AN EVALUATION OF PLANTS SUITABLE FOR BOBWHITE HABITAT MANAGEMENT IN CENTRAL OKLAHOMA

By

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INTRODUCTION

Many states are engaged in a program of habitat management intended to improve conditions for wildlife. Since no previous evaluation concerning habitat management had been made in central Oklahoma, the present investigation was undertaken. Its objectives were: (1) to ascertain means of improving habitat for bobwhite quail (Colinus virginianus L.) in central Oklahoma, and (2) to investigate available plants, both native and introduced, in order to evaluate their relative worth for food and cover. This investigation was a phase of a larger study of bobwhite ecology carried on for several years by workers of the Oklahoma Cooperative Wildlife Research Unit and through the Federal Aid program of the Oklahoma Game and Fish Department.

Full-time field work was carried on from September 1949 to September 1951. A major part of the first year was spent in gathering information concerning pen-reared quail restocking, but information relative to this investigation also was gathered during that time. Several trips were taken to areas in central Oklahoma during the period of September 1951 to August 1953.

Field work was conducted in central Oklahoma, primarily in Okfuskee and Payne Counties. Headquarters for the field work were at Okemah and at Stillwater. In addition, investigations were carried out to a lesser extent in Coal, Creek, Hughes, McIntosh, Noble, and Seminole Counties.

Unless otherwise stated, the area covered in this report includes almost all of the "postoak-blackjack forest" and "tallgrass prairie game

types" of Duck and Fletcher (1944). The western limit of the two "game types" follows in a general way the parallel of 98° and 30' west longitude, and the eastern limit traverses from 95° in northern Oklahoma to 96° west longitude in southern Oklahoma. A map of the state of Oklahoma showing the "game types" of Duck and Fletcher and the region considered in this report, designated as Division 2, is shown in Figure 1.

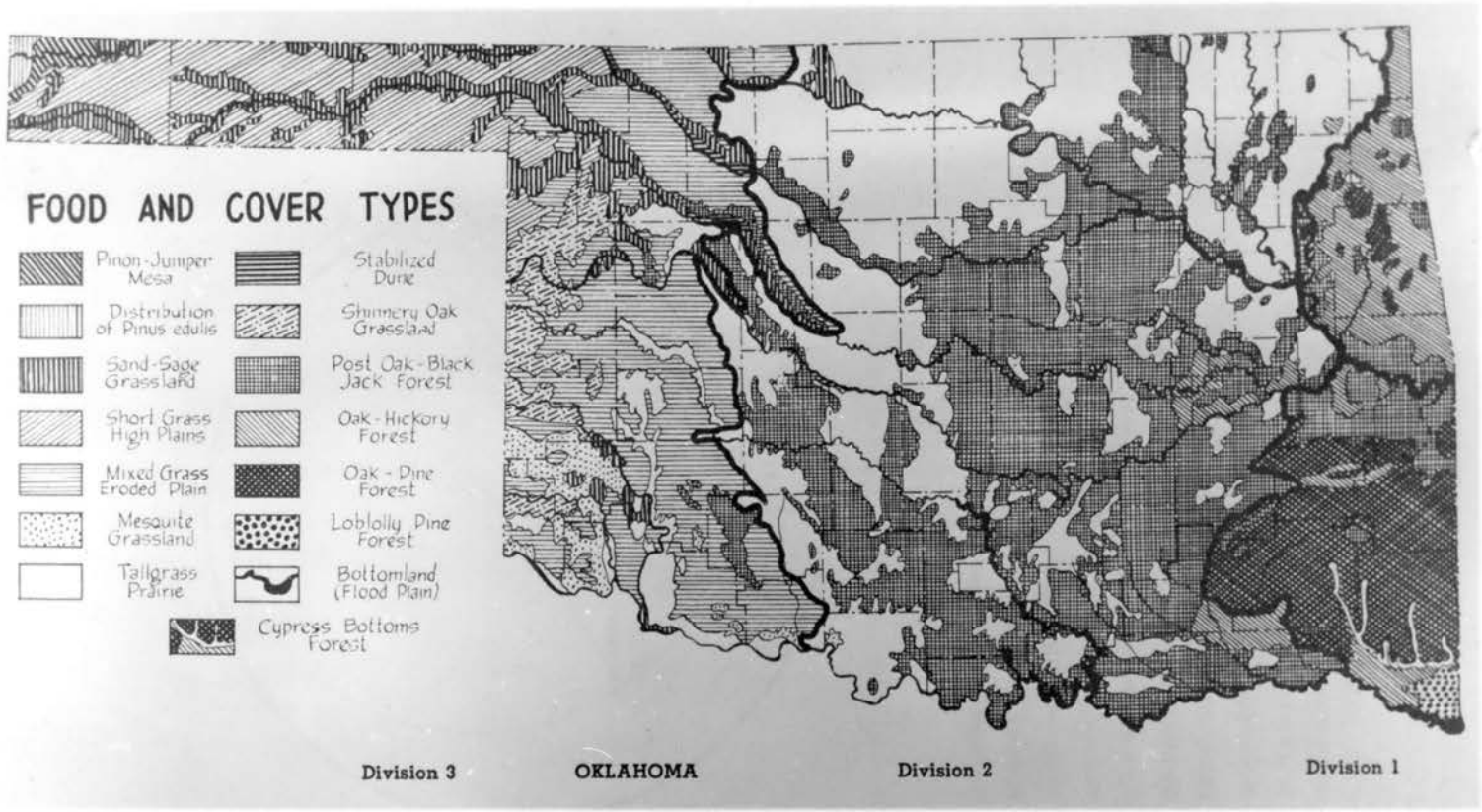

Figure 1. The three major geographic and vegetative divisions or regions and the "game types" of Oklahoma. This report is primarily concerned with the central region, designated on the map as Division 2 (Map taken from Lee, 1948).

ENVIRONMENTAL CONDITIONS IN CENTRAL OKLAHOMA

Climate

The climate of Oklahoma is of the continental type characterized by long hot summers and comparatively mild winters (Wahlgren, 1941). There are pronounced seasonal and geographic differences in both temperature and precipitation, and duststorms and drought frequently occur.

The annual precipitation for central Oklahoma varies from an average of 28 inches in the western part to an average of 42 inches in the eastern part. Much of this precipitation occurs during the growing season, April to October, inclusive. The warm-season precipitation varies from 20 inches to 25 inches from west to east. Heavy to torrential rains are not uncommon.

The growing season in central Oklahoma averages 200 days in the northern part to 230 days in the southern part. Clear skies and high summer temperatures are usual. These are usually accompanied by dry winds of moderate velocity from the southwest.

Physiography

Almost all of central Oklahoma is included in the Osage Plains section of the Central Lowland province (Fenneman, 1938). The Osage Plains has a low relief and no record or evidence of glaciation. Most of the immediately underlying rocks of the Osage section consist of alternations of shales with limestones and sandstones.

North of the Arkansas River, local relief is generally less than

250 feet. West of the 96th meridian, there is a belt 50 to 60 miles wide where a relief of 300 to 400 feet is not uncommon. This belt runs from northern Oklahoma to the Arbuckle uplift. Farther west there is a belt 50 to 150 miles wide which stretches from north to south throughout the state. This belt is a gently rolling plain in which the relief rarely reaches 50 feet.

Most of the main streams, the Cimarron, Canadian, North Canadian, Washita, Arkansas, and Red Rivers, flow in a general southeastward direction. Most of the rivers have their channels on wide beds of sand and are often considerably subdivided by bars. They do not generally carry a large volume of water except during flood periods which are usually of short duration.

Soils

Six major soil groups occur in sizeable areas in the central part of the state. The following brief discussions of these great soil groups are taken from the Yearbook of Agriculture, 1938 (U. S. Department of Agriculture, 1938).

Typical Prairie soils, occurring in central Oklahoma north of the Arkansas River, have developed under the influence of a grass vegetation. Their profiles are characterized by dark-brown to nearly black, mildly acid surface soils underlain by brown well-oxidized subsoils. Their parent materials range widely in composition, especially in lime content. Some of the Prairie soils have developed from limestones and shales, and some have developed from sandstones.

In Oklahoma, the Reddish Prairie soils lie south of the region of the true prairie soils. The soils are deep on smooth land and have red or brown surface soils over red and brown crumbly clay or sandy clay subsoils.

The parent materials are beds of sandy clay or red calcareous clay, which sometimes also contain strata of sandstone, limestone, and gypsum.

The Red and Yellow Podzolic soils occur in central Oklahoma in the area denoted by some authors as the "Cross Timbers" section. The soils are low in organic matter and mineral plant nutrients, strongly-leached, and acid in reaction. Surface soils are commonly sandy and light-colored; subsoils are tougher, heavier, and of a red, yellow, or mottled color. The parent materials are sandstones and shales or weathered residues of sandstones. On the smooth lands the soils are largely fine sandy loams with crumbly clay subsoils. Some of the soils are very sandy and subject to severe wind erosion.

Planosol soils which occur in eastcentral Oklahoma are characterized by the accumulation of a well-defined layer of clay or cemented material at varying depths below the surface. Associated soils in the group are quite variable in their characteristics. The parent materials consist of shales, sandstones, and limestones. Most of the soils of this group have been successfully drained.

The Rendzina soils, which lie in southcentral Oklahoma, are characterized by dark-gray or black surface layers overlying soft, light-colored, highly calcareous material. These immature soils have derived large amounts of black organic matter from grass vegetation. The parent materials are limestone, sandstone, and shale for the most part. Surface soils are mostly brown or black clay, and subsoils are generally heavy brown and yellow clays. The soils may be quite deep on the more level sites but are thin on steeper slopes.

Alluvial soils occur throughout central Oklahoma and are found on flood plains, first bottoms, low second bottoms, and low terraces along streams. The nature of the materials from which the soils have been

derived determines largely their characteristics. Drainage ranges from fairly good to poor, and the soils are subject to rather frequent and heavy overflow. Alluvial soils are generally fertile and are highly productive when drained and protected from overflow.

Vegetation Before Settlement

Edwin James (Thwaites, 1905) traversed Oklahoma from west to east along the course of the South Canadian River with the S. H. Long expedition in 1820. James, biologist and geologist of the expedition, says: "The luxuriance and fineness of the grasses, as well as the astonishing number and good condition of the herbivorous animals of this region, clearly indicate its value for the purposes of pasturage."

Thomas Nuttall (1837) made several explorations into what is now eastern and central Oklahoma. On one expedition up the Arkansas River he noted the decreasing stature of the woody vegetation and the increasing amount of prairie as he traveled up stream past the Illinois and Grand Rivers. Of the grassy openings in the forest and the prairies of the savannah (Figure 2) he says: "These vast plains, beautiful almost as the fancied Elysium, were now enameled with numerous flowers, among the most splendid of which were the azure larkspur, gilded coreopides, fragrant phloxes, and the purple Psilotria."

