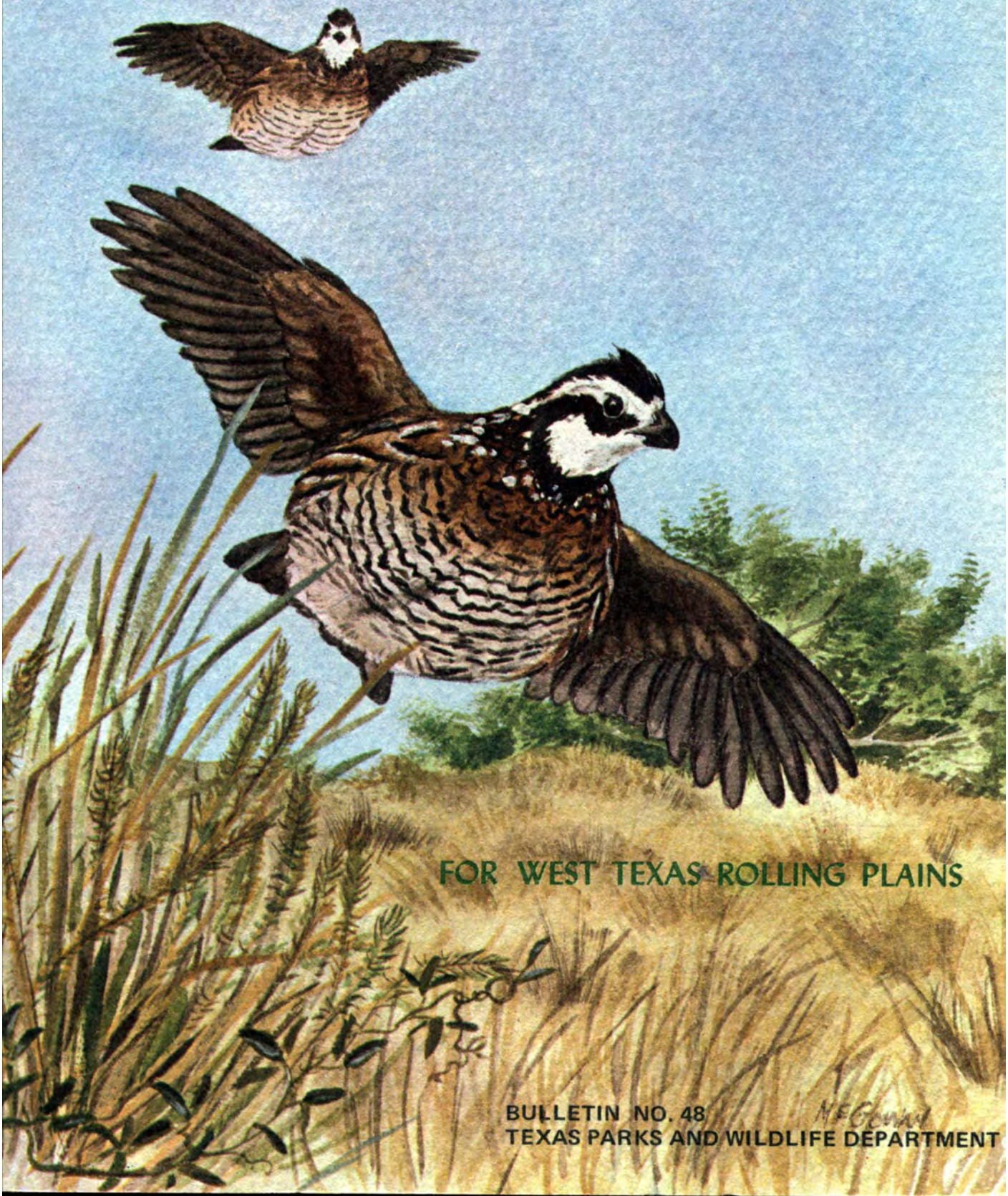
QUAIL MANAGEMENT HANDBOOK

By A. S. Jackson



FOR WEST TEXAS ROLLING PLAINS

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TEXAS PARKS AND WILDLIFE DEPARTMENT

A Handbook for

BOBWHITE QUAIL MANAGEMENT

in the

WEST TEXAS ROLLING PLAINS

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Photographs by the author and staff photographers

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Gratitude is tendered the many bobwhite hunters who contributed many thousands of bobwhite wings for study during the 1950's. The regional game wardens were no less cooperative, and without their assistance in carrying out the Panhandle Regulatory Project during the period 1950-60, the data on bobwhite populations would have proven impossible to collect on so wide a front. Credit is also due the several biologists who were associated with the Panhandle Regulatory Project and the Gene Howe and Matador Game Management Areas in the Panhandle during the time.

Appreciation is expressed to the ranchers and landowners in the Rolling Plains. During the years when the fieldwork behind this publication was being carried out they gave help and encouragement at every turn and, as a treasured bonus, their friendship.

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FOREWORD

In Texas, with the possible exception of the mourning dove, no game bird is hunted so widely and with so much burning of powder, as is the bobwhite quail. When one says he is going "bird hunting," it is commonly understood that bobwhite hunting is meant. The Bureau of the Census estimated that in 1960 a total of 321,000 Texas hunters bagged 9.8 million quail. We may safely assume that four-fifths of these were bobwhites.

Few Texans live far from bobwhite territory. Only in the high, short grass plains and the Trans-Pecos region does the bobwhite fail to find at least a minimum of desirable habitat. Anywhere else in Texas, stop your car on a road any early June morning and you will hear the whistled "'bob
- - - white" that signals another nesting season underway.

Traditionally, the bobwhite quail in Texas has been regarded as a wild crop, mostly accidental, so far as human planning is concerned. Ironically, the food and cover upon which bobwhites depend usually is the result of indifference rather than purpose on the part of the land manager. The statement of Aldo Leopold (1939: 146), "We will have no conservation worthy of the name until food and cover for wildlife is deliberately instead of accidentally provided for," applies particularly in the case of bobwhite quail in the Rolling Plains.

In a time when nearly all the products of farm and range are subject to management, the quail harvest, which gives recreation to so many and makes a substantial contribution to the economy, is left to chance. Even worse, the management of other resources is all too often thoughtlessly and unnecessarily detrimental to bobwhites. This is especially true in the case of the extensive programs of brush and weed control being carried out in the Rolling Plains. Up to a certain point, the bobwhite is an adaptable species and can live in harmony with people and their activities, but he cannot cope with bulldozers, spray planes, and weedless plant associations.

Time is running out and we can no longer depend upon chance to provide all the right conditions for quail. The alternate route is at the choosing of the land manager. He can conserve the remaining quail habitat, improve it, and even extend it if he wishes. This does not need to conflict with good land management, nor prove unduly expensive. On the contrary, most of the practices which result in good quail habitat fit into the framework of good soil and water conservation, thus cutting the cost of quail management as such.

An attempt is made here to describe, as simply as the subject permits, some of the facts concerning the life and habitat of bobwhite quail in the West Texas Rolling Plains. For the most part, non-technical language has been used, but for those who wish to check common names of plants against technical identities, a list is included in the Appendix. Photographs have been used freely. Certain key principles for improving and maintaining quail habitat are presented. All the information from periodic reports has been summarized here for convenience.

The ability to recognize the essential features of quail habitat will assist land managers to spare strategic patterns of cover when conducting brush-clearing operations. This practice is currently gaining favor throughout the region. It is hoped that this booklet will prove to be a guide for improving existing bobwhite habitat. To do so is the only way by which bobwhite numbers can be increased or even maintained with any degree of stability.

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INTRODUCTION

The Rolling Plains in the Texas Hunting Picture

The land resource area known as the West Texas Rolling Plains consists of some 24 million acres including all or parts of 51 counties in northwest Texas. About two-thirds of this acreage is utilized for cattle range. Nearly all farm units have attached pasturage. Common mesquite is the dominant woody plant and has spread throughout the region. The Rolling Plains, with the mixed pattern of range and cropland, constitutes one of the important bobwhite hunting regions of Texas.

For management considerations, the major places where bobwhites live in the Rolling Plains may be said to fall into three types. The first and perhaps the most important type is made up of the bottomlands. Today, as probably before settlement, the bottomlands of the several rivers and their many tributaries that cross the region are the “key” or ”survival” habitat in most years. Being better watered than other regions, and in many cases having deeper alluvial soils, these bottoms support a greater diversity of vegetation, including woody species, and this vegetation is more stable during seasons of drought.

A second favorable association for bobwhites is the pattern of field crops and pasture edges that is common in areas partly devoted to farming. Soils are likely to be especially rich and deep, a natural choice for cultivation. The combination of grain field and types of plants that grow after soil has been disturbed provides better winter foods for bobwhites than those to be found on strictly grazing land. Most hunters of bobwhites know that a field margin bordered by mesquite or shin oak brush is a promising place to hunt. It was in this type habitat that the Great Plains Shelterbelt Project was launched during the 1930’s. Many miles of these windbreak plantings still thrive and provide winter homes for bobwhites in farm communities that otherwise lack winter cover. Many other miles of these shelterbelts, however, need improvement by certain simple procedures.

Finally, there are the great areas of rangeland. These frequently consist of many thousands of acres of rolling prairie, covered with types of ground cover that vary from year to year with changing rainfall and grazing treatment. Within these ranges, there are bottomlands of the type already described as the best and most stable habitat for bobwhites. The woody cover on the uplands, depending on the soils, may be mesquite, shin oak, or juniper. Frequently, two of these species occur together, and less often all may occupy the same range. These uplands prove the most unstable as bobwhite habitat. At their worst, they are barely habitable. This condition may prevail whether following several excessively dry seasons or several wet ones.

From time to time, bobwhite populations erupt and all of the above described habitats overflow with quail. When this happens, large acreages may hold populations approaching the maximum possible - an average density of one bobwhite per acre. In such a year the hunting season kill often exceeds total populations for the several previous years.

For example, in the fall of 1958, a total of 1,125 bobwhites and scaled quail were counted on a 1,280-acre block of mesquite brush pasture in Baylor County. The harvest was closely determined during the hunting season. Approximately 1,000 quail were killed, of which 65 percent were bobwhites. During the same season, records of 9 Motley County leased shooting preserves, totaling 30,000 acres, revealed a harvest of 12,000 quail - a bird per 2-1/2 acres.

During the 1958 hunting season, quail hunters in the Rolling Plains contributed 11,525 bobwhite wings for a study of reproduction in the bobwhite population, At the time, it seemed unlikely that as much as 1 percent of the harvest was represented; yet, if that figure is accepted, a harvest of 1,152,000 bobwhites is

indicated. It is not likely that management will ever bring about as many bobwhites as occurred naturally in the Rolling Plains during the fall of 1958. No practical methods could involve the vast acreage, nor would enough hunters be able to reap such a crop and prevent its waste.

Aside from the recreation provided by good huntable quail populations in the Rolling Plains, there is impressive economic benefit to businesses offering such services as lodging, food, gasoline, and outdoor equipment. The records of public hunts on the Gene Howe and Matador Game Management Areas in the Panhandle have demonstrated that quail hunters will drive across the State to engage in one day of hunting when populations are up. A large number of those who regularly hunt each fall in the Rolling Plains reside outside the State. Based on many years of observation, it appears that, for any county in the region, more than 50 percent of the quail hunting is done by nonresidents of that county.

Game Warden A. W. Fromm gathered figures on acreages leased for quail shooting in Motley County during the year 1958-59. The number of acres leased increased from 30,000 to 75,000 the following year. The total harvest for the 1959-60 season, as recorded in shooting preserve license books, was approximately 15,000 quail. No separation of figures for bobwhites and scaled quail was made.

The income to 52 landowners from leases for the 1959-60 season was approximately $36,000. This, plus expenditures for food, lodging, and other commodities, adds up to a lot of money spent in a single county because of a small, huntable, brown bird weighing approximately 6 ounces.

MAJOR PROBLEMS

Major problems facing the quail manager include (1) wide fluctuations in quail numbers--sometimes from abundance to scarcity within a few months; (2) general lack of understanding of quail needs, among landowners and sportsmen alike; and (3) an almost traditional dependence on the part of the public upon ineffectual techniques during times of low quail populations.

Population Fluctuations

If every opening season found bobwhites as abundant in the Rolling Plains as they were in 1958 there would be no management problem except that of encouraging enough harvest to prevent a great waste. Unfortunately, bobwhites seldom hold at such numbers for more than a year- rarely two. Often, their populations decline so much that hunting comes to a near standstill. Low densities likewise rarely last for more than a year or two. It is in the "in-between," average years that the best opportunity exists to do something toward increasing the bobwhites.

Anyone about to undertake management of bobwhite quail habitat in the West Texas Rolling Plains would be wise to bear in mind one limitation of this geographic location. From the map (Figure 1), it will be seen that the Rolling Plains lie along the western edge of the bobwhite’s native range on the North American continent. This is to say that the bobwhites of the Rolling Plains are as far west as they can spread and hold their ground without being stopped by unfavorable climatic conditions. This would be of little concern to the quail manager if the western limits of the range were as clear to the bobwhites as they are to the mapmaker. However, the annual rainfall along this western edge of the bobwhite’s native range fluctuates widely within a more or less regular cycle and, other things being equal, the quality of the bobwhite habitat varies with these extremes. Weather reporting stations situated in Rolling Plains counties have records of annual rainfall varying from approximately 7 inches to well over 50 inches. These fluctuations and their influences upon bobwhite reproduction and habitat comprise a serious problem for the manager of bobwhite habitat. That problem, however, does not justify a do-nothing attitude or repeated mistakes in quail management on the part of landowners and sportsmen. An occasional dry year can result also in failure of farm crops in the same region, but such failures have led

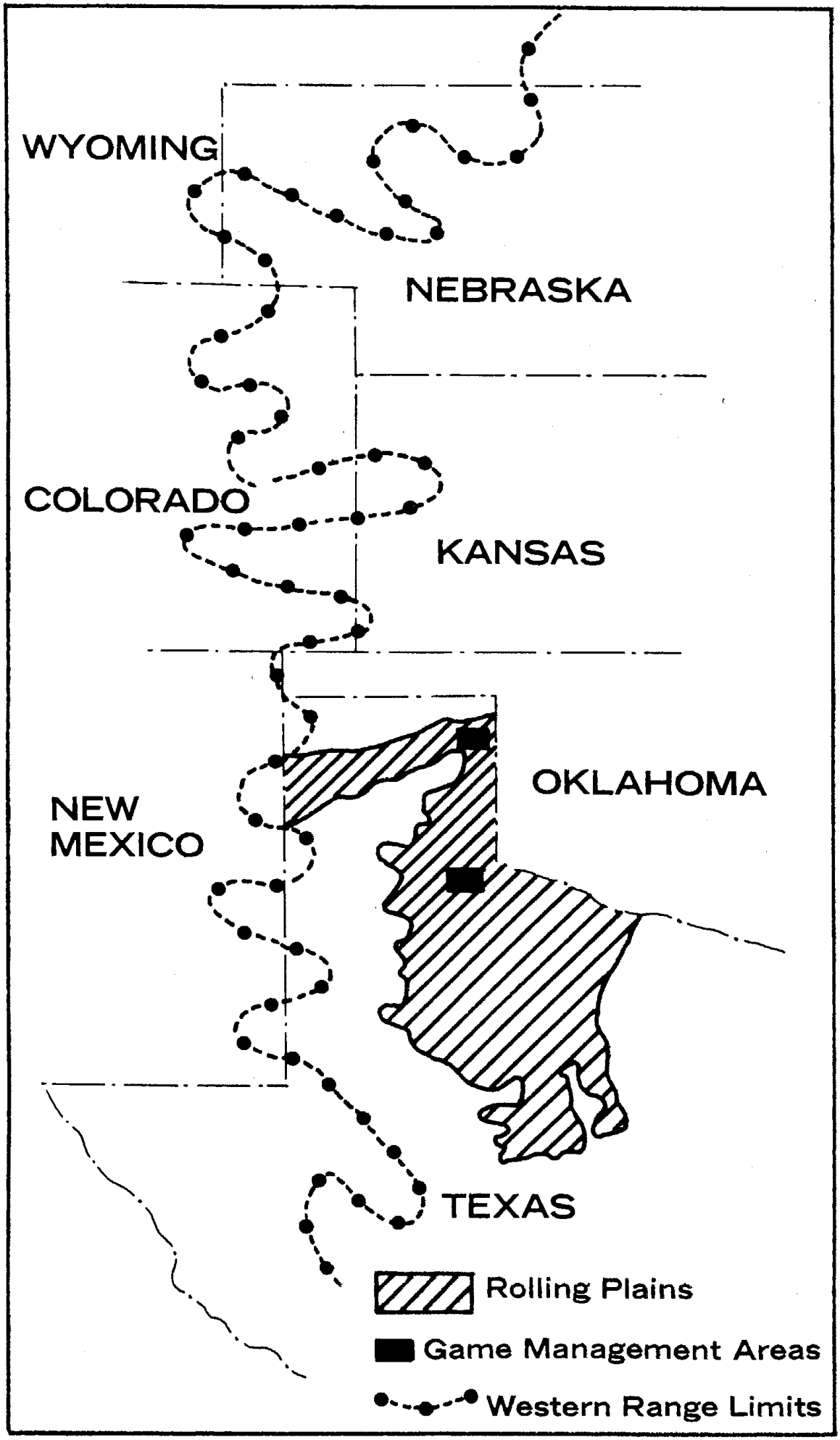


Figure 1. West Texas Rolling Plains and approximate western limits of bobwhite quail native range.

to better management and improved methods of agriculture, so that the difficulties that thwarted the first homesteaders have been largely overcome by today's farmers. And so it should be with quail management. Techniques should be adapted to weather and other uncontrollable factors.

Periodically, there will occur a year so dry that bobwhite reproduction will be curtailed generally throughout the Rolling Plains. At such times, range vegetation may wither and die before seeds are matured, thus affecting bobwhites on two fronts. Such years usually mark the climax of a drought of several years' duration and, fortunately, seldom occur more than once in a decade. In the between years, bobwhite numbers vary between abundance and scarcity according to the effect on the habitat of any number of accidental factors, only one of which is rainfall. In most seasons, these other factors can be controlled by procedures as simple as common farm operations.

Difficulty in Recognizing Habitat

The average interested person is unable to tell the difference between habitable and non-habitable range. The most common mistaken belief is that if the range supports good forage for livestock it must be equally suited to quail. This view leads to bewilderment on the part of the land manager when bobwhites are absent on good grazing range. Again, essential features of the quail habitat may be destroyed because the land operator does not recognize their importance to quail.

The total wiping out of quail habitat is a case in point. For lack of planning, the large-scale programs of brush control in the Rolling Plains effectively destroy all quail cover. Replacement is always costly and often impossible. Up to now, there have been very few sources of information available concerning the needs of bobwhites in this type of habitat. This is an area in which it is hoped this manual will prove helpful.

Persisting Faith in Ineffectual Techniques

A major problem lies in the holdover of faith in management techniques that have proven ineffectual in the past. The most widely advocated of these is the close-the-season-stop-all-hunting approach. Another is the stocking of non-habitable range with pen-reared bobwhites. Still another is predator control. None of these works in deficient habitat and none are needed where the habitat is right. Such apparently easy solutions cripple effective management and merely repeat past failures.

SOME BASIC PRINCIPLES FOR BUILDING A POSITIVE BOBWHITE MANAGEMENT PROGRAM

Guides to bobwhite management that are based on research findings can be summarized as follows.

The annual rate of population turnover in bobwhites, approximately 80 percent per year, rules out management by refuges, closed seasons, or other stockpiling efforts. Instead, management must be for the bird-of-the- year.

Bobwhite food and cover requirements are distinct for the species. These are in no way the same general requirements as needed by other wildlife species and livestock.

Forbs, the so-called "weeds," are key sources of quail food. A narrow range of plant species provides a large part of the bobwhites' winter food. These species belong to early successions, i.e. plants that come up following soil disturbance. These can be maintained year after year by spring discing.

Bobwhite quail require cover for resting (headquarters), for escape (to screen them while feeding and moving about their daily range), and for nesting. To be effective, all these types must be close to each other, and in close proximity to food, because of the short cruising range of the bobwhite.

