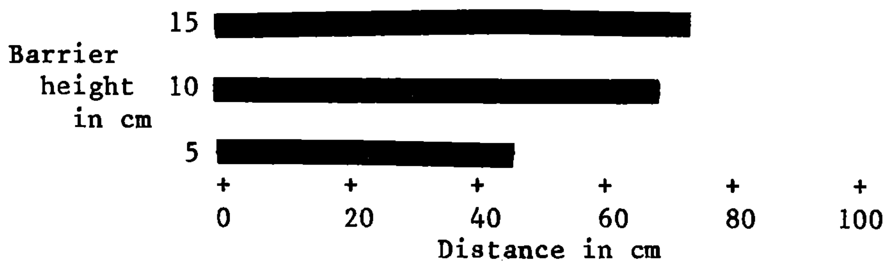

Figure 13-6. The effects of solid barriers 5, 10, and 15 cm high extended for greater absolute distances as barrier heights increased.

What basic principle is illustrated by the two previous figures? A low barrier is relatively more effective than a high barrier; a jackrabbit will find protection behind a rock that may be little higher than the rabbit itself.

Solid barriers such as rocks are not as desirable barriers to wind as porous barriers because of the effect of the barrier on air circulation. A clump of grass, a thicket, a shelter belt . . . all provide porous barriers which impede the wind, providing protection to animals on the leeward side. Photos of bubble tracers in Moen (1974) illustrated experimental results. The general pattern looks like this (Figure 13-7).

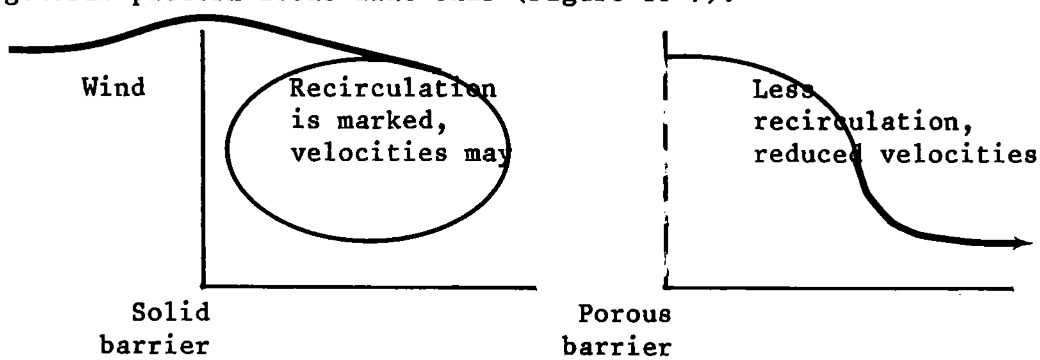

Figure 13-7. Wind patterns behind solid and porous barriers.

Shelterbelts also cause the accumulation of snow as a result of the reduction in wind speeds. The distribution of the snow depends on the design of the shelterbelt. If the shelterbelt is too narrow, the wind passes through it and snow is deposited on the leeside (Figure 13-8a). If the shelterbelt is just wide enough to provide a place for snow to be deposited, then the shelter belt becomes a snowtrap across its entire width (Figure 13-8b). If the shelterbelt is wide enough to trap the snow and offer additional protection from the wind, then it is good wildlife cover (Figure 13-8c). The design of a shelterbelt determines whether it is good cover or a death trap.

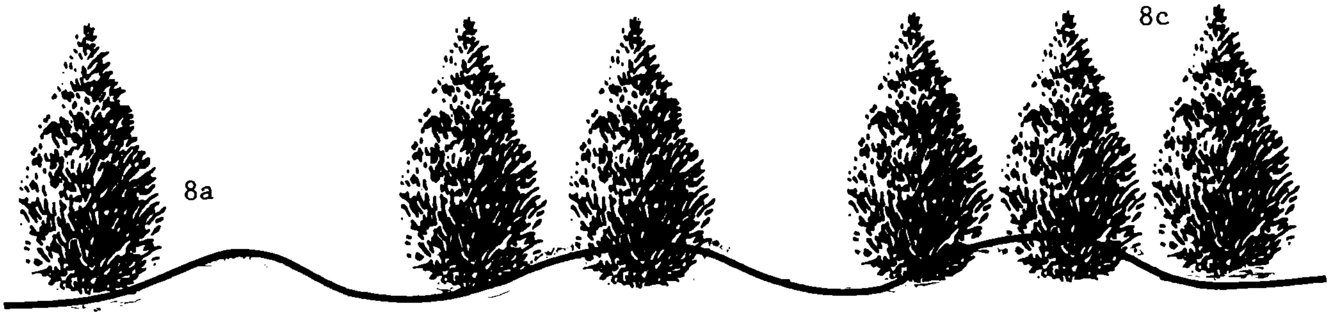

Figure 13-8. The design of a shelterbelt determines whether it is good cover or a death trap.

In the examples illustrated in Figure 13-8, "a" is a good shelterbelt for snow accumulation on fields where the moisture will be of value on the field in the spring. "c" is a good shelterbelt for wildlife, but the snow is not distributed as well for soil moisture during spring.

Permanent cover may be maintained on topography that is too steep for farming and too far away from the farmstead to be pastured. Permanent cover may also be located on small corners or little areas that may be inconvenient to farm; prime farmland is likely not going to be set aside as wildlife cover for economic reasons.