In the fall of 1832, Washington Irving crossed what is now eastern and central Oklahoma. Irving's account (1926) frequently mentioned the density of trees, shrubs, and vines along the stream courses. He commented often on the extensive and frequently prairie fires resulting from the activities of Indians.

A Santa Fe trader, Josiah Gregg, reports eight expeditions across the great western prairies (Gregg, 1844). He says: "The Cross Timbers may

Figure 2. Typical scene in the oak savannah. Hills dotted with clumps of oaks present a beautiful landscape. Payne County.

be considered as the fringe of the great prairies. It is a continuous brushy strip composed of . . . blackjack, post oaks and in some places hickory, elm, etc., intermixed with a very diminutive oak." He mentioned the luxuriant eastern "interior" prairies and assumed prairie fires to be the main factor in keeping the more moist prairies free from trees.

In 1849 and 1850 Sitgreaves and Woodruff (1858), with S. W. Woodhouse as naturalist, surveyed the northern boundary of the Creek Indian country. The general features of the vegetation along several rivers including the North and South Canadian Rivers were noted. Their report does not mention tall grasses except along one river bottom. They stated that pasture was hard to find, and fires set by Indians were very prevalent.

Bigelow (1856) gave a brief description of the vegetation of Oklahoma as it was noted in traversing the state from east to west. He described the "Cross Timbers" and the alternating areas of prairie and woodland as being "most beautiful and picturesque" and arranged so as to "give them the appearance of vast cultivated fields formed on a scale of great magnitude stretching away in every direction as far as the eye can reach."

Present Vegetation

Blair and Hubbell (1938), Clements and Shelford (1939), Carpenter (1940), Dice (1943), and Allee et al. (1949) have classified the biotic communities of central Oklahoma in various ways. Bruner (1931) and Weaver and Clements (1938) classified the vegetation alone.

Under the direction of Duck and Fletcher (1944) a "game type" map of Oklahoma was prepared. Figure 1 has been adapted from that map. This map compares well, for the central part of the state, with the map of biotic districts published earlier by Blair and Hubbell (1938). Both of these maps are, in turn, closely related to the map of vegetation units

developed by Bruner (1931).

The ecologic regions presented by Duck and Fletcher (1944) in their study are called "game types" which are stated to be ". . . a result of actual field mapping correlated with prior studies concerning vegetation, geology, soils, climate, and land use in relation to game populations." The "game types" occurring in central Oklahoma, "postoak-blackjack forest," "tallgrass prairie," and "bottomland," will be discussed in some detail, since these ecologic regions will be referred to later in this study.

The "postoak-blackjack forest game type" (Figure 3) of Duck and Fletcher contains dominants from both the deciduous forest formation and the prairie formation. Dominants in the overstory are mostly post oak (Figure 15), blackjack oak, and black hickory; blackjack oak increases in frequency as one moves west through the type. The understory is composed of little bluestem, big bluestem, and other grass species depending upon the site. This "game type" covers approximately 17,600 square miles and generally includes the eastcentral part of the state, with fingers reaching out into the western region. In general the soils are coarse textured, leached, acid in reaction, and of a relatively low productive capacity for farm crops. The topography is rolling to rough with some dune reliefs in the northwest fingers of the type. About 75 per cent of the type is in woodland and pasture, and the amount of idle land is increasing (Duck and Fletcher, 1944). The principal farm crop is cotton, but sorghums (Figure 7), peanuts, berries, and orchards are becoming more important in some sections. About 65 to 70 per cent of the farm families are tenants, and more than 50 per cent of these families remain on the same farm for only a year or less. Sheet and gully erosion (Figure 4) present serious problems in the type, and the productivity of the land has been greatly reduced. The principal game species now are the bobwhite, fox squirrel

Figure 3. The "postoak-blackjack forest." Note fire set to "improve" grazing and the scarcity of ground cover in this woodland. Okfuskee County.

Figure 4. Severe gully erosion in sandy soil in the "postoak-blackjack forest game type." Okfuskee County.

(Sciurus niger rufiventer Geoffroy), and cottontail (Sylvilagus floridanus Allen). Some furbearers and white-tailed deer (Odocoileus virginianus macrourus Raf.), although not abundant, are found throughout the type.

The "tallgrass prairie game type" (Figure 5) is the most extensive in the state, covering an area of about 20,500 square miles. Most of it occupies a belt from north to south just west of the "postoak-blackjack forest game type." However, a sizeable area, the Cherokee prairie, is located in northeast Oklahoma. The natural vegetation is composed of a mixture of such grass species as big bluestem, little bluestem, yellow Indiangrass, switchgrass, and silver bluestem in the eastern part of the type. Thickets of shrub species such as plum and sumac are fairly common within the type as shown in Figure 6. As one travels westward through the type there is a gradual increase in numbers of such species as buffalograss, blue grama, and sideoats grama. The "tallgrass type" is characterized, in general, by clean cultivation as it occupies most of the best agricultural land in Oklahoma. The topography is from flat to gently rolling except in the Arbuckle Mountain area which is fairly rugged. West of the Cross Timbers the type is approximately 80 per cent cultivated except in the more rugged areas. In this part of the type, wheat is the principal crop in the north and cotton in the south. In the northeastern section corn (Figure 18) and hay are the ranking crops; the Osage grasslands are used mainly for pasture. Farm tenancy ranges from about 35 per cent in Garfield County and 49 per cent in Craig County in the north to 60 to 70 per cent in sections in the south. In the tall grass uplands, the greater prairie chicken (Tympanuchus cupido americanus Reichenbach), badger (Taxidea taxus berlandieri Baird), striped skunk (Mephitis mephitis Schreber), and coyote (Canis latrans Say) now are the principal animals. Stream borders, mapped as "bottomland game type" in most cases, support

Figure 5. The "tallgrass prairie." Wooded prairie ravine in center and oak woods on ridge in upper right. Note gully erosion in left center. Okfuskee County.

Figure 6. A sumac and plum thicket in the "tallgrass prairie game type." These patches are quite common within the type and afford excellent game cover. Payne County.

most of the wildlife in this type. Bobwhite are most abundant in the southern portion of the type and in some areas where Johnsongrass has invaded the prairie.

The "bottomland game type" (Figure 9) follows the natural drainages of the state. Within the "tallgrass prairie game type" a typical streamside growth consists of American elm, chinkapin oak, post oak, blackjack oak, hackberry, woollybucket bumelia (Figure 14), eastern poplar, Chickasaw plum, fragrant sumac, smooth sumac (Figure 11), and roughleaf dogwood. Black oaks, pecan, American sycamore, bitternut hickory, and eastern black walnut become more abundant to the south and east. Johnsongrass has invaded this type (Figure 8) in some areas to the point where cultivation is difficult. The topography varies from flat bottomlands to steep canyon-like valleys. The soils are extremely fertile alluvium deposits, intensively cultivated, and, in some areas, subject to wind erosion (Figure 10). Saline deposits are found in some areas, particularly along the Cimarron, Salt Fork of the Red, and Salt Fork of the Arkansas Rivers. Much of the type is cultivated in central Oklahoma; sorghums, wheat, common oats, vegetables, alfalfa, corn, cotton, and native meadows are the main crops. Farm tenancy is high, running up to 70 per cent in the Arkansas and Red River valleys. Game populations are high in general, but some of the better agricultural bottoms support few game animals due to the intensive cultivation resulting in a deficiency of cover. The more common game species are the bobwhite, gray squirrel (Sciurus carolinensis Gmelin), fox squirrel, cottontail, and such furbearers as raccoon (Procyon lotor L.), opossum (Didelphus virginiana Kerr), skunk, mink (Mustela vison Schreber), and muskrat (Ondatra zibethica L.).

Figure 7. Sorghum, a leading quail food, and foxtail millet growing in a "habitat plot." Okfuskee County.

Figure 8. Johnsongrass growing on a roadside near a small creek bottom. Noble County.

Figure 9. View in the "bottomland game type." Elm, hackberry, and oaks in background; wildbean, seacoast sumpweed, lespedezas, and Johnsongrass in foreground. Okfuskee County.

Figure 10. Wind erosion on deep sandy soil in the "bottomland type." Wind-blown sand has almost covered a fence located on the north side of a cultivated field. Okfuskee County.

Land-Use

Although land-use within the "game types" has been discussed to some extent in the preceding section, agricultural practices in particular sections of central Oklahoma will be reviewed for completeness. The Bureau of Agricultural Economics (1950) states that farming has assumed its present form in the United States in response to ". . . well-defined physical, biological, and economic forces or conditions." The physical factors are chiefly climate, topography, and soils; the biological factors mainly adapted crops and livestock, weeds, insect pests, plant and animal diseases, and development of new crop varieties; the economic factors being largely costs of production, distance from centers of consumption, geographic variation in prices, and governmental regulations.

Except for the Arbuckle Mountains, the central and southern parts of the region are general farming areas. Peanuts are an important crop in the extreme southcentral portion. In the southwestern and central areas of the region wheat, sorghum, cotton, and range livestock are important crops. In the eastcentral and southeastern portions of the region various enterprises supplement cash crops in the farming systems. Specialty truck crops, woodland operations, and home use products are valuable enterprises. On the uplands general livestock and diversified farms are numerous.

In the northcentral Osage, and the southcentral Arbuckle Mountain areas seasonal grazing constitutes the most important use of the land. Some dryland farming is included in the areas, wheat and sorghums being used for winter forage and for cash crops. In addition, hay is harvested from native meadows in many places for winter feed. The northwest section produces hard winter wheat (Figure 12) primarily, but sorghums, barley,

Figure 11. View of sumac showing the growth form and fruit. Ground cover is mostly bluestems, euphorbia, and ragweed. Payne County.

Figure 12. Combines harvesting a field of wheat. After combining some waste grain is available to wildlife until the ground is plowed. Alfalfa County.

corn, and common oats are also grown. In the northeast section livestock, dairying, cash grain, and poultry are the chief enterprises.

Many farm ponds have been built throughout central Oklahoma. Their value to upland wildlife is questionable, however, since very few of them have been fenced from livestock. Land management agencies have been promoting the establishment of improved pastures, crop rotations, and other soil-conserving practices that may be of great benefit to upland game.

METHODS

Food Habits

The methods followed in the collection and analyses of quail crops have previously been reported in the food habits study of Baumgartner, Morris, Steele and Williams (1952). A total of 1,771 quail crops were included in the study which covered the 13-year period, 1939-1951. The majority of those crops were collected during the legal hunting season, only 150 out-of-season crops being available for analyses. The months of November through April were represented in the study; late spring, summer, and early fall foods were not included since no quail crops were available from those seasons.

