study and is readily adaptable to the check-in, check-out type of hunt held in many southeastern states. The technique has an additional advantage in that it gives the hunter a feeling of "participation" which may be helpful to his acceptance of deer management programs. We offer the hunter observation index as cheap and easy, but inherently variable. The technique is limited in its accuracy, but probably no more so than many other conventional techniques. Where greater accuracy is required, we recommend an entirely new approach. We cannot suggest what direction the new approach should take, but feel that an attempt to further refine any technique affected by the variability of weather or deer movement is a waste of time and money.

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SOME SPECULATIONS ON THE MINIMUM HABITAT REQUIREMENTS OF BOBWHITE QUAIL

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ABSTRACT

This paper reports on a review of 24 selected publications dealing with the habitat requirements of the bobwhite quail *(Colinus virginianus)*. Its purpose is to bring the results of these investigations into sharper focus in an effort to determine the minimum number of vegetative types, and the minimum amount of each, that are needed to support a single covey the year round. It also seeks to stimulate further inquiry into the validity of the hypothesis presented. The literature reviewed indicates that quail ordinarily require at least three vegetative types—crop fields, brushy cover, and grassland. A further requirement of quail range is that these vegetative types be well interspersed so some of each is available to each covey. The winter food requirements of a covey of 12 birds can probably be met by three-fourths of an acre of annual food plants or one-seventh of an acre of bicolor (*Lespedeza bicolor*). The presence or absence of a "headquarters" area of brushy cover may be the determining factor in deciding the habitability of a covey range. A minimum of 450 square feet of this brushy cover appears to be needed. At least one-fifth of an acre of grassland, primarily for nesting cover, is needed. It is suggested that a hypothetical covey range might consist of the above amounts of vegetation concentrated in a rectangular field 99 feet wide and 484 feet long when the annual food patch is used, and a rectangular field 39 feet wide and 454 feet long when bicolor is used for food. The habitability of such a covey range may be modified by population density,

mobility, soil fertility, harassment, weather, "tradition," or the continuity of the quail range. If the hypothetical covey range proves valid, ways and means of establishing it on intensively used agricultural land need to be found.

INTRODUCTION

This paper reports on a review of 24 selected publications dealing with the habitat requirements of the bobwhite quail *(Colinus virginianus)*. Its purpose is to bring the results of these investigations into sharper focus in an effort to determine the minimum number of vegetative types, and the minimum amount of each, that are needed to support a single covey the year round. It also seeks to stimulate further inquiry into the validity of the hypothesis presented.

Edminster (1954) recognized the need for such information more than a decade ago. Those who work directly with business-minded farmers are aware of the reluctance with which many landowners devote any of their land to quail production. They are also aware of the equal reluctance of most farmers in areas of intensive agriculture to make even a minimum amount of improvement to land that could, or should, be used only for wildlife production.

Consequently, if huntable bobwhite populations are to be maintained on the more intensively used farmland of the country, it appears to me that the wildlife manager will need to develop his understanding of the habitat requirements of quail to the point where he can say with assurance that so many units of this or that type of vegetation, arranged thus and so, will support a covey the year round. Errington and Hamerstrom (1936) thought it might be possible to develop a formula to express the habitability of an area. Whether or not such is possible, I think it is essential that this understanding, when applied, dictate no practices that conflict with the farm enterprise, or, indeed, require any modification of farming methods. Most farmers simply will not stand for any interference with their usual methods of operation.

There is another reason why such precise knowledge is needed. I have spent a considerable portion of my professional career trying to sell farm game habitat restoration to farmers. I have found it a most difficult task. I am sure that many of my urgings fell upon deaf ears. But in those instances in which I found a farmer who was ready, willing, and able to do whatever I thought necessary to create or improve quail environment, I found myself in the embarrassing position of having to hedge when the farmer insisted that I guarantee the effectiveness of the practices I recommended. Biologists know that there are many factors that can nullify the objectives of habitat improvement measures, but a farmer who has had to be sold on carrying out such measures is not nearly as likely to accept explanations for failures as is someone better informed on the subject. A more precise understanding of the minimum habitat requirements of quail would have relieved me of my embarrassment, enabled me to be of better service to the landowner, and enhanced the management of this bird.

It may be impossible to achieve the degree of understanding needed to guarantee the results of habitat manipulation. But the effort to do so is justified because of the bobwhite's importance as a game bird.