The provision and maintenance of cover for wildlife should include as wide a diversity of plants as possible. Extensive areas of domestic grasses that have been seeded, for example, will have many fewer forbs than native grassland. Such grassland cover is not as good as a diverse mixture of grasses and forbs. This point was emphasized by Ellis et al. (1969), who provided diverse food and cover crops for bobwhite quail by not only leaving ¼ of the share-cropped fields in standing corn, but the corn was left for 3-4 years, allowing time for a plant community to develop that was heavily used by both quail and cottontail.

One management practice with regard to nesting cover is the use of "bait cover" (Leopold 1933:309), which is cover deliberately provided to keep nests out of crops or other dangerous ground. Frank and Woehler (1969) used this approach when providing 3-acre blocks of nesting cover for pheasants. Suitable roadside nesting cover attracted pheasants, and the hatch of pheasant nests on seeded roadsides, on a per acre basis, exceeded that in hay fields, pasture, small grains, row crops, and other cover types (Joselyn et al. 1968).

UNIT 2.3. WATER MANAGEMENT

Water is an essential requirement of both domestic and wild animals. It is essential for crop production, and irrigation is often used to supplement rainfall. The increase in plant production may also benefit some species of wildlife. A general rule, which I personally believe is the best approach of several alternatives, is to maximize water conservation as passively as possible. Engineering technology can do much with water, but the most natural and least-technological water conservation can be, the better in the long run.

UNIT 2.4. SPACE RESOURCES AND POPULATION RESPONSES

When food and cover are distributed in appropriate amounts over a large land area, wildlife populations may increase to the point where space becomes limiting. This is a difficult concept to grasp, since it may appear to us humans that ample space is available--elusive wild creatures may seldom be seen--but to the species, there are limitations due to behavioral traits. The patterns of use of roadside ditches by blue-winged teal is an example; long ditches with good visibility will hold fewer breeding pairs than ditches broken up by vegetation (Figure 13-9).

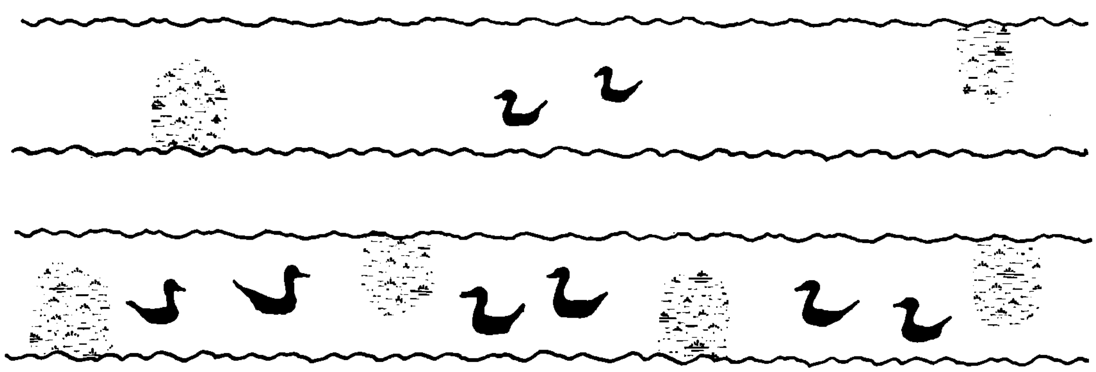

Figure 13-9. Long ditches with good visibility (top) will hold fewer ducks than ditches broken up by vegetation (bottom).

Why do such spatial limitations exist? Because the strongest competitor of an individual during the breeding season is another individual of the same species. This holds true for those species which are territorial, who actively defend an area against other members of the species. Thus, space becomes a limited resource; the habitat is saturated.

It is safe to say that most areas of farmland do not contain space-limited wildlife populations. Rather, wildlife populations are limited by food and cover. Responses of bobwhite populations to improvements in food and cover resources on the 3,000 acre Remington Farms in Maryland were dramatic as the number of coveys increased from 5 to 38 in 8 years (Burger and Linduska 1967). Further, this increase occurred as hunting pressure increased and predator control was discontinued, indicating the potential of bobwhites to reproduce successfully when habitat conditions are favorable.

Remington farms had beef cattle and cash crop enterprise when the bobwhite management practices, especially habitat-improvement plantings, were instituted. These included, from 1956 to 1964:

Multiflora rose hedges:	From	0.3 to 7.1 miles
Autumn olive, shrub honeysuckles and bicolor lespedeza:		3.25 to 14.00 acres
Sericea lespedeza strips:		0 to 8.5 miles
Grasses:		0 to 49.4 acres

A map in Burger and Linduska (1967) shows the layout of the plantings. A patchwork effect has been instituted; quail are never far from food and cover. It is also important to note that the bobwhie responses were not immediate; new coveys appeared in the multiflora hedge plantings two to seven years (mean 3.7 years) after planting. Good wildlife habitat improvement practices involve long-term plans for both plant and animal responses, and for follow-up studies of these responses.

Wildlife management, habitat improvement, surplus game populations . . . are all good ideas in the minds of wildlife biologists, most of the public, and many farmers. Given the present system of land ownership (private) and wildlife jurisdiction (public), cooperative efforts are needed if wildlife management practices are to be initiated on the land. Cooperative assistance has been available through the Soil Conservation Service, State Departments of Conservation and other agencies, and the current economic pressures on agriculture and all of society results in new challenges unlike any faced before. We must, as wildlife professionals, speak convincingly and with authority.

The continuation of wildlife management practices should depend on demonstrated proof that they have benefitted wildlife. This means that follow-up evaluations are very important--essential if we are to use a scientific approach to wildlife management.