An arbitrary sorting of the quail crops according to ecologic associations called "game types" and again into three major divisions or regions of the state was made by Baumgartner et al. (1952). Aggregate volumes and frequencies of the quail foods, expressed in percentages, were determined for each "game type" and region. An additional measure, called the "volume-frequency index," was developed in an attempt to express the significance of frequency in the analyses of game bird food habits. The divisions or regions and "game types" considered by Baumgartner et al. (1952) are identical with those in this report. This report, however, covers only the central region for which 1,072 crops were available. The central region is designated as Division 2 in Figure 1.

Plant Investigations

In this country we have one vast proving ground for plants. This proving ground is composed of many types of climate, soil, and site, wherein organisms have succeeded or failed for significantly long periods. Aldous and Shantz (1924) have pointed out that the normal or natural plant cover occurs as a result of all the growing conditions of the area wherein the plant cover is produced. The plant life is, therefore, a measure or index of the factors which influence its growth and serves as an indicator of the possibilities of producing other plants on the same area.

As a part of this investigation many plants were observed in their native habitat, in nurseries, or in experimental plantings. Plant species that exhibited possibilities or capabilities for the purposes of habitat management were studied in greater detail.

Relative availability of plants as food or cover for quail was continually being observed during the field work. These observations were supplemented whenever possible by existing research reports. The conditions under which a plant furnished food or cover was also taken into account as, for example, the availability of a particular species during the time when snow or ice covered the ground.

Site relations of the plants here considered were observed and noted in as great detail as possible. These relations included soil preferences such as fertility, reaction, texture, permeability and depth, and shade tolerance. The kind of site on which the plant species grew was also noted. Relative abundance was estimated and checked with published accounts whenever possible. No attempts were made to sample the vegetation for frequency distribution, however, as the area involved in the investigation was too great and the time limit too short.

The growth characteristics of plants were noted both from direct observation and from the literature. The growth form of a plant is of prime importance because of cover production, and this was taken into account. The life cycle, kind of fruit, size of fruit, and in some cases, manner of reproduction are also important and were noted.

The cultural requirements of the plants, where known, were also listed. These included methods of propagation, seedbed preparation required, and planting methods and time. It should be emphasized that some of the cultural methods for certain species are still in the experimental stage or are not known at the present time.

Several other relations of the plants were also considered. Such things as the ability to withstand competition and other biotic influences and the presence or lack of objectionable characteristics were noted. The value of a plant to the landowner, other than for quail management, was considered to be very important. Throughout the investigation, the utility of a plant in a habitat management program was kept in mind. Every plant is considered to be a valuable resource in itself, but if it does not fit into the land operator's scheme it is not considered suitable for a habitat management program.

QUAIL FOOD HABITS

A thorough knowledge of quail food habits and the ecologic relationships of these foods is essential in the management of the bobwhite. The environment is dynamic, undergoing ceaseless changes. Conditions are never constant but vary with time and from place to place (Graham, 1944; Dice, 1952). With this in mind then, a food habits study should extend over a long period of time. The various seasons of the year and many sample areas in the region being studied should be included.

As stated previously, this food habits study covered a period of 13 years, 1939 through 1951. Approximately 35 per cent of the quail crops used were collected during 1950; this may have biased the results to some extent. Most of the crops were collected during the legal hunting season, mid-November to the end of December, so all seasons of the year are not included in the study. It is almost certain that the results would be different if crops could have been collected for all the seasons. The collections were quite extensive within the central region. All the counties in this region were represented in the total sample, but the county samples were not representative as to area and quail numbers.

Plants are listed by the common or vernacular names and, in most cases, are those given by Kelsey and Dayton (1942). Scientific names of plants corresponding to the common names are given in Table 8. Scientific names were taken from the catalogue of Waterfall (1952) if listed there, while those of many cultivated plants follow Bailey (1949).

It is difficult to distinguish the seeds of species, or even genera

of certain plants. Some food items, therefore, have been grouped together. For instance, crabgrass and fall witchgrass were placed in the same group because their seeds so closely resemble each other.

The index number which is given in the following food habits tables is the "volume-frequency index" developed by Baumgartner et al. (1952). The index number was obtained by dividing the sum of the rank of the volume and frequency by two. For example, panicum, which represented 0.66 per cent of the total food volume, has a volumetric rank of 23, and which occurred with a frequency of 28.01 per cent, has a frequency rank of five. Its index number would then be $\frac{23 + 5}{2} = 14.0$ (Table 1). Percentage volume in the tables refers to the total volume of each food in a group of crops divided by the total volume of all the foods in that group, the resulting figure being expressed as a percentage. Percentage frequency of each food was determined by dividing the number of crops containing that food by the total number of crops.

The index number was developed to provide a single measurement expressing the relative position of both volume and frequency of occurrence. For example, in the "tallgrass prairie game type" acorns and panicum have the same index number. Acorns rank seventh in volume but sixteenth in frequency. Volume is an expression of the abundance and the palatability of foods; frequency is a measurement of distribution. Following this line of reasoning, acorns would be a readily acceptable and highly available food but limited in distribution. Crop analyses and field studies support this hypothesis. When bobwhites eat acorns their crops are normally crammed with this food, but many coveys occupy homesteads which do not include oak woods. The rating of panicum seed is practically the opposite of acorns, seventeenth in volume and sixth in frequency, suggesting that panicums are widely distributed plants but seldom produce enough seed to

furnish a full meal for the bobwhite. Field observations and crop analyses support this conclusion. One or more species of panicum are found in most plant associations in central Oklahoma, but the plants are typically scattered. The seeds are small and often fall into a heavy grass or leaf litter. We cannot be certain that bobwhites find panicum as palatable as acorns, but the fact that some seeds showed up in more than 28 per cent of the crops suggests that these are readily acceptable foods. On the basis of these findings I believe that acorns and panicum seed are of about equal importance as a bobwhite food and that the index number expresses a valid relationship.

Food by "Game Types"

Table 1 shows the late fall and winter quail foods in the "postoak-blackjack forest game type." The table is quite similar to the one presented by Baumgartner et al. (1952) except that more foods are included, and the foods are listed in order of index number rank. In Table 1 all of the foods occurring in crops collected from this "game type" are itemized down to the last food showing a percentage volume or frequency of at least one per cent. Some foods that do not have a percentage volume or frequency of at least one per cent are included in the table. These foods are listed because their index number rank is higher than the last food having at least one per cent volume or frequency. A total of 54 foods was thus obtained by following this arbitrary restriction.

It will be noted in Table 1 that the top 10 foods, on the basis of volume, made up more than 75 per cent of the total in the "postoak-blackjack forest game type." Acorns alone comprised more than one-fifth of the total volume during the seasons studied.

Table 1. Late Fall and Winter Quail Foods in the "Postoak-Blackjack Forest Game Type" (Based on 432 crops)

Food	% Volume	% Frequency	Index
Oak	21.32	40.97	1.0
Ragweed	8.59	35.88	2.5
Cultivated lespedeza	11.86	27.55	4.0
Wildbean	7.85	32.64	4.5
Sorghum	7.87	10.18	7.5
Johnsongrass	4.16	13.42	7.5
Corn	4.36	10.18	8.5
Sunflower	3.84	10.65	9.0
Tickclover	3.35	11.11	9.5
Succulent parts	1.22	35.65	10.0
Crabgrass and Fall witchgrass	3.66	9.72	10.5
Sumac	2.42	7.87	13.0
Wild grape	1.69	8.33	13.0
Animal matter	0.97	27.55	13.0
Panicum	0.66	28.01	14.0
Paspalum	0.87	23.84	14.5
Woollybucket bumelia	2.32	2.78	16.5
Ash	1.46	3.70	16.5
Croton	1.00	8.10	16.5
Treebine	1.38	3.47	17.5
Peanut	1.56	2.31	18.5
Euphorbia	0.44	6.02	20.5
Showy partridgepea	0.22	11.11	21.5
Tumble ringwing	1.03	1.39	22.5
Wild lespedeza	0.23	9.72	22.5
Rye	0.93	1.62	23.5
Hogpeanut	0.50	2.08	24.0
Milkpea	0.27	5.09	24.0
Seacoast sumpweed	0.34	2.55	25.5
Broadleaf uniola	0.41	1.16	27.0
Common perilla	0.39	0.92	28.0
Crownbeard	0.27	1.39	29.0
Cottonseed meal	0.37	0.23	30.0
Osageorange	0.33	0.69	30.0
Copperleaf	0.12	2.08	30.0
Indiancurrant coralberry	0.07	2.78	30.0
Black locust	0.22	1.39	30.5
Spanishclover deervetch	0.03	3.24	31.0
Pecan	0.24	0.23	32.0
Crotonopsis	0.12	1.16	32.0
Sedge	0.01	3.70	32.0
Common persimmon	0.20	0.69	32.5
Texas treadsoftly	0.22	0.23	33.0

Table 1. -- Continued

Food	% Volume	% Frequency	Index
Dogwood	0.09	0.92	33.0
Amaranth and Goosefoot	0.04	1.85	33.0
Beggarticks	0.03	2.08	33.5
Hawthorn	0.08	0.46	34.5
Plum	0.08	0.23	35.0
Scurfpea	0.04	0.92	35.0
Wheat	0.07	0.23	35.5
Mung bean	0.05	0.46	35.5
Bristlegrass	0.02	1.39	35.5
Knotweed	0.01	1.85	35.5
Dropseed	0.00	1.85	36.0

The top 10 foods in this "game type" according to index number were acorns, ragweed, cultivated lespedeza, wildbean, sorghum, Johnsongrass, corn, sunflower, tickclover, and succulent parts. Foods that ranked high in volume generally ranked high in frequency. There were some notable exceptions to the rule. Succulent parts, animal matter, panicum, paspalum, and showy partridgepea (Figure 13) were foods that ranked low in volume but high in frequency. Several reasons may account for these exceptions. A food could be widely distributed but scarce on a particular site. A food may be taken infrequently because other available foods are preferred. Again it might be that only a small amount of these foods fills a particular physiological need in quail.

The late fall and winter quail foods in the "tallgrass prairie game type" are shown in Table 2. A total of 64 foods, arranged according to index number, are given in this table compared with a total of 54 foods in Table 1. The top 10 foods in this "game type," on the basis of volume, also made up more than three-fourths of the total volume. The food with the highest percentage volume, sorghum, comprised about 18 per cent of the total.

Figure 13. A view of showy partridgepea showing growth form and flowers. Payne County.

Figure 14. Typical growth form of woolly-bucket bumelia on an open site. Payne County.