The substance of this report is a discussion and interpretation of the findings of 29 investigators as reported in 24 selected publications. The publications were selected on the basis of their availability to me and their pertinency to the subject. From the findings reported in these works I have tried to construct a theoretical optimum covey range that is of minimum total size and is constituted of the minimum number of vegetative types and the minimum amount of each. The hypothesis presented and the interpretations made are strictly my own and are based on my personal fund of empirical information.

Other workers, Schultz and Brooks (1958), and Schultz (1959), have already attempted to provide the information being sought by means of a statistical analysis of the vegetative composition of selected farms and the resident quail population thereon. But their analyses failed, or at least it seems so to me, to provide the kind of definitive information the practicing field biologist needs. My own attempt, as

discussed in this paper, is not entirely satisfactory either, and needs to have its validity tested. But the problem with which it is concerned is examined, as far as I know, more closely than it has otherwise been to date.

DISCUSSION

Gross Habitat Characteristics

That quail use more than one vegetative type to satisfy their habitat needs was readily apparent to Stoddard (1931) in his classic study of quail in the Southeast. He observed that to be attractive an area had to contain a plentiful supply of food close to good protective cover. This cover needed to be in the form of thickets of brush interspersed with open areas of herbaceous vegetation for nesting and roosting. He noted, too, that a covey appeared to occupy a more or less definite area that contained all these types. This area has been termed a covey "range."

Leopold (1933) went a step farther and suggested that quail require the vegetative types furnished by four kinds of land—woodland, brushland, grassland, and cultivated land—and that for these to be of maximum usefulness all four had to meet at a common point which was the focal point of a covey's activities.

Ridley (1952), in his study of unmanaged refuges in Kentucky, found the highest quail population on an area on which four kinds of land uses—crops, pasture or meadows, fallow, and woods—occurred in about equal amounts and were well interspersed.

Edminster (1954) described the most productive quail ranges as those that had an adequate amount and arrangement of grassland, crop fields, brushy cover, and woodland.

In Indiana, Allen (1959) described that region of the state most productive of quail as an area characterized by the presence of cultivated land interspersed with woodland and a plentiful amount of both nesting and winter cover. Stanford (1952) said practically the same thing about the quail range in Missouri. He specified that brush, grass, and woods must be near fairly fertile land used for growing legumes, corn, or small grains. Errington and Hamerstrom (1936) noted that one of the reasons Iowa farmland was of so little use in determining quail carrying capacity was that most of the land was cultivated and the fields were so large that too little of it was within 50 to 100 yards of suitable winter cover.

In the Western Cross Timbers section of Texas, Jackson (1951) reported that during spring and summer quail seemed to prefer to live around former homestead sites, but that in fall and winter they moved into the post oak *(Quercus stellata)* thickets and stayed near heavy brush or other woody cover the balance of these seasons.

Lay (1952), reporting on the use quail make of the pine woodlands of Newton County, Texas, points out that before livestock farming came to dominate the area, it contained excellent quail habitat. He describes the area as having wooded stream courses, brushy fence rows, and small and scattered crop fields that produced heavy crops of weed seeds usable by quail.

From these reports I conclude that there appear to be four major vegetative types used by quail. Whether or not all or only the vegetative types mentioned by these writers are essential throughout the quail range is not clear. Davison (1949) concluded that quail need only two kinds of cover, brush and grass. He apparently was referring only to the bobwhite's cover needs, not its food needs, in reaching this conclusion. Robinson (1957) did not seem to consider woodland an important constituent of quail habitat. Both Leopold (1933) and Edminster (1954) assert that quail may, under some conditions, get along with only one vegetative type. Leopold uses open Ozark woodland as an example. Edminster is not as specific, but says that brushy cover is, in some cases, indispensable. These authorities agree, however, that higher populations can be maintained on an area containing several well-interspersed vegetative types than can be

maintained on an area containing only one. Scott and Klimstra (1954) reported that bare ground, or at least ground covered by only a light litter, appeared to be a need of quail. Stoddard (1962) has recently corroborated this view. Perhaps this is another "type" that has not been individually recognized before because it is a concomitant of crop fields.

Specific Habitat Characteristics

Working in southern Illinois, Hanson and Miller (1961) reported that 30 per cent of an area could be in cultivation and still produce a fair number of birds, provided the cultivated fields were interspersed with grass and brush. Murray and Frye (1957) in Florida thought that to make an open pine woods attractive to quail, one-eighth-acre food plots should be planted at the rate of one to each 20 acres of woods. No mention is made of the area that is, or needs to be, in woods, brush, or grass. They do say, though, that a forty-acre cultivated field, surrounded by suitable cover, is the largest tract that can be devoted to crops and still maintain a fair number of quail. They also observed that quail, in their quest for food, did not get much more than 50 yards from woody cover.

