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Effects of Changing land Use Patterns on Bobwhite Quail Habitat in Virginia

Michael L. Fies, Virginia Department of Game and Inland Fisheries, 1229 Cedars Court, Charlottesville, Virginia 22903
Irvin L. Kenyon, Jr., Virginia Department of Game and Inland Fisheries, Route 8, Box 1750, Ashland, Virginia 23005
Jack V. Gwynn, Virginia Department of Game and Inland Fisheries,1229 Cedars Court, Charlottesville, Virginia 22903

ABSTRACT

Bobwhite quail (*Colinus virginianus*) populations have been steadily declining in Virginia for at least 50 years. Wildlife biologists generally agree that changing land use patterns and more intensive agricultural methods are major factors contributing to this decline. A rapidly expanding human population now occupies many areas of former quail habitat. The total number and area of farms in Virginia have declined substantially since 1925. Many former open areas have reverted to forest that is no longer suitable for quail. Diverse mixtures of cereal grains have largely been replaced by monocultures of soybeans and improved grassland. Cattle production has increased, while the total area of pastureland has declined. The intensity of land use on farms has increased dramatically. Changing farm practices such as the removal of fencerows, fall plowing, double cropping, and the increased use of agricultural chemicals have been detrimental to quail. The fragmentation of remaining habitats has increased the vulnerability of quail to predation and other naturally occurring sources of mortality. Quail populations are likely to continue declining if current patterns of land use persist.

Keywords: bobwhite quail, *Colinus virginianus*, land use, agriculture, habitat

INTRODUCTION

The decline in bobwhite quail populations throughout the Southeast has long been a subject of concern for biologists and sportsmen (Stoddard, 1931). According to Rosene (1969), quail numbers in the South increased until about 1890, remained at relatively high levels until 1940, then began a slow decline. Rosene blamed deteriorating habitat conditions due to increased pasture development and the decreased use of fire in forested areas for observed declines. From 1939 to 1948, Goodrum (1949) found "clean" farming and increased livestock production to be the two primary factors responsible for a nationwide decrease in quail numbers.

During colonial times, bobwhite habitat increased in Virginia as forests were cleared and put into agricultural production. Subsistence farming was a way of life for many Virginians and bobwhite quail flourished during this period. Cultivated fields were small, diverse, and supported an abundance of food-producing weeds (Stoddard, 1931). During the twentieth century, "pioneer agriculture" (Edwards,

1985) was gradually replaced by more intensive "clean farming" methods. The large fields and monocultures typically associated with modern agriculture were much less suitable as quail habitat (Roseberry and Klimstra, 1984). Urban expansion and development also destroyed many areas formerly occupied by quail.

Virginia quail populations have probably been decreasing for at least 50 years, yet there are few historical data to document observed declines. More recent data, however, provide convincing evidence of a downward trend. Droege and Sauer (1990) reported that the number of bobwhite quail heard on North American Breeding Bird Survey (BBS) routes conducted in Virginia between 1966 and 1988 declined 41.8%. Hunter surveys conducted by the Virginia Department of Game and Inland Fisheries show that the total number of quail bagged by Virginia sportsmen declined from almost 1.2 million birds in 1968 to fewer than 200,000 in 1989 (Gwynn, unpub. data), a decrease of 84 %. Also during this period, the number of quail hunters declined 79 %. Among those avid hunters who remained, the number of bobwhites harvested per day and per season declined 31 % and 25 % respectively.

Gehrken (1950) provides the only source of hunter success information prior to 1968. Compared to similar data from the same regions of the state that were collected in 1990 (Fies, unpub. data), the number of quail bagged per hunter hour declined 55 % since 1949. The number of coveys flushed per hunter hour decreased 62 % during this period. An annual survey of quail hunters conducted since 1979 (Fies, 1991) provides further evidence of a downward trend (Figure 1).