Table 2. Late Fall and Winter Quail Foods in the "Tallgrass Prairie Game Type" (Based on 376 crops)

Food	% Volume	% Frequency	Index
Ragweed	16.51	44.15	1.5
Sorghum	17.97	29.52	2.5
Sunflower	8.05	31.38	4.0
Cultivated lespedeza	8.07	23.40	6.0
Corn	9.89	15.96	6.5
Wildbean	5.76	25.53	6.5
Animal matter	1.95	29.26	8.5
Croton	2.18	15.42	10.5
Succulent parts	1.17	35.90	10.5
Oak	3.98	8.78	11.5
Panicum	1.29	28.72	11.5
Wild grape	2.50	10.37	12.0
Sumac	3.09	7.71	12.5
Johnsongrass	1.84	12.50	12.5
Euphorbia	1.74	10.90	14.0
Seacoast sumpweed	2.18	6.38	14.5
Crabgrass and Fall witchgrass	1.30	11.44	14.5
Paspalum	0.66	18.35	15.5
Wheat	1.24	5.58	18.5
Bristlegrass	1.04	4.52	21.5
Ash	1.34	2.66	22.0
Tickclover	0.63	4.79	22.5
Knotweed	0.26	5.32	24.0
Woollybucket bumelia	0.69	2.92	24.5
Dogwood	0.61	2.66	26.5
Amaranth and Goosefoot	0.16	4.26	27.5
Common oat	0.24	2.92	28.5
Goldenweed	0.13	3.99	28.5
Black locust	0.32	2.13	29.0
Peanut	0.53	1.33	29.5
Brome	0.38	1.33	30.0
Mung bean	0.61	0.53	30.5
Showy partridgepea	0.04	5.05	30.5
Dropseed	0.11	2.66	31.5
Wild lespedeza	0.06	3.46	32.0
Copperleaf	0.05	3.72	32.0
Common cowpea	0.18	1.06	32.5
Crownbeard	0.07	2.39	33.0
Snakeweed	0.18	0.53	33.5
Cottonseed meal	0.18	0.26	34.0
Indiancurrant coralberry	0.06	1.86	34.5
Sweetclover	0.12	0.53	35.0
Sedge	0.00	3.99	35.0
Treebine	0.10	0.80	35.5

Table 2. -- Continued

Food	% Volume	% Frequency	Index
Hogpeanut	0.07	0.53	36.5
Dalea	0.07	0.27	37.0
Beggarticks	0.04	1.33	37.0
Tumbling Russianthistle	0.04	1.33	37.0
Milkpea	0.03	1.60	37.0
Geranium	0.00	2.66	37.0
Hawthorn	0.06	0.53	37.5
Gaura	0.04	0.80	37.5
Scurfpea	0.00	2.39	37.5
Avens	0.01	1.60	38.0
Hackberry	0.01	1.60	38.5
Nightshade	0.02	0.80	39.0
Pricklepoppy	0.01	1.06	39.0
Groundcherry	0.00	1.60	39.0
Bundleflower	0.03	0.26	39.5
Buffalograss	0.03	0.26	39.5
Catalpa	0.02	0.53	39.5
Dayflower	0.00	1.33	39.5
Crotonopsis	0.01	0.80	40.0
Buttonweed	0.00	1.06	40.0

The top 10 foods (according to index number) in the "tallgrass prairie game type" were ragweed, sorghum, sunflower (Figure 16), cultivated lespedeza, corn, wildbean, animal matter, croton (Figure 19), succulent parts, and acorns. Eight of the top 10 foods in both "game types" are the same, although arranged in different order. Since the two "game types" are often in juxtaposition throughout the region and since quail usually inhabit the edges of the types, it is not surprising that the foods are quite similar. There are differences in food items, of course, between the two "game types," but the main foods are much the same.

Food of the Region

Table 3 shows the late fall and winter quail foods in the central region. Almost all of the quail crops that were included in Tables 1 and

Figure 15. View in the oak savannah showing typical growth form of post oak in an open situation. Payne County.

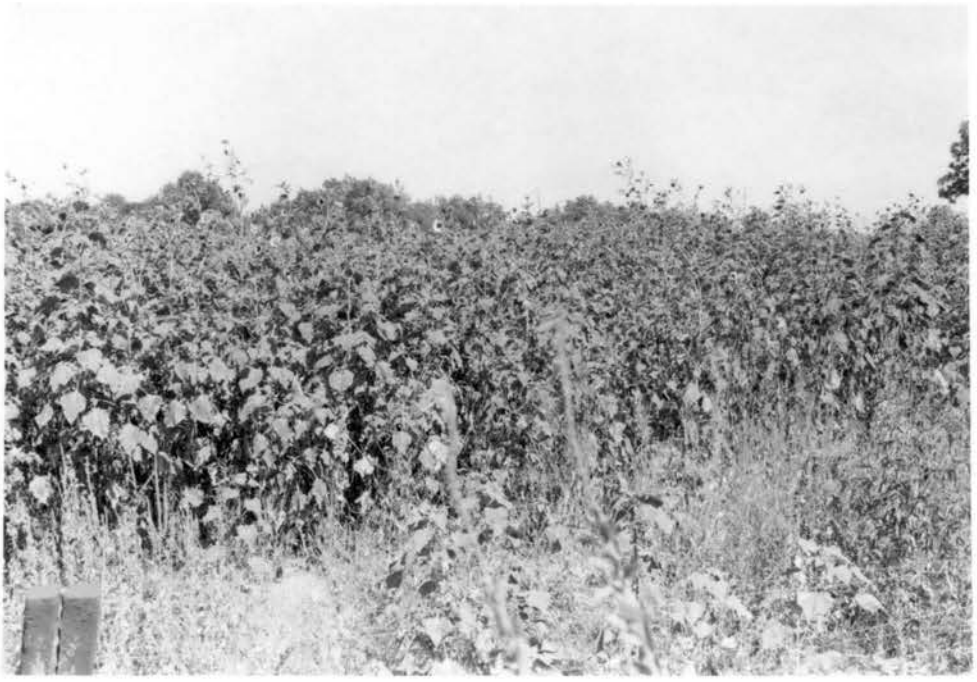

Figure 16. Sunflower growing 9 to 15 feet tall in a field which had been cultivated. A good, but temporary, source of food for bobwhite. Noble County.

2 are tabulated in Table 3. About 300 additional crops, mainly from the "bottomland game type" within the central region, are also contained in Table 3. A separate analysis of foods in the "bottomland game type" was not made. The "bottomland game type" constitutes only a small fraction of the total study area, and apparently the foods from the "bottomland game types" in the central region. At least the inclusion of this type in the regional analysis did not materially alter the index rank of many foods, especially those that ranked in the 10 most commonly taken foods.

Table 3. Late Fall and Winter Quail Foods in the Central Region (Division 2) (Based on 1072 crops)

Food	% Volume	% Frequency	Index
Ragweed	12.49	41.98	2.0
Sunflower	17.44	30.04	3.0
Oak	13.61	22.39	4.5
Wildbean	6.31	34.05	5.0
Sorghum	11.75	17.44	6.5
Succulent parts	1.54	37.41	7.0
Cultivated lespedeza	6.51	15.86	8.0
Panicum	1.61	27.05	8.5
Corn	7.00	11.01	9.0
Animal matter	1.47	32.09	9.0
Johnsongrass	3.05	13.62	9.5
Sumac	2.81	8.68	12.0
Paspalum	0.91	19.40	12.0
Crabgrass and Fall witchgrass	2.52	8.40	13.0
Euphorbia	1.48	5.35	13.5
Croton	1.42	12.59	13.5
Wild grape	0.74	3.17	20.0
Tickclover	0.56	4.29	20.0
Bristlegrass	0.44	3.82	22.0
Knotweed	0.32	4.01	22.5
Showy partridgepea	0.29	5.97	22.5
Wild lespedeza	0.19	6.62	23.5
Ash	0.73	1.12	25.0
Hackberry	0.66	1.21	25.0
Wheat	0.75	0.84	25.5
Seacoast sumpweed	0.16	2.33	27.0

Table 3. -- Continued

Food	% Volume	% Frequency	Index
Peanut	0.49	0.75	28.5
Rye	0.40	0.93	28.5
Crownbeard	0.15	1.40	30.5
Amaranth and Goosefoot	0.09	2.24	30.5
Woollybucket bumelia	0.24	0.75	31.5
Mung bean	0.29	0.37	32.5
Catalpa	0.20	0.56	33.0
Dropseed	0.07	1.40	33.5
Milkpea	0.06	1.96	33.5
Black locust	0.15	0.65	34.0
Scurfpea	0.13	1.03	34.0
Dayflower	0.14	0.84	34.5
Avens	0.05	1.77	35.0
Nightshade	0.07	1.12	35.5
Indiancurrant coralberry	0.06	1.31	35.5
Copperleaf	0.03	2.05	35.5
Dogwood	0.14	0.47	36.0
Hogpeanut	0.07	0.65	37.0
Snakeweed	0.09	0.19	39.0
Sedge	0.01	1.77	39.5

A total of 46 foods, arranged by index number rank, are given in Table 3. The top 10 foods in the region, on the basis of volume, made up about 83 per cent of the total; the top five comprised about 62 per cent of the total volume. It seems apparent from these figures that, on the average, only a small number of foods provide the bulk of the diet of quail in the central region during late fall and winter.

The top 10 ranking foods according to index number in the central region were ragweed, sunflower, acorns, wildbean, sorghum, succulent parts, cultivated lespedeza, panicum, corn, and animal matter. Succulent parts, panicum, and animal matter are replaced by Johnsongrass, sumac, and crabgrass and fall witchgrass when considering the 10 leading foods on the basis of volume. Only one food, corn, is replaced and that by paspalum when the top 10 are ranked according to frequency.

Several food items listed in Table 3 are considered to be pests, at

least by some individuals and under certain circumstances. As Lucretius once said, "What is food to one man may be fierce poison to others" (De Rerum Natura. IV, 637). It is certainly true that certain plants, such as Johnsongrass, present a very serious problem to the farmer when they decrease his land's capacity to produce agricultural crops. Other weedy plants, however, may actually protect the soil as, for example, the invasion of some cultivated fields by crabgrass after crop harvesting (Figure 18), thus providing a certain amount of stability to soil particles.

The relationships of the leading fall and winter quail foods in Oklahoma have been discussed in the study by Baumgartner et al. (1952). Some findings presented in that study which have not been given in the preceding sections are the following.

1. "Of the total food, vegetable matter composed nearly 99 per cent of the volume. Annual plants provided 52 per cent of the food and perennials 27 per cent. . . . Cultivated plants provided 29 per cent of the food eaten in comparison with native plants which furnished 68 per cent."

2. Overgrazing favors the increase of such important foods as perennial ragweed, euphorbias, and crotons.

3. "The early stages of plant succession on abandoned fields result in heavy stands of sunflowers and ragweeds. . . . climax stages on the prairies and plains are annual and perennial grasses that provide relatively little quail food."

4. Grain sorghums and corn are two important foods produced by cultivation. These food sources are usually eliminated by clean harvesting in the fall.

5. "By-products of cultivation such as sunflowers, crab grasses, spurges [euphorbias], crotons, and ragweeds are significant fall and winter foods."

FOOD AND COVER PLANTS FOR HABITAT MANAGEMENT

Basis for Evaluation of Useful Plants

In selecting plants for use in a habitat management program some criteria were established for judging the possible value of the different plants investigated. No relative ranking of importance is necessarily attached to the order of listing of the criteria listed in this section.