Lehmann (1937) has done a great deal of work in Texas and has arrived at some rather specific recommendations for developing the various vegetative types occurring there to improve conditions for quail. The salient points of his studies seem to be that 10 to 30 percent of large woodlands should be maintained as openings and that these openings should have strips plowed or disked through them to stimulate the growth of annual food plants. He felt that these strips should be no farther than 30 feet from brushy growth.

Stoddard (1931) recommended that on Southeastern quail preserves, strips about 50 feet wide be marked off at approximately 100-yard intervals, and that these strips be either planted to medium-sized trees or allowed to grow up to volunteer brush and herbaceous cover. Handley (no date) was of the opinion that, for Virginia conditions, food patches should be no more than 100 feet from protective cover. He suggested that grown-up areas be kept in condition for quail by crisscrossing them with mowed strips, such strips to constitute about one-third of the total area. The remaining two-thirds was to be left for woodland.

In their work in the farming region of southern Wisconsin, Kabat and Thompson (1960) have provided more specific information than any of the authors mentioned thus far. Their records showed that quail disappeared from an area when the amount of brushy hedgerow cover dropped less than about one mile of hedgerow to 550 acres of farmland. They recommended, therefore, that a program of hedgerow preservation or restoration should seek to maintain one mile of hedgerow for each 450 acres of farmland. They recommended a hedgerow width of 12 feet. My calculations indicate that this amounts to one acre of brush to each 30 acres of farmland. However, these workers thought that scattered thickets ranging in size from 10 square feet to one-fourth of an acre, plus the cover provided by woodlots, were necessary to supplement the hedgerows. They also considered grassy cover for nesting, and cultivated cropland for food, to be necessities.

In areas where land had been retired from cultivated crops, they recommended the planting of annual food patches or the plowing of strips on which annual food plants would develop through natural plant succession. It is difficult to determine how much of this type they think is needed for an individual covey, but they suggest that no more than two one-fourth-acre planted patches are needed per farm. From their mention that the average farm has an area of 150 acres, and from their conclusion that the one mile of hedgerow to 450 acres of land would support a population of one bird per 20 acres, I calculate that the average farm would have a population of eight birds. Assuming 12 birds to the covey, this would be two-thirds of a covey. From these calculations I deduce that three-fourths

of an acre of annual food and three-fourths of an acre of hedgerow, supplemented by thickets and woodlots, are adequate amounts of these types to support a single covey of quail. How much grass is needed for nesting cover is not clear, but these investigators thought there was an adequate amount produced by the land use methods followed in the area in which they carried on their study.

In his summary of the habitat requirements of quail, and the desirable land use pattern for good quail range, Edminster (1954) gives the needs as 30 to 40 percent grassland, 60 to 40 percent crop fields, 5 to 20 percent brushy cover, and 5 to 40 percent woodland. The desirable size for each unit of these types of vegetation is given as 5 to 20 acres, 1 to 5 acres, ¼ to 1 acre, and 5 to 20 acres, respectively. This is probably the best summarization of quail habitat needs we have had to date, but the ranges in both percentages and acres are too broad for the task at hand.

Davison (1949) places great reliance on the efficacy of bicolor *(Lespedeza bicolor)* to feed and hold birds in a given area. He recommends the planting of this food plant in strips 15 to 18 feet wide and 400 feet long. This gives an area of about one-seventh of an acre and is thought to provide enough food to feed a single covey through the critical period from late fall to early spring. As I have already mentioned, Davison thinks brush and grass are adequate for the bobwhite's cover needs. Brush and grass, then, plus this winter food, should constitute the vegetative types needed to support a covey. He does not say how much brush and grass are needed to complete the covey range. But he does suggest that one bicolor strip to each 20 or 25 acres of southern pineland is conservative and that one to each 10 acres is possibly better.

The findings of Kabat and Thompson (1960) and Davison (1949) have enabled me to arrive at a conclusion regarding the food requirements of a single covey, but I still do not have information specific enough to enable me to determine what vegetative types, and how much of each, are needed for cover.