Despite the noticeable loss of quail habitat, rural landowners and sportsmen often do not understand why bobwhite quail populations have declined. "What happened to all the quail?," is one of the questions most frequently asked of Department of Game and Inland Fisheries biologists. The purpose of this paper is to document changes in agricultural land use that have occurred in Virginia since 1925 and to evaluate the effects of these changes on bobwhite quail habitat.

MATERIALS AND METHODS

To obtain agricultural land use data, statistics were compiled from Census of Agriculture reports published approximately every five years from 1925 to 1987 (U.S. Bureau of the Census, 1925, 1930, 1935, 1940, 1945, 1950, 1954, 1959, 1964, 1969, 1974, 1978, 1982, 1987). We chose the year 1925 as the starting point for our analyses because it represented the earliest year for which comparable census data were available for most variables measured. We obtained additional data on Virginia grain and hay crops from the Virginia Cooperative Crop Reporting Service (Virginia Department of Agriculture and Commerce, 1968).

General land use data and forest statistics for Virginia from 1940 to 1986 were compiled from U.S. Forest Service reports (Craig, 1949; Knight and McClure, 1967; Brown, 1986). We obtained information on human population growth from U.S. Bureau of Census Current Population Reports (U.S. Bureau of the Census, 1930, 1950, 1980). For 1990, we used population projections published by the Virginia Department of Planning and Budget (Lillywhite and Robinson, 1986). Our evaluation of the relationships between land use changes and bobwhite quail habitat is based upon descriptions of habitat quality by many authors (see review by Schroeder, 1985).

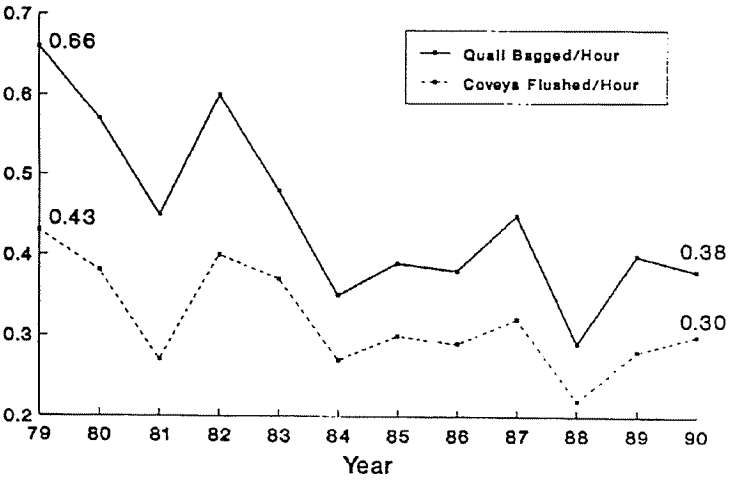

FIGURE 1. Number of quail bagged and coveys flushed per hunter hour during the 1979-80 through 1990-91 Virginia hunting seasons.

RESULTS

In contrast to the lack of historic data regarding quail population levels, there is much information available on land use trends. In 1940, the U.S. Forest Service estimated that 25% of Virginia was comprised of cropland (Craig, 1949). Only 4% was classified as "other land" (residential, urban, roads, etc.). More recently, Brown (1986) estimated that the percentage of cropland in Virginia had declined to 14% while the percentage of "other land" increased to 10% (Figure 2). Forested area also increased from 58 to 63% during this period. These data suggest that increases in urban development and reforestation appear to have contributed almost equally to the loss of Virginia cropland.

Census of Agriculture data (U.S. Bureau of the Census, 1925-1987) provide further evidence that Virginia cropland is disappearing. Between 1925 and 1987, the total area of harvested cropland declined 39% in Virginia (Table 1). Not surprisingly, total farmland area also decreased, from almost 7 million ha in 1925 to approximately 3.5 million ha in 1987, a reduction of 50%. The total number of farms was reduced 76% from 185,697 to 44,798 farms and the average farm size almost doubled from 40.3 ha in 1925 to 78.4 ha in 1987 (Table 1).