Normal seasonal movements of bobwhites quickly restock vacant ranges when changing conditions make them habitable.

Under Rolling Plains conditions, hunting is self-regulating. When hunting is poor, seasons, in effect, close themselves after the first few days.

The best predator control consists of maintaining high quality quail habitat.

POPULATION TURNOVER

Before proceeding with a discussion of quail food and cover, a look should be taken at a certain aspect of the life of the bobwhite that has an important bearing on management.

Sources of Data

Most of the information summarized in this and the following sections was obtained from region-wide collections of quail wings and crops during hunting seasons, from bag checks during public hunts on two management areas (see Figure 1 for locations), and from trapping, banding, and census with bird dogs. Only summaries of the data on population turnover, food habits, movement, and parasitism could be included in this booklet. All aspects have been reported in detail in the various Job Completion and Final Reports for the respective Federal Aid in Wildlife Restoration Projects listed under the ACKNOWLEDGEMENTS section.

How Ages of Bobwhite Quail Are Determined

Largely due to the publicity given waterfowl banding over a period of many years, most persons know the general purpose behind bird banding. But not so many understand the use that biologists make of the molting patterns of game birds. In the case of the bobwhite quail, the young bird-of-the-year carries on its wings a set of feathers that indicates its juvenile status throughout its first winter. These are "chick" or baby feathers, which persist long after the rest are molted and replaced by adult-colored plumage. They comprise a row of 10 small feathers called the "primary wing coverts," which lie at the base of and on the

upper side of the primary flight feathers of each wing. Figures 2 and 3 show these mottled feathers of the juvenile bobwhite, and the difference between them and those of an adult.

Figure 2. Mottled, white-tipped, primary coverts that distinguish juvenile bobwhites.

Figure 3. Uniform color of primary coverts, same color as primary flight feathers, which distinguish adult bobwhites.

Annual Turnover in Bobwhite Populations

The presence of the juvenile coverts was used to determine the percentages of young bobwhites in fall populations for a period of 15 years, beginning in 1950. Hunters contributed many thousands of bobwhite wings in pre-addressed and postage-paid envelopes distributed by wardens and biologists during the hunting seasons. Additional information resulted from examination of bobwhites bagged in the course of public hunts on management areas. The combined data are summarized in Table 1.

A comparison of the fall populations of bobwhites and their age composition for the two years 1950 and 1953 illustrates the phenomena of reproduction. During the fall of 1950, habitats were crowded with quail and hunters took a tremendous harvest. In contrast, drought was well advanced in the Rolling Plains by 1953, and all but the most stable of habitats were empty of birds. Few hunters went afield after the first weekend of the season because birds were so scarce. Yet the percentages of young quail among the two populations differed by less than 6 percent.

Bobwhite numbers hit a peak again in 1958. During that year a total of 11,525 wings was contributed by hunters. These showed only 0.89 percent more young among quail than had been present the previous year when the population was much lower. The data make it clear that each fall the crop of bobwhites is comprised principally of young birds of the current year's hatch. From this it follows that just as many of the parent generation had disappeared-approximately 80 percent in most years. Biologists term this the "annual turnover." It represents a yearly loss of bobwhites that is fairly constant, and has been found to occur independently of hunting. Studies have shown that hunted and unhunted areas exhibit the same turnover.

Table 1
Percent of Young Quail in Fall Populations
1950 - 1964

Year	Area	Number Quail Aged	Number Young Quail	Percent Young
1950	Rolling Plains	3,627	3,098	85.41
1951	Rolling Plains	6,901	5,413	78.44
1952	Rolling Plains	1,391	976	70.17
1953	Rolling Plains	503	40 1	79.72
1954	Rolling Plains	1,430	1,164	81.40
1955	Rolling Plains	4,705	3,956	84.08
1956	Rolling Plains	4,708	3,187	67.69
1957	Rolling Plains	3,284	2,732	83.19
1958	Rolling Plains	11,525	9,485	82.30
1959	Rolling Plains	2,473	1,892	76.51
1960	Matador Area	589	456	77.42
1961	Matador Area	322	282	87.58
1962	Matador Area	29 1	245	84.19
1963	Matador Area	203	166	81.77
1964	Matador Area	508	320	62.99
Totals and Average		42,460	33,773 Young	79.54 Avg. Percent

The high rate of turnover among bobwhites is not peculiar to the Rolling Plains of Texas nor is it characteristic only of quail in poor habitats. It occurs throughout Texas, and the figures are essentially the same for such dissimilar ranges as Florida and Wisconsin. In fact, it has been found to occur wherever a study of bobwhite populations has been carried out.

What Annual Turnover Means to the Quail Manager

The high rate of annual turnover in bobwhite populations must be recognized in any realistic approach to management. In short, management must be based on the bird-of-the-year. Each year about 4 out of 5 of the previous year's adult bobwhites have vanished to make room for the young crop. This crop cannot be "banked" nor will next year's crop be increased by trying to save all the current birds. Neither refuges nor any other known means can prevent the annual turnover of bobwhites.

BOBWHITE FOODS

Food Requirements of Bobwhites

It is unfortunate for the bobwhite that man has set up an arbitrary classification of plants wherein almost all of the key foods of bobwhites have been designated as weeds. Often, cattle and horses greedily eat these weeds. These plants may have important symbiotic relationships with "non-weed" plants, be soil enrichers, or prevent wind and water erosion. But, if they are broad-leafed (or dense, in the case of snakeweed) and occupy space that grass might otherwise fill, they are all too often considered unsightly evidence of range mismanagement and thus become targets for eradication. The so-called weeds include a relatively small group of plants which are the staples of bobwhites and, more than anything else, prescribe the limits of bobwhite habitat.

The above statement is based on analysis of more than 3,000 bobwhite crops (craws) taken from State game management areas where the composition of the range vegetation was known. A great many other crops analyzed were contributed by hunters throughout the Rolling Plain's. While the habitats from which these were collected were not known, their analysis consistently showed the importance of the same few plants as bobwhite food sources.

The food habits of bobwhites on the Gene Howe Wildlife Management Area may be said to be typical of the northern Panhandle only. On the other hand, the Matador Area is centrally located in the red soils and deep sands of the western half of the Rolling Plains, and the food habits of bobwhites here are believed to be representative of the western half of the region. The food habits data for the eastern half, where soils are tighter and rainfall greater, are taken from studies made by biologist Clyde E. Holt, Jr., leader of the Possum Kingdom Game Management Survey Project (W-73-R).

Winter foods, north Panhandle. Seeds of forbs comprised 60 percent of the winter foods of bobwhite quail during 4 years on the Gene Howe Wildlife Management Area (Figure 4). Both bottomland and upland habitats were represented among the 963 bobwhite crops analyzed. Seven forbs contributed 40 percent of the total volume of food. These were western ragweed, erect dayflower, Texas croton, rag sumpweed, small wildbean, Stevens sandlily, and redroot amaranth.

The 28 percent of total foods contributed by grasses include seeds of seven species. The only important native grass source of winter food for bobwhites in the north Panhandle is fringeleaf paspalum, which in this case comprised 20 percent of the winter food of bobwhites on the Gene Howe Wildlife Management Area. Away from the sandhills of the north Panhandle, fringeleaf paspalum is not an important item in bobwhite foods.

The woody plants which provided a total of approximately 10 percent of bobwhite food on the Gene Howe Area were Russian olive (planted for wildlife cover), netleaf hackberry, black locust, fragrant sumac, and common persimmon. Region-wide, only hackberry may occasionally be important as an emergency food, but the supply usually is insufficient to meet the demands made upon it by a host of non-game birds and mammals. Their shade values for livestock, along with their production of wildlife food, merit sparing of hackberry trees in brush control operations.

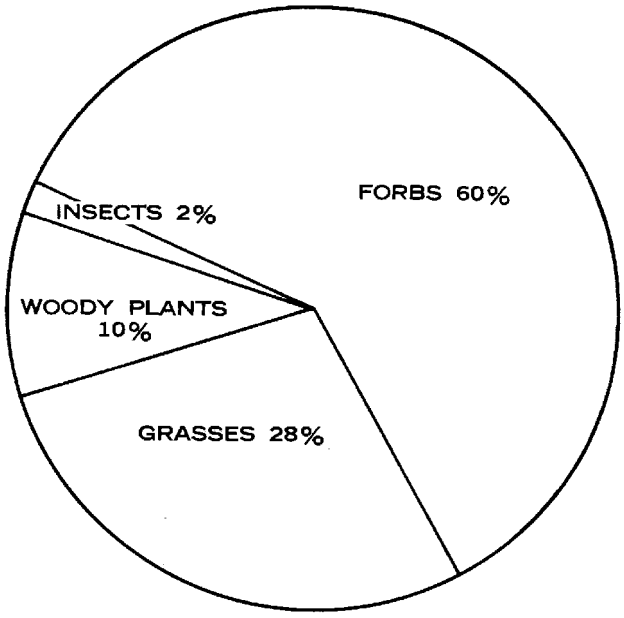


Figure 4. Sources of bobwhite quail fall and winter foods, from 963 crops; Gene Howe Wildlife Management Area, 1958-1963, not including crops for 1961.

Winter foods, south Panhandle. Figure 5 summarizes the data from the analysis of 1,934 crops of bobwhites taken on the Matador Game Management Area during public hunts, in seasons beginning December 1959, and ending with that of 1963-64. As on the Gene Howe Area, forbs contributed over half (57 percent) of bobwhite winter foods. Again, a major part of these was derived from a narrow range of plants including western ragweed, erect dayflower, and Texas croton. As in the case of the Gene Howe Area crops, even though 43 species of range plants were represented in the contents of the 1,934 bobwhite crops, only seven species of plants provided approximately 40 percent of the total. Seeds of fringeleaf paspalum appeared merely as traces, and seeds of all native grasses amounted to only 3 percent. Insects comprised 8 percent, although the seasons were past the time of greatest insect abundance.

During the five winters, woody plants provided 29 percent of the food eaten by Matador Area bobwhites. Fruits of woollybucket bumelia (chittam to most plainsmen) comprised 16 percent and netleaf hackberry fruits made up 5 percent. Seeds of common mesquite and fragments of shin oak acorns totaled 8 percent.

Each of the management areas had a critical year during which food habits of bobwhites were not typical. Data for these two years are discussed separately below. In both cases, they represent use of emergency rations that were scarce and limited in distribution.

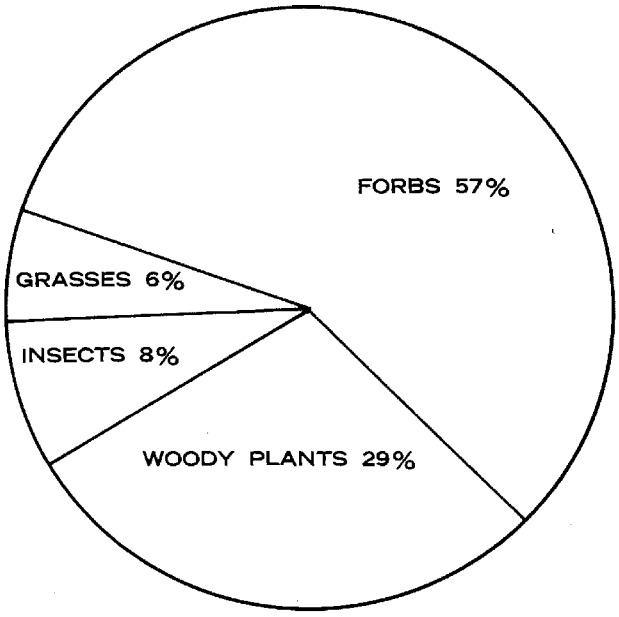


Figure 5. Sources of bobwhite quail fall and winter foods, for 1,934 crops; Matador Wildlife Management Area, 1959-1963 inclusive.

During the winter of 1956-57, bobwhites from the different pastures of the Gene Howe Area showed diets consisting largely of insects. From 50 to 75 percent of the food was stink bugs, Order Hemiptera. While this may have been the result of a heavy flight and ready availability of bugs, a general scarcity of seeds was known to exist. Evidence of this was the acceptance of such low quality "stuffing" foods as seeds of Russian thistle. Significantly, a sharp decline in the bobwhite population followed.

Mention has been made of the occasional year when vegetation in the Rolling Plains would receive too little rainfall to enable seeds to mature, and bobwhite reproduction also would be retarded. The year 1964 was such a time in the western half of the region. Approximately 13 inches of rain fell on the Matador Area, with only 7 inches of this falling during the important March through August period. Early public hunts, on October 31-November 1 and November 28-29, made 402 bobwhite crops available for food analysis. These revealed what studies of range vegetation had already made apparent. The number of forbs had declined and few of those remaining had made mature seeds.

Seeds of western ragweed comprised only 1 percent of the total volume of food, in contrast to 1963, when they amounted to 50 percent of the food. Fruits of woody plants comprised 75 percent of the total volume. These consisted of woollybucket bumelia, shin oak acorns, and netleaf hackberry. Seeds of forbs, notwithstanding their much wider and more uniform distribution, amounted to only 22 percent. Five species contributed 12 percent and these included two of the key species of normal years, Texas croton and western ragweed. The percentage of young in the greatly reduced bobwhite population was 63 percent. This represented the lowest number of young recorded in 15 years (Table 1).

Winter foods, east Rolling Plains. East from about the 100th meridian, the redlands and sandy soils in the Rolling Plains give way increasingly to tighter clayey soils, which generally support a more stable association of plants. Rangeland, especially, provides an even smaller variety of forbs producing winter food for bobwhites. Among the best of these forbs, again, are the western ragweed, three species of croton and, in certain seasons, snakeweed. Others, which are locally important and easily encouraged by soil disturbance, are the common sunflower, snow-on-the-mountain, Illinois bundleflower, and bluestem pricklepoppy.

In the fall and winter of 1960, seeds of snakeweed comprised 55 percent and 44 percent respectively of the food of bobwhites in Baylor and Throckmorton counties. Western ragweed provided 19 percent of the total food in Baylor County and 38 percent in Throckmorton County. Insects comprised 5 percent and 6 percent respectively. Grasses provided only 6 percent of the winter quail food in both counties.

Summer foods of bobwhites. Four years of study of the summer foods of bobwhites on the Matador Area showed that a sufficient quantity of food is seldom a problem during the growing season. When the vegetation becomes green and insects begin stirring, bobwhites begin a changeover from dependence upon old seeds of the previous summer‘s growth to green shoots and insects. Often, in the study, over 50 percent of the individual bobwhite’s meal was found to be insects, and crops full of insects were common. By midsummer a bobwhite’s crop may be found to contain, in addition to insects, new seeds of such plants as tropic croton, erect dayflower and panic grasses. These seeds are plucked green from the plant. Green seed items and ”juicy” insects, including larval forms, are abundant at all times except during the most severe droughts, and very likely supply the small amounts of moisture needed by bobwhites.

Grasshoppers are the most commonly found insects in quail crops, perhaps because they are the most available. Other insects are eaten as their numbers make them convenient. One bobwhite was found to have consumed 136 winged ants (Figure 6). Beetles, bugs, spiders, and larva are common food items. Walking sticks (Family Phasmidae) are stuffed down, and one bobwhite was found to have swallowed a hairy, full-grown tarantula. It had been dismembered only enough to allow swallowing.

Figure 6. Contents of 1 bobwhite crop, comprising 136 ants.

Water requirements. No evidence was found that a supply of surface water was essential to habitability of bobwhite range. Waterholes were watched throughout a week of torrid summer heat on one ranch known to have a population of quail whose nesting season had been terminated by dry weather. Few bobwhites came to water and these, it appeared, were more interested in the wet soils and green vegetation found at these sites than the presence of drinking water.

Bobwhites lose little water with their body waste. What is lost is normally replaced by the moisture in available foods.

Summing up the bobwhite food picture in the Rolling Plains, we find that the native forbs are the principal sources on which bobwhites must rely and that relatively few varieties of these supply a large proportion of the food supply. A few others (sunflowers, for example) are often important in local situations, but seldom assume high rank, even in the aggregate, where many crops are studied.

In Appendix A, those plants which offer the greatest potential for management are pictured along with their seeds. The hunter or landowner who wishes to do more than wonder why there are not more quail should learn to recognize these plants and look for the seeds in the crops of bobwhites he harvests.

In Appendix B, the part played by these plants in the ever-changing pattern of plant succession is explained, as well as the sequence in which they occur. An awareness and an understanding of these natural events are essential for the production of bobwhite food and cover.

MANAGEMENT OF BOBWHITE FOOD

Maintaining Sub-climax or Weedy Plant Successions

There are few farms where quail habitat could not be improved by management of native quail food plants. Grazing range always has such possibilities. The soil holds seeds of key food plants that may have lain dormant for many years. Germination of these seeds is best encouraged by some sort of soil disturbance.

Spring discing. The most practical method of stimulating growth of native quail foods in the Rolling Plains is discing with a tractor-drawn, tandem disc harrow. The kind of plants resulting will depend upon past history or land use of the soil. Vigor and seed production of the new vegetation will, as in the case of any crop, depend upon the growing season, rainfall, and the fertility of the soil. But, nearly always, the native forbs will withstand dry seasons better than will domestic grains.

In many cases, the remembered locations of former weed patches will indicate where to disc for the return of certain plants. When the State acquired the Gene Howe Wildlife Management Area in 1950, there were numerous old feed lots where cattle had been wintered for many years. In that same wet year, these plots grew stands of rag sumpweed, giant ragweeds, and common sunflowers. All those that were suitably located with respect to cover have been maintained since, by annual spring discing. Others, less suitably located, were not disced, and the forbs have been crowded out by grasses. Figures 7 and 8 show the result of discing old sites of weedy growth on the Gene Howe Area.

Figure 7. A mixed stand of common sunflowers and western ragweed resulting from March discing.

Figure 8. A stand of rag sumpweed and common sunflowers resulting from March discing between rows of Russian olive

Weedy successions such as those described above are typical, following disturbance of bottomland or alluvial soils. Upland sandy soils, when disturbed, give rise to successions of crotons, western ragweed, redroot amaranth, partridge peas, and (in less amounts) a grass, fringeleaf paspalum, which alone among the grasses supplies considerable quail food.

Tighter upland soils, when disturbed, give rise to stands of crotons, western ragweed and snakeweed. In most cases, a variety of other weeds are present also. Many of these produce seeds to supplement quail foods. Figures 9 and 10 show the results of discing in the sagebrush sandhills of the north Panhandle and the tight clay soils of the eastern Lower Plains, respectively. In both these instances, the plant successions were principally of crotons, though of different species. Note that the disced strip in sandhill range skirts the woody cover of Chickasaw plum, while the other, which was placed on the contour for run-off control, fails to be effective quail management only because the mesquite brush has been bulldozed. A heavy concentration of mourning doves was utilizing the croton seeds when the photograph was made.

Figure 9. The results of spring discing in the sandhills of the north Panhandle. Texas croton in association with woody cover (Chickasaw plum).

Figure 10. Growth of tropic corton resulting from contouring tight soils in Rolling Plains grazing range.

When to disc. Discing for food management may be done at any time during the dormant season. However, March is the best time because then quail that might have used the area in winter are beginning to find new sources of food. March discing also destroys a minimum of food and cover. The depth of discing may be from 3 to 6 inches, with the shallower depth preferable if the soil is stirred thoroughly at that depth. Discing should not be done after spring growth starts or after seeds germinate, for then many of the seeds will be lost.

Where to disc. In mixed farm-pasture land, always locate areas for discing in close association with existing woody cover. The latter may be a shelterbelt planting, a brush field border, timbered creeks or gullies, or the irregular, uncultivated edges or margins between cultivated land and brush pastures. These are common situations in the Rolling Plains and have high potential for development of quail habitat. Some of the best bobwhite habitat in the region is the by-product of the accidental occurrence of such areas.

It is important to plan the pattern and dimensions of disced areas in such a way that they will have the maximum frontage or edge quail cover. This insures maximum availability of food and cover on a common edge.

In many cases, field crops will not grow near the margins of shelterbelts or brushy thickets. Some of the desirable weeds will do so, and even thrive between the tree rows if spring discing is carried out.