"Undermanned, underfinanced, and underequipped . . ." Sound familiar? Those are the terms used by Marshall (1953) thirty years ago in describing evaluations of wildlife habitat development projects. He also lists five questions to use when analyzing and evaluating the effectiveness of wildlife habitat management programs. They are:

1. Are the programs sound as regards basic plant ecology?
2. Are the programs sound as regards wildlife ecology?
3. What is the permanence of the practice?
4. What are the real costs in terms of game produced over a period of years?
5. Are these questions understood and analyzed objectively by the agencies carrying out the programs?

Marshall concludes these questions with: "These points seem basic to a lasting program of habitat management." They should be given careful consideration when developing a management plan, whether it be for a farm, a county, a state, or a nation. Wildlife are essential parts of our heritage and our habitat. When wildlife cannot survive, we will not either for very long.

TOPIC 3. GAME FARMING

There has been considerable controversy over the values of game farms in wildlife management. Opinions range from their having no value to game farms being the sole source of local wildlife populations. Both extremes are probably wrong; the question is better addressed in terms of objectives, costs, and local interest.

Game farms can be a source of stock when none other exists, they can bring people in close contact with game species, and they can involve cooperators among the public who take an active interest in particular species.

One must ask not only about the benefits provided by game farms, but also what detriments result. There is concern over the genetic and behavioral characteristics of game farm stock. They do not have the long-term survival capabilities of wild stock, and if this is a genetic trait, the potential exists for dilution of wild stock as a result of short-term effects.

Game farms might also be expected to do impossible jobs; wildlife populations simply can't be maintained over large areas of land as a result of direct placement by man. Rather, they must be self-supporting, with the land providing long-term habitat conditions which maintain resident populations of sufficient size to allow long-term stability in spite of short-term fluctuations.

UNIT 3.1. STATE GAME FARMS

State game farms were common enterprises in many states a few years ago. They have been controversial, generally supported by hunters but not by biologists. The costs of raising and releasing birds have been high, and birds bagged by hunters have cost several times more than the license fee.

Survival of game farm birds has generally been low, and radio telemetry studies have demonstrated that such is the case. Juvenile game-farm pheasants were readily taken by predators in experimental releases in Minnesota (Hessler et al. 1970). Eighty-one precent died within four weeks after being released, and 92% of the mortality was attributed to predation. Hawks, owls, fox, and mink were the major predators.

The high predation rate observed in the study cited above was attributed to deficiencies in the behavioral repertoire of the birds. They were not wary, and appeared reluctant to fly. It would be interesting to raise pheasants under different conditioning regimes, including:

1. Disturbed and frightened regularly,
2. As above, plus radio telemetry harnesses,
3. Radio telemetry harnesses, but no disturbances, and
4. None of the above.

Would conditioned birds be more wary? Heart rate increases of a female pheasant to a benign hawk silhouette declined in magnitude as habituation appeared to be very rapid (Soong 1981). Responses to wild lone hawks over the telemetry pen resulted in increases similar to those in response to the silhouette when the bird was in an alert posture, but alarm bradycardia occurred when the bird exhibited freezing behavior. Then, heart rates dropped as low as 80% of the prestimulus rate. It is interesting that deer fawns exhibit alarm bradycardia too when they lie motionless (Moen et al. 1978).

The complexity of physiology and behavior of individual animals, coupled with the complexity of interactions between species, makes it very difficult to program game farm operations that result in the birds produced being able to cope in the wild.

Another form of game farming has appeared in recent years, and may grow in the future. Wild species are raised <u>and harvested</u> in captivity, providing the control necessary over the animals, and evaluation of cost-effectiveness on an annual basis. Harvesting may be by put-and-take shooting, or by direct purchase of the game. Such enterprises have been developed by private individuals; commercial farms are devoted to raising wild rather than domestic species.

TOPIC 4. INFORMATION PROCESSING

There are no simple answers to complex questions. The amount of information available to wildlife biologicts is far more than can be synthesized and applied in management decisions, especially using conventional methods characteristic of the past. Books and journals are valuable records, but the time taken to access the information in them is considerable.

Abstracting services have speeded access to professional literature by providing key word listings and abstracts in single volumes, making it possible to evaluate large numbers of items in one sitting. Wildlife Review is an example of an abstracting service specifically for wildlife; the contents are organized by groups of species.

Computer-assisted library searches are quick ways of accessing literature titles and abstracts using electronic technology. I conducted such a search recently for a review paper on energy metabolism. The first search using "energy metabolism" as a key word revealed 65,000 possible titles in the last 3 years! Using combinations of key words, the list was reduced to 465, all of which were checked for pertinent data.

Computer-stored data bases of literature have resulted in some changes in formats. An international system of journal abbreviations has been developed, called CODEN (code name), reducing journal titles to five characters. This system is used in my 7-PART series in THE BIOLOGY AND MANAGEMENT OF WILD RUMINANTS (see the back side of the sheet inside the front cover of this book for a list of PARTS), with each literature reference listed on one line with the following headings:

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CODEN VO-NU BEPA ENPA KEY WORDS---------------AUTHORS------YEAR

JWMAA 42--4 715- 738- Seas,hrt rt,activ,metab Moen,A.N.    1978
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Line- heading abbreviations are defined as:

CODEN: Journal abbreviation or code name,
VO-NU: Volume and issue number,
BEPA: Beginning page, and
ENPA: Ending page.