Leopold (1933) has discussed qualities that make plants valuable as winter cover for game. Van Dersal (1938) has stated the properties of woody plants that make them useful for erosion control and wildlife, and Graham (1941) has discussed similar criteria for legumes. More recently, Edminster (1950) has offered criteria for selecting kinds of shrubs useful in developing farm wildlife habitat. Their qualifications are very similar, regardless of the objectives, and many of their criteria are similar, or the same as those given below.

Value to Landowners

Much of our wildlife is produced on private lands. Although public agencies may desire an increase in game populations, it is these private landowners who will probably have to accomplish most of the task. As Bennett (1939), Graham (1947), Davison (1949), and others have pointed out, wildlife management, to be successful on private lands, should be an integral part of a sound land management plan.

Thus, in order to be more readily acceptable to farmers and ranchers, it is desirable that plant species used in a habitat management program be

multiple purpose plants. The term, multiple purpose as here used, implies that, in addition to a plant's usefulness in connection with wildlife, a plant should have value for one or more of such uses as erosion control, soil improvement, fencepost production, timber production, pasture improvement, windbreaks, shelterbelts, farm crops, honey production, or even as ornamentals.

Value to Quail and Other Wildlife

The proposing of a plant species for use in a planting program has, in general, been based on food habits studies. These studies have included both stomach analyses and field observations. Plants that have been used heavily by quail probably should be given priority in the management program. However, records of infrequent use of a given species do not always indicate that a plant is worthless. It is possible that we do not know enough about the plant because of inadequate studies. Also, single studies usually do not cover a sufficient number of variable conditions. In this report, plants that furnish both food and cover for quail are usually given preference. Some plants are listed, however, that are useful for special purposes but do not provide both food and cover.

Climate and Soil Tolerances

Naturally, plants considered for use in a habitat planting program must be able to thrive in the climate and the soil where they are to be grown. Growing conditions are influenced by such factors as altitude and latitude, which in turn have a bearing on temperature and temperature extremes, frosts, and length of growing season; rainfall, both total and distribution throughout the year; humidity as influenced by wind and rainfall; intensity and amount of sunshine; and soil type and character.

Plants that tolerate a wide range of climate and soil differences are

generally most desirable in conservation plantings. Other plants having more narrow tolerance ranges might be recommended for limited use or for specific purposes.

Choice for a Given Site

Our first choice of species for planting on a chosen area should be from those that are native to the region in question. If there is no native species that fulfills the necessary requirements in the planting program, then we are justified in turning to exotic forms. The choice of species for planting on a given site should depend on the ability of the plants to survive competition. It is unfeasible to select others than those that have already shown themselves capable of succeeding on similar sites.

The tendency to resist such biotic influences as insect damage, diseases, and grazing is valuable. Solid stands of plants favor the spread of insect pests and disease (Toumey and Korstian, 1942). For this reason, mixed plantings are more desirable. Mixed stands also result in a more efficient use of space.

Growth Characteristics

The growth form and habit of a plant are of vital importance in aiding the technician in the selection of species to fit his needs. If a windbreak is desired, for example, he would choose a plant with dense branching and foliage for protection of the site and with a deep, spreading root system to support the plant against strong winds.

Characteristics such as speed of establishment to obtain prompt results; quick and effective, but not aggressive, reproduction; and resistance to fire or ability to coppice after cutting or burning are important properties that should be considered in selecting suitable species.

Other qualifications by which a plant should be judged for use in habitat plantings are growth height and kind and quality of "cover" provided. Bobwhite prefer plant cover that is dense overhead and relatively open near the ground level (Stoddard, 1931).

Cultural Requirements

Often plants which are easily established are desirable in a planting program. Species that can be propagated by direct seeding, by planting stock of small size or by cuttings, and which can be handled with the usual field planting techniques should be selected, especially in large-scale operations. It is important that the planting materials be easily obtained, be of reasonable cost, and have a high survival and longevity to avoid early replacement.

Species that require a minimum amount of soil preparation for planting, and very little maintenance work after establishment are valuable and should be chosen whenever possible. Economy in the planting program is, of course, a prime factor, and all plans should include a thorough evaluation of the costs involved.

Lack of Objectionable Characteristics

Plant species that are poisonous to man or livestock, those harboring injurious fungi or insect pests, kinds that are extremely agressive and likely to spread, or having other qualities likely to make them a nuisance should be avoided. There are undoubtedly situations in which plants possessing some objectionable characteristics can be used, but it would probably be advantageous to select species having more desirable properties.

List of Useful Plant Species

The plant species listed in Tables 4 and 5 were selected on the basis

of the criteria discussed in the preceding section. The 21 species given in Table 4 were considered as being the most satisfactory for use in quail habitat management plantings in central Oklahoma, while the 27 plants in Table 5 were selected as being suitable for special or limited purposes or for experimental use.

The symbols used in Tables 4 and 5 denote the characteristic under which a species has been classified and, in some cases, further designate a degree of classification. These symbols will be discussed in detail under the appropriate tabular headings. If all of the columns under a major heading, such as fertility or depth, are blank for a particular species, it indicates a lack of reliable information. When one or more symbols occur under a major heading for a particular species, a blank space under the same heading usually indicates that the species is not characterized by that column classification.

It is possible that future research may reveal species superior to many of the plants listed in these tables. Some of these plants have not been shown to be valuable sources of quail food, but are recommended because they are known to provide excellent cover. Further study, however, may even show some of these to be good food sources.

Chief Use

The relative utility of a plant as a source of food or of cover, or both, is indicated in the two columns under the major heading, chief use, in the two tables. The symbol (X) denotes that the plant is of major importance in furnishing food and/or cover as the case may be, and the symbol (/) designates that the plant is of minor importance. It is recognized that the distinction between major and minor importance is subject to criticism similar to that of many other such arbitrary classifications.

That is, the classification is based partially on subjective observations and, as such, may involve a serious bias. The degree of importance of a plant in furnishing food for quail has been derived largely from the results of food habits studies and is to that extent objective in character. The degree of importance of cover use is based on four years of personal field observations and supported by the observations of several former Oklahoma Cooperative Wildlife Research Unit and Game and Fish Department employees. According to a personal communication from F. M. Baumgartner, the degree of cover use also appears to be closely related to the abundance and distribution of a particular plant as well as its importance as a food species.

It will be noted in Tables 4 and 5 that only four species, dwarf chinkapin oak, flameleaf sumac, smooth sumac, and Johnsongrass, are listed as of major importance under both the food and cover headings. About one-half of the plants, however, are classified as being of major importance under one heading and of minor importance under the other.

Period of Availability of Food

General information for most of the species relative to monthly food availability is given in the two tables. The first month listed indicates when the food first becomes available to any appreciable extent; the second month indicates when the food is no longer available, either on the plant or in considerable quantity on the ground. The period of availability refers primarily to the time when the fruit is available, but succulent parts may also be taken from some plants during this period. The period of availability implies, of course, that the food is of sound condition, that is, not affected by rot or insect infestations. The time at which the fruit becomes available to quail will vary somewhat from year

PLANT SPECIES	CHIEF USE		MONTHLY FOOD AVAILABILITY	RELATIVE ABUNDANCE			SITE RELATIONS																		GROWTH CHARACTERISTICS								
							Soil Preferences														Shade Tolerance			Growth Habit					Life Cycle			Kind of Fruit
							Fertility			Reaction			Texture			Permeability			Depth													
	Food	Cover		Scarce	Common	Abundant	Low	Medium	High	Acid	Neutral	Basic	Fine	Medium	Coarse	Slow	Moderate	Rapid	Shallow	Deep	Shade	Half-shade	Sun	Herb	Grass	Vine	Shrub	Tree	Annual	Biennial	Perennial	
American bittersweet	/	X	Sept.-Feb.	X			X	X	X	X	X		X	X	X		X	X			X	X	X			X	/				X	Capsule
Blackjack oak	X	/	Sept.-Apr.		X		X	/		X	X		X	X	X	X	X	X	X	X			X				/	X			X	Acorn
Black locust	/	X	Sept.-Apr.		X		X	X	X	/	X	/		X	X		X	X		X	X	X	X					X			X	Legume
Blue panicum*	X	/	Aug.-	X					X	/	X	/	/	X	X		X	X					X		X						X	Caryopsis
Chickasaw plum	/	X	May-Sept.		X		/	X	X	/	X			X	X		X	X					X				X	/			X	Drupe
Dwarf chinkapin oak	X	X	Sept.-Apr.							X	X			X	X		X	X					X				X	/			X	Acorn
Eastern redcedar	/	X	Continuous	X			X	X	X	X	X	/	X	X	X	X	X	X				X	X					X				X	Berry
Flameleaf sumac	X	X	Sept.-June		X		/	X	X	X	X			X	X		X	X		X	X	X	X				X	/			X	Drupe
Gray dogwood	/	/	Aug.-Jan.	X			X	X	X	X	X	/	X	X	X		X	X				X	X				X				X	Drupe
Korean lespedeza*	X	/	Aug.-May	X			X	X	X	X	X		X	X	X	X	X	X			X	X	X	X					X			Legume
Northern catalpa	/	X	Sept.-Apr.	X				X	X	/	X	/	X	X	X		X	X		X			X					X			X	Capsule
Pink wildbean	X		Oct.-Mar.	X										X	X		X	X						X							X	Legume
Post oak	X	/	Sept.-Apr.		X		X	X		X	X			X	X		X	X	X	X		X	X				/	X			X	Acorn
Roughleaf dogwood	/	/	Aug.-Jan.		X		/	X	X	X	X			X	X		X	X					X				/	X			X	Drupe
Rusty blackhaw viburnum	/	X	Oct.-Mar.	X			/	X	X		X		/	X	/		X						X				X	/			X	Drupe
Sand paspalum	/	X	Aug.-Mar.	X				X	X	X	X	/		X	X		X	X		X			X		X						X	Caryopsis
Showy partridgepea	/	X	Oct.-Apr.		X		X	X		X	X		/	X	X	X	X	X			X	X	X	X					X			Legume
Smooth sumac	X	X	Sept.-June		X		/	X	X	X	X		/	X	X	X	X			X	X	X	X				X	/			X	Drupe
Southern catalpa	/	X	Sept.-Apr.	X				X	X		X		X	X	X	X	X	X		X			X					X			X	Capsule
Switchgrass	X	/	Sept.-Apr.		X			X	X	/	X	X		X	X		X	X					X		X						X	Caryopsis
Woollybucket bumelia	X	/	Sept.-May		X									X	X		X	X	X	X		X	X				X	X			X	Drupe

* Exotic species

Table 4. Some Characteristics of Plants Potentially Suitable for Habitat Management