Accompanying this downward trend in the total area of Virginia farmland has been a disproportionate loss in the number of small farms (less than 20 ha). In 1925, almost 50% of Virginia's farms were less than 20 ha in size and only 6% were 105 ha or larger (Figure 3). In 1987, 32% of all farms were less than 20 ha and 20% were 105 ha or larger. These comparisons reflect the change from small, diverse, "all purpose" farms to large, intensively managed monocultures.

The loss of farmland to urban development is a direct result of Virginia's rapidly expanding human population. According to the Bureau of Census, Virginia's population has increased 163% from 1920 to 1990. More importantly, the area of greatest human population growth has been in the Coastal Plain region, which

TABLE 1. Changes in selected agricultural statistics for Virginia, 1925 to 1987.

Item	1925	1987	% Change
Total Farmland (ha)	6,964,717	3,511,192	-49.6
Total Number of Farms	185,697	44,798	-75.9
Average Farm Size (ha)	40.3	78.4	+94.5
Harvested Cropland (ha)	1,606,025	974,069	-39.3
Corn Harvested (ha)	580,785	226,262	-61.0
Wheat Harvested (ha)	242,468	76,254	-68.6
Soybeans Harvested (ha)	38,710[1]	186,125	+380.8
Hay Harvested (ha)	337,855	435,120	+28.8
Idle or Fallow Cropland (ha)	566,406	205,095	-63.8
Total Pastureland (ha)	2,139,977	1,356,109	-36.6
Number Cattle on Farms	806,524	1,510,920	+87.3
Number Cattle per 100 ha Pasture	37.7	111.4	+195.5

[1] Statistic for year 1930. No data available for 1925.

historically has had the greatest quail abundance (Kenyon and Gwynn, 1988). The human population in this region has increased 167% since 1920 (Figure 4).

Natural plant succession in abandoned fields has also been an important factor contributing to the decline in quail habitat. Although habitat conditions in abandoned fields are often favorable for quail during the first 4 years (Byrd, 1956), habitat quality quickly deteriorates as invading woody vegetation matures. Figure 5 shows that the area of forest in the seedling-sapling stage (which is often excellent quail habitat) increased 162% between 1956 and 1966 (Knight and McClure, 1967). This increase was due, in part, to the reversion of former cropland to forest. More importantly, an increased demand for pulpwood products during this period resulted in record levels of timber harvest and an increase in the area of early successional regrowth. Between 1966 and 1986, however, the area of seedling-sapling forest declined 37% (Brown, 1986). This decrease, and the corresponding increase in sawtimber area (Figure 5), were largely a result of the maturation of early successional seral stages.

Another important change in bobwhite quail habitat is related to the increased production of cattle and the higher grazing intensity of available pastureland. In Virginia, the total number of cattle on farms increased 87% between 1925 and 1987 (Table 1). The total area of available pastureland declined 37% during this period. As a result, grazing intensity on Virginia pastures (number of cattle per 100 ha of pastureland) increased almost 200% since 1925 (Table 1). The percentage of farm woodlands that are grazed has also risen substantially, from 19 % in 1925 to 26 % in 1987.

The types of crops harvested in Virginia have also changed significantly. Corn for grain was the principal crop harvested in 1925 (Figure 6). In 1987, hay was the most important crop harvested. Corn for grain dropped to the third most important crop, behind soybeans, for which harvest levels in 1925 were almost insignificant.