The complete citation for the example given above in the traditional format, using up 3 lines of space, is:

Moen, A.N. 1978. Seasonal rhythms in heart rates, activity, metabolism, and forage intake of white-tailed deer. J. Wildl. Manage. 43(4):715-738.

Note the savings in space, yet essential information is given in the one-line format. This format makes it possible to list over 12,000 references in THE BIOLOGY AND MANAGEMENT OF WILD RUMINANTS in a minimum of space.

Information processing is "big business." We should, as professionals, make decisions on the best information available, so we must search for efficient access and processing techniques. The two UNITS which follow describe sources of information and some thoughts on the development of a management plan. The transition from these descriptions to a new way of information processing is described in CHAPTER 15, TOPIC 3: SPECULATIONS ON THE FUTURE.

UNIT 4.1. SOURCES OF INFORMATION

Where does one begin searching for information on wildlife and agriculture? Professional journals, such as Journal of Animal Science, Journal of Wildlife Management, Canadian Journal of Plant Science . . . and hundreds more contain results of original research. Research results have been summarized by authors of books, some of them cited here in this text. Many more books on the subjects of agriculture and wildlife may be found in local, high school, college, and university libraries. A college education should provide not only insights into ways of thinking but also factual information in journals and books.

College-educated wildlife managers usually do not have the time to review large numbers of journal articles and books when making management plans. Summaries are relied on, sometimes as brief as 1-2 pages, such as those put out by the Soil Conservation Service. These contain general recommendations, the kinds of things that are expected to benefit wildlife. It is important that recommendations be reviewed regularly since there are so many changes in land management practices.

As electronic information processing is used more, larger amounts of information and options may be made available to those needing information for management decisions. The potential of electronic information processing presents more exciting challenges to cooperative wildlife extension work than at any other time in history.

UNIT 4.2. DEVELOPING A MANAGEMENT PLAN

How does one develop a management plan for a particular area? Whether done manually or electronically, the basic steps are in the same order. These steps are illustrated in a very simplified way, with sketches of a dairy farm of about 240 acres to provide a a basis for logical thinking in the sketches that follow.

The first step involves an inventory of the land and water characteristics (Figure 13-10). Note that the relief is slight and there are several areas of wetlands on the farm. It looks like it has good potential as waterfowl, especially puddle ducks, and upland game bird (especially pheasant) habitat. General management objectives may now be written.

GENERAL OBJECTIVES:

1. Maintenance of a family dairy farm with a net income sufficient for a family of five.

2. Provision of the best long-term soil and water conservation and wildlife habitat possible for maximum production of crops,, waterfowl and upland game,with a large amount of "edge" throughout the farm.

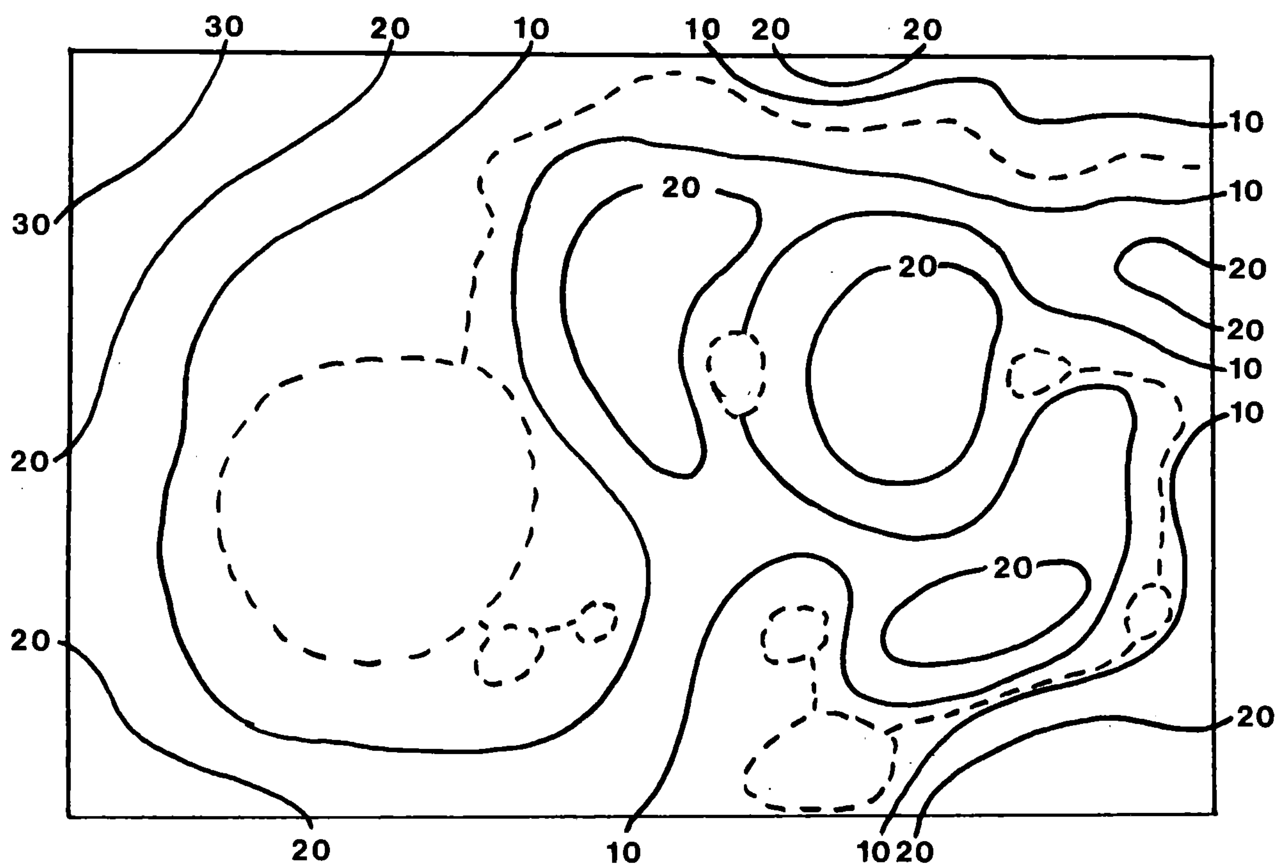

Figure 13-10. The land and water characteristic of a 240-acre dairy farm.