PLANT SPECIES	CHIEF USE		MONTHLY FOOD AVAILABILITY	RELATIVE ABUNDANCE			SITE RELATIONS																GROWTH CHARACTERISTICS								
							Soil Preferences														Shade Tolerance			Growth Habit					Life Cycle			Kind of Fruit
							Fertility			Reaction			Texture			Permeability			Depth												
	Food	Cover		Scarce	Common	Abundant	Low	Medium	High	Acid	Neutral	Basic	Fine	Medium	Coarse	Slow	Moderate	Rapid	Shallow	Deep	Shade	Half-shade	Sun	Herb	Grass	Vine	Shrub	Tree	Annual	Biennial	Perennial	
American filbert	/	/	Aug.-Mar.	X				X	X	/	X			X	X		X	X	X			X	X				X				X	Nut
Amur privet*		X	Sept.-	X				X	X	/	X	/		X			X	X			X	X	X				X				X	Drupe
Birdsfoot deervetch*	/			X			X	X	X	/	X	/	X	X	X	X	X	X						X							X	Legume
Chinese lespedeza	/	X	Oct.-Mar.	X			X	X	X	X	X		X	X	/	X	X	X			X	X	X	X							X	Legume
Common cowpea*	X			X			X	X	/	X	X	/	X	X	X		X	X				X	X	X					X			Legume
Field pea*	/			X						/	X	/	X	X		X	X	X		X			X	X					X			Legume
Hairy vetch	/	/		X			X	X	X	X	X	/	X	X	X	X	X	X					X	X					X	X		Legume
Hybrid filbert*	/	/	Oct.-Mar.	X				X	X	/	X			X	X		X	X				X	X				X				X	Nut
Indiancurrant coralberry	/	X	Aug.-May		X		X	X	X	X	X	/		X	/		X	X	X	X	X	X	X				X				X	Drupe
Japanese rose*		X	July-Apr.	X			X	X	X	X	X	/		X	X		X	X		X		X	X				X				X	Achene
Japan lespedeza*	X	/	Sept.-Apr.	X						X	X										X	X	X				X				X	Legume
Johnsongrass	X	X	Aug.-May		X			X	X	X	X		X	X	X	X	X	X		X		X	X		X						X	Caryopsis
Milkpea	/				X									X	X		X	X			X	X		X							X	Legume
Mung bean*	/		Aug.-Dec.	X						/	X	/		X	/		X	X						X					X			Legume
Rafinesque viburnum	/	X	Sept.-Nov.	X							X										X	X	X				X				X	Drupe
Robust lespedeza*		/	Sept.-Apr.	X						X	X										X	X	X				X				X	Legume
Scribner panicum	X	/	-Mar.		X					/	X	/		X	/		X	X			X	X	X		X						X	Caryopsis
Shortleaf pine		X	Continuous	X			X	X	/	X	X		X	X	/		X	X	X	X			X					X			X	Cone
Shrub lespedeza*	X	/	Oct.-May	X			X	X	X	X	X	/		X	X		X	X			X	X	X				X				X	Legume
Small wildbean	X		Sept.-Apr.	X										X	X		X							X					X			Legume
Spanishclover deervetch	/		June-Oct.		X					X	X			X	X		X	X						X					X			Legume
Sudangrass*	/	X	May-Jan.	X			X	X	X	X	X		X	X	X		X	X		X			X		X				X			Caryopsis
Tatarian honeysuckle*		X	Aug.-	X			X	X	X	/	X	/		X	X		X	X				X	X				X				X	Berry
Thunberg lespedeza*		/	Oct.-May	X						X	X										X	X	X				X				X	Legume
Trailing wildbean	X		Oct.-Apr.	X			X	/						X	X		X	X						X					X			Legume
Weeping lovegrass*		X	June-		X		X	X	X	X	X	X	X	X	X		X	X	X	X			X		X						X	Caryopsis
Woollypod vetch	/	/		X					X	X	X	/											X	X					X	X		Legume

* Exotic species

Table 5. Some Characteristics of Plants Suitable for Limited, Special, or Experimental Purposes

to year, but according to Park (1942) this variation is slight. The information concerning food availability was obtained primarily from personal field observations. Additional information was taken from such references as Westveld and Bennitt (1938), Pearson and Sturkie (1944), and Forest Service (1948). These references were in agreement with the observations obtained in this study. It should also be mentioned that the yield of fruit on the various species will vary from year to year; in some years a large crop of fruit will be produced and, in other years, little or no fruit will be produced.

As shown in Tables 4 and 5, several of the species, for which information was available, provide a food supply throughout the winter months. In general, it may be said that a species which retains the bulk of its fruit on the plant and releases this food material gradually through the winter and early spring is of superior value to quail. If the fruit is shed early by the plant, it may be eaten by rodents and other seed-eating animals, become covered with soil, or otherwise become unavailable to the bobwhite. This becomes particularly important during the time when snow or ice covers the ground, for it is during such periods that quail may suffer a high incidence of mortality (Baumgartner, 1945).

It will be noted that eastern redcedar and shortleaf pine provide a more or less continuous food supply, but neither species appears to be a preferred food of quail in central Oklahoma. Several more important species such as flameleaf sumac, Korean lespedeza, smooth sumac, woollybucket bumelia (chittam wood), Indiancurrant coralberry (coralberry), Johnsongrass, and shrub lespedeza (Figure 17) do, however, provide food through early spring.

Relative Abundance

In Tables 4 and 5, three classes of relative abundance of the various

Figure 17. Shrub lespedeza planted by the Oklahoma Game and Fish Department in a "habitat plot." Age of plants is one year. Hughes County.

Figure 18. Corn cut and placed in shocks, a good source of game food. Ground cover is mainly crabgrass. Payne County.

species are shown: scarce, common, and abundant. The classification of the tabulated species as to relative abundance was derived mostly from field observations. Stemen and Myers (1937), Featherly (1946), and Phillips, Gibbs and Mattoon (1950) were in agreement with the results obtained in this study and furnished some additional information on relative abundance.

It will be noted that no species is shown in the tables as being abundant, and less than one-half of the plants are classed as common. This is not too surprising, however, in view of the fact that several of them, such as common cowpea, field pea, and hairy vetch, are maintained only by cultivation. Several of the other plants, such as the shrub lespedezas, have only been experimentally grown and have been quite limited in their distribution.

Site Relations

The site relations shown in the tables were first divided into conditions of soil preference and then of shade tolerance. Soil preferences were further divided into conditions of fertility, reaction, texture, permeability, and depth. There are, of course, other site relations, for example, structure and aeration, that are not considered in this report. The particular ones given in Tables 4 and 5 were chosen because they are in common usage by land managers.

Under the subheading, fertility, three categories are recognized: low, medium, and high. The symbol (X) in the low category denotes that the species will grow in soils of moderately to very low fertility. The symbol (/) means that the plant appears to be adapted to soils of slightly low fertility. The same classification applies to the high fertility category. The fact that a plant will grow on poor soils does not

necessarily imply, however, that it will not do better on more fertile soils. Differences in yield of fruit, forage yield, or growth habit are known to exist in comparisons of a species growing on areas of different soil fertility. As shown in the tables, many of the plants, for which information is given, are adapted to a wide range of soil fertility. Notable among these are some of the legumes which can grow and apparently thrive on much of the poor lands in central Oklahoma. There are, of course, many other native plants in central Oklahoma that are not listed in the tables that do very well on poor soils. Roundhead lespedeza (Figure 22) and snow-on-the-mountain (Figure 25) are among the native plants that are outstanding in this respect. These two plants were not selected for inclusion in Tables 4 and 5, however, since they did not appear to satisfy the criteria established earlier in the report.

Three classes of reaction, namely: acid, neutral, and basic, are listed under this subheading. The symbol (X) under the acid subheading signifies that the species is adapted to soils having a pH range from about 4.9 to 6.1; the symbol (/) denotes a pH range of 6.1 to 6.7. The neutral range of reaction has been selected as the pH values of 6.7 to 7.3. The symbol (/) under the basic subheading implies that the plant is adapted to soils having a pH range of 7.3 to 7.9; the symbol (X) denotes a pH range of 7.9 to about 9.0. The above classification was taken from Harper (1947), from which some of the specific information in the tables also was taken.

Common cowpeas (Figure 23) can be grown on soils which vary from strongly acid to slightly alkaline. Other important acid-tolerant legumes adapted to central Oklahoma include hairy vetch, the annual and perennial lespedezas, field peas, and mung beans (Figure 20). Most pasture grasses and small grains are acid tolerant. Best growth occurs,

Figure 19. Woolly croton growing in wheat stubble. A good quail and dove food. Payne County.

Figure 20. View of mung beans showing the large amount of fruit produced by this crop. Okfuskee County.

however, only when nitrogen and other plant nutrients are readily available. Black locust (Figure 27) and red cedar are tolerant of basic soils, while dogwood and pine are tolerant of moderately to strongly acid soils. The growth of any plant which develops a deep root system, however, is affected by many factors besides soil reaction. The growth of an annual plant with shallow roots is influenced to a much greater extent by the pH of the surface soil than a perennial with deep roots.

Under the subheading, texture, three classes are listed: fine, medium, and coarse. The fine textured soils, denoted by the symbol (/), include clay loam and silty clay loam. Clay and silty clay are very fine textured soils which are denoted by the symbol (X). The medium textures include silt loam, loam, very fine sandy loam, fine sandy loam, and sandy loam. The coarse textures, denoted by the symbol (/), include loamy fine sand, loamy sand, and fine sand; the very coarse textures, denoted by the symbol (X), include sand, coarse sand, and stony and rocky soils.

It will be noted in Tables 4 and 5 that several of the plants, for which information was available, will grow on very fine textured soils. Examples of some of these are American bittersweet, blackjack oak, blue panicum, eastern redcedar, Korean lespedeza, and the catalpas (Figure 21). Many of the plants listed in the tables are adapted to very coarse textured soils. It must be realized, of course, that other factors besides texture are related to the species ability to grow on any particular site and must be considered along with soil texture.

The category, permeability, in the tables is subdivided into slow, moderate, and rapid. Two variations in soil depth, shallow and deep, are recognized in Tables 4 and 5. The depth of the soil is here defined as the depth of the layers that are readily penetrated by plant roots or the depth to some layer, such as a hard pan, that would restrict root

Figure 21. Catalpa growing in a postlot. Payne County.

Figure 22. Roundhead lespedeza growing on a road cut. Payne County.

penetration. Deep soils are those that can be readily penetrated more than 20 inches by plant roots. In general, these soils are sufficiently deep to provide ample storage for moisture during normal seasons. The shallow soils include those that cannot be penetrated at least 20 inches by plant roots. These limits should not always be interpreted rigidly. Other environmental factors, such as texture, structure, and consistence of the layers, should be considered along with depth. Usually the species that will grow on the shallower soils will also grow on deep soils, but competition from deep-rooted species may eliminate them.