Rangeland quail management is easier to plan because the vegetation is evenly distributed, and the soils usually hold immense quantities of seeds of the plants that produce quail food. Here, as in the case of farm cropland, all locations known formerly to have carried the larger forbs such as common sunflowers, crotons, and ragweeds, should be marked for restoration through soil disturbance.

Several ranch practices carried out primarily for other purposes result in increased production of quail food. Since any soil disturbance sets back plant successions, it follows that contouring to route water to ponds or to divert water from pasture roads will increase the supply of quail food. Fireguard lanes commonly grow stands of crotons, ragweeds, or other prime sources of food (Figure 11). By use of a double lane, one of which would be bladed in alternate years, annual supplies of seed would be produced.

Figure 11. "Bladed" fireguard in Lipscomb County, with summer growth of Texas croton and erect dayflower.

Area required for food management. The food potential in strictly grazing range is limited only by the amount of time area operators are willing to devote to it. A round trip across a section of rangeland with a 6-foot tandem disc harrow at intervals of 440 yards, or five such strips per section, would in most years make food available for an adequate and well-distributed population of bobwhites. This is provided cover requirements were met. Such a pattern of disced strips would insure that no covey would ever be more than 220 yards from a food supply, and this on a mile-long edge. The area requirement would be 7.27 acres, or 1.13 percent of the square mile. This would not all be lost to livestock grazing because, almost certainly, some of the plants in the new succession would be a palatable and welcome change for livestock.

The above is offered as an ideal pattern and would have to be adapted to terrain features and the pattern of existing brushy cover. It would not be practical, for instance, on highly erosive soils where discing on slopes might start gullies, On such soils, the disced strips should follow contours or be placed on level areas and interrupted when crossing slopes.

Heavy "spot" grazing. As already pointed out, during years of high quail populations most of the quail food results from increasing rainfall following depletion grazing. The same principle can he put to work in any season by using "shock" or heavy grazing for small areas where such grazing can be controlled. The small pastures called "traps" by cattlemen, roundup grounds, corrals, stack lots used intermittently, and any waste areas can be grazed out in March with the same resulting plant successions as if disced. The cattle must be removed before the growing season, in order to permit growth of the new plant succession. Figure 12 shows a small lot in its third year after being grazed out, following the fire on the Gene Howe Wildlife Management Area in March of 1962.

On mesquite brush ranges where cattle are called up and fed at regular intervals during the winter, the growth and quantity of quail foods can be increased by moving the location of feeding grounds from time to time.

Figure 12. Soil disturbance resulting from heavy livestock usage causes same weedy succession as produced by burning off range.

Figure 13 shows one of the feed grounds on the Matador Area that was covered with a stand of tropic croton during the 1965 growing season.

Figure 13. Tropic croton growing where cattle trampled feed spot the previous Winter

Only experience in a given location can indicate how long plant successions will last without repetition of soil disturbance. In some locations it may not be necessary to disc more often than in alternate years. The rainfall pattern is undoubtedly a factor.

Other Types of Food Management

Food patches. Planting patches of small grains or sorghums for bobwhite food is not recommended in the Rolling Plains. The domestic grains are less drought resistant than the native weeds, and may be depended upon to fail in those critically dry years when quail foods are most needed. If located in grazing range, the plantings must be large, out of all proportion to quail needs, in order to keep rodents and grasshoppers from destroying them before seeding occurs. If the crop escapes these hazards, hordes of blackbirds, starlings, and rodents consume the grain before quail can make winter use of it. As an instance, a 10-acre plot of splendid kafir corn on the Gene Howe Area was consumed in a week by flocks of blackbirds, while the grain was still soft.

On the other hand, leaving unharvested strips or rows of farm grains along margins of fields adjacent to mesquite or shin oak grasslands, or alongside a shelterbelt, is a measure that not only supplements the food supply but also creates valuable escape cover. Here the size of the field is great in proportion to the number of grain consumers, and large amounts of waste grain are left after harvest. Many grain fields are margined on one or more sides by brushy pastureland. Some that are completely surrounded are not uncommon. In these situations a strip spared around the margins, if only a few feet wide, will prove a valuable addition to the bobwhite food supply, and also serve as travel and escape cover.

Weedy stands in odd corners or fencerows, while not of the kind which produce quail food, often may connect food and cover, thus providing travel lanes for quail. These weeds should be left in place until spring.

Saving woody sources of quail food. Thickets of netleaf hackberry and woollybucket bumelia should be flagged and bypassed in brush control operations because they afford livestock shade and provide emergency supplies of quail food. Both hackberry and bumelia have their greatest growth in river bottoms and, in large blocks of range, are important in the ecology of the wild turkey.

Quail feeders. For several decades there has been occasional interest in the use of quail feeders in the Rolling Plains. Feeders have been used on some of the larger ranches in the region, and no doubt some will continue to be used. At times of low quail populations, the artificial feeder presents the same appeal that closed seasons, predator control, and restocking does; the feeder is relatively easy to use, seems a simple and direct approach and, since it works with livestock, why not with quail?

Wildlife biologists, including the writer, have experimented with feeders and have studied results of feeder use by private individuals. The consensus is that taking care of the food requirements of bobwhites by use of feeders is, like predator control, no simple thing. Perhaps the strongest evidence of the value of feeders is the fact that in places where they have been used in numbers, they have more often than not been abandoned after a season or two.

Some users have credited feeders with increasing quail where, instead, quail were only baited from adjacent areas and more easily found. When feeders are placed properly with respect to cover, that is, beneath grapevines or in thickets of plum and sumac, the presence of quail is often wrongly attributed to the use of feeders. In reality, the quail are merely utilizing the best cover available to them. In more than one instance hunters have reported shooting quail near feeders only to find, after dressing them, that crops were full of weed seed.

For those persons who, nevertheless, wish to employ feeders, the following suggestions as to their use are made:

Use a string of several feeders for each covey expected to avail itself of the feed. This is to keep avian predators guessing. When a covey has access to only a single feeder, hawks, particularly the Cooper's hawk, quickly learn the feeding schedule and will harass the quail daily.

Make certain that the feeders are connected by travel ways of good cover such as brushy fencerows, weed hedges, or half-cut mesquites. Without covered access, each feeder becomes in effect isolated, and the bobwhites using it will become victims of waiting predators or be forced to abandon the location.

Check and service feeders at regular intervals, especially during severe weather when feeders would presumably be of most value.

Do not expect quail feeders to compensate for other habitat deficiencies.

Feeders are devices for taking care of domestic animals, which, through domestication, have lost the ability to care for themselves in the wild. The peculiar attraction bobwhite holds for most of his admirers' lies in his not having the characteristics of the domestic bird. The game manager should keep it that way.

BOBWHITE COVER

Cover Needs of Bobwhite Quail

The bobwhite cannot live long without cover, any more than he can live without food. His cover requirements, like his food requirements, are specialized. Just any cover will not suffice. However, bobwhite cover varies with the climate, the soils, and the kind of use man makes of the land. Also, because the functions of quail cover overlap to some extent, and because outside influences such as weather and predation are often variable, bobwhites often adjust to cover deficiencies more successfully than they do to food scarcity.

So far no one has been able to define the exact line where quail habitat becomes immediately untenable because of too little or too much cover. Nevertheless, bobwhites will in time be cut back to numbers commensurate with the amount of safe cover or be forced to move, thus inviting excessive mortality in unfamiliar ranges. If cover is near the minimum for security under normal conditions, even the growing necessity for a covey to forage longer or further to meet its daily food requirements can prove disastrous. The usual signs of such a crisis are excessive wildness, running before dogs, and long feeding periods. If accipter hawks are in the country, signs of hawk kills frequently may be found.

Types of cover needed. Bobwhites need these types of cover: screening overhead for concealment while feeding and moving around; tangled woody thickets, or dense patches of coarse weeds and grasses, which easily can be reached when quick escape from an enemy is essential; a "living room" type of cover for resting, dusting, and the midday inactive period; and nesting and roosting cover. The "living room" type is often referred to as a covey headquarters.

It is difficult to describe the types of cover that meet these requirements because their composition varies with almost every watershed in the Rolling Plains. In the sandhills of the upper Panhandle, sand sage and tall bunch grass provide the screening cover for feeding and traveling activities in the fall and winter, nesting and brooding young during the spring and summer, and roosting at all seasons. Thickets of wild Chickasaw plum and fragrant sumac and, in bottoms, grapevines often occur in a friendly pattern and

provide the "living room" type of cover. In seasons of good rainfall the overall distribution of these, when linked together with good ground cover, is all that is needed for escape cover. Overgrazing can, and all too often does, reduce the value of escape cover.

Further south in the mesquite brush and shin oak ranges, the resting and screening cover needed for feeding and movement is provided by moderately grazed vegetation dotted with islands of taller weeds and grasses in the shelter of mesquite shrubs, or by shin oak motts interspersed with tall grasses. In years when rainfall and plant succession result in a continuous stand of snakeweed, screening cover is at its best. The type of screening cover, in every case, must not be too dense for easy travel and access to food on the ground. In this respect, it is distinct from escape cover, which may be a dense mat of ungrazed grasses into which quail may drop for concealment.

It is important to remember that what we have called screening cover has the function of bringing bobwhite and his food safely together. While this type may be less generally recognized than the more conspicuous escape and loafing types of cover, it is no less essential. Without it, a covey can be pinned down in a certain safe escape or loafing cover situation most of the day by a single hawk or, worse yet, be forced by weather or predators to abandon the location entirely.
An excellent example of living room (headquarters) and escape cover in close conjunction consists of the combination frequently found in farm communities where a shelterbelt planting is margined by a strip of uncut sorghum almum, Johnson grass, or even Russian thistle. Bobwhites use the woody coverts for resting headquarters, but scatter and hide in the thick herbaceous margin when flushed. Few situations provide so clear a distinction.

Along the valleys of the Canadian and Washita rivers, thickets of tall weeds such as rag sumpweed and common sunflower often serve as both headquarters and feeding cover for bobwhites. In these expansive "groves" of robust weeds three functions are served: screening, resting, and escape. In addition, ample supplies of food are present (Figure 14). However, herbaceous cover alone, no matter how tall, cannot compensate for lack of high-grade woody cover. Dead weeds are easily pushed over or trampled by cattle and often blow down before the end of winter.

Figure 14. Rag sumpweed growing in Canadian River bottomland.

Except in extremely dry seasons, or when Chickasaw plum, aromatic sumac, and sand sage have been "controlled" by aerial sprays, adequate quail cover is seldom a problem in the upper Panhandle bobwhite range. However, the upper Panhandle contains a relatively small part of the Rolling Plains bobwhite range. Throughout the greater part of the region, mesquite brush and shin oak provide the basis or foundation of most of the quail cover found on grazing range. Both plants have marginal value in that, taken alone, they offer too little concealment for either resting cover or escape cover. After frost drops the leaves, neither has much canopy. Occasionally, a mesquite will be found with a sprawling or recumbent form under which a covey can rest. Such a setting offers a minimum of concealment and often one or more bobwhites in a covey will be exposed to view. Such tree forms serve their best purpose when acting as a living fence to discourage grazing by livestock, thereby preserving the islands of mixed herbaceous and woody cover which make this type of range habitable for bobwhites.

Shin oak, especially, provides deceptively poor cover after the leaves fall. As in the case of mesquite, the value of shin oak as quail cover is determined by the quality of the herbaceous cover intermingled with it.

As is generally known, bobwhite nests are skillfully concealed and there are quite a few people living on farms and ranches who have never seen a quail nest. In nearly all instances, bobwhites make use of dead grass of the previous year's growth to effect this concealment. In farmlands, nesting cover is found in fencerows, odd corners neither cultivated nor grazed, and old reverting fields under the Soil Bank Program. On livestock ranges, bobwhite nests are built in stools of dead bunch grass. On heavily grazed ranges, three-awns and tobosa grass, being unpalatable for cattle, are frequently the only species left, and comprise most of the nesting sites. Prickly pear sometimes protects old grasses for quail nesting. About half the nests studied have been located at the base of shrubs of mesquite or sand sage.

Bobwhite nesting cover needs to be continuous, or nearly so, and should exist in greater acreages than is required for needs of quail during the period of covey existence. This is because 1) bobwhites disperse widely for nesting and 2) small scattered units of nesting range are easily reconnoitered and hunted out by predators such as skunks and snakes. A range in excellent condition as regards nesting cover is shown in Figures 15 and 16.

Figure 15. Excellent quail nesting cover. Roosting cover is seldom absent if the other types are present.

Bobwhites roost on the ground and prefer sites where an explosive flush can be made in the dark without their striking overhead limbs or other obstacles. With few exceptions, the actual roost is on bare ground, in the open or in the midst of fairly tall cover, depending upon the weather. On cold still nights, bobwhites go to high ground to roost where temperatures do not drop as much as

Figure 16. Bobwhite nest in excellent nesting cover, close-up.

they do in low places. In storms and blizzards, bobwhites seek low places or areas where dense vegetation breaks the force of the wind and affords some overhead protection.

Cover and food relationships. The special needs of bobwhites for foods and cover have been emphasized. No less important is the relationship that must exist between all the types of cover described above, and between these and the food supply. This special relationship of food and cover to each other is termed interspersion, and is a key requirement. Without it, any amounts of food and cover on the range will not insure the presence of bobwhites. In general, interspersion means that all of the food and cover types essential to the welfare of a species are within the daily travel range of that species. In the case of the short-ranged bobwhite, this means that the habitat limits are where all food and cover types meet at a common point. For instance, if a given farm is divided into quarters, one of which is fallow (food), another in grass (nesting), another in brush and undergrowth (escape}, and the fourth in timber (resting), we have an interspersion habitat for one covey at the point where all quarters come together, How to make room for more coveys? Create a similar pattern in each of the four quarters, thus increasing the interspersion (or places where types meet) by four and making room for five coveys. This is merely an illustration; we do not find bobwhite food and cover laid out geometrically, and it is possible that bobwhites would not care for so artificial a pattern in any case.

When the interspersion appears to consist of only two or three types, we can safely assume that multiple use is being made of one or more. As an example, an extensive stand of snakeweed on mesquite brush range serves as screening cover for travel and feeding, a source of food, and often
escape cover. In the same manner, a shelterbelt may provide resting cover, have a weedy understory providing food, and a strip of Johnson grass or tall-grass margin providing escape cover. Here the interspersion is largely vertical in structure rather than horizontal.

Importance of edges. From the above discussion it will be obvious that the place where the edges of the various cover and food areas meet is the place offering the most to a bobwhite covey. In other words,

edges in common provide some of each type at, or very near one location. Such quality conditions still exist in the case of mesquite and shin oak grazing ranges, although they may not be readily detected by the untrained eye. In a good pasture interspersion, motts of ragweeds, crotons, or other key food plants are bounded, or have edges, on stands of grasses. The woody plants have suitable edges and are close enough together for access from any point. Taken together, the amount of edge is great and makes for an interspersion favorable to bobwhites. Even normal grazing, which is seldom uniform, causes openings which again contribute edge effects.

It should be emphasized here that the form of rangeland interspersion described above is the most vulnerable of all types to overgrazing and breaks down completely under continued heavy grazing. It may as easily deteriorate in the absence of enough grazing during good grass years.

The essence of bobwhite management lies in providing adequate food and cover to meet the needs of the population desired, plus a maximum amount of interspersion commensurate with other uses of the land.

MANAGEMENT OF COVER

Improvement of Existing Cover

The common mesquite is the most abundant source of woody quail cover in the Rolling Plains, and affords the most opportunity for improvement. Shin oak ranks second in abundance, but its usefulness can be improved only by encouraging a healthy interspersion of tall grasses and forbs. Certain areas, notably the north Panhandle, have woody quail cover comprised of Chickasaw plum, wild grape, and aromatic sumac, all of which possess qualities of form and concealment which make them superior to mesquite or shin oak as quail cover. Nevertheless, mesquite and shin oak remain the most important woody components of quail habitat in a region where wide distribution is limited to a relatively few species of woody plants.

It is recognized that mesquite and shin oak are regarded as undesirable plants by range managers and that brush eradication, rather than preservation, is a popular program with land use agencies. Yet the control measures to date can hardly be said to be wholly effective, and mesquite, particularly, seems destined to be a feature of the Rolling Plains landscape for a long time. It must be conceded that the densities and acreages in which mesquite and shin oak commonly occur are probably far greater than would be required for maintaining even maximum bobwhite numbers. Thus a modicum of brush left on a given range, in the proper pattern, would suffice in the preservation of bobwhite habitat.

Persons planning brush removal for specific areas should understand that entire removal of brush under Rolling Plains conditions, without consideration for preserving bobwhite habitat, is certain to displace quail to the same degree. Leaving a small percentage of the brush is far easier, less costly, and more certain of results than replacing a matching amount with transplants. If the land operator is unwilling to spare any brush at all then he may as well forego the privilege of having bobwhites on his range.

Making mesquite and shin oak better quail cover. A great deal of the remaining mesquite growth in the region consists of second or even third growth stands that have followed control efforts. The value of these as quail cover varies greatly, according to the kind of ground cover comprising the understory. Hardly ever does the mesquite plant alone have much value as quail cover. Its value lies in the degree to which it repels livestock, protects an understory of grass and forbs, and also provides overhead protection for quail. (An occasional mesquite will have all these virtues.)

An intensive study of a 10-year-old stand of second-growth mesquite on the Matador Game Management

Area revealed that approximately 17 percent of the plants were capable of affording good quail cover when accompanied by a suitable understory. In stands of older, straight-trunked trees, few have the form that contributes to quail habitat.

The tenacity of mesquite makes it possible to improve its form by a process known as half-cutting. Mesquite plants suitable for improvement by this means are selected on the basis of their being multiple-trunked (Figure 17). Such plants, with numerous main limbs springing from the ground, may be any size up to 4 inches in diameter, at a height 30 inches from the ground, so long as the bark is smooth and green. The larger and taller these main trunks are, the more area will be "fenced" when the limbs are half-cut. In half-cutting, the main limbs are cut about half-way through from the top side and allowed to assume a position horizontal to the ground. The cutting is commonly done with an axe but survival is better if a handsaw or a chain saw is used, and the cut treated with appropriate tree surgery paint for protection from weather and boring insects. The best quail cover is provided when limbs are cut not more than 30 inches from the ground.

Figure 17. Multiple trunked mesquite, the form offering best opportunity for improving quail cover by half-cutting.

Old rough-barked mesquites are brittle and usually will not survive when half-cut. Smooth-barked trees should be half-cut in the spring or early summer when sap is flowing. In many instances, one or more of the main limbs may already be nearly parallel to the ground. In such cases, it is better to half-cut the other limbs, bring them down to a common level, and weight them down with limbs cut from nearby mesquite. These should be placed at right angles to the radius of the plant in a wagon wheel pattern. Figures 18 and 19 show a half-cut mesquite after completion of the procedure and after a 5-year interval. This tree was a poor selection and the work was done by men new to the procedure, but bobwhites were still utilizing the shelter after 5 years.

In those parts of the Rolling Plains where wild grape is found, the plant is commonly supported by a tree which has been pruned by shading or by rubbing of livestock and rendered useless as quail cover (Figure 20). Here top quality quail cover results from cutting the supporting tree 24 to 30 inches above the ground, leaving the trunk supported by the stump (Figure 21).

Figure 18. Half-cut mesquite immediately after procedure, Matador Wildlife Management Area, March 28, 1962.

Figure 19. Same mesquite as shown in Figure 18; summer 1965. A covey was found using this "improved" cover during each annual quail census.