Current land use may now be described, using the same size base map as Figure 13-10 so the current land use may be overlaid on the land and water characteristics (Figure 13-11). Note that the fieldsa have been laid out in rectangular blocks characteristic. Such blocks make field work easier by having square turns for machines, fencing is easier, and fields and pastures may be rotated in blocks of easily-determined acreages. But a shift to contour farming is desired to maximize soil and water conservation. Further, long, narrow fields will provide fewer turns during field work, and more "edge" for wildlife. The new configuration is shown in Figure 13-12.

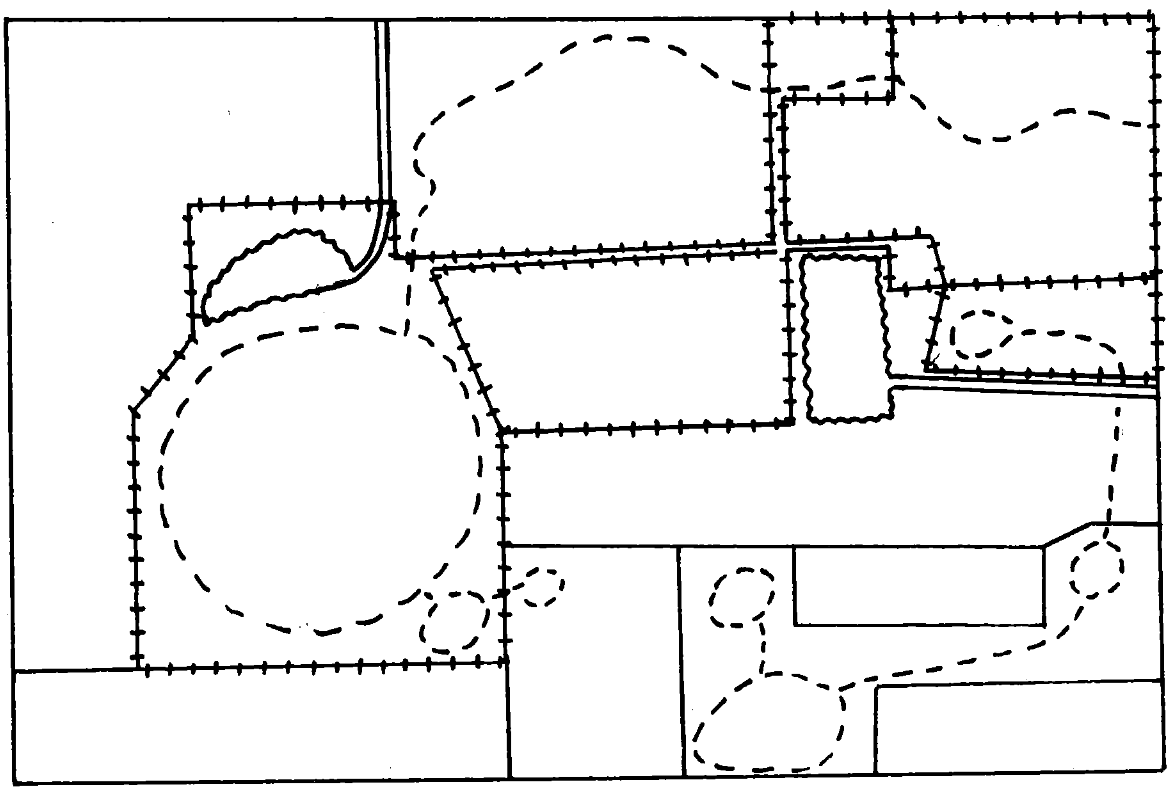

Figure 13-11. Current land use patterns for the 240-acre dairy farm.