Shade tolerance has been broken down into shade, half-shade, and sun. Stratification of light is one of the factors which determine the habitat which a species can fill in a given community (Allee et al., 1949). By knowing the shade tolerance of a plant, then, it is helpful in predicting what layer, or stratum, the plant will occupy under natural conditions or after being planted. Consequently, the shade tolerances, where known, of the selected plants are given in Tables 4 and 5.

Although grassland plants, as a whole, are subjected to an abundance of intense light, there are some low-growing species which live in the shade much of the time. Scribner panicum is an example of this type of plant. When planting is to be done in woodland interiors, or other sites where sunlight is limited, species must be selected which are tolerant, or partially tolerant, to shade. Some of the shrubs included in the tables are of this type. Examples are American bittersweet, flameleaf sumac, amur privet, Indiancurrant coralberry (coralberry), Rafinesque viburnum, and shrub lespedeza (bicolor). Two references that furnished some additional information for this category were Van Dersal (1938) and Edminster (1942). These references were in general agreement with the results of this study where data were available.

Growth Characteristics

In Tables 4 and 5 the heading, growth characteristics, has been divided into the following categories: growth habit, life cycle, and type of fruit. Under the subheading, growth habit, the symbol (X) denotes that the typical growth type of the plant occurs as one or more of the classes listed as herb, grass, vine, shrub, or tree. The symbol (/) means that the species may occur, under certain conditions, as one of the other types listed under growth habit. For instance, post oak is typically found growing as a tree, but on extremely poor sites it may be found growing as a shrub type. An interesting point in connection with different growth types is stated by Klages (1942) who says, "Dwarf types of plants show in most instances a more favorable ratio of absorbing to transpiring surfaces." By this he means that the ratio of roots to tops is greater for dwarf types than for types growing under more humid conditions.

Knowledge of the general growth characteristics of plants may assist the habitat manager in selecting species to suit his needs. If winter cover is desired, for example, an evergreen species such as eastern redcedar will more nearly fit the requirements than a deciduous species.

The importance of some plants in the control of wind and water erosion should be carefully considered in habitat management work. Generally speaking, a direct relation exists between the height of a plant and its wind-retarding power, other factors being equal. Dense stands of trailing or decumbent species may offer effective protection against wind erosion under local conditions. The amount of foliage concentrated on or near the surface of the soil determines to a large extent the effectiveness of a plant in controlling water erosion. Many of the grass species, such as weeping lovegrass, are very effective in reducing water run-off and,

Figure 23. Planting of common cowpea showing dense growth and large amount of fruit produced. Okfuskee County.

Figure 24. A Japanese rose living fence in Okfuskee County. Note the density after only two years of growth.

consequently, loss of soil particles.

The density of the growth form is not only important in reducing losses from erosion but is also important in providing wildlife cover. Many kinds of small game prefer some dense plant cover. Bobwhites prefer cover that is dense overhead and relatively open near the ground (Stoddard, 1931). This observation is in agreement with the results obtained from this study. Chickasaw plum, smooth sumac (Figure 11), Japanese or multiflora rose (Figure 24), and shrub lespedeza (Figure 17) are plants that provide this type of cover. Plants possessing thorns or prickles, if their other attributes fulfill the requirements, are useful not only as cover for wildlife but also as a livestock barrier. These plants are used in establishing the so-called "living fences" which have been recommended so highly in several areas.

The characteristics noted under life cycle and kind of fruit need very little amplification. Perennial species are much more desirable than annuals for use in a planting program because they require less work. Several annuals are listed that reseed themselves quite readily and also possess several other very desirable characteristics. Examples of such annuals given in Tables 4 and 5 are Korean lespedeza, showy partridgepea, small wildbean, Spanishclover (American) deervetch, and trailing wildbean (Figure 26).

Many references were consulted in compiling Tables 4 and 5 in addition to field observations and information furnished by various persons. Rehder (1940) and Fernald (1950) were very useful for growth characteristics and plant distributions. Graham (1941), Pearson and Sturkie (1944), McKee and McNair (1948), and Chaffin and Woodward (No date) were helpful references for the legumes in general. Much information on the lespedezas came from Pieters (1939); McKee (1946); Davison (1948); Mississippi Game

Figure 25. Snow-on-the-mountain growing on the side of a road. Payne County.

Figure 26. Close-up of trailing wildbean. Plant to the right is showy partridgepea. Payne County.

and Fish Commission (1949); Pieters, Henson, Adams and Barnett (1950); Elder (1952); and Durham (No date). Vinall (1941); Featherly (1946); U.S. Department of Agriculture (1948); and Harlan, Denman and Elder (1953) were useful references on the grasses. Some information on pasture and forage crops came from Ahlgren (1949), Wheeler (1950), and Wolff (1950). Van Dersal (1938), Forest Service (1948), Talbert and Smith (1948), U.S. Department of Agriculture (1949), Edminster (1950), Phillips et al. (1950), and Rigdon (No date) furnished a great deal of information on trees and shrubs.

Plant Culture

A great deal of information on general methods of culture for some kinds of plants and on special cultural methods for certain species is readily available. For other species, particularly many native plants, very little, if any, information is available in the literature. During the course of this investigation some notes concerning cultural information of certain species were taken from some of the references cited at the end of the preceding section on growth characteristics. Other sources which gave useful information on methods of propagation and establishment of plants are as follows: Kains and McQuesten (1938), Toumey and Korstian (1942), Bailey (1944), Yerkes (1945), McKee (1947), and Oklahoma Planning and Resources Board (1948).

The notes are presented in Tables 6 and 7 which list the same plants as do Tables 4 and 5 respectively. Table 6 gives some information on the culture of plants which were selected as being potentially suitable for habitat management in central Oklahoma.

Table 7 gives some information on the culture of plants which were selected as being suitable for limited or special use or for experimental

Table 6. Some Cultural Information of Plants Potentially Suitable for Habitat Management

Species	Method of* Propagation	Number of Seed/Pound	Commercial Source	Time of Planting
American bittersweet	1,2,3,5	26,000	Yes	Dec.-Feb.
Blackjack oak	1,2	524	No	Fall
Black locust	1,2,3,4	24,000	Yes	Dec.-Feb.
Blue panicum	1	657,000	Yes	May-Aug.
Chickasaw plum	2	1,060	Yes	Dec.-Feb.
Dwarf chinkapin oak	1,2	400	No	Fall
Eastern redcedar	2,3	43,200	Yes	Feb.-Mar.
Flameleaf sumac	2,3	42,000	Yes	Spring
Gray dogwood	2,3,5,6	12,100	Yes	Dec.-Feb.
Korean lespedeza	1	225,000	Yes	Mar.-Apr.
Northern catalpa	2	21,000	Yes	Dec.-Feb.
Pink wildbean			No	
Post oak	1,2	400	Yes	Fall
Roughleaf dogwood	2,3,5,6	15,700	Yes	Dec.-Feb.
Rusty blackhaw viburnum	1,2,3		No	Spring
Sand paspalum	1	258,000	No	Feb.-Apr.
Showy partridgepea	1	64,000	No	Mar.-Apr.
Smooth sumac	2,3	68,600	Yes	Spring
Southern catalpa	2	20,000	Yes	Dec.-Feb.
Switchgrass	1	389,000	Yes	Mar.-Apr.
Woollybucket bumelia	2	5,700	No	Dec.-Feb.

* 1 - Seeds
2 - Seedlings
3 - Cuttings
4 - Sprouts
5 - Layers
6 - Division

purposes. Many of the field crops, such as common cowpea, are examples of the type of plant recommended for limited or special uses. These plants form an integral part of many farm crop systems and probably should not be used in locations other than cultivated fields. At least, survival and seed production on other sites, such as upland pastures and woodlands, were generally quite limited in the plantings observed during the course of this study. It will be noted in comparing Tables 6 and 7 that several more plants with unknown characteristics or requirements occur in the latter

table. Some of these plants are recommended for experimental purposes since they appear to have many very desirable features. Milkpea is an example of this type of plant. Some milkpeas grow in the woods as herbaceous, twining vines. They are tolerant to shade, and the fruit does not appear to deteriorate over winter. They are perennials, and quail are known to eat them when they are available (Table 1). But the management of milkpeas is unknown. Much work must be done in study of the ecology of milkpeas, as well as many other plants, before complete recommendations can be made concerning their use in quail management.

Table 7. Some Cultural Information of Plants Suitable for Limited, Special, or Experimental Purposes

Species	Method of* Propagation	Number of Seed/Pound	Commercial Source	Time of Planting
American filbert	1,2,3,4,5,7	476	Yes	Dec.-Feb.
Amur privet	2,3		Yes	Dec.-Feb.
Birdsfoot deervetch	1	400,000	Yes	
Chinese lespedeza	1	355,000	Yes	Mar.-Apr.
Common cowpea	1	3,000	Yes	May-June
Field pea	1	3,000	Yes	Sept.-Oct.
Hairy vetch	1	20,000	Yes	Aug.-Oct.
Hybrid filbert	1,2,3,4,5,7		Yes	Dec.-Feb.
Indiancurrant coralberry	1,2,3	144,000	Yes	Fall
Japanese rose	2,3,5		Yes	Dec.-Feb.
Japan lespedeza	1,2		No	Dec.-Feb.
Johnsongrass	1,6	118,000	Yes	April
Milkpea			No	
Mung bean	1	10,000	Yes	May-June
Rafinesque viburnum	1,2,3		No	Dec.-Feb.
Robust lespedeza	1,2		No	Dec.-Feb.
Scribner panicum	1		No	
Shortleaf pine	2	48,000	Yes	Feb.-Mar.
Shrub lespedeza	1,2	86,000	Yes	Dec.-Feb.
Small wildbean			No	
Spanishclover deervetch	1	104,000	No	
Sudangrass	1	55,000	Yes	May-June
Tatarian honeysuckle	2,3	142,000	Yes	Dec.-Feb.
Thunberg lespedeza	1,2	45,500	Yes	Dec.-Feb.
Trailing wildbean	1	9,000	No	

Table 7. -- Continued

Species	Method of* Propagation	Number of Seed/Pound	Commercial Source	Time of Planting
Weeping lovegrass	1	1,463,000	Yes	Mar.-Apr.
Woollypod vetch	1	10,000	No	Aug.-Oct.

* 1 - Seeds
2 - Seedlings
3 - Cuttings
4 - Sprouts
5 - Layers
6 - Rootstocks
7 - Suckers

Seedbed preparation and planting methods have been covered quite thoroughly by various authors. Some generalized remarks concerning these subjects might well be pertinent here. Plants that are to be established by direct seeding usually require a seedbed that is free of weeds, firm, and well supplied with moisture and plant nutrients. This is especially true of the small grains, grasses, and some legumes. Plowing followed by a disc or field cultivator to conserve moisture and control weeds will usually provide a satisfactory seedbed. Discing or harrowing just before planting will destroy weed growth. If the seed is to be drilled, a cultipacker or corrugated roller used before and after drilling will firm the soil surface and place the seed in closer contact with soil particles. When fertilizer is needed, a combination drill or drill with fertilizer attachment may be used for planting the seed and distributing the fertilizer. In some cases the seed is broadcast and covered by discing or harrowing.