The Headquarters Concept

For more insight into this matter, the work of Robinson (1957) in Kansas is extremely helpful. He found that the number of coveys a given area could be expected to support was determined by the number of covey "headquarters" that occurred there. To be habitable, a headquarters area had to have protective vegetation that was dense enough at the critical season (i.e., after the leaves of deciduous vegetation have fallen) to reduce the amount of incident light at the birds' level to an amount less than 1000 foot-candles at midday. He found that daily quail movements are a function of light intensity and that on sunshiny days the birds resort to "loafing" cover at midday, not because they have nothing else to do, but because they are intolerant of strong light. He thought, too, that a patch of dense, woody vegetation no more than 15 yards square was sufficient for a covey headquarters, provided it was not closer than 138 yards to another headquarters. The area between two such headquarters areas, he felt, should be in short grass, annual and perennial weeds, and, possibly, small cultivated plots. He thought the size of his suggested headquarters area to be better than one mentioned by Lehmann in Texas, in which a clump of woody vegetation only six or seven feet in diameter was used.

Bushong (1959), reporting on his work in Indiana, has also commented on the significance of the headquarters area and its anchoring effect. He reported that a small clump of brush 15 feet wide and 30 feet long was used by a covey as a headquarters year after year. This was apparently all of this type the covey required since it never moved to a nearby woods. He does not say whether or not the birds took refuge in the woods when flushed from their headquarters area.

Also in Indiana, Allen (1959), referring to quail populations in the northwestern and eastcentral parts of the state, pointed out that

food was plentiful but that winter cover, suitable for covey headquarters, was the factor limiting population density.

Not quite so specific, but pertinent to the point being made, was Lehmann's (1937) observation that, in Texas, the area used by quail during the winter was less than 15 percent of that used in summer. He surmised that the factor that determined the suitability of a given area as winter range was protective cover.

Also in Texas, Springs (1952) mentions that mesquite *(Prosopis chilensis)* and huisache *(Acacia farnesiana)* that had been half-cut to produce ground cover for quail were used in late winter as covey headquarters. He does not say how much ground cover was produced by each of the plants thus treated, but from photographs I infer that it covered an area approximately 10 feet in diameter.

Errington and Hamerstrom (1936) also theorized that perhaps only the cover in specific parts of an area is really significant.

Although he does not say so, Handley (no date) probably was aware of the significance of the headquarters area when he recommended that, when developing quail preserves, brushy thickets about 50 feet in diameter be left at about 100-yard intervals.

Edminster (1954) was apparently referring to the headquarters area when he stated that a small amount of brushy cover is often the key to the habitability of a covey range.

Stoddard (1931), in discussing covey ranges, recognized that each covey had its own headquarters in a thicket from which it issued to feed over the surrounding area.

I suggest that these observations from the western, eastern, northern, and southern fringes of the bobwhite range, plus those from the central portion of that range, are sufficient evidence to support the suggestion that the brushy headquarters area is an essential part of the bobwhite's environment throughout its natural range.

I hesitate to accept the minimum size of such headquarters areas as that reported by Robinson's (1957) reference to Lehmann and by Springs (1952) because I do not have sufficient evidence to support it. But that reported by Bushong (1959) is stated with such finality that I conclude that the minimum size for a headquarters area is approximately 450 square feet. This is substantially less than that suggested by Robinson (1957).

Nesting Cover

The use of grassy cover for nesting is so well established that I do not consider documentation of this need necessary. However, there is a paucity of information on just how much of this vegetative type is necessary. Since the actual space required for a single nest is infinitesimal, I must assume that the amount of nesting cover needed is based on an expression of territoriality on the part of the hen, rather than on mechanical needs. If this is actually the determining factor, then Stoddard (1931) has supplied the best information I am able to find on this subject. He reported having five nests under observation at the same time on a single acre. I conclude from this that at least one-fifth of an acre is needed to supply the nesting cover needs of a single pair of birds.

Woodland

While the literature reviewed leaves no doubt that woodland, woods, or woodlots—whatever terminology is applied to this type of vegetation—are used by quail, serious doubt is cast upon their necessity. Davison (1949) excludes them from his estimate of cover needs. Robinson (1957) appears to do the same thing. In their study of quail mobility in Missouri, Murphy and Baskett (1952) found that the birds made little use of woods. Kabat and Thompson (1960) thought the main value of woodlots was as a supplement to hedgerows. Woodlots become unfit for winter cover when subjected to heavy grazing (Reeves: 1954). Therefore I suggest that, since it is the brushy understory of woodlands that provides the protective

cover that quail need, the overstory vegetation that gives the type its name can be dispensed with and the covey range still be habitable.