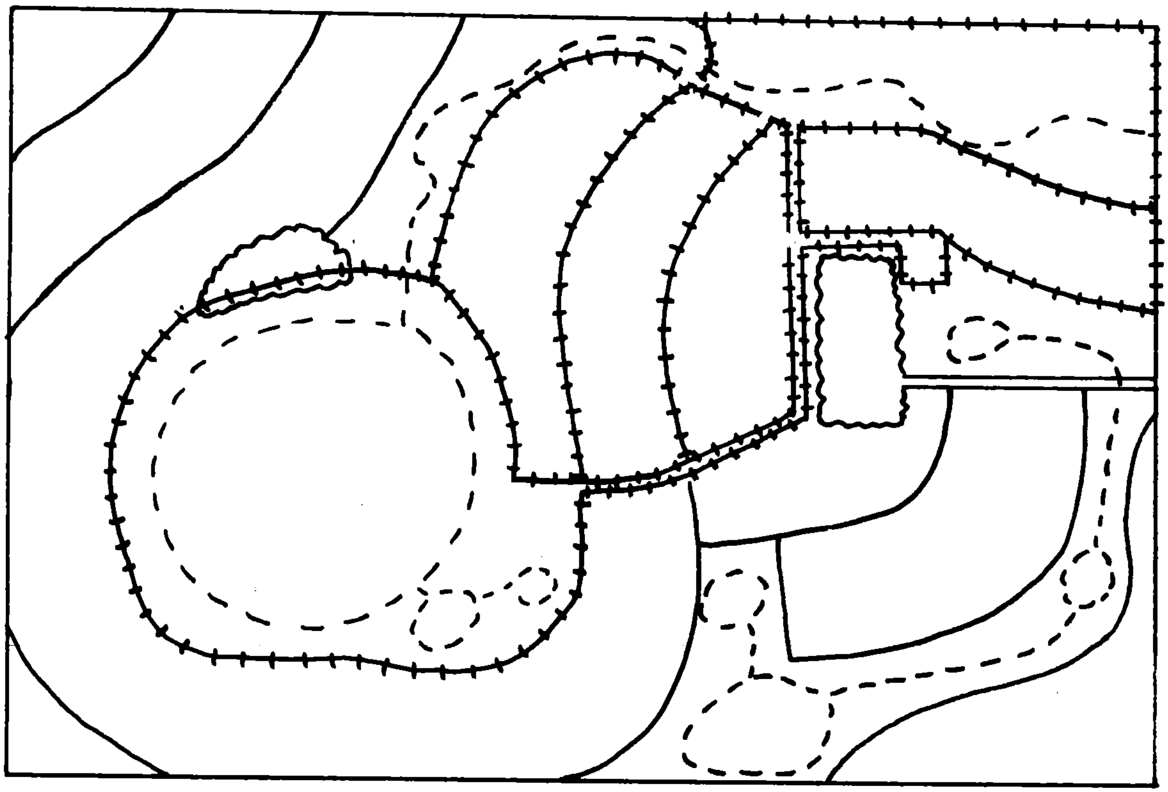

Figure 13-12. The proposed layout of fields for maximum soil and water conservation, and a large amount of "edge" for wildlife.

Note that no wetlands have been drained. Fields are a more uniform distance from wetlands as a result of contoured rather than straight-sided borders. Acreages in field, pasture, and permanent hayland remain about the same, as does the amount of fence required. In years with higher rainfall, less vegetation bordering the streams may be cut, but this will be compensated for by higher production of field crops. In dryer years, crop production will be down, but more permenent hay will be available for cutting. These changes in forage composition may be easily integrated into the feeding regime for the dairy herd by linear programming (see CHAPTER 6) feed formulation (the farmer has a computer).

What does the final layout look like with all the rotations indicated? These are shown in Figure 13-13, with notes on the map indicating use of each area. Areas with several designations, such as SG-RC-TH, are in small grain, row crop, temporary hay rotations over a 3-4 year period.

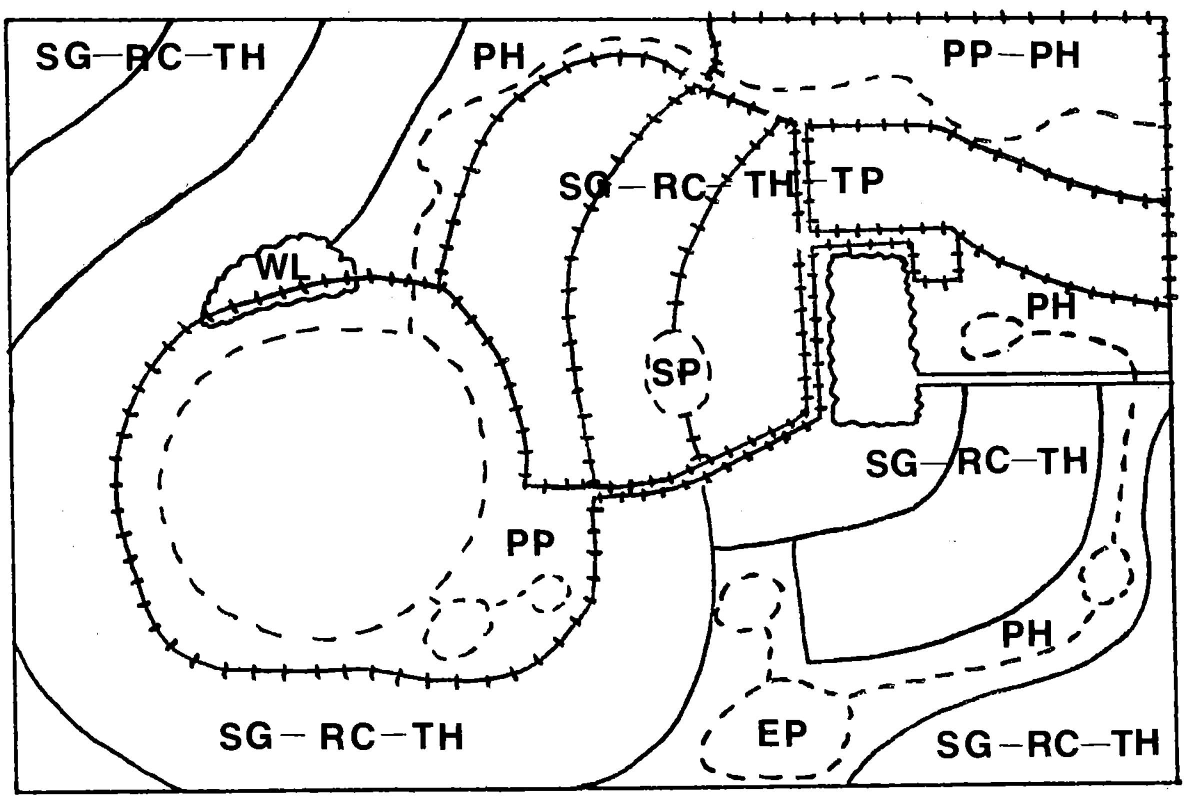

Figure 13-13. The uses of each area on the 240-acre dairy farm. Abbreviations are defined below.