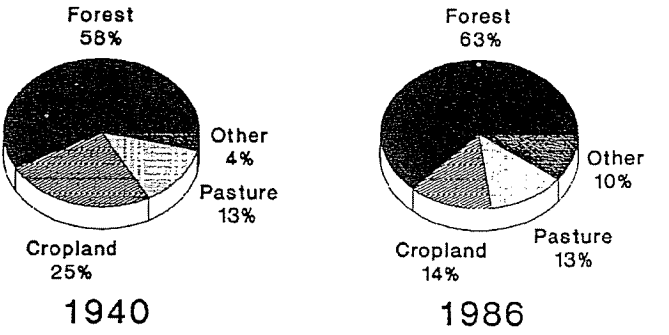

FIGURE 2. Percentage of all Virginia land by land use classification, 1940 versus 1986.

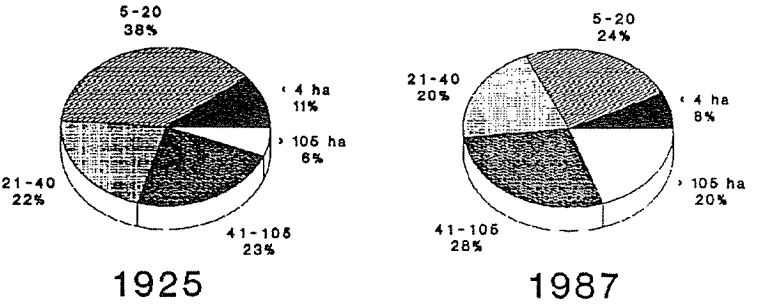

FIGURE 3. Percentage of Virginia farms by size class, 1925 versus 1987.

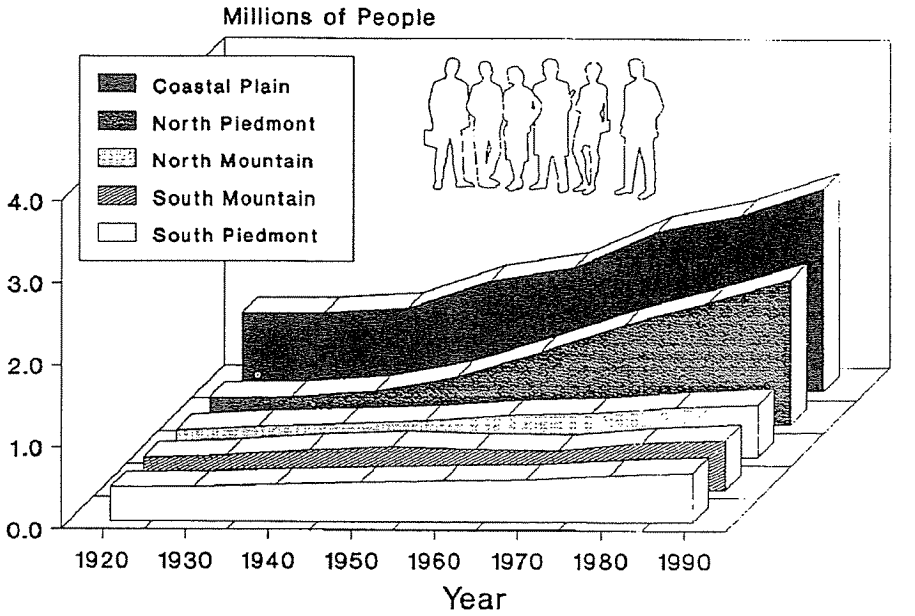

FIGURE 4. Human population in Virginia by geographic region, 1920 to 1990.