An efficient method of planting seedlings or transplant stock consists of preparing a plowed and disced strip and then cutting a bed-furrow down the center of the strip. The seedlings are then properly spaced

Figure 27. A black locust postlot with bluestem understory. Provides good winter cover and food for wildlife. Okfuskee County.

Figure 28. Shrub lespedeza being placed in furrow. Plow will complete planting on next round. Okfuskee County.

Figure 29. Planting shrub lespedeza with an Oklahoma Game and Fish Department jeep equipped with plow. Okfuskee County.

Figure 30. An Oklahoma Game and Fish Department "habitat plot." Shrub lespedeza on left, sorghum and foxtail millet on right, and oak woods in background. Okfuskee County.

against the vertical berm or side of the furrow and a handful of soil pushed against the roots and base of the plant to hold it upright. The soil is then turned back by reverse-furrowing and packed by running the rear tractor wheel along each side of the row. The soil may also be firmed with a heavy roller or tramping with the feet. Figures 28 and 29 illustrate this method; a jeep was used in place of a tractor in this case. Where the soil is deficient in nutrients, a topdressing of fertilizer should be used. Mulching to suppress grass and weed competition and help prevent soil erosion is also very beneficial in most cases of establishment of seedlings or transplant stock.

Other Plants

In the following annotated list, 18 plant species or genera are given. These plants, in addition to the 48 species described earlier in this report, were suggested by W. C. Elder, Assistant Agronomist, Oklahoma Agricultural Experiment Station, and H. I. Featherly, Professor of Botany, Oklahoma A. and M. College, as being possibly important in quail habitat management work. Some of the plants listed below are unquestionably important to the farmer or rancher, and some have been shown to be eaten readily by bobwhites. These additional plants, however, did not appear to meet the criteria set forth above as well as the 48 species listed.

1. Alfalfa. This perennial plant is the most important legume hay crop in Oklahoma (U. S. Dept. of Agriculture, 1955). Alfalfa is also used in pasture mixtures, crop rotations, for green-manure, and for seed production. Although Stoddard (1931) considered alfalfa an important succulent food, it does not appear to be important in central Oklahoma. This statement is based on the fact that alfalfa is rarely found in quail

crops and, based on my experience and others (Baumgartner, personal communication), quail are seldom flushed from alfalfa fields. Alfalfa may benefit quail indirectly by raising the fertility level of the soil.

2. Common poisonivy. The habit of this plant varies from a small shrub to a high-climbing vine. Poisonivy is commonly found along fencerows, in open woods, and in bottomlands. The fruit is eaten some by quail but, based on use, is not an important food. It is not a desirable plant because of its irritating effect on the skin of many people.

3. Crotons. These reseeding annuals are common in overgrazed pastures, on idle croplands for a year or two, and in fields following small grains (Figure 19). The seeds are fairly large and do not deteriorate rapidly. Croton is an important quail and dove food in late fall and winter, especially on the prairies and plains of central Oklahoma and may have possibilities for habitat management.

4. Carolina snailseed. This climbing, bushy vine is found in woods, thickets, and along roadways. Its red drupe is available in September and is often persistent over winter. The fruit does not appear to be eaten by quail, but the plant might be good for cover.

5. Euphorbias or spurges. Many annual and perennial species of euphorbia are found in such places as overgrazed pastures, cultivated fields, idle croplands and abandoned fields, and in waste places. Some kinds also grow in thin woods and along roadsides (Figure 25). The seeds are large and apparently, based on use, a good quail food. Euphorbia seems to be unpalatable to livestock.

6. Greenbriers. These shrubby or herbaceous plants are mostly vines; some are armed with prickles or spines, and some are evergreen. The berry is eaten by quail but, based on use, has not been shown to be an important food. Some species are considered to be pests in certain

areas. Greenbrier may have limited possibilities for habitat plantings.

7. Groundcherries. Some species of these low, annual or perennial herbs are sometimes cultivated for the fruit. The berry is eaten rarely by quail and has not been shown to be an important food. The possibilities of groundcherries for habitat management are unknown.

8. Guar. This annual, drought-resistant, erect legume is adapted to about the same conditions as cowpeas. Bobwhites apparently eat the seed readily (Graham, 1941). This plant is being used somewhat as a summer forage crop in Oklahoma, and the seeds made good livestock feed. This herb has distinct possibilities for habitat management programs.

9. Hackberries. The size varies from large shrubs to large trees. Hackberry is found on a variety of sites from moist woods to dry, rocky slopes. It is drought resistant. The drupes are often persistent over winter. The fruit is eaten by quail but has not been shown to be an important food. Hackberry might be important for special plantings such as windbreaks.

10. Pennsylvania smartweed. This annual, ascending to erect herb is an inhabitant of damp shores and other moist soils. It is moderately tolerant to alkalines. The fruit is an achene, eaten some by quail but has not been shown to be important.

11. Ragweeds. All are annuals except western ragweed. Ragweeds are often abundant in grazed prairie pastures (Figure 11) and old fields and common in woodland pastures and cultivated fields after harvest. Food habit studies have shown them to be the most important late fall and winter quail food in central Oklahoma. They are not considered to be desirable plants since their pollen is one of the chief causes of hay fever.

12. Roundhead lespedeza. This stiff, erect, perennial legume which grows about three feet tall occurs in fields and pastures, open woods,

and on bare areas (Figure 22). The seeds are used by quail but have not been shown to be an important food, possibly because of the relative scarcity of the plant. This species and other native lespedezas appear to have some possibilities for habitat management.

13. Sorgho or sugar cane. This sweet sorghum is grown for the making of syrup from the stalks and for fodder. The seeds from some varieties, based on use, are important to quail for food. The grain sorghum varieties are more important, however. Sorgho does not appear to be as desirable in a management program as many other plants.

14. Sunflowers. These species are mostly perennials, but common sunflower is a well-known annual. They are second in importance, based on use, to ragweed as a late fall and winter food. Sunflowers are mainly tall-growing herbs (Figure 16) that are often dominants for a year or two following cultivation. They provide good cover in summer and fall. Many birds and small mammals compete with quail for the seed; the supply is thus limited in late winter (Baumgartner, 1946). Sunflowers might have some possible uses in quail management.

15. Sweetclover. This tall-growing, branching, annual or biennial, herbaceous legume is used for a pasture crop, in crop rotations, and for soil improvement and green-manure. Sweetclover is drought resistant but has a high requirement for calcium and phosphorus. The seed is eaten by quail but has not been shown to be an important food. Sweetclover is very important in soil conservation programs and may indirectly benefit quail.

16. Tickclover. This perennial, herbaceous legume is often confused with native lespedezas. Tickclover grows in open woods, slightly shaded areas, and idle fields and disturbed areas. Based on use, the fruit is a good food but the plant is generally not very abundant. It has been grown to some extent as a forage and green-manure crop and has some

possibilities of development for habitat management.

17. Wild grapes. These plants are usually vigorous, high-climbing vines, but some may occur as shrubs on unfavorable sites. Some kinds occur commonly as shrubs, the forms varying from stout, erect types to low, bushy or trailing ones. The sites vary from dense river bottoms to exposed, dry slopes. The fruit is eaten by quail but has not been shown to be an important food. The frost grape has been tried in the field in the Northeast and is not recommended for habitat plantings (Edminster, 1950). Some species may have possibilities for habitat planting in Oklahoma.

18. Yellow Indiangrass. This moderately tall, erect, perennial grass is common in prairies and open woods. The seed is eaten by quail but in very limited amounts. This important forage species is used in pasture mixtures and revegetation of range lands.

Table 8. Common and Scientific Names of Plants Used in This Report

Common Name	Scientific Name
Alfalfa	Medicago sativa L.
Amaranth	Amaranthus spp.
American bittersweet	Celastrus scandens L.
American elm	Ulmus americana L.
American filbert	Corylus americana Walt.
American sycamore	Platanus occidentalis L.
Amur privet	Ligustrum amurense Carr.
Ash	Fraxinus spp.
Avens	Geum spp.
Barley	Hordeum vulgare L.
Beggarticks	Bidens spp.
Big bluestem	Andropogon gerardi Vitmin
Birdsfoot deervetch	Lotus corniculatus L.
Bitternut hickory	Carya cordiformis (Wang.) K. Koch
Black hickory	Carya texana Buckl.
Blackjack oak	Quercus marilandica Muench.
Black locust	Robinia pseudo-acacia L.
Black oak	Quercus spp.

Table 8. -- Continued

Common Name	Scientific Name
Blue grama	Bouteloua gracilis (HBK.) Lag.
Blue panicum	Panicum antidotale Retz.
Bluestem	Andropogon spp.
Bristlegrass	Setaria spp.
Broadleaf uniola	Uniola latifolia Michx.
Brome	Bromus spp.
Buffalograss	Buchloe dactyloides (Nutt.) Engelm.
Bundleflower	Desmanthus spp.
Buttonweed	Diodia spp.
Carolina snailseed	Cocculus carolinus (L.) DC.
Catalpa	Catalpa spp.
Chickasaw plum	Prunus angustifolia Marsh.
Chinese lespedeza	Lespedeza cuneata (Dumont) G. Don
Chinkapin oak	Quercus muhlenbergii Engelm.
Common cowpea	Vigna sinensis (L.) Endl.
Common oat	Avena sativa L.
Common perilla	Perilla frutescens (L.) Britton
Common persimmon	Diospyros virginiana L.
Common poisonivy	Rhus radicans L.
Common sunflower	Helianthus annuus L.
Copperleaf	Acalypha spp.
Corn	Zea mays L.
Cotton	Gossypium spp.
Crabgrass	Digitaria spp.
Croton	Croton spp.
Crotonopsis	Crotonopsis linearis Michx.
Crownbeard	Verbesina spp.
Cultivated lespedeza	Lespedeza spp.
Dalea	Dalea spp.
Dayflower	Commelina spp.
Dogwood	Cornus spp.
Dropseed	Sporobolus spp.
Dwarf chinkapin oak	Quercus prinoides Willd.
Eastern black walnut	Juglans nigra L.
Eastern poplar	Populus deltoides Marsh.
Eastern redcedar	Juniperus virginiana L.
Elm	Ulmus spp.
Euphorbia	Euphorbia spp.
Fall witchgrass	Leptoloma cognatum (Schultes) Chase
Field pea	Pisum sativum L., var. arvense (L.) Poir.
Flameleaf sumac	Rhus copallina L.
Foxtail millet	Setaria italica (L.) Beauv.
Fragrant sumac	Rhus aromatica Ait.
Frost grape	Vitis vulpina L.
Gaura	Gaura spp.
Geranium	Geranium spp.

Table 8. -- Continued

Common Name	Scientific Name
Goldenweed	Prionopsis ciliata