EP = Ephemeral pond,
PH = Permanent hayland,
PP = Permanent pasture,
RC = Row crops,
SG = Small grains,
SP = Stock pond,
TH = Temporary hayland,
TP = Temporary pasture, and
WL = Woodlot

Note that the layout results in almost continuous access to permanent vegetation from the farmstead. Leaving the farmland and going east into the permanent hay (PH) area, the first ephemeral pond (EP) is passed. Proceeding east, then south, west, north, and west again, across a field strip, 6 ephemeral ponds are passed on the way to the permnent water area. Going north and east along the intermittent stream brings one back to the eastern boundary, south to the first PH entered, and west back to the farmstead. Field borders would be continuous along this whole route, and waterfowl and upland game birds could be expected anywhere through the entire distance.

What are the alternatives to such a layout? Drained marshes, large fields of corn and hay, continuous cropping, cattle in confinement with forage brought to them . . . and a land barren of wildlife. I personally believe that the layout described first is much to be preferred, both by the farmer and by those who enjoy seeing farm landscapes and wildlife. Is it economically feasible? I think so, and new technology which allows for better genetic selection of crops and livestock, better soil management, better feed formulation . . . and more should also allow for better wildlife management. A fundamental concern has to be whether we as a society force ourselves into a single-objective style of life (make the most money) or a multiple-objective style, which includes appreciation of natural beauty, other species, music, art . . . all of those things which add such important dimensions to our lives, making them richer for the living.

LITERATURE CITED

Arata, A.A. 1959. Ecology of muskrats in strip-mine ponds in southern Illinois. J. Wildl. Manage. 23(2):177-186.

Baldassarre, G.A., R.J. Whyte, E.E. Quinlan, and E.G. Bolen. 1983. Dynamics and quality of waste corn available to post-breeding waterfowl in Texas. Wildlife Society Bulletin 11(1):25-31.

Baldwin, W.P. Jr. and C.O. Hardley. 1946. Winter food of bobwhite quail in Virginia. J. Wildl. Manage. 10(2):142-149.

Beckwith, S.L. 1959. Mourning dove foods in Florida during October and December. J. Wildl. Manage. 23(3):351-354.

Bruger, G.V. and J.P. Linduska. 1967. Habitat management related to bobwhite populations at Remington Farms. J. Wildl. Manage. 31(1):1-12.

Chesness, R.A., M.M. Nelson, and W.H. Langley. 1968. The effect of predator removal on pheasant reproductive success. J. Wildl.Manage. 32(4):683-697.

Dillon, O.W. Jr. 1961. Mourning dove foods in Texas during September and October. J. Wildl. Manage. 25(3):334-336.

Davison, V.E. 1942. Bobwhite foods and conservation farming. J. Wildl. Manage. 6(2):97-109.

Durant, A.J. 1956. Impaction and pressure necrosis in Canada geese due to eating dry hulled soybeans. J. Wildl. Manage. 20(4):399-404.

Ellis, J.A., W.R. Edwards, and K.P. Thomas. 1969. Responses of bobwhites to management in Illinois. J. Wildl. Manage. 33(4):749-762.

Evans, K.E. and D.R. Dietz. 1974. Nutritional energetics of sharp-tailed grouse during winter. J. Wildl. Manage. 38(4):622-629.

Frank, E.J. and E.E. Woehler. 1969. Production of nesting and winter cover for pheasants in Wisconsin. J. Wildl. Manage. 33(4):802-810.

Fried, G.A. 1940. The food habits of the ring-necked pheasant in Minnesota. J. Wildl. Manage. 4(1):27-36.

Gates, J.M. and E.E. Woehler. 1968. Winter weight loss related to subsequent weights and reproduction in penned pheasant hens. J. Wildl. Manage. 32(2):234-247.

Hanson, H.C. and C.W. Kossack. 1957. Weight and body-fat relationships of mourning doves in Illinois. J. Wildl. Manage. 21(2):169-181.

Hanson, L.E. and D.R. Progulske 1973. Movements and cover preferences of pheasants in South Dakota. J. Wildl. Manage. 37(4):454-461.

Harper, J.A. and R.F. Labisky. 1964. The influence of calcium on th distribution of pheasants in Illinois. J. Wildl. Manage. 28(4):722-731.

Hessler, E., J.R. Tester, D.B. Siniff, and M.M. Nelson. 1970. A biotelemetry study of survival of pen-raised pheasants released in selected habitats. J. Wildl. Manage. 34(2):267-274.

Hintz, J.V. and M.I. Dyer. 1970. Daily rhythm and seasonal change in the summer diet of adult red-winged blackbirds. J. Wildl. Manage. 34(4)::789-799.

Jarvis, R.L. and S.G. Simpson. 1978. Habitat, survival, productivity, and abundance of pheasants in western Oregon, 1947-1975. J. Wildl. Manage. 42(4):866-874.

Jones, R.E. 1963. Identification and analysis of lesser and greater prairie chicken habitat. J. Wildl. Manage. 27(4):757-778.