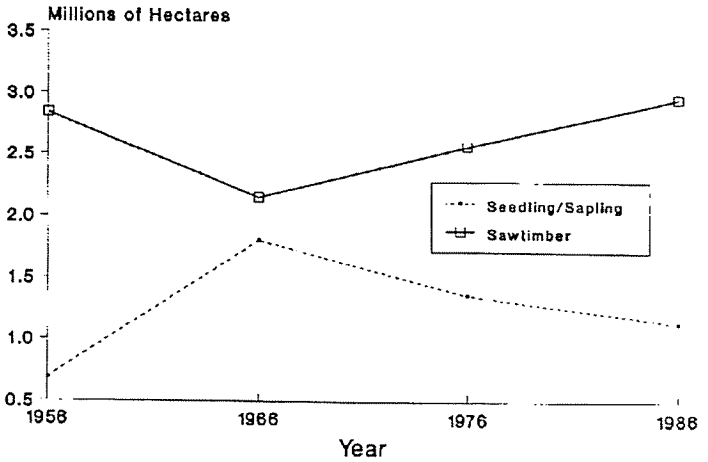

FIGURE 5. Hectares of Virginia forest land by timber size class, 1956 to 1986.

The total area of corn harvested for all purposes declined 61% from 1925 to 1987 (Table 1).

Along with this decline in the area of corn harvested has been a change in the way corn has been utilized. In 1925, 93% of Virginia's corn was harvested for seed or grain while only 7% was cut for silage. In 1987, corn harvested for silage comprised 39% of the total corn utilization.

Wheat is another important grain crop that has had a significant decline in land area harvested. From 1925 to 1987, the total area of wheat harvested in Virginia declined 69% (Table 1). Other grain crops, such as oats and rye, have followed similar trends but were less important crops during this period (fewer ha harvested). A notable exception to the general decline in grain crops has been the increase in the area of soybeans harvested, which has risen 381% since 1930 (Table 1).

The area on which hay is harvested in Virginia has also increased. From 1925 to 1987, the area of hay harvested rose 29% (Table 1). Accompanying this increase was a change in the types of crops that were used for hay. For example, lespedeza was a popular hay crop during the 1940's and 1950's and cowpea was often cropped for hay in the 1930's. In addition to providing forage for livestock, these legumes were also used as soil builders in crop rotation systems. Both of these crops were excellent quail foods and were valuable as nesting cover. Today, the use of these crops for hay is almost nonexistent as more chemical and natural fertilizers are used to enhance soil quality. A mixture of clover and timothy grass is presently the most common hay harvested in Virginia.

The area of idle or fallow fields, which are often prime quail habitat, is declining. Between 1925 and 1987, the number of ha left fallow or unharvested declined 64% (Table 1). As farm technology improved, more efficient utilization of available cropland became possible. Recently, the reduced participation in and availability of federal soil conservation and agricultural cropland set-aside programs has also