Definition of Terms

Before I proceed to describe the hypothetical covey range for which I have been developing a base, I want to clarify the terminology used by the writers I have cited to describe the vegetative types to which they referred. The best descriptions I have encountered for the vegetative types used by quail are those given by Edminster (1954). To repeat, those types are grassland, crop fields, brushy cover, and woodland. References in this paper to pastureland, meadowland, grassland, grass, grassy cover, and nesting cover, can, I think, be considered under the heading of grassland.

Similarly, terms such as brushland, brush, brushy cover, shrubs, and winter cover can all be considered to belong to the category of brushy cover. Also in this category belong sturdy herbaceous plants whose physical dimensions and structural stability give the same degree of mechanical protection as that afforded by the woody plants usually considered under the term "brush."

Under crop fields can be listed cultivated land, cropland, crops, and fallow land. Technically speaking, fallow land is cropland that has been allowed to lie idle or "rest" for a few years with the intention of returning it to cultivation in the near future. However, the term is often used colloquially to refer to abandoned agricultural land on which natural plant succession has taken over and proceeded to the stage in which the vegetation consists of a stand of perennial grasses and forbs, mixed with brush. It was this latter meaning that Ridley (1952) intended.

To Edminster's crop fields type I would like to add disturbed land, meaning that some disturbance, either man's cultural activities or some natural phenomenon such as fire, wind, or flood has so disturbed the surface of the ground that it has been left with mineral soil exposed or covered by only a very light litter.

Woodland, woods, and woodlots can all be placed under the heading of woodland. For want of a better definition I would like to suggest that woodland be considered a stand of trees whose diameter at breast height is over four inches and whose height is greater than 20 feet. I believe all the references to woodland in this paper are describing stands of trees that fit this definition.

A Hypothetical Covey Range

From my gleaning of the literature I am now ready to suggest the size, shape, and vegetative composition of a hypothetical covey range. From my discussion of specific habitat characteristics I conclude that either three-fourths of an acre of crop field planted to annual food plants or one-seventh of an acre planted to bicolor will adequately feed a covey of 12 birds. Although bicolor is a shrubby plant, assigning it to the crop field vegetative type does not constitute a violation of our definition of crop fields. Quail do not use bicolor for cover; they use it only as a place to feed (Davison: 1949). And the light litter usually found in a patch of bicolor seems to further justify its inclusion under crop fields.

From my treatment of the headquarters concept I conclude that the minimum size of brushy cover needed for this purpose is 450 square feet.

And from my discussion of nesting cover I conclude that one-fifth of an acre of grassland is needed.

I have already mentioned that I do not consider woodland to be a necessity and have excluded it from consideration in constructing this hypothetical covey range.

The question that now has to be considered is how the aforementioned amounts of the three vegetative types—crop fields, brushy cover, and grassland—need to be arranged.

If the annual food plants, such as corn, soybeans, and grain sorghum, are used to provide food, I suggest a rectangular field

99 feet wide and 484 feet long. This field should be completely enclosed by a strip of grassland 12 feet wide. In the exact center should be the clump of brushy cover, 15 feet wide and 30 feet long, to serve as a headquarters area. The remainder of the field should be a crop field planted to annual food plants. The total area covered by this hypothetical covey range is one and one-tenth acres.

If bicolor is used to provide food, then a rectangular field 39 feet wide and 454 feet long is suggested. Again, the field should be completely surrounded with a strip of grassland 12 feet wide and the clump of brushy cover should be placed in the center. The remainder of the field should be a crop field planted to bicolor. The total area covered by this covey range is four-tenths of an acre.

Population Density and Mobility

I recognize that the hypothetical covey ranges I have constructed suggest radical views and stagger the imagination. Two objections immediately arise, one dealing with population density, the other with quail mobility.

The first hypothetical covey range I suggested infers a population density of 11 birds per acre, the second a population density of 30 birds per acre. The one-bird-per-acre saturation point has become a dogma of the game management profession and would seem to contradict the validity of my hypothetical models. But I suggest that the validity of this saturation point also needs to be tested. References to the intolerance of quail to overcrowding (Errington and Hamerstrom: 1936, and Stanford: 1952) seem to assume a saturation point based on competition for food and cover. But in the models I have constructed there is no competition. All the covey's needs are provided for and it should be possible to add additional covey ranges at will to produce additional coveys.