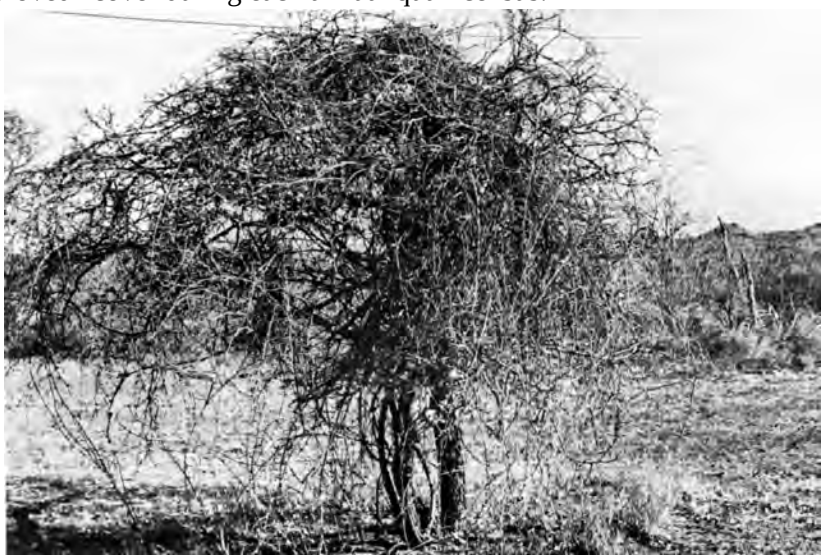


Figure 20. A grapevine useless as quail cover because canopy too far from ground.

For good management of bobwhite cover habitat, all mesquites in odd corners of fields, along fence rows, along gullies, and in waste margins of any kind should be half-cut. Remember that isolated half-cut mesquites, like any other unit of woody cover, serve only to pin a covey down. Nor are straight rows so good as staggered rows. The best pattern is a checkerboard, wherein, depending upon the density of the brush, diagonal distances between individual half-cut units are 50 to 150 feet. It is emphasized that piles of completely cut brush are in no sense comparable to these living brush piles. Brush piles of dead limbs deteriorate rapidly under the influence of weather and boring insects and quickly settle into useless piles of sticks. On the other hand, a large dead tree, if it occurs in a strategic location, can be felled and its limbs will prove a useful protector of ground vegetation for several years. Such opportunities to add to quail cover should not be overlooked.

Figure 21. Same grapevine as shown in Figure 20, following cutting of support tree and 1 season's growth.

Grazing must not be allowed to deplete the ground cover beneath mesquite or shin oak, since neither of these species alone provides much concealment. Bobwhites need ground cover beneath woody cover to assist in their natural camouflage, as well as to protect them from winter cold. Figures 22 and 23 show a mesquite brush pasture that held 5 coveys in an estimated area of 75 acres during early September, but held none 2 months later after being grazed out. Figure 23 is a vivid picture of conditions that all too often arise on the bobwhites' winter range.

The shin oak plant cannot be improved as quail cover by half-cutting, but only by taking steps to improve the herbaceous ground cover associated with it. This includes discing for encouragement of food plants, and moderate grazing to allow development of bunch grasses and forbs among the shin oak shoots.

Improving shelterbelts for quail cover. Shelterbelts, because of their shade, are always pruned and opened up by livestock if the latter are allowed access to them. They should be protected wherever possible by excluding livestock. Comparatively few shelterbelts have enough understory to meet quail needs for escape cover, a need that is all the greater in such habitats because of the plowed fields that usually surround them during the winter. Here the most practical method of adding good escape cover is to sow a belt of sudan or sorghum almum along the field side (Figure 24). In many cases the central tree rows in shelterbelts have died and been removed. Both food and cover can be grown in the middle rows of such plantings by employing discing during March. Addition of a good fertilizer at the time of discing will add to the seed production of the resulting growth.

Figure 22. Mesquite brush and heavy herbaceous ground cover. This held good population of bobwhites during the early fall.

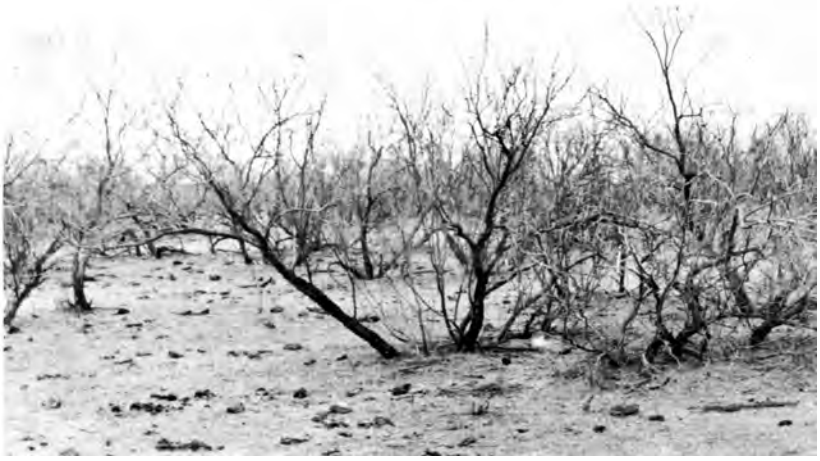


Figure 23. The same general area as shown in Figure 22, 2 months later. Ground cover depleted by cattle grazing, and bobwhites gone.

Figure 24. Field side of shelterbelt planting with border of sorghum almum left over winter.

Fitting Cover Management into Brush Control Programs

Fortunately, many Texas ranchers who are concerned with brush control are not callous to the needs of quail. Personnel of the Parks and Wildlife Department receive many requests each year from landowners interested in preserving quail habitat but at the same time desirous of alleviating a brush problem.

Relatively minor amounts of Chickasaw plum, aromatic sumac and wild grape occur throughout the sandhills and stream bottoms of the north Panhandle. These species are of such great value to wildlife of all kinds, and their occurrence covers so small a part of the total acreage, that all should be retained as useful and attractive features of the landscape.

Elsewhere in the Rolling Plains, there is a brush problem involving a vast total acreage of common mesquite, shin oak and juniper. It seems certain that this woody growth will be removed from the range in increasing amounts as new and more efficient techniques are put into operation. If these techniques were to result in the total eradication of brush, the bobwhite population would be evicted. The same is believed to hold true for the lesser prairie chicken in that species' greatly limited range.

On the other hand, if bobwhites are desired, their habitat can be retained and even improved by making use of the principle of interspersion described earlier. This is accomplished by retaining brushy growth in certain patterns on as little as 1 to 3 percent of the land area. Ranges are few, indeed, where the retaining of brushy growth in these or greater amounts cannot be justified for the additional purposes of preventing wind and water erosion on certain sites.

Sparing brush for dual purposes. Locations where brush should be retained for serving multiple purposes are: 1) sandy field edges sheltered from prevailing winds by mesquite margins; 2) draws and gullies where herbaceous cover alone is inadequate to prevent water erosion; 3) steep hillsides subject to gullying; 4) sandy ridges and dunes vulnerable to wind erosion; and 5) brushy clumps made up in part of livestock shade trees such as woollybucket bumelia, netleaf hackberry, and western soapberry. More times than not, clump and strip stands of several species will be found on the floors and steep slopes of ravines and canyons, while the more level uplands will have a more uniform type of growth of the species for which control is most desired. The diversified vegetation of these ravines and canyons makes them of superior value to bobwhites, and provides a ready guide in selection of brushy cover to be retained.

Figures 25 and 26 show representative parts of a brushy pattern that was retained for wildlife in the course of brush control on one of the larger Texas Panhandle ranches. The photographs were made soon after heavy river-bottom mesquite brush was bulldozed. Lack of a wide-angle lens on the cameras and sufficient elevation precluded effectively picturing the overall pattern of the management operation. Shown are, respectively: parallel strips of mixed mesquite, hackberry, and bumelia on sand dune sites, and an end view of the mesquite strip on the north margin of a large sandy field where irrigated feed crops are grown. The strip of quail cover (and windbreak) has been left intact along the north and west sides of this field.

The pictures clearly show the soil disturbance which accompanied the bulldozing and which will, for several seasons, result in abundant sources of quail food in an ideal relation to woody cover. The brush retained here represents good soil conservation practice as well as good quail management. However, in this case the purpose of the ranch owners was to retain good quail hunting in a favorite location.

Figure 25. Parallel strips of mixed mesquite, hackberry, and woollybucket bumelia retained on sand dunes for quail cover in brush control operations.

Figure 26. End view of mesquite strip retained at field side for quail cover.

For large units with homogeneous cover of mesquite or shin oak, a linear strip retained at regular intervals is recommended. Such a pattern is better suited to the mechanics of brush control, whether it be by mechanical or chemical means. Strips can be laid out easily by flagmen controlling the operation, and the acreages left in brush can be easily computed. Long, narrow strips provide a maximum of edge. Disced strips for food production can be placed in the closest relation to them, or even within them in many cases. The food-cover interspersion is favorable. Hedge like strips of woody cover are conducive to high success in quail hunting, whereas dense, uniformly distributed cover makes for low hunting success in all but the peak years. In February of 1963, a census of a square mile of heavy mesquite brush on the Matador Wildlife Management Area resulted in a count of approximately 1 bobwhite per 6 acres. This is a better than average quail density for the range type in mid-winter. Yet the last hunters of the season had reported no quail here and a sportsmen's organization had called off a March field trial because of the lack of quail. With an increasing number of landowners deriving income from the sale of quail hunting privileges, strip-rowing mesquite or shin oak brush should go a long way toward making brush worth its keep.

How much brush to leave. The area to be devoted to strip brush cover would depend upon the number of bobwhites and the amount of hunting desired by the land operator. The bobwhite quail rarely ventures much more than 200 yards from brushy quarters. For a square mile of range, 5 parallel strips including strips on 2 opposite sides of the section, at intervals of 400 yards, would represent a minimum, if the entire range were to be utilized for feeding. Halving the interval would insure bobwhites safer access to all parts of the range, and would double the quail carrying capacity in years of optimum range conditions and high quail production.

The width of the strips would depend upon the density of the brush. In some shin oak ranges with dense stands and frequent "motts," a strip 10 feet wide might suffice. At the wider intervals of 400 yards, this would involve leaving a total of approximately 6 acres of brush per square mile, or less than 1 percent of the area. In mesquite brush range, the width of the strip to be left would vary with the density pattern and growth form of the individual plants. As has been pointed out, relatively few mesquite plants are of much value to quail without half-cutting. As strips are narrowed, the intervals between good such cover units tend to become greater. In most stands of mesquite, strips of brush 16 to 32 feet wide would be adequate. At the maximum distance of approximately 400 yards apart, this pattern would involve approximately 10 to 20 acres of brush left per square mile, or approximately 1.5 to 3 percent of the area. Again, halving the intervals between strips would be desirable.

On the credit side for retaining patterns of brushy cover as described above, aside from insuring habitability for quail, is the windbreak effect that would result. If strips were positioned in a generally east-west direction they would tend to loft some of the hot summer winds, thus decreasing evaporation. In winter, a degree of protection from wind would be afforded livestock.

Establishing Woody Cover Where Cover is Absent or Insufficient

Where the range holds abundant supplies of quail food or its potential, but is deficient in woody cover, habitat can be created by transplanting suitable woody species. This is a procedure which entails work, patience, and expense, and should not be undertaken lightly. The young seedlings of woody plants cannot compete with the native vegetation unless assisted by tillage for at least 3 years. This is a lesson game managers have been slow to learn. Its neglect has caused more failures than poor selection of soil sites or selection of inadaptable species.

What to transplant. Experimental establishment of woody cover by transplanting has been carried out on the Gene Howe Wildlife Management Area and the U.S. Forest Service National Grasslands in the north Panhandle. Extensive transplanting, involving about a dozen species of shrubs and trees, were started on the Gene Howe Area in the early 1950's. Most of the transplanting was made, as it turned out, in time to undergo the severe test of continuing drought through 1956. As a result, two species emerged as survivors. These were Russian olive and fragrant sumac. Most of the others tested can be found growing in shelterbelts in the Panhandle and Lower Plains, which shows the importance of timing (in respect to rainfall) to success with many species.

By 1960, approximately 13 row-miles of Russian olive were functioning as quail and pheasant cover on the Gene Howe Wildlife Management Area. Nearly all of these plantings have been made in river bottom soils. The Russian olive on average sites attained a height of 6 feet in 5 years. Where planted no further than 6 feet apart in the row, crowns closed in 5 years, and excellent quail cover resulted. The cover value has continued to improve, and in recent years all plantings have held coveys of bobwhites.

The consistent and prolific production of fruit by Russian olive has made little difference in the winter

food habits of bobwhites, perhaps because spring discing has usually produced an abundance of native food in close proximity to the tree rows. While bobwhites continue to feed predominantly on seeds of forbs, ring-necked pheasants are observed to rely heavily on the fruits of Russian olive, and a marked increase in pheasants has accompanied maturing of the plantings. Wild turkeys also consume large quantities of these fruits, as do deer, raccoons, and a host of non-game birds. Figure 27 is a typical view of the laden branches.

Figure 27. Fruit-laden branches of Russian olive tree.

Fragrant sumac, also called three-leaved sumac, is a native shrub that occurs throughout the Rolling Plains. A similar species, squawbush sumac, is readily procured from the larger nurseries. Squawbush sumac does not possess the weedlike rate of growth of Russian olive, but is longer lived. Russian olive is believed to have a life of 15-25 years in the Rolling Plains. Squawbush sumac is most useful as a border or fill-in planting in association with the faster growing and much larger Russian olive (Figure 28).

Figure 28. Cover planting of Russian olive with border planting of squawbush sumac.
The fruits of squawbush sumac contribute little to the winter food of bobwhites, but the tight, many branched form makes it superior quail cover for escape and travel purposes.

Neither Russian olive nor sumac transplants have been tested in the tighter, clayey soils along the eastern edge of the Rolling Plains. Each is drought resistant when once established, but is likely to do best when transplanted during a time of rain.

If the objective is to go all out and create woody cover which will hold quail where there is a lack of native shrubs or heavy herbaceous ground cover, extra benefit would be provided by addition of a third species such as desert willow, which is a common planting in the Rolling Plains for shelterbelts and windbreaks.

Seedlings of Russian olive, squawbush sumac, and desert willow should be purchased from nurseries located in the Great Plains states. Stocks from these sources are generally better adapted to the Rolling Plains situation. Names and locations of such nurseries can usually be obtained at local offices of the U. S. Soil Conservation Service or County Agricultural Agent.

Where to transplant cover. Before selecting sites for transplanting woody cover, the chapter on quail cover should be read again, particularly concerning the importance of mingling woody cover and other desirable vegetation. A great deal of money and effort has been wasted in making cover plantings without regard to this interspersion. If the woody cover is to be of value to quail, either an intermixture of several types of herbaceous cover and food plants must be present, or there must be a potential for producing them by manipulating plant successions.

The most effective use of woody transplants, and one requiring the least acreage, is in tying together existing cover. Such cover may consist of scattered clumps of native shrubs in fencerows, field margins, or along intermittent stream courses. Use of transplanting to convert these to continuous travel lanes and escape coverts should receive first consideration when planning cover improvement. Odd corners or waste areas in cultivated fields, common boundaries between pastures and fields, along drainage ditches, and uphill sides of terraces in reverting cropland are good sites for transplanting, particularly if already existing fences can be used to exclude grazing animals during the critical early stages of growth.

Livestock will use the plantings for shade and fly protection, and in time will cause pruning of lower limbs, thus destroying the cover's value for quail. The trampling packs the soil, reduces humus, and destroys the ground litter which helps give quail security.

The land operator should bear in mind that a covey of bobwhites will require, on the average, about as much range as a cow and perhaps more. This means that shrubby cover should be established along a relatively long front of screening, herbaceous vegetation, which holds a source of food sufficient to last throughout the winter months. It is evident, then, that it is hardly practical to attempt to bring an entire unit of large acreage under intensive bobwhite management if all the woody cover has to be established by transplants. This applies particularly to grazing ranges where native shrubs are already present and which, with proper management, will provide quail cover.

In general, transplanting woody cover in the Rolling Plains is best for improving relatively small units of land, especially farmland. It also is most practical where the bobwhite population is limited by poor access to winter food supplies.

How to transplant trees and shrubs. All planting sites should be fallowed during the summer and fall preceding spring transplanting. The chief reasons for fallowing in the Rolling Plains are to conserve moisture and to make easier the preparation of the planting sites at time of planting. Time spent in fallowing is compensated by better survival and less trouble in tillage during early growth of the plants.

The season for transplanting Russian olive and squawbush sumac in the Rolling Plains is February and March. Because the nursery stock will have been ordered at an earlier date, it is essential that it be cared for properly between receipt of the shipment and the actual planting. This is best done by a process called heeling, although nursery stocks are commonly packed in such a manner that they will survive for a few

days in cool cellars. In heeling, a trench is excavated deeply enough to receive the seedling bundles when inclined about 45 degrees. The bundles are then covered with the soil removed from the trench. If the soil is not wet at the time, both it and the bundles of seedlings should be thoroughly moistened while covering. Seedlings stored in this manner may be safely kept for several weeks. In no case should seedlings be allowed to dry out or be exposed to the atmosphere before planting. While being transported and handled during planting, they should be carried in buckets with the roots liberally covered with mud. Care at this time will insure good survival through the first weeks after transplanting.

In experimental plantings of Russian olive on the Gene Howe Wildlife Management Area, intervals of 4 to 8 feet between plants and 9 to 16 feet between rows were used. The minimum spacings, 4 feet apart in rows and 9 feet between rows, were found to result in superior quail cover, in less time. Russian olive, planted at wider spacings, tended to make large trees that shaded out herbaceous vegetation for a wider belt on either side, and did not close the gaps to the extent that closer spacing permits.

Single to 4-row plantings were made, but the multiple-row plantings now are believed to be superior as quail cover for most situations. Where rich associations of forbs can be maintained, there would appear to be little difference between them. Four-row plantings are recommended.

In order to allow tillage, rows should not be spaced closer than 9 to 10 feet apart. The same interval would suffice for border plantings of sumac, or sumac and desert willow, but these species should be planted with intervals no greater than 2 to 3 feet between plants for the hedge effect provided.

End and side views of a 4-row planting of Russian olive are shown in Figures 29 and 30. Note the closure between plants and between rows that occurred during 7 years.

Trees may be planted by hand with "sharpshooter" spade, by means of power posthole digger, by a furrow method, or with a tree planter. Time, labor and expense are progressively less for the methods in the order named. If a tree planter is available, several thousand trees can be planted in a single day. Some units of the Soil Conservation Service have such machines available to them.

Lacking a planter, the furrow method is most practical and works very well for the hardy species recommended. Conditions under which this method is satisfactory are: 1) when there is plenty of moisture in the soil; 2) when it is possible to plow a furrow deep enough to accommodate the roots of the trees up to the root collar; and 3) where there is little debris. Plowing the site several months in advance and allowing it to lie fallow before planting usually results in these conditions on suitable soils. If the soil is such that a furrow cannot be plowed to an adequate depth, it is probably unsuited for the successful establishment of woody cover.

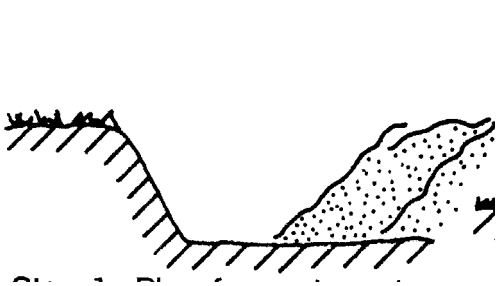
Figure 29. End view of 4-row planting of Russian olive; trees spaced 4 feet apart in rows, 9 feet between rows; 7-year growth.

Figure 30. Side view of planting shown in Figure 29.

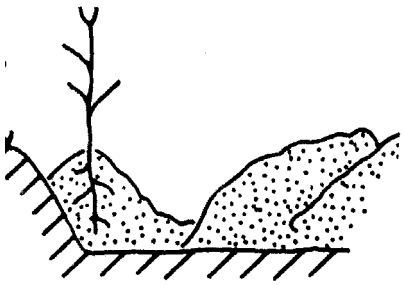
Procedures:

1. Mark the location of the tree row and turn a deep furrow with a plow. Adjust tilt of plow so that "land" side of the furrow is approximately vertical. Do not allow soil to dry out before proceeding with planting.
2. Stand the trees at proper intervals against the "land" side and shovel enough loose soil around them to hold them in position. Stamp down with feet.
3. Reverse direction of plow and throw dirt against the trees by back furrowing.
4. Drive the tractor down the row with a rear tire on loose side of furrow, close against but not on trees.