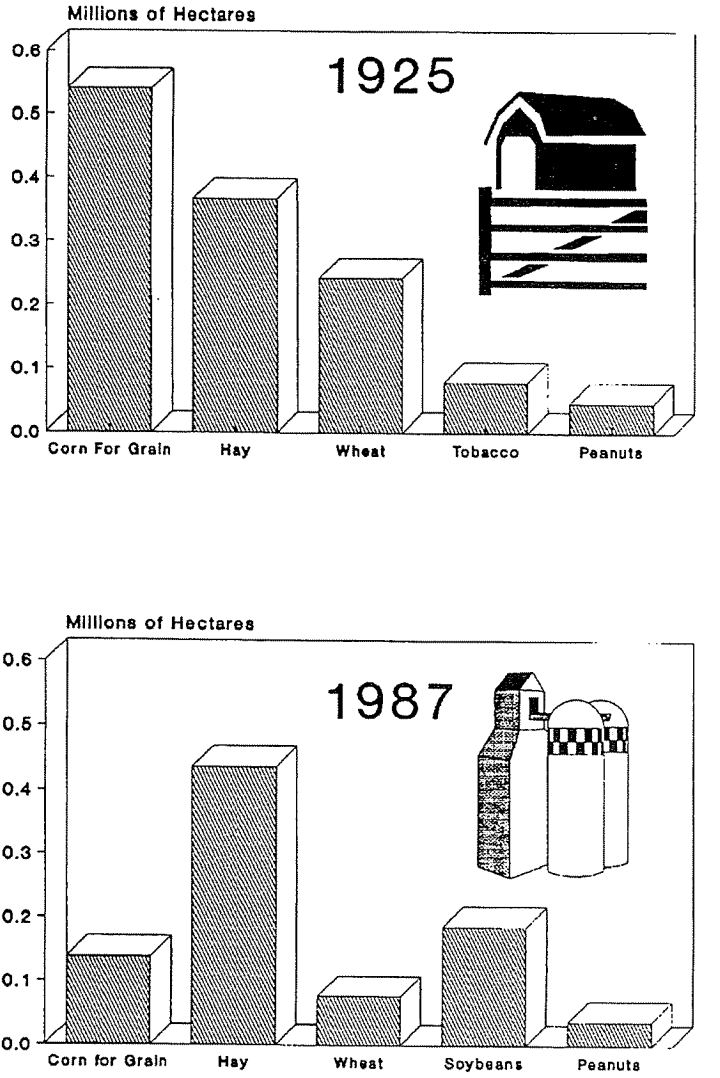

FIGURE 6. Comparison of major crops harvested (ha) in Virginia, 1925 vs. 1987.

resulted in fewer fields left unharvested. Also, adverse economic conditions have forced many farmers to boost production by cropping all available land area.

Farmers have also used agricultural pesticides to increase crop yields. Prior to the 1960's, the application of pesticides on Virginia farmland was relatively insignificant. Between 1969 and 1987, however, the use of pesticides to control insects, nematodes, disease, and weeds in Virginia crop fields increased 104% (Figure 7). Exposure to many of these chemicals is known to have adverse effects on avian species, including bobwhite quail (see review by Stinson, 1989).

DISCUSSION

Considering the data presented, Virginia's agricultural landscape has been drastically altered since 1925. Because bobwhite quail are often associated with farmland habitats, their populations have been affected by these changes. The direct loss of habitat due to urban development and natural succession has contributed to the decline in quail numbers. The situation has been exacerbated by changes in farm technology and the agricultural economy that have resulted in more intensive use of remaining farmland habitats.

The increase in average farm size has been particularly significant. In general, larger farms have larger fields with fewer field borders. Since many "old-fashioned" field borders were weedy split-rail fences or brushy strips that provided excellent nesting and escape cover, the removal of this "edge" habitat adversely affected quail numbers. Farmers removed many fencerows to facilitate the use of large farm machinery and to maximize the use of available cropland. Other fencerows were removed because farmers believed that they harbored insect pests and were not consistent with the image of a "clean" farm. Regardless of the reason, removal of these fencerows resulted in decreased amounts of quality "edge" habitat, less diversity, reduced escape cover, and fewer travel lanes. Leopold (1931) eloquently described the need to protect hedgerow habitats:

> "More game would be produced by in some way paying the farmer a bonus on hedges, than by spending the same money on foreign birds or Kansas rabbits. The fact that questions of this kind are not discussed, not investigated, nor even mentioned, is evidence that the game conservation movement has not yet come to grips with the real fundamentals of the problem which it intends to solve."

Changing land use has also had a great impact on bobwhite quail habitat by reducing or eliminating plant diversity and the interspersion of cover types, particularly those associated with the early stages of natural plant succession. Pimlott (1969) characterized habitat diversity as "the life blood of the majority of species," the ramifications of which "extend from the subsistence of an individual to the viability of a population and to the survival of species." For quail, increased plant diversity usually results in a greater range of food options (McRae et al., 1979) and is characteristic of prime nesting and escape cover (Klimstra and Roseberry, 1975). In contrast, the large-scale farming of monocultures reduces crop diversity and decreases the interspersion of habitat types. On a study area in Illinois, the conversion of a variety of crop fields to large soybean fields decreased the interspersion index for quail by 67 % (Vance, 1976). Baxter and Wolfe (1972) also demonstrated the importance of interspersion by documenting a significant positive correlation between the number of cover type changes with quail abundance along summer call-count routes.