Similarly, the mobility studies of Murphy and Baskett (1952) in Missouri, and Stoddard (1931) in the Southeast indicate that quail are sedentary and that most of them spend their lives within a radius of one-fourth to one-half mile of the place they were hatched. The former investigators suggest that an area of four square miles is about the smallest unit upon which quail management should be attempted in Central Missouri. They add, however, that if mobility is decreased by management practices, less area is required. This reduction in mobility when all the covey needs are supplied on a small area is one of the bases upon which I constructed my hypothetical covey range. The studies of mobility with which I am familiar have been based on observation rather than experimentation. I suggest that we need to know to what extent mobility can be reduced by management practices.

Other Factors Affecting Range Habitability

Those who have worked with the bobwhite quail will immediately recognize that there are many such areas as the hypothetical covey ranges I have described that do not support a covey, so the existence of such kinds and amounts of vegetation *per se* does not automatically assure the presence of a covey. Any of a number of reasons for the absence of quail from what appears to be habitable range can be suggested. It might be that the soil is so infertile that the cover is too sparse and the food production too low for the minimum requirements to be met on one and one-tenth acres or four-tenths of an acre as the case may be. Or the birds that may have been established on the area at one time may have been subjected to excessive harassment, were driven off the area, and have not been able to return permanently because of continued harassment. Or a recent severe winter may have so reduced the population within a given area that there has not been time for the birds to recover and occupy every available covey range. Or, as Errington and Hamerstrom (1936) suggested, it may be due to the capricious preferences

of the birds themselves. And, probably most important of all, it may be due to lack of continuity in the inhabited quail range.

This lack of continuity in the quail range merits close attention. Kabat and Thompson (1960) thought that one or more miles of coverless land was sufficient to interrupt the continuity required to maintain a population throughout a given area. If this is true, this lack of continuity militates against the possibility of establishing and maintaining quail populations by natural reproduction on small, isolated farms not contiguous to inhabited quail range. The field biologist needs to understand this before he expects too much from his efforts at habitat planning.

CONCLUSION

I dislike ending this paper on an inconclusive note, but I have probably carried this discussion as far as it can be carried at this time. The validity of my hypothesis needs to be tested, and if it is found to be tenable, ways and means found to fit it into existing land use patterns, taking advantage of these patterns when the opportunity arises, but never requiring their modification. The technical planning services of the Soil Conservation Service can be instrumental in getting such knowledge applied to the land. If this paper stimulates further discussion and experimentation along these lines, it will have served its purpose.

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QUAIL MORTALITY AND MOBILITY STUDY

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INTRODUCTION

Records maintained on quail shooting areas in South Carolina for several years showed the juvenile-adult ratio of harvested birds to be approximately 4 to 1. The annual harvest was estimated to be about one-fourth to one-third of the fall population. Consequently, there was some concern as to what happened to the excess unharvested quail that were not evident as adults in the quail harvest of the following year. Of concern also, was the question of when did the excess quail disappear from the population. Consequently, this study was designed so as to collect data on daily and seasonal activities and population levels of the quail utilizing an isolated developed range where no hunting was permitted.

TECHNIQUES

A study area consisting of approximately 10 acres of open land and adjacent woodlands was obtained from Clemson University in June of 1961 for conducting studies on quail. Adjoining woodlands were to receive no silviculture practices until the study was completed. This area was previously used for experimental work on various grain and truck crops. These land use practices provided a habitat conducive to the utilization of the area by two coveys of quail for several years prior to the initiation of the study.

The first quail habitat development practices were instigated during the fall and winter of 1961-62. This environmental development included the establishment of permanent plantings of bicolor lespedeza *(Lespedeza bicolor)* and Korean lespedeza *(Lespedeza stipulacea)* near the center of the study area. This operation included the establishment of one strip of bicolor lespedeza, approximately 300 by 15 feet, which was encircled by a 40-foot strip of Korean lespedeza. The survival and subsequent growth of these plantings throughout the study period were excellent. The remainder of the open area, excluding approximately two acres of serecia lespedeza *(Lespedeza serecia)* that was previously established in a narrow strip along a portion of the woodland border, was seeded during the spring of 1962 with browntop millet *(Panicum fasciculatum)*, iron cowpeas *(Vigna sinensis)* and oats *(Avena sativa)*. Annual plantings of browntop millet and cowpeas were continued each year thereafter while the study was in progress. In addition to the above plantings, two permanent 1/10-acre plots of ladino clover *(Trifolium*

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