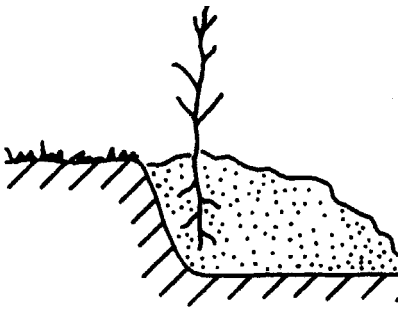
The above procedures are sketched in Figure 31



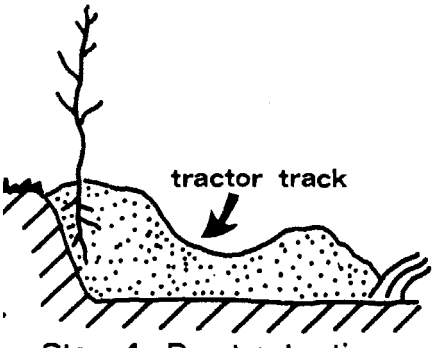
Step 1. Plow furrow to root depth.



Step 2. Stand tree against land side, Shovel and pack soil around to hold in place.



Step 3. Back furrow to throw soil against tree row.



Step 4. Run tractor tire alongside row to pack soil.

The amount of tillage that tree plantings will require per season will depend upon the fertility of the site and local rainfall. In weedy and rich soils (the best locations) a rainy spring may make it necessary to use a hand hoe to clear competing weeds and grasses from the spaces between and about the young trees. Under most conditions, the best cultivating implement for the "middles" or between row spaces is a 6-foot tandem disc harrow, preferably with 20-inch blades. This implement will take care of heavy growth, if the plantings have been neglected, and provides a mulch to conserve moisture. Under the usual rainfall pattern of the Rolling Plains, tree plantings will seldom need tillage after August 1 and would seldom need more than two cultivations before that date.

Management of Nesting Cover

The best nesting cover for bobwhites is the dry, standing grass of the preceding year's growth. Any procedure that will insure existence of this kind of cover, not too rank or dense, and in strategic locations, may be said to be management. Strategic locations are such places that will not be subject to overflowing in spring rains, mowing, burning, or other destruction during the nesting season. Marginal strips of hay or small grains at field sides, retired fields with scattered bunch grass, and ditch banks grown to grass, are all desirable nesting cover, and should be burned or plowed in rotation if these practices are deemed necessary.

Where habitat is comprised of grazing range, the best management of nesting cover is range deferment or pasture rotation.

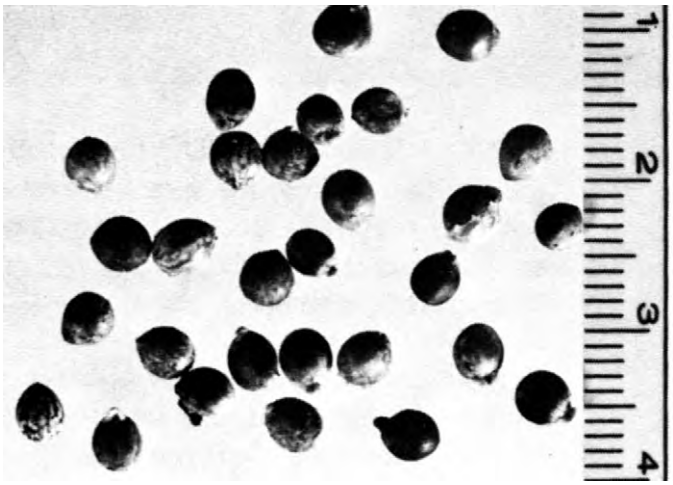
It is impossible here to present a detailed management plan. A plan depends upon the natural features and land use pattern of each specific farm or ranch. The quail manager can learn much by a study of particular covey ranges that seem to be stable and safe habitats year after year. He should appraise these ranges in the light of food and cover relationships as described here, and attempt to duplicate them.

By now it must have occurred to the reader that the tools that have been recommended for quail management -- plow, cow, axe, fire, and gun -- are the ones almost universally blamed for reductions in quail numbers. Actually, in the past, a favorable but coincidental combination of these agencies has been responsible for our good quail years. Management simply means substituting purposeful planning for accident, and putting these tools to work for quail. "These recommendations are based upon observations of bobwhite use of woody cover in the Rolling Plains over a period of more than 25 years. Experimental control of mesquite is being conducted on the Matador Wildlife Management Area to determine the minimum of brush to be left and the most effective pattern for bobwhite habitability.

APPENDIX A

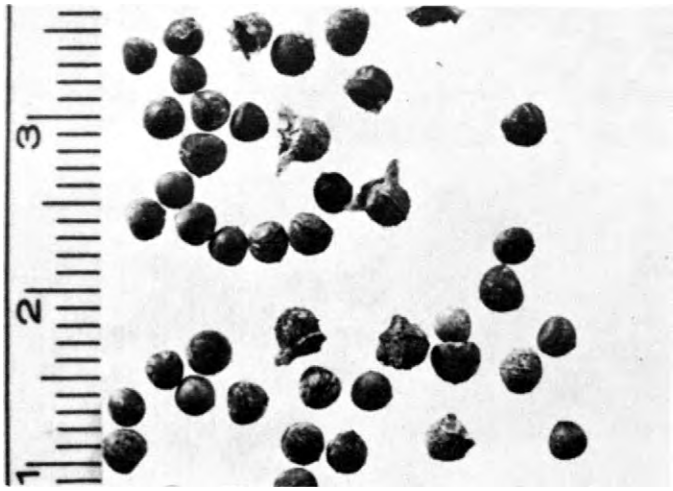
Key Native Foods of Bobwhites in the Rolling Plains

WESTERN RAGWEED. The seeds are weather resistant and may rank among the top two or three quail foods in the region. The plant is widely distributed in many soil types. Ragweed has flowers or two sexes. The male blossoms are usually mistaken for seed by most persons.



TEXAS CROTON. Seeds shown magnified. An excellent quail food, but the plant is partial to sandy soils. Fruits May till frost, and the seeds weather well.

TROPIC CROTON. Seeds shown magnified. Widely distributed in Redlands and clay soils of cattle range and stubble-fields. Responds quickly to any type of soil disturbance. Favorite of mourning doves as well as bobwhites.



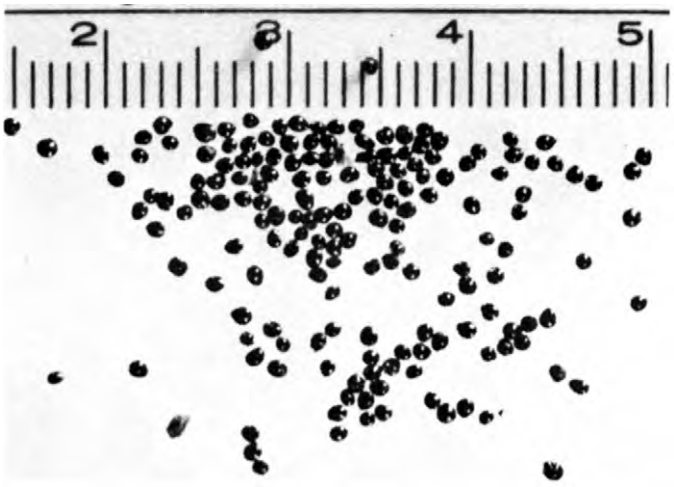
ERECT DAYFLOWER. A lover of shade, it is shown here supported by a sandsage plant. Most abundant in sandhill and sand-shin oak ranges. Seeds rank high among quail foods and are one of the native foods of the lesser prairie chicken. An attractive wildflower. Seeds magnified.

SMALL WILDBEAN. Seeds shown magnified. One of the best of quail foods but unfortunately, often disappears on livestock ranges. The vine is palatable to cattle. Shown here climbing on sandsage, with which it is often associated.

SNAKEWEED. This plant, often called “broomweed”, produces great amounts of small seeds. At the same time, stands have closely interlaced canopies which afford screening cover for quail movement. These features and the sometimes vast distribution are often solely responsible for quail survival in mesquite brush ranges during critical winters. Seeds shown magnified.

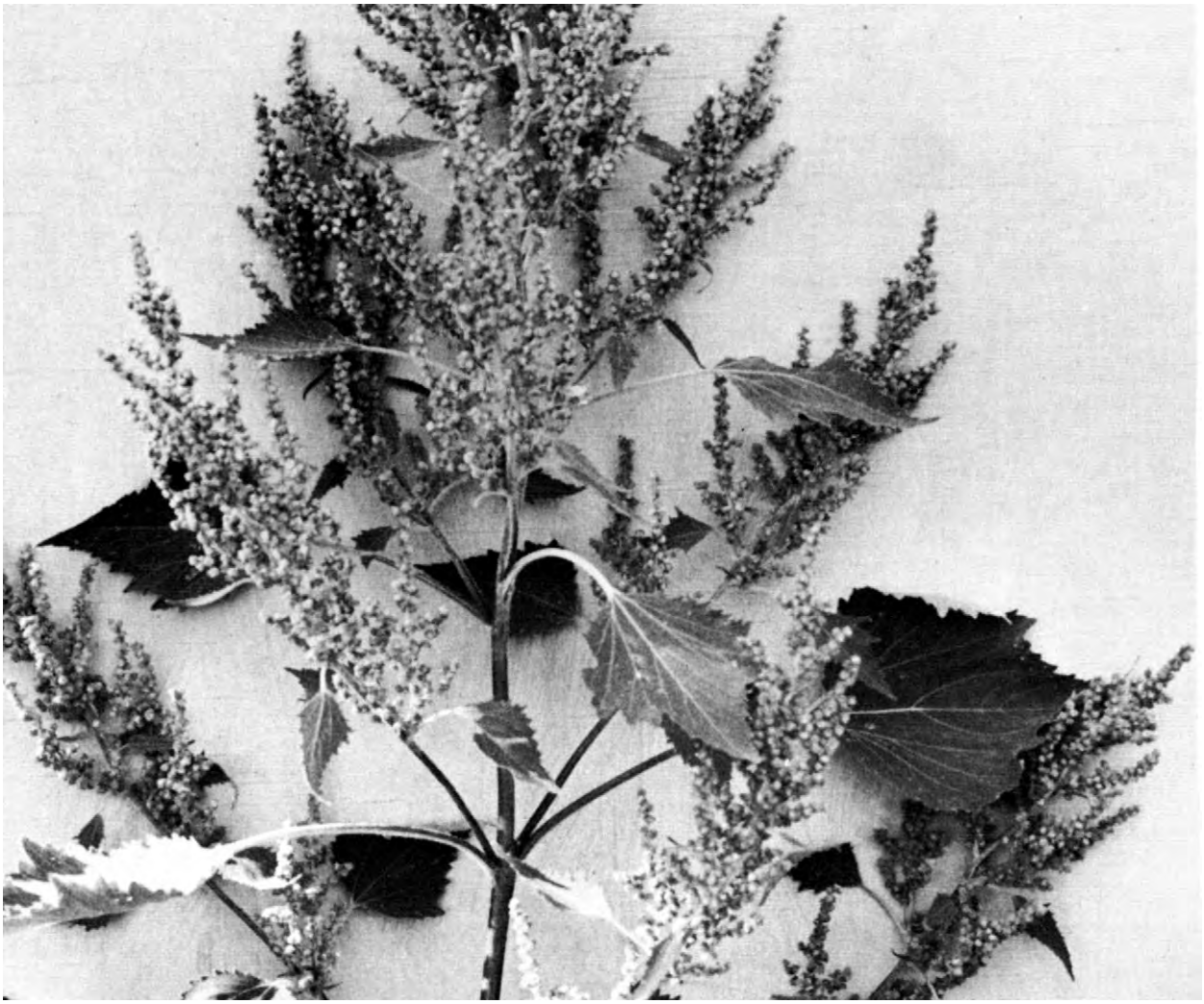
REDROOT AMARANTH. Other names are “carelessweed” and “pigweed”. A plant of field edges, roadsides, or other areas where soils are frequently stirred. Seeds are shown magnified.

Seeds are jet black and have a shiny gloss. Over 6,000 were counted in 1 dove’s crop. Bobwhites are equally fond of them.

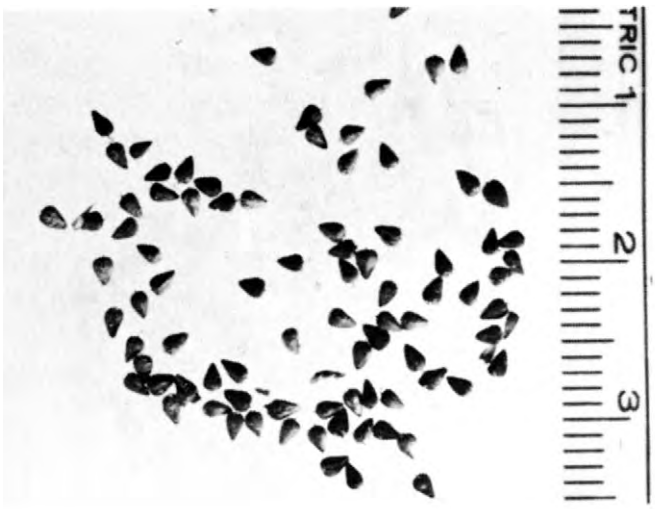


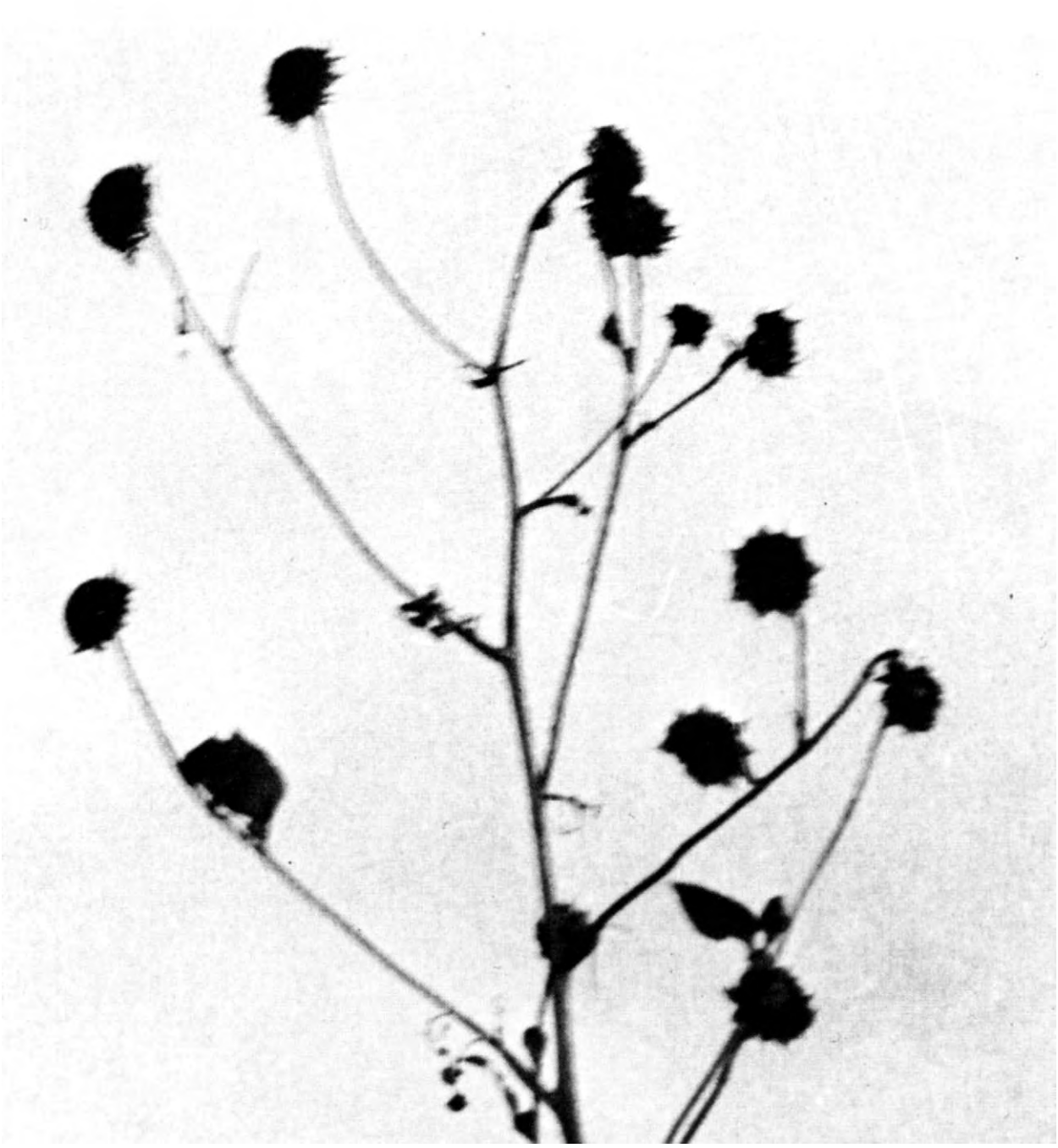
SHOWY PARTRIDGEPEA. An excellent quail food, partridgepea is a resident of sandy soils. It appears in rather thin stands in the Rolling Plains, but nearly always in associa-tion with dayflowers, wild eans, and other quail foods, thus adding to the aggregate of available food.

Seeds shown magnified.



RAG SUMPWEED. Grows in dense thickets in wet bottomlands of north Panhandle. Seeds fall throughout winter; thus are often the only quail food on top of snow.
Seeds shown magnified.

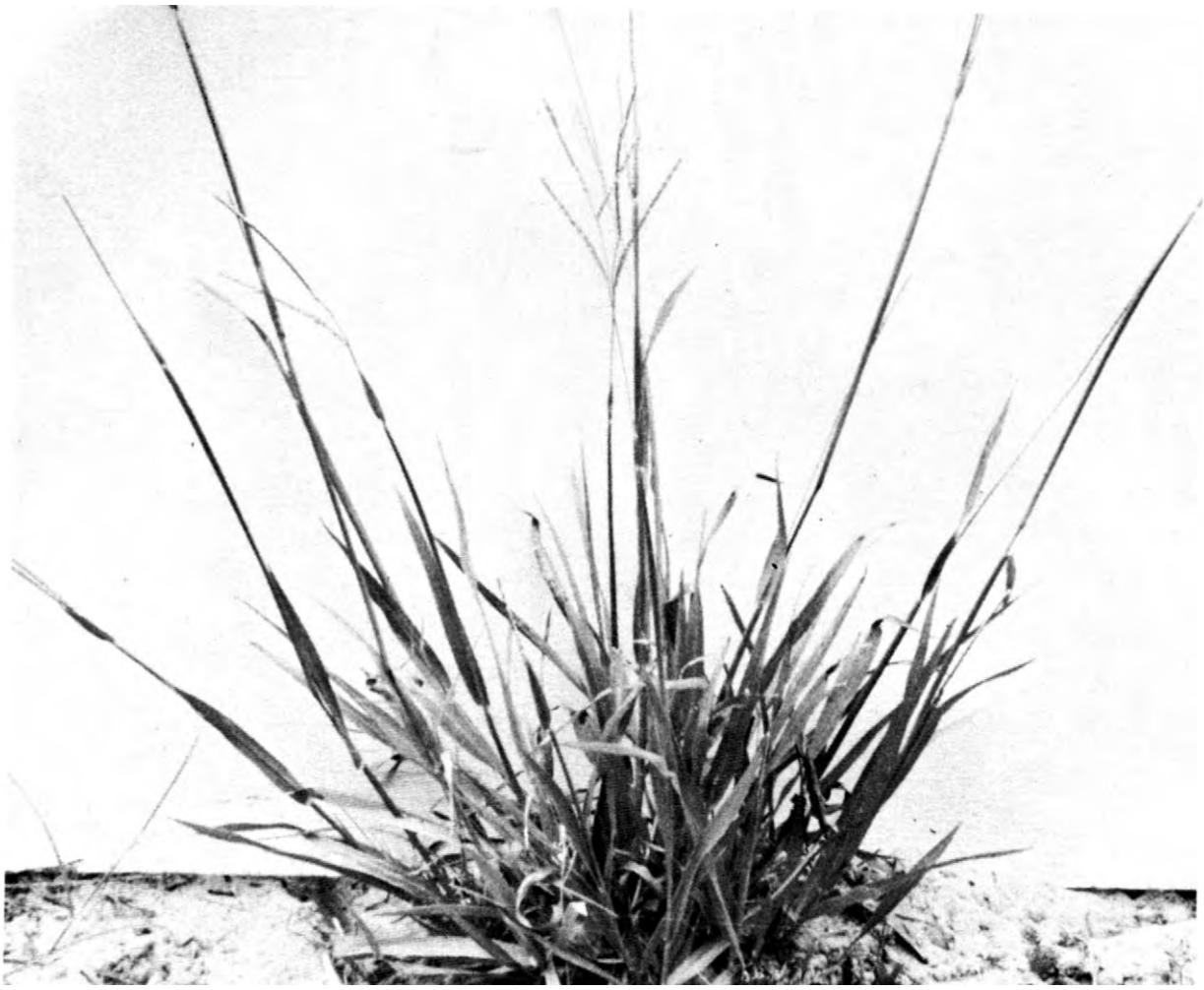


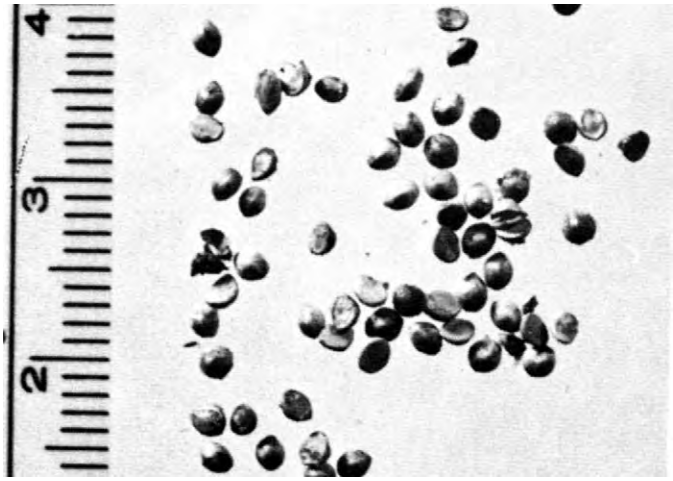


COMMON SUNFLOWER. Shown withered and dry as the hunter sees it after frost. Old locations of sunflower stands can be rejuvenated and made to produce every year by discing in March.
Seeds shown magnified.