The quantity and quality of "edge" habitat are also considered to be important measures of habitat quality. In fact, maximizing edge is considered to be an effective quail management tool (Conlin and Giles, 1972). The quality of edge habitat in Virginia, however, has declined as land use has changed. In 1925, the typical agricultural edge was comprised of a crudely farmed field adjacent to a weedy fence or brushy hedgerow. The cropped field provided a source of food and

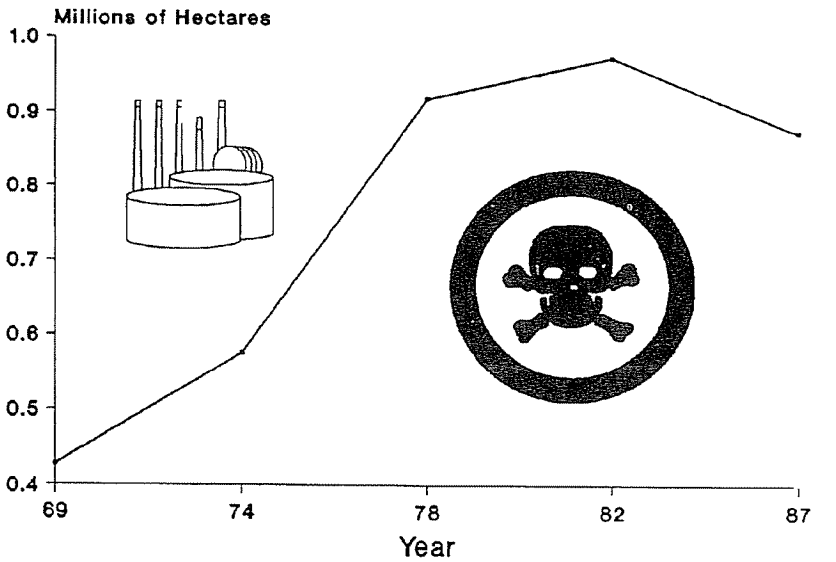

FIGURE 7. Hectares of Virginia cropland treated with insecticides, nematocides, fungicides, or herbicides, 1969 to 1987.

the weedy fencerow offered nesting and escape cover. In contrast, the modern edge is often a "clean" farmed field next to a mature woodland. Edges of heavily grazed pasture adjacent to grazed woodlands are also common. None of these habitat types are useful to quail.

Perhaps the greatest problem facing quail today is the lack of available nesting and brood range habitat. In earlier days, an abundance of rough pasture and fallow fields filled this important role. Today, most pastures are excessively grazed and are almost completely devoid of useful ground cover. Also, many intensively grazed pastures have been "improved" by replacing native grasses with sod-forming exotic species like fescue. Fescue conversion has been particularly detrimental to quail, and may be the single most important factor responsible for the observed decline in quail numbers. Matted growths of fescue are too thick for quail to utilize effectively and are unsuitable for nesting purposes (Roseberry and Klimstra, 1984:32). Even worse, fescue often takes over a field quickly by "choking out" other more useful quail plants. Fescue seed is also of little value as quail food (Michael and Beckwith, 1955).

The decline in grain crops harvested has affected quail by reducing the availability of winter foods. Quail often use waste grain from harvested corn fields as an important food source (Landers and Johnson, 1976). Wheat is also a preferred food (Michael and Beckwith, 1955). While the loss of these grain crops appears to have been partially offset by an increase in soybean area, only a small fraction of the soybeans remaining after harvest are used by quail. Waste grain in harvested soybean fields is usually plentiful, but quail will not frequent these areas because cover is limiting (Exum et al., 1982). Typically, soybeans are harvested

with combines that cut close to the ground, leaving almost no stubble for cover. Quail that feed in harvested soybean fields are often fully exposed to predators.