Joselyn, G.B., J.E. Warnock, and S.L. Etter. 1968. Manipulation of roadside cover for nesting pheasants--a preliminary report. J. Wildl. Manage. 32(2):217-233.

Klimstra, W.D. and T.G. Scott. 1973. Adaptation of pen-reared bobwhites to foods in a natural environment. J. Wildl. Manage. 37(4):492-494.

Kobriger, G.D. 1965. Status, movements, habitats, and foods of prairie grouse on a sandhills refuge. J. Wildl. Manage. 29(4):788-800.

Korschgren, L.J. 1948. Late-fall and early-winter food habits of bobwhite quail in Missouri. J. Wildl. Manage. 12(1):46-57.

Korschgren, L.J. 1958. Food habits of the mourning dove in Missouri. J. Wildl. Manage. 22(1):9-16.

Korschgren, L.J. 1960. Production of game bird foods in Missouri. J. Wildl. Manage. 24(4):395-401.

Korschgren, L.J. and G.D. Chambers. 1970. Propagation, storking, and food habits of Reeves pheasants in Missouri. J. Wildl. Manage. 34(2):274-282.

Korschgren, L.G. 1962. Foods of Missouri deer, with some management implications. J. Wildl. Manage. 26(2):164-172.

Krapn, G.L. 1974. Foods of breeding pintails in North Dakota. J. Wildl. Manage. 38(3):408-417.

Kuck, T.L., R.B. Dahlgren, and D.R. Progulshe. 1970. Movements and behavior of hen pheasants during the nesting season. J. Wildl. Manage. 34(3):626-630.

Leopold, A. 1933. Game Management. Charles Scribner's Sons, New York. 481 pgs.

Marshall, W.H. 1953. A survey of Farm-game habitat restoration programs in fifteen states. Transactions of the North American Wildlife Conference 18:390-412.

Martin, A.C., H.S. Zim, and A.C. Nelson. 1951. American Wildlife and Plants. Dover Publications, Inc. New York. 500 pgs.

Massey, A.B. 1938. A yardstick for measuring the habitat of the bobwhite quail. Transactions of the third North American WildlifeConference. 3:782-786.

McGilvery, F.B. 1966. Fall food habits of ducks near Santee Refuge, South Caroline. J. Wildl. Manage. 30(3):577-580.

McGilvery, F.B. 1966. Fall food habits of wood ducks from Lake Marion, South Carolina. J. Wildl. Manage. 30(1):193-195.

Michael, V.C. and S.C. Beckwith. 1955. Quail preference for seed of farm crops. J. Wildl. Manage. 19(2):281-296.

Moen, A.N. 1973. Wildlife Ecology. W.H. Freeman and Company, San Francisco. 458 pgs.

Moen, A.N. 1974. Turbulence and the visualization of air flow. Ecology 55(6):1420-1424.

Moen, A.N., M.A. Dellafera, A.C. Hiller, and B.A. Buxton. 1978. Heart rates of white-tailed deer farms in response to recorded wolf howls. Can. J. Zool. 56(5):1207-1210.

Mott, D.F. R.R. West, J.W. DeGrazio, and J.L. Guarino. 1972. Foods of the red-winged blackbird in Brown County, South Dakota. J. Wildl. Manage. 36(3):983-987.

Nixon, C.M. M.W. McClain, and K.R. Russell. 1970. Deer food habits and range characteristics in Ohio. J. Wildl. Manage. 34(4):870-886.

Robel, J.R. 1969. Food habits, weight dynamics, and fat content of bobwhites in relation to food plantings in Kansas. J. Wildl. Manage. 33(2):237-249.

Robel, R.J., A.R. Bisset, T.M. Clement, Jr., A.D. Dayton, and K.L. Morgan. Metabolizable energy of important foods of bobwhites in Kansas. J. Wildl. Manage. 43(4):982-987.

Robel, R.J. and P.G. Watt. 1970. Comparison of volumetric and point-analysis procedures to describe deer food habits. J. Wildl. Manage. 34(1):210-213.

Robel, R.J., R.M. Case, A.R. Bisset, and T.M. Clement, Jr. 1974. Energetics of food plots in bobwhite management. J. Wildl. Manage. 38(4):653-664.

Seubert, J.L. 1952. Observations on the renesting behavior of the ring-necked pheasant. Transactions of the 17th North American Wildlife Conference 17:305-329.

Smith, L.M., J.W. Hupp, and J.T. Ratti. 1982. Habitat use and home range of group partridge in eastern South Dakota. J. Wildl. Manage. 46(3):580-587.

Soong, S.S. 1981. Heart rate patterns in the female ring-necked pheasant (Phasianus colchicus). M.S. Thesis, Cornell University, Ithaca, N.Y. 74 pgs.

Sugden, L.G. 1971. Metabolizable energy of small grains for mallards. J. Wildl. Manage. 35(4):781-785.

Wright, T. Jr. 1941. A study of the fall food supply of the ring-necked pheasant and the bobwhite quail in Washngton county, Rhode Island. J. Wildl. Manage. 5(3):279-296.

Ward, A.L. 1964. Foods of the mourning dove in eastern Colorado. J. Wildl. Manage. 28(1):152-157.

Warner, R.E. 1979. Use of cover by pheasant broods in east-central Illinois. J. Wildl. Manage. 43(2):334-346.

Yeager, L.E. 1959. Status and population trend in fox squirrels on fringe range, Colorado. J. Wildl. Manage. 23(1):102-107.