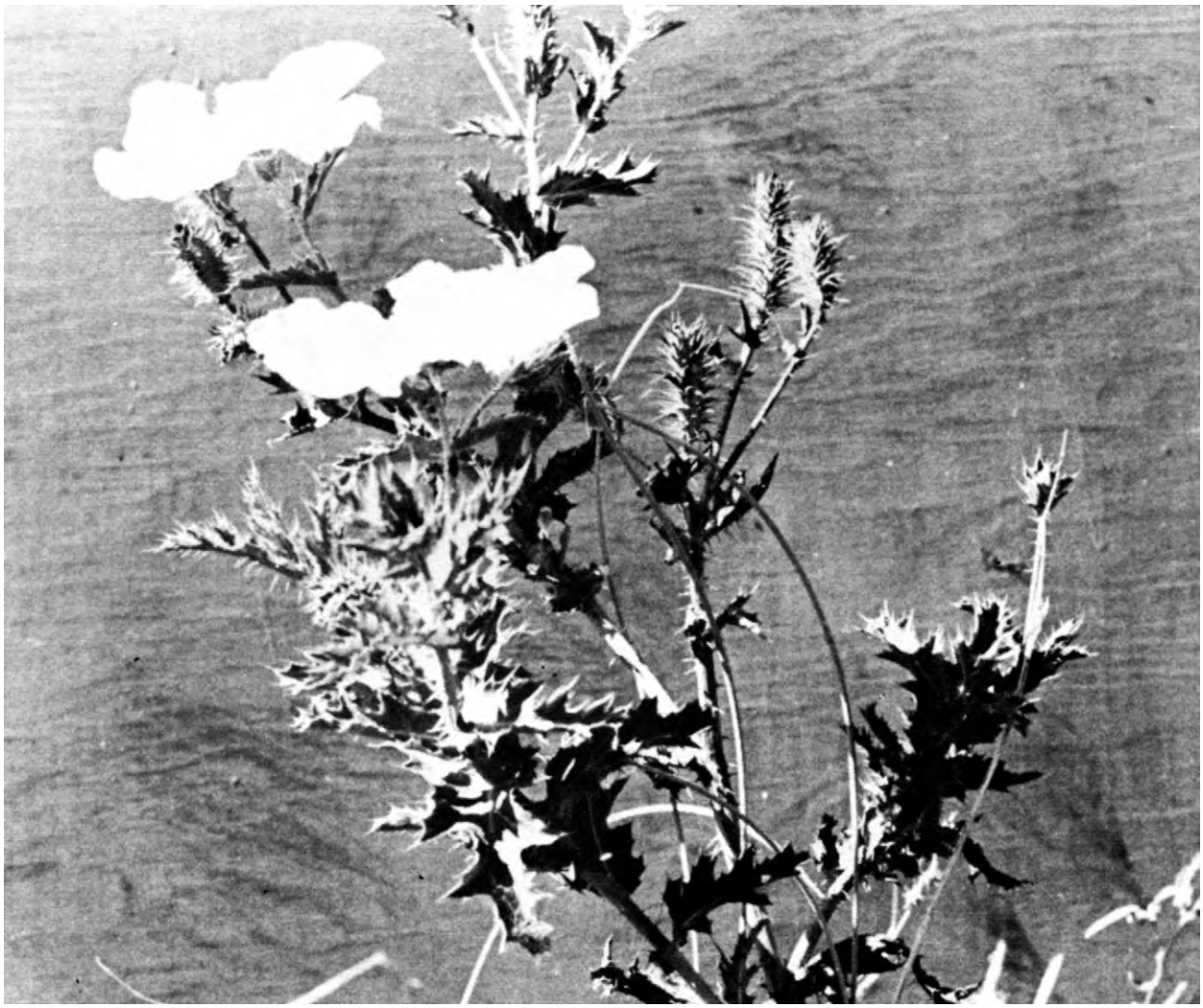
SNOW-ON-THE-MOUNTAIN. The mature leaves have white margins giving patches of the plant a white appearance, hence the name. Numerous about wells, ponds, corrals, or wherever soils are stirred. Responds to discing.

Seeds have a rough surface and resemble miniature golf balls. Shown magnified.

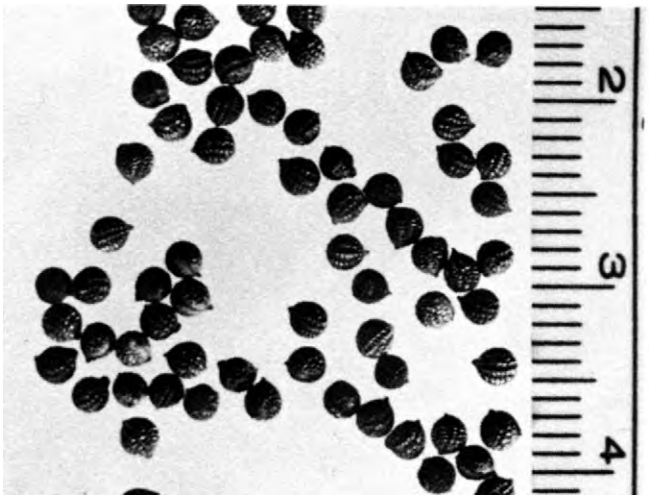


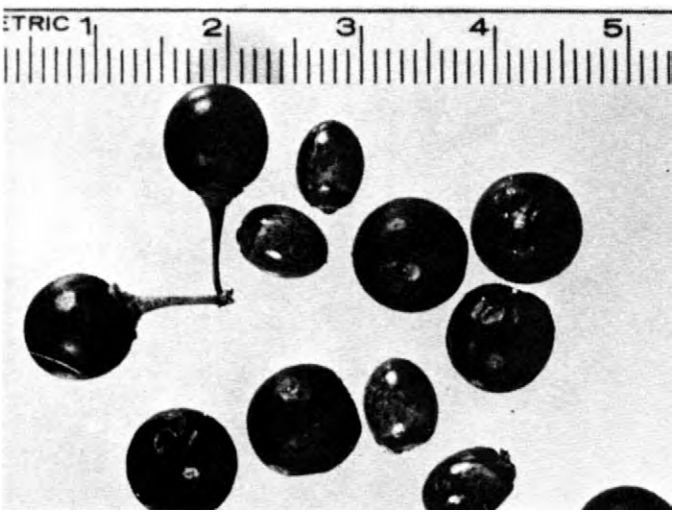


FRINGELEAF PASPALUM. The one grass that rates mention as a key food of quail in the Rolling Plains. It grows in deep sands and is like the forbs in that fire or discing causes an increase.
The seeds, which are hard and weather well, are shown magnified.



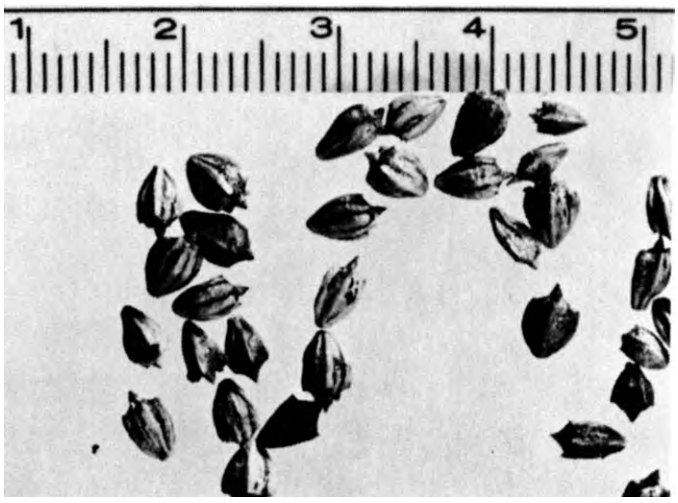
BLUESTEM PRICKLYPOPPY. Another forb which, while thinly spread, contributes important amounts to the aggregate of bobwhite foods. The large white blossoms are conspicuous, and the dried seedpods sound enough like a rattlesnake to make many a hunter jump. Seeds shown magnified.

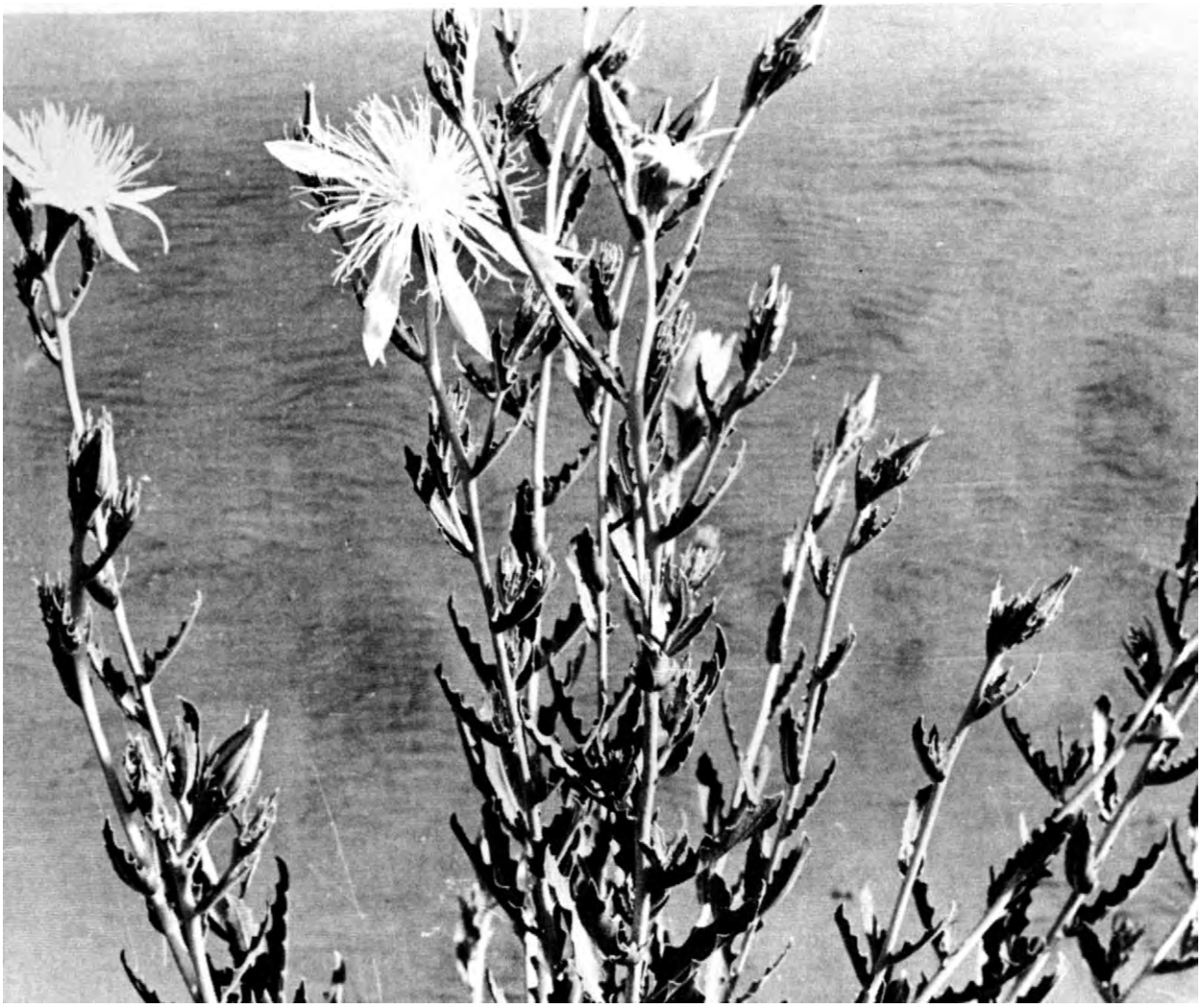


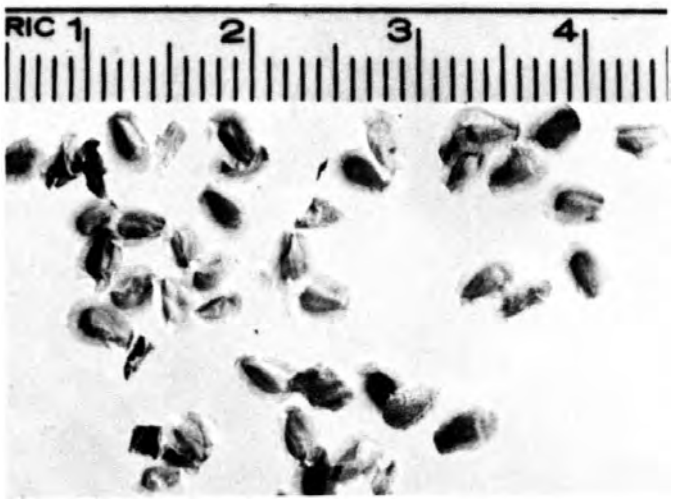


WOOLYBUCKET BUMELIA. The bumelia or “chittam” occurs as a shrub or tree along most of the stream bottoms in the Rolling Plains. It fruits in the driest seasons and the fruit or naked seeds are found in quail crops well into January. It is also an important fall food of the wild turkey. For these reasons, bumelia should be spared in brush-control programs.
Fruit shown magnified.

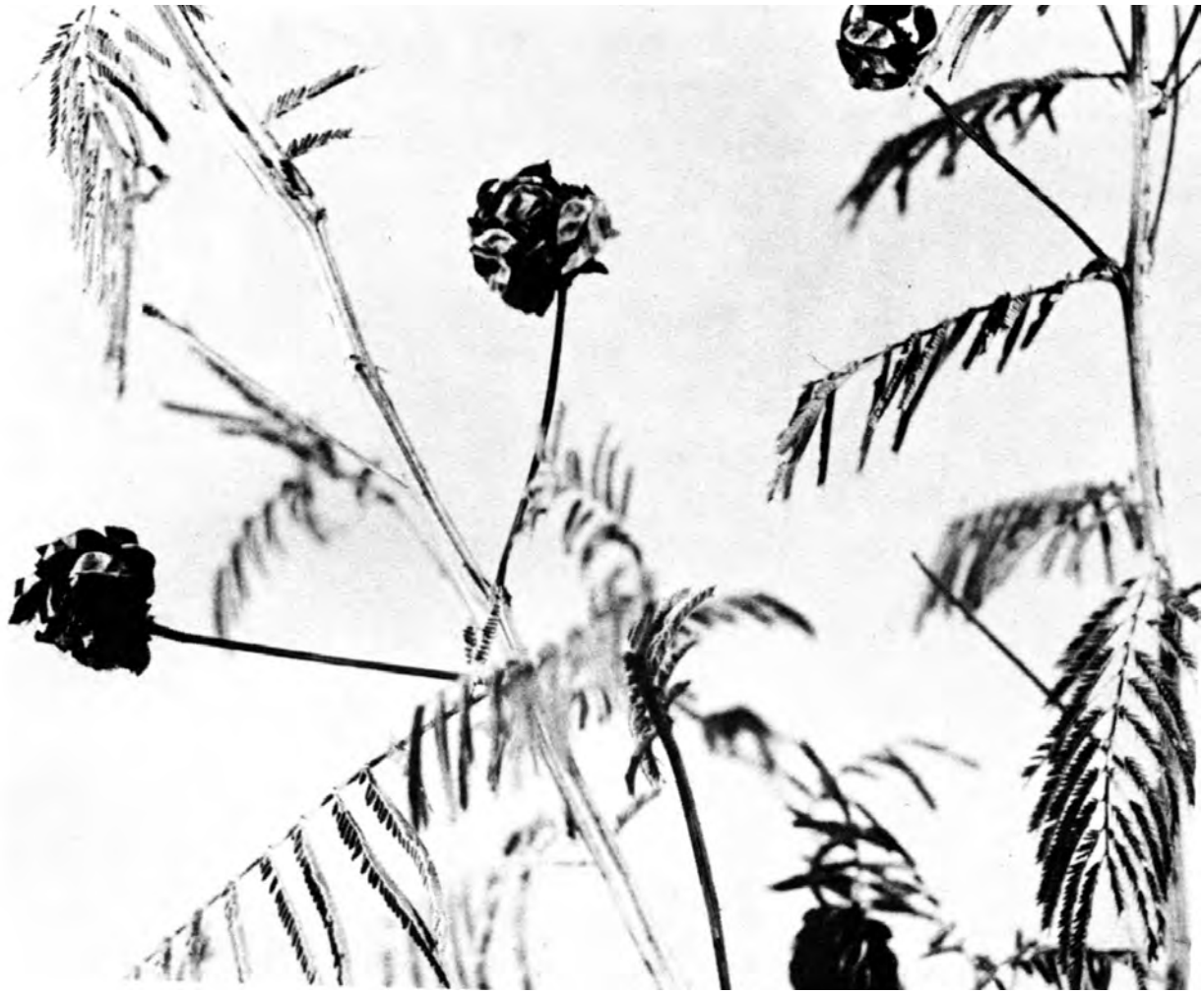
GIANT RAGWEED. Occurs as dense thickets of tall, straight-stemmed plants. It is usually confined to wet bottoms and rich soils. Patches may provide a substitute for woody cover until late winter, when they are apt to fall down. Seeds, shown magnified , are rough coated with spines.