The increased percentage of corn that is harvested for silage has also contributed to the decline in winter food availability. Corn harvested for silage is cut earlier and there is less hardened crop residue left for winter food. Also, silage corn is cut close to the ground (to maximize use of the entire stalk), leaving no stubble available for fall and winter cover.

In general, the types of hay presently harvested in Virginia are less useful to quail than those harvested prior to 1950. In 1931, Herbert Stoddard considered common lespedeza to be "one of the most valuable of quail foods and pasture plants of the South." In Virginia, C. O. Handley (quoted in Kennedy, 1936) reported that the spread of lespedeza as a pasture crop was "becoming general enough to exert a tremendous influence toward the increase of quail." Unfortunately, the popularity of lespedeza hay declined rapidly during the 1940's and 1950's. Today, farmers rarely plant lespedeza as a hay crop and its area has dwindled to only a small fraction of that which it once occupied. Cowpea, also a preferred food of quail (Landers and Johnson, 1976), has followed a similar pattern of reduced popularity. The decline in the availability of these preferred quail foods has reduced the quality of habitat in many areas.

Perhaps more important than the loss of lespedeza and other hay crops beneficial to quail, have been the technological improvements developed for harvesting hay. In contrast to the former use of pitchforks and small balers, most hay is now baled using large package balers. The increased efficiency of these balers has contributed significantly to the increase in hay area harvested. Farmers are now harvesting many areas of suitable quail cover that would not have been hayed in the past (because of time or money constraints).

Increased farm technology and changing farm practices have had other detrimental impacts on quail habitat. Efficient farm machinery increased bobwhite nest destruction and reduced food availability through "clean" farming (Edminster, 1954). The development of the tractor and bulldozer also allowed for easy removal of fencerows. Improvements in mowing equipment (i.e. the bushhog) enabled farmers to clear brushy areas that were often attractive to quail. Fall plowing, double cropping, mowing for aesthetic reasons, and the reduced use of fire are other more recent farm practices that quail managers consider detrimental to quail.

The increased use of pesticides on Virginia farmlands may also be an important factor contributing to the decline in quail numbers. Aside from the direct mortality associated with exposure to toxic chemicals, sublethal doses can increase the susceptibility of quail to predation and decrease reproductive performance (Stromborg, 1982). Insecticides also reduce the number of insects available to developing quail chicks and can cause secondary poisoning when contaminated insects are eaten. The use of herbicides reduces the availability of native plant foods and decreases the amount of cover. Before the widespread use of herbicides, weedy corn fields provided excellent quail brood habitat. Today, "clean" corn fields are seldom used by quail broods.

Finally, the fragmentation of existing habitats has had a negative impact on Virginia quail populations. Large expanses of good quail habitat have been reduced to many small "islands" of suitable habitat. As a result of this fragmenta-

tion, quail are more susceptible to predation and other naturally occurring losses. Due to the relatively low mobility of bobwhites, recolonization of depleted habitats is often slow or fails to occur because of the reduced proximity of these areas to occupied range (Roseberry and Klimstra, 1984:194). Also, "island" quail populations have fewer surplus birds available to repopulate these areas. The detrimental effects of habitat fragmentation are more severe in areas of marginal habitat quality.

In summary, changing land use patterns and the intensity of land use have had profound effects on the availability and quality of quail habitat in Virginia. We attribute the current downward trend in quail population levels to these deteriorating habitat conditions. Although many of the factors discussed in this paper are at least partially responsible for the decline in quail numbers, we believe that loss of suitable nesting and brood range habitat has had the greatest negative impact.

Unfortunately, there is no reason to believe that quail populations will not continue to decline. To significantly increase quail numbers, it will be necessary to reestablish large areas of suitable quail range. Considering that the vast majority of quail habitat is on private land and that there is presently little economic incentive for landowners to make necessary habitat improvements, it seems unlikely that bobwhite populations will recover soon. The factors affecting quail abundance are well understood; what is lacking is the public's commitment to reverse the observed trends.

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