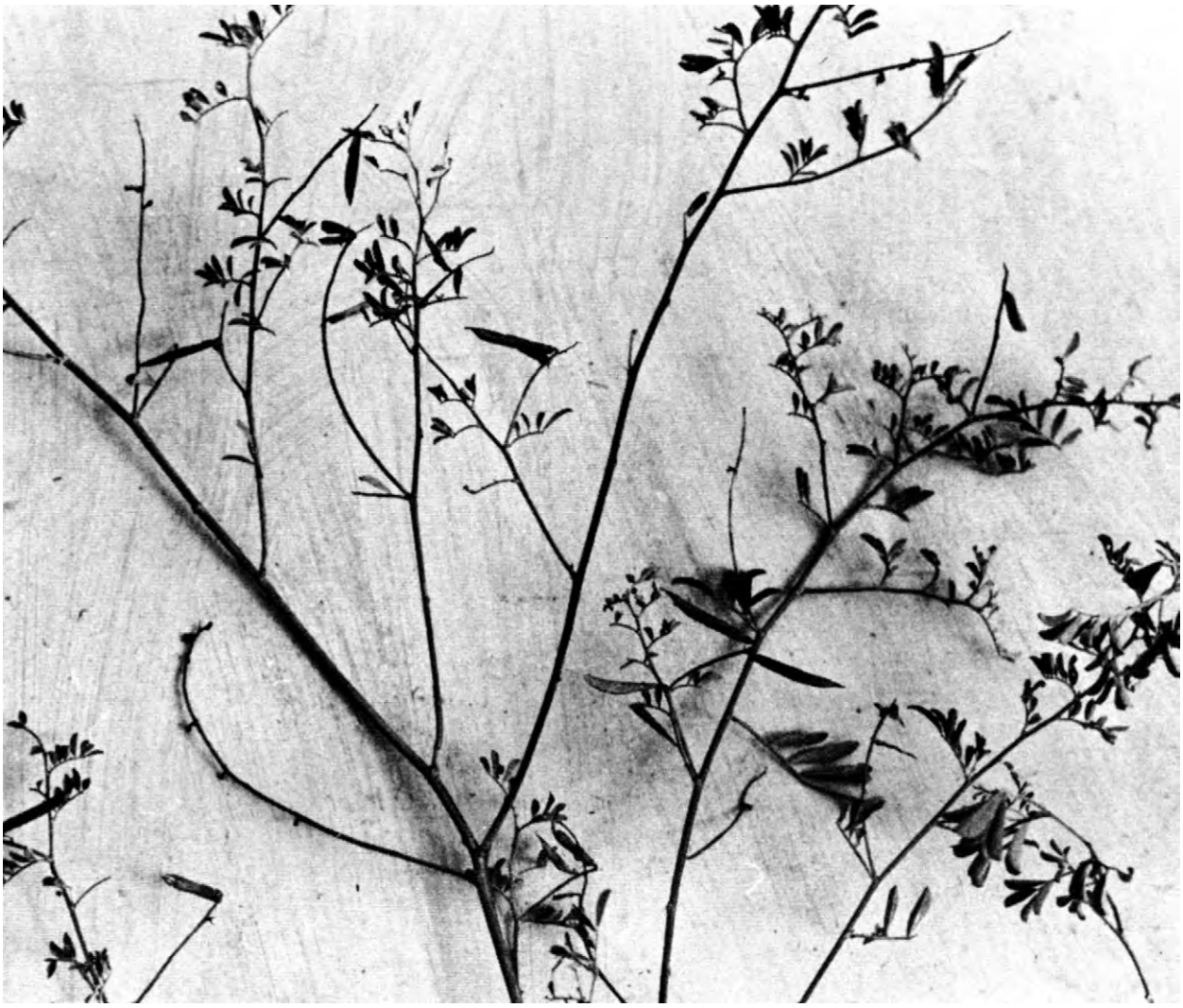


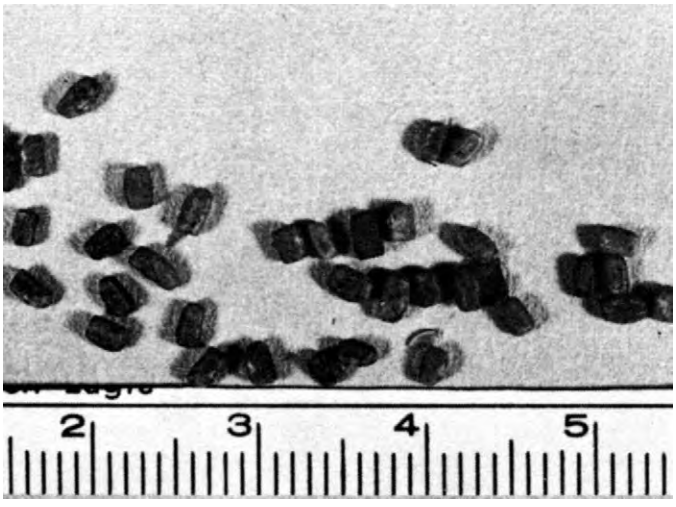
STEVEN'S SANDLILY. The sandlily occurs on sandy soils throughout the Rolling Plains. Each wafer-thin seed is at the center of an equally thin semitransparent disc. It seems important as bobwhite food in those seasons when heavier and perhaps more nutritious seeds are scarce.
Seeds shown magnified.



ILLINOIS BUNDLEFLOWER. Bundleflower is a native legume found throughout the Rolling Plains. A large part of the seed pods is usually infested by a larval insect but, nevertheless, seed production is usually great enough to show in important amounts in winter foods of bobwhites.

The seeds, shown here magnified, are frequently difficult to distinguish from the seeds of the partridgepea.





WESTERN INDIGO. A low-spreading legume bearing inch-long pods. Gravel hills and tight soils seem to suit it best. The small beans are square in cross section. Important in the quail-food sense, it is a member of the relatively small group of plants that contribute largely to the supply of winter food. Seeds shown magnified.

APPENDIX B

Plant Succession: What It Means and How It Influences Bobwhite Numbers in the Rolling Plains

Picture two plots of the same type of soil under the same climatic conditions. One, formerly native pasture vegetation, was plowed before the last killing frost of spring and lay fallow during the summer. The other plot has been fenced for many decades against grazing animals. No plows have touched it and no fires have burned over it (this in Texas would probably mean an ancient rural cemetery). At the end of the growing season we can safely assume that both plots will be supporting a plant community. But there the similarity ends.

The plot where pasture grasses were plowed under largely will be supporting annual forbs, with perhaps a few species of annual grasses present. There likely will be quite a variety of species, all differing in height, stem structure, canopy, and shade and moisture requirements. Competition will not have had time to eliminate the weaker plants. In almost any place in the Rolling Plains, such a plant association would be almost certain to contain one or more of the forbs cited as being key sources of bobwhite foods. The kinds of these and their density would depend upon the past history of the plot.

In contrast, the plot that has been shielded against disturbance by the plow, grazing, or fire, will in all probability be covered by a stand of perennial grasses of one or at the most a few species. Plants producing quail food will be lacking.

Respectively, the two plots represent initial and final stages of a sequence of changes in plant cover, which is called plant succession. In a humid climate, plant successions starting with bare ground tend to occur in the following sequences: 1) bare ground to forbs; 2) forbs to grasses; 3) grasses to brush; and 4) brush to trees. In the climate of the Rolling Plains, the succession should normally stop at perennial grasses. However, a stable, final or climax stage is rarely achieved under prevailing land usage.

Biologists have found that many species of birds and animals, bobwhites among them, fit best in a niche in the succession. In the case of bobwhite quail, this niche lies in stage number 2. This is the temporary stage that follows soil disturbance, and is located between bare ground and the recovery of the grasses. It is temporary because, with favorable rainfall, the grasses follow fast on the heels of the forbs and may crowd the latter out within a few favorable seasons. When this happens, the carrying capacity of the range for quail is reduced, and their numbers must adjust to the new carrying capacity.

A great increase of bobwhites in the Rolling Plains occurred in 1958. Prior to this there was a great increase in 1950 and another in 1942. It is no coincidence that these great increases in bobwhites each occurred during the second year after major droughts were broken by heavy rainfall or that quail were not able to maintain such population levels even though, as occurred after 1958, the following several years were years of favorable rainfall and heavy ground cover.

To understand the part played by plant successions in these high bobwhite numbers, we must look behind the years of high rainfall. For example, let us trace the origin of the peak population of 1958. Soils were drought-seared and grazed-out during the dry period from 1951 until 1956, a year when rainfall totaled only 7 to 12 inches over most of the region. Then, rainfall for 1957 totaled up to 40 inches at some of the same stations. The results upon plant successions were about the same as if the entire range *had been plowed.* Vast areas were covered with forbs in which such key quail food species as Texas croton, western ragweed, erect dayflower, and others predominated. Ground cover grew well into the lower branches of mesquite shrubs. Stands of snakeweed (broomweed) formed unbroken canopies of safe feeding cover, producing at the same time emergency supplies of small but nutritive seeds. These made

practically all ranges, even those normally of doubtful habitability, temporary bobwhite havens. Under these conditions, bobwhites spread and increased and brought about the eruptive populations remembered by so many hunters. Unfortunately, the plant succession even then was moving away from the one so favorable to bobwhites. The year's great quail crop was caught out on a limb, so to speak, in a habitat in which another type of ground cover was taking over. The number of quail declined, as it must when the favorable habitat constricts.

Because of the cow-calf type of ranching economy characteristic of the region, numbers of livestock must remain fairly constant, despite wide differences in amount of rainfall from year to year. The result is that under extremes of annual rainfall great extremes occur in the composition and amount of ground cover. At one extreme, quail habitat may be practically nonexistent because of depleted ranges. On the other hand, when a series of wet years occur the stocking rates are seldom increased in proportion to the increase in forage production. Then, even while "wet" summers may be improving quail reproduction, the grasses are crowding out the forbs upon which bobwhites must depend for winter foods. Too, while some forbs are present, even in a grass climax, the matting of perennial grasses makes the seed unavailable to quail. Such conditions result in spotty habitat.

Bobwhite fluctuations in the Rolling Plains of northwest Texas generally may be said to follow the sequence outlined below: '/

a. The picture starts with a drought of several years' duration, grazed-out and barren ranges, and minimum bobwhite numbers. The relic population survives in niches of stable habitat along brushy watercourses, about ranch buildings and feedlots, and at field edges where weed seeds and waste grain result from the land use. These quail are, in a sense, selected stock and, to a degree, adapted to scant cover. They represent the fittest of the last year's population.

b. As the drought progresses, soils on which the grass turf has been broken give rise to weedy plant successions with each spring and summer's scant rainfall. The seeds go largely unharvested and relatively few germinate. The rest are added to the store of dormant seeds, which are nearly always present in grazing range soils. The first year of increased rainfall will bring about a mantle of crotons, sunflowers, ragweeds, snakeweeds, and other suppliers of good winter food. The herbaceous ground cover affords functional but fragile quail cover when supplemented by the lower branches of mesquite shrubs. Now the nutritional situation is good, the predator population has lagged for want of food during the dry years, and the bobwhite has the advantage in reproductive potential to rapidly extend and occupy the range. Call this a lateral increase of quail.

c. A year of excessive rainfall breaks the drought. A great amount of the mesquite brush range is canopied with snakeweed, which provides excellent winter cover yet is open enough beneath for freedom of quail movement in feedings. Now the range is all bobwhite habitat. Bobwhite colonizes it and begins his increase in population density with nowhere to go but up. The food picture is still good and reproductive success is high. Call this a vertical increase.

d. Another year of adequate rainfall occurs, with good moisture carryover from the previous season. Bobwhite has a big hatch and the population explodes. Coveys occupy all marginal habitats and overflow into roadsides and towns. In the meantime, the last year's plant succession is giving way to one composed principally of grasses and forbs providing little food for quail. The great mass of the bobwhite population

'/ This section from paper: A Pattern to Population Oscillations of the Bobwhite Quail in the Lower Plains Grating Ranges of Northwest Texas, by A. S. Jackson, presented at the 16th Annual Conference of Southeastern Association of Game and Fish Commissioners, Charleston, South Carolina, October 1941.

finds itself in unstable habitat and very probably competing with an eruptive rodent population for a diminishing food supply. The same conditions and an even higher reproductive potential have brought about high rodent numbers.

e. The bobwhite population crashes if food and/or cover fails before spring growth makes other sources available. Otherwise, the numbers may not show decline until some time after the close of the hunting season, and the decline will not be apparent before the next season. The spring shuffle will have spread the survivors thinly over the range, and the fall population will depend upon the success of the reproductive season (i.e., the supply of young bobwhites). In any case, the hunter will find his birds in niches of habitat that are exceptions to general conditions. If annual rainfall hovers in the vicinity of normal, this continues to be the situation for several seasons and results in minor population peaks and depressions.

f. Dry years set in and continue. Conditions revert again to the ones described under item (a).

The weedy successions and high bobwhite populations which accompany them are hardly worth the cost if, to enjoy good hunting, we must first endure droughts and costly range depletion. The preceding analysis, which is over-simplified for any particular habitat, is given in order to impress the landowner and sportsman with the role of plant successions in the ecology of the bobwhite.

Heretofore, we have largely been afforded good quail hunting by the twin influences of rainfall and grazing, which, from time to time, set back the clock of plant succession. These, however, demonstrate a principle, which can be put to use on a practical scale by those who would like to improve or develop quail habitat and are willing to sacrifice a small amount of land surface for this purpose. That principle is that soil disturbance sets back plant successions, resulting in more of the key producers of quail food. The management of these foods need not involve a large percentage of the total acreage, or extensive range misuse. It only requires that a different view be taken toward patches of forbs (weeds) and a residuum of brush.

Fortunately, plant successions can be set back by means other than overall severe grazing. These methods work best in the middle and wet end of the rainfall cycle, leaving only the problem of the critically dry years. Even in these years, ranges will produce more quail cover and food when properly managed.

Fire is a great setback to plant successions but the ranges of the southwest offer few opportunities to use it with safety or without temporary loss of needed forage. A grass fire, which started on a ranch adjacent to the Gene Howe Wildlife Management Area in March 1962, burned off approximately 2,000 acres of the management area before it was controlled. Following the fire, and after new growth had occurred, great increases in the numbers of crotons, dayflowers, ragweeds, and other forbs were found to have occurred. Plants producing quail food increased 15 percent in the burned area, but decreased 30 percent in the unburned area. Perennial grasses decreased 13 percent in the burned area and 6 percent in the unburned area. The decline in grasses was attributed to the fact that little rain fell until June. When fall came, bobwhites were most abundant in those areas that had been burned off.

It was well to consider the condition of plains vegetation as it must have been before the rancher and farmer came on the scene. Popular writers like to picture the early prairies as being carpeted with a sea of grass or, in other words, a climax or final stage of plant succession. Actually, and fortunately for most wildlife species, the influences named above, which set back plant successions, were all operative before settlement. When drought occurred, great numbers of buffalo concentrated in the vicinity of remaining water and were held there as surely as if fenced in. Depletion grazing and trampling of soils took place. Grass fires, started by lightning or Indians, raged until extinguished by rain or stopped by the wider streams. Early explorers have written accounts of these fires and frequently mention encountering burned-

off range. Marcy (1866:206) found the Brazos Clear Fork country in Shackelford and Throckmorton counties, in the summer of 1854, yellow with sunflowers as far as the eye could see. This condition, in what is one of the best, if not the best, grasslands in the Rolling Plains today, could only have resulted from fire or intensive grazing in a time of severe drought.

If we exclude fire as a practical means of managing quail foods because of the danger and inconvenience, as well as public relations in a country where the emphasis is upon preventing range fires, we are left with two procedures which can be applied where wanted. These are controlled grazing, and soil disturbance by mechanical means. Available to today's quail manager, then, are two tools-the cow and the tandem disc harrow (or, less preferably, the one-way plow). By their use, enough ground cover can be maintained somewhere between either extreme, too little or too much, and food production can be stimulated.

The best management of bobwhite quail lies in controlling plant successions.

APPENDIX C

Bobwhite Movement and Vacant Habitats

Probably the question most often put to the quail biologist is, "Where did they go?" It is asked during each quail season when the bobwhite hunter returns to the scene of his dove hunts and finds that the quail seen during September are not there in December. The question is asked again each time a quail population diminishes greatly in its normal habitats.

Bobwhite quail do not migrate in the true sense of the word. If they did, declines in one part of the country would be accompanied by population increases in another. This does not occur. More often, declines occur simultaneously over entire regions.

Bobwhite movements, which are relatively local, do occur. These movements fall in two classes. Some seasonal movement takes place twice a year. In the spring, when coveys break up, bobwhites disperse and in the Rolling Plains are often found occupying nesting ranges several miles distant from any winter habitat. Neither the extent of these movements nor the degree of participation of the population has been determined. The distance seems to be considerable in the case of some individuals.

In the fall, usually from about mid-September to mid-October, a reverse movement occurs. Biologists term this the fall shuffle. A great deal of aimless drifting about occurs, apparently involving families of bobwhites that have hatched in summer habitats. If the fall population is high, the number of such coveys that find difficulty in locating unoccupied winter coverts leads to invasion by quail of residential sections of towns and cities. There are few towns in the Rolling Plains where this has not occurred during the fall months of "good" quail years, such as 1958.

The fall shuffle sometimes results in the dove hunters' being unjustly blamed for the disappearance of quail from their fall ranges. The disappearance happens regardless of whether or not hunters are present.

Not all quail movement is confined to these seasonal ones involving entire coveys. Band recoveries, following the trapping and banding of approximately 3,500 bobwhites, showed that not only do some quail move considerable distances-up to 24 miles in an extreme case-but frequent interchange of birds between coveys is not unusual. At one trap station, more isolated than most, a covey was trapped for banding at almost weekly intervals during the period of September through December. Almost every time trapped, there were one or more unbanded birds in the covey. In the meantime, missing banded birds from this covey were showing up in other coveys that were trapped. Only the presence of bands on the quail revealed that the membership of the different coveys was not constant.

It seems likely that the tendency to wander exhibited by some bobwhites in this western part of the species' range may represent a built-in drive to repopulate ranges made vacant by such agencies as fire, drought, and depletion grazing. Perhaps the best evidence of this lies in the rapidity with which vacant ranges are repopulated once increasing rainfall, changing land use, or other influences make them again habitable.

During the great drought of the 1930's, a greater part of the Rolling Plains grazing range became bare of ground cover. Bobwhites, to all appearances, vanished from the land and hunting practically ceased. This was the general status of bobwhites in the summer and fall of 1939. Three years later, in the fall of 1942, bobwhite populations were phenomenally high throughout the region. Ranges were crowded and coveys overflowed into roadside borrow ditches wherever shrubs were present. Without rapid dispersal of spring breeding populations, bobwhites could hardly have filled so vast an area in so short a time.

More recently, a fire in the grasslands of Hemphill County provided a setting in which to measure the ability of bobwhites to move into and repopulate a range as soon as it becomes habitable. The fire started on a ranch adjacent to the Gene Howe Wildlife Management Area on the morning of March 3, 1962. The heavy ground cover was tinder dry. Before it was brought under control it had burned off approximately 30,000 acres. Approximately 2,000 acres were destroyed on the management area. Only the larger trees were left standing. Plum and sumac cover was burned off at the ground level. No rains followed this fire until the last week in April, when light showers fell. There was no rain in May. During the three-month period, this block of some 30,000 acres remained without a vestige of habitat for quail.

After rains came in June the grasses and forbs sprouted, and before the end of the month the sandhills were ringing with the calling of bobwhites. When fall came hunters reported the best hunting to be in the area that had been burned over. Thus, a block of range as large as the average Panhandle ranch, which had been reduced to shifting sands and windblown ashes through the spring months, was filled with bobwhites at the first emergence of vegetation. Local movement had taken care of restocking a vacant range.

APPENDIX D

Secondary Role of Hunting in Population Turnover

Hunting plays only a small part, if any, in the 80 percent annual turnover of bobwhite populations. Even in heavily hunted areas, the hunter harvest removes only a part of the population, which would, in absence of hunting, be lost to other causes before a new crop of quail is on the ground. In the Rolling Plains there are a few ranches where heavy hunting pressure is applied year after year. Yet, in only a few cases where high populations existed has it been possible to harvest enough quail to prevent waste. On the other hand, these ranches come up year after year with as many quail as are on adjacent ranches where no hunting at all is permitted. The explanation is that, in the case of both ranches, survival of bobwhites is adequate to replace fall and winter losses and does so to the extent set by weather and range conditions.

The quota for public hunts on the Matador Area for the 1964-65 season was set high, to allow a large number of hunters to participate. A total of 1,080 permits was made available. Only 558 hunters applied for permits and only 290 permit holders arrived for the hunt. These quail hunters bagged an average of 1.91 quail per hunter, from the average of 3 coveys found per party. Attendance the first day was 87.93 percent of the total of hunters reporting for the season. Only 3 hunters reported for the hunts scheduled January 16-17. Nevertheless, the 1,988 hunt man-hours in all probability exceeded the hunting pressure applied in any comparable area in the region.

Prior to the hunts, a close census was made of 16 miles composed of 440-yard wide strips, in representative proportion to the various habitat types on the Matador Area. A minimum population of 1 bobwhite per 12 acres was found. This was an indicated population of more than 2,000 bobwhites on the entire area. Following the hunts, but after a 2-month interval, the strips were censused again, using the same bird dogs. This time a bobwhite per 28 acres was found. This was an indicated population of 1,000 quail for the entire area.

The censuses indicated that during a 3-month winter period the Matador quail population dropped from a minimum of 2,333 bobwhites to a minimum of 1,000, a decrease of slightly more than 50 percent. The harvest taken by hunters, 554 bobwhites, was 41.48 percent of this loss, or about half of the approximately 80 percent decline that was certain to occur before a new generation was on the ground.

In the case of the Matador Area hunts, an early season, starting October 31, had been set to facilitate certain research procedures. The results bore out something long evident: hunting tends to be self-regulating. In this case, the season, in effect, closed itself after the December 20 hunts. There was no evidence that a greater kill occurred because of the earlier season.

In every community there are a few hunters, usually less than half a dozen in the smaller towns, who keep trained dogs, have prearranged places to hunt, and go hunting regularly throughout most seasons, regardless of whether quail populations are high or low. These more or less expert hunters have little effect on the total hunting picture because they are too few in number to cover much of the available range. Even the most skillful of these find that coveys hunted too often become too wild to al low productive hunting.

A much more numerous class of hunters may be said to consist of opportunists. These go afield often, throughout seasons of high quail populations, and easily bag limits. Their contribution to the annual harvest during such seasons represents a large percentage of the total. When quail populations are low, and hunting hard, the same hunters put away their guns after the first weekend or two of the season or whenever hunting success, in their view, reaches the point of diminishing returns.

In effect then, the quail harvest is consistently heavy during "good" quail years, but self-regulating during seasons of low quail populations. This built-in factor, plus the fact that hunting, even when most successful and continued, can account for only a fraction of the annual turnover of quail populations, insures against the possibility of over-hunting the types of habitat characteristic of the Rolling Plains.

APPENDIX E
On Parasites and Predators

Parasitism. Parasitism, as in the case of domestic poultry, seems to increase with the crowding of bobwhites. During the hunting season of 1950-51, when quail populations were high, recurring reports were received of "wormy" quail. By the time these reports reached the biologists the quail had either been destroyed or were so decomposed as to reveal nothing. Finally, in December of 1958, biologists were given the opportunity of examining 36 birds that were killed at Canadian, Texas. Every bird was so parasitized as to be unfit to eat. This was the "breast-worm" that hunters had been talking about for several years.

During the 1958-59 hunting season, when quail populations were again high, hunters and game wardens reported parasite-infested bobwhites from several counties of northwest Texas. In that same season, the first public hunts were held on the newly acquired Matador Wildlife Management Area. Examination of the bobwhite kill revealed that a large percentage of the birds were parasitized with round worms in the breast muscles and in the eyes. This led to speculation that parasitic infestations may increase with

occurrence of peak populations of bobwhites. Accordingly, a study of parasitism was included in the Federal Aid Research Project initiated on the Matador Area on April 1, 1961.

Parasitologists of the Texas State Board of Health cooperated during the first year with a laboratory examination of 54 bobwhites. In addition, serological tests were made on 19 bobwhites that were shipped alive to the laboratories. The latter were found negative for encephalitis viruses. Ectoparasites were found in surprisingly small numbers. In fact, personnel of the Board of Health stated that the birds were unnaturally free of the "external" parasites. The ones found comprised 4 species, all biting lice of the order Mallophaga. *Oxylipeurus clavatus* was found most frequently. *Goniodes ortygis* was second in abundance, *Lagopoecus mumidianus* was third, and *Menacanthus sp*. was occasional.

The internal or endoparasite story was different. Among the 54 bobwhites which were examined in the Board of Health laboratories, 5 species of round worms were found; i.e., *Ascaridia lineata*, *Cheliospirura spinosa*, *Strongyloides avium*, *Subulura brumpti*, and *Tetrameres sp*. *Subulura brumpti* was the most abundant in number and in frequency of infestation. It occurred in 85 percent of the bobwhites. *Cheliospirura spinosa* occurred in 14.81 percent. The other three round worms were found in less than 5 percent of the quail. A flat worm, *Hymenolepis sp*., was found in 11.11 percent of the quail. Approximately 13 percent were found to be free of endoparasites. Unfortunately, no examinations were made of the eyes or breast muscles.

During the June 1961 to March 1962 period, a total of 61 bobwhites was examined for presence of endoparasites. Of these, 47 (77.05 percent) were found to be parasitized. The intestinal round worm *Subulura brumpti* was found in 59.62 percent of the quail examined. Round worms were found in the breast muscles of 14.75 percent of the bobwhites. This parasite has been identified as a physalopterid, *Skrjabinoptera sp*. that reaches sexual maturity in a reptile. It, or a related species, has been reported from the horned lizard, *Phrynosoma sp*. Possibly the harvest ants are alternate hosts, since the horned lizard subsists largely on ants and ants are not uncommon in the diet of quail. An occasional bobwhite is found to have consumed a crop full of ants at one meal. In the quail the parasite should be incapable of completing its life cycle.

The eye worm, *Oxyspirura sygmoides* 1/, was found under the nictitating membrane of the eyes in approximately half (49.45 percent) of the quail. It had not been reported in quail before. A related species, *Oxyspirura masonii*, is known to occur in poultry, with cockroaches serving as an alternate host. The life history of the eye worm found in bobwhites has not been determined. Because few persons would examine the eye of a bobwhite closely, there is a strong probability that this parasite has been common in the past history of bobwhites in the Rolling Plains.

During 4 years following the parasite investigation, prevalence of the eye worm and the intestinal worms did not significantly change. On the other hand, the round worms infesting the breast muscles of bobwhites showed a decreasing trend that coincided with the decline in bobwhite numbers. It would appear from these and later records that infestations of these parasites follow closely the fluctuations in density of bobwhite populations. The eye worm and the intestinal worms, however, are commonly present but vary in the degree of infestation; that is, in the numbers found in individual birds. Few are found in young bobwhites during the summer months.

No differences that could be attributed to parasite infestations were found in weight or body fat. In fact, many of the infested birds were heavier than those uninfested. A few bobwhites with as many as 15 or

1/ This parasite and the ones found in breasts of quail were identified by Mrs. M. B. Chitwood, Research Associate, Parasite Classification and Distribution Investigations, Beltsville Parasitological Laboratory, US. Department of Agriculture, Beltsville, Md.

more worms in the eyes showed slight hemorrhaging around the eyes and nostrils. This may have been caused by irritation from the worms or their waste discharges.

Erratic and peculiar behavior of some bobwhites led to speculation that the vision of some may have been impaired. In the course of census with pointing dogs, coveys were found in which one or two quail would rapidly run away instead of flying with the others. It was almost impossible to make those birds fly: when again found and pointed by the dog, they would run aimlessly around him, and perhaps run away a second time. It had formerly been believed that such behavior was due to deficient cover but these instances occurred in the best cover the area afforded. This is a phase of parasitism that needs more investigation.

No evidence has been found that parasitic infestations cause mortality among bobwhites in the Rolling Plains. Most birds, including domestic poultry, are commonly infested and it is likewise probable that bobwhites are rarely without parasitic worms. Except in cases of extreme infestations by the worm found in the breast muscles, parasitism need not concern the hunter or the cook. All the other parasites are removed with the disposable parts of the bird. Where only a few of the worms are present in the breast, they can be removed with the point of a sharp knife. Heavy infestations are aesthetically offensive, to say the least, and, fortunately, such cases are rare.

Predation. Bobwhite populations underwent spectacular reductions during early 1943 and again during the winter of 1958-59. In each instance, an extremely high quail population was cut back sharply to the low carrying capacity of a deteriorating habitat.

Populations on grazing range crashed in January of 1943. This occurred when the thin cover of grass and forbs collapsed leaving nothing under which quail could find concealment. The reduction was accomplished by several species of hawks, the most numerous of which were marsh hawks. A concentration of these followed the development of high rodent and cottontail rabbit populations in the Rolling Plains.

The peak population of bobwhites in 1958 also failed to hold for more than one year. In the eastern half of the Rolling Plains there was a crash decline well under way when the hunting season opened December 1, and the bobwhite population was stable at a much lower level by mid-February. In this part of the region a plague of cotton rats and other range rodents, even more striking than the bobwhite population, had flourished, competing with the quail for vanishing stores of seeds. As in 1943, these seeds were mostly of the previous year's crop. The deeper soils were covered with a dense mat of fallen annual grasses under which the rodents gleaned all seeds. Under these conditions, starving bobwhites, their breast profiles reduced to acute V's, died off with the advent of the first severe winter storms. This time there was no more than a normal population of hawks, and the heavy ground cover of annual grasses provided escape cover for the bobwhites that were able to use it.

In the western half of the Rolling Plains, from about the 100th meridian to the Cap Rock, the rodent outbreak was not so severe, nor was the ground cover of grasses so dense. Nevertheless, weedy successions had phased out and for the next several years, despite favorable rainfall, quail populations continued to decline.

Both of the phenomenally high bobwhite populations discussed above were products of range and weather conditions that were apparently as favorable to predator increase as they were to quail.

Field work on the study areas in Cottle and King counties during the spring of 1942 led to the mistaken conclusion that the fall crop of quail would be small because of the high degree of nest losses due to predators. On the Cottle County area, 22 nests were located for observation. Only 7 escaped predation. Six nests were lost to snakes, 4 to skunks, 1 to a coyote, and 3 to farm and ranch operations. Yet the

cumulative results of nesting and renesting were such that the fall population was determined to be approximately 1,200 quail (including scaled quail) on the 1,600-acre study area. Obviously, predation here did not seriously limit fall populations. It may have contributed to the high population by staggering bobwhite nesting, thus timing many hatches to come off after hard rains in May and June, which could have been disastrous to newly hatched young birds.

The following year, 1943, nesting was limited to May and June. There was little or no nesting during the hot rainless summer. Again, predation on early nests seemed excessive, because out of 34 nests found on the King County study area, 28 were robbed by predators or destroyed by range cattle. In light of the weather conditions prevailing during 1943, it would have been advantageous to have all early nests hatch. But even if the weather could have been foreseen it would not have been practical to try managing an early hatch. To prevent the 28 nest losses observed it would have been necessary to eradicate skunks, snakes, quarrelsome range bulls, and even terrapins (these destroyed two nests by shading in them).

Predator control is not the simple or practical cure-all it appears to be. It is more complex because of the interrelationships between the predatory species themselves. Predators prey on each other a great deal more than is generally realized. Marsh hawks commonly feed on rodents that compete for the bobwhites' food. Red-tailed hawks commonly feed their young on snakes that, in the Rolling Plains, are the worst offenders in robbing nests. Both coyotes and horned owls preyed on skunks on the study areas and fed far more often on the species of rodents capable of destroying quail eggs.

The best predator control lies in improvement of habitat conditions for the prey species.

APPENDIX F

Lists of Common Names and Their Scientific Equivalents

Standardized Common Name	Local Usage	Scientific Equivalent
Redroot amaranth	Carelessweed, pigweed	*Amaranthus retroflexus*
Fragrant sumac	Skunkbush, threeleaf sumac	*Rhus aromatica*
Skunkbush sumac	Skunkbush, sumac, squawbush	*Rhus trilobata*
Erect dayflower	Widow's tear	*Commelina erecta*
Western ragweed	Ragweed	*Ambrosia psilostachya*
Giant ragweed	Bloodweed,horseweed	*Ambrosia trifida*
Common sunflower	Sunflower	*Helianthus annuus*
Ragweed sumpweed	Marsh elder	*Iva xanthifolia*
Snakeweed	Broomweed	*Amphiachyris dracunculoides*
Common persimmon	Persimmon	*Diospyros virginiana*
Russian olive	---	*Elaeagnus angustifolia*
Tropic croton	Doveweed, croton	*Croton glandulosus*
Texas croton	Doveweed, goatweed, croton	*Croton texensis*
Snow-on-the mountain	---	*Euphorbia marginata*
Havard Oak	Shin oak, shinnery oak	*Quercus havardi*
Fringeleaf paspalum	Paspalum	*Paspalum ciliatifolium*
Showy partridgepea	Partridgepea, Senna	*Chamaecrista fasciculata*
Illinois bundleflower	---	*Desmanthus illinoensis*
Western indigo	---	*Indigofera leptosepala*
Common mesquite	Mesquite	*Prosopis juliflora*
Black locust	---	*Robina pseudo-acacia*
Small wildbean	Trailing wildbean	*Strophostyles pauciflorus*
Steven's sandlily	---	*Mentzelia stricta*
Bluestem pricklepoppy	Wild poppy	*Argemone intermedia*
Chickasaw plum	Wild plum	*Prunus angustifolia*
Western soapberry	Wild chinaberry	*Sapindus drummondi*
Woollybucketbumelia	Chittam	*Bumelia lanuginosa*
Netleaf hackberry	Hackberry	*Celtis reticulata*
Desert willow	Desert willow	*Chilopsis linearis*

APPENDIX G

Questions Often Asked

Would 'fresh blood" improve my quail crop?

This question is asked with the assumption that little or no intermixture occurs between bobwhite coveys, and that inbreeding is detrimental to the bobwhite strain. It has been pointed out in Appendix C that the covey is not a fixed association hatched from the same nest, but composed of quail that often trade back and forth between coveys. This mixing is intensified each year during the fall shuffle, and again in the spring when coveys break up. Thus, a covey is a social group of a size or number which best carries out the functions of finding food, detecting and escaping danger, and surviving cold nights. Probably it has also a great many other purposes, which may be obscure to humans but perfectly, clear to bobwhites. For the above reasons, the sportsman who regulates his quail harvest by never reducing a covey below a certain minimum number (for instance 6) is following a rule based on a false assumption. The survivors will at the first opportunity join another covey. This results in another covey to be shot down to 6. Few coveys are hunted this closely in the big acreages of the Rolling Plains. A geneticist would rule that inbreeding among bobwhites would do no harm, in any case. Bobwhites are genetically refined to be alike, and "line" or inbreeding would merely repeat the genetic pattern that makes bobwhite what he is. In the hazardous life of a bobwhite covey, individuals who do not conform to the pattern are the first to perish.

Do bobwhites and scaled quail ever crossbreed?

In recent years, crosses between bobwhites and scaled quail in the wild have been verified beyond doubt. A number of hybrid bobwhite-scaled quail, which have been shot by hunters, have been passed on into the hands of game biologists. When the Parks and Wildlife Department acquired the Matador Game Management Area there was a small covey of hybrids ranging near a ranch employee's residence. One of these odd quail survived through the spring months of 1961. His whistled "bob-white" had the tonal quality of a scaled quail and could be distinguished any morning from the many bobwhite calls in surrounding range.

During nesting studies carried out in King County during the 1940's, several nests were found in which eggs of both bobwhites and scaled quail had been deposited. During drive-trapping of the fall population, coveys of bobwhites occasionally were observed in which one or more scaled quail seemed natural members. A few coveys of scaled quail were likewise found in which a bobwhite or two seemed at home, although compelled to run desperately to keep up with his companions. It seems probable that these associations of bobwhites and scaled quail were the results of successfully hatched clutches of mixed eggs. The close association in the same covey might result in crossbreeding.

Hybrid scaled-bobwhites are probably sterile, thus accounting for the relative scarcity of such birds in the areas of the Rolling Plains where ranges of the two species overlap.

Do bobwhites sometimes hatch more than one brood in a season?

There is a widely held belief that bobwhites sometimes hatch and rear more than one brood in a season, thus accounting for the occasional peak in quail numbers. Quail biologists have not verified this possibility. There are good reasons why this is not likely, and the assumption is not necessary to account for a sometimes rapid increase in quail numbers.

The popular supposition that a pair of bobwhites rears two or more broods in a season arises from seeing

small, young quail late in the summer. Less often, a brood is seen comprised of two distinct sizes of young quail. The former results from the renesting that follows earlier failures. The shifting of young between coveys accounts for the second observation.

Second broods and renesting are two quite different aspects of quail reproduction. If her nests are broken up or destroyed before incubation is completed, the bobwhite hen is capable of laying several clutches during the spring and summer months. High nest losses are normal for all ground nesting game birds. If climatic and vegetative conditions remain favorable throughout the summer, this is not important. The bobwhite hen keeps on trying and the odds favor an eventual, successful incubation of a clutch.

Peak fall populations in the Rolling Plains are nearly always the result of a high degree of cumulative nesting success during a drawn out reproductive season. A nesting bobwhite on the Gene Howe Area hatched all of her 9 eggs on September 20, 1965. The small clutch, less than the normal size, was evidence that the hen's capacity for laying eggs had been lowered by earlier nestings which had failed.

Landowners and hunters would be less likely to attribute the sighting of two sizes of young quail in the same covey to double brooding, if they would consider the time element involved. If we assume that the young are dependent upon their parents for as little time as 6 weeks, the acts of laying, incubating and rearing the young would require 85 to 90 days, or approximately 3 months. In the studies reported here, no mixed broods were seen where the ages of the young were this disparate.

What is the average life span of a bobwhite quail?

Biologists have no means of determining the average life of a bobwhite. To find this out would involve the periodic trapping, at regular intervals, of every quail in a banded population until such time as all the banded quail had disappeared because of mortality. Then the data might vary with time and place. It is clear, however, that about 80 percent of a given generation never lives to participate in more than one reproductive season. Sometimes the adult turnover is even greater. On the Gene Howe Area, the 1965 reproductive season resulted in a high fall population of which 90.6 percent were young of the year. This was determined from a sample consisting of approximately 300 bobwhites that were taken during 3 public hunts. Only 11 adult hens were found in the sample. Almost the entire adult population had disappeared from the area, but not without first producing a bountiful crop of young.

How are hatching dates determined from examination of bobwhite wings?

In an earlier chapter, it was explained how to determine whether bobwhites are adults or young birds-of-the-year by examination of the primary covert feathers. The wings of young bobwhites also reveal the age of the bird in days or weeks up to an age of about 150 days. The regular sequence in which the primary feathers are dropped and replaced, one at a time, in the post-juvenile molt makes this determination possible. Game technicians have charted the growth rate of primaries 1 to 8, and have found that usually the true ages of a large majority of specimens can be expected to fall within a tolerance limit of one week.

The primaries are numbered from 1 to 10, starting with the inside or bend of the wing and counting outward from the bird's body. However, the secondary feathers make it confusing to locate primary number 1, and it is simpler to start with primary number 10, the one at the tip of the wing, and count backwards. What is looked for is a gap where a feather has been lost, or a replacement much shorter than the other 9. Numbers 9 and 10 are ignored here, for they are not dropped in the post-juvenile molt.

For aging, a sufficiently accurate method for the man in the field is to add 3 to the number of the shortest or missing primary. The sum will be the age of the bird in weeks. Multiplying the sum by 7 will, of course, give the age in days. This simple method will work with sufficient accuracy until primary number

7 is replaced. Number 8 takes a much longer time to grow back, and fractional measurements have to be taken.

The bobwhite wing pictured in Figure 50 with primary number 6 being replaced, represents a bird 9 weeks of age (6 + 3), and the wing in Figure 51, a bird 8 weeks of age (5 + 3).

The hunter may wish to know of what use is this kind of information? There are many uses. Wing aging of young bobwhites enables the biologist to appraise the annual production of bobwhites. Examination of a sufficient number provides information concerning the peak or peaks and duration of the nesting season. These data can then be examined for correlation with climatic, range, or other influences that may have affected the reproductive effort. Such techniques help to provide the facts with which to regulate and manage the bobwhite harvest.

Figure 50. Bobwhite wing showing primary no. 6 being replaced. Age(6+3) 9 weeks.

Figure 51. Bobwhite wing, showing primary No. 5 being replaced. Indicated age (5+3), 8 weeks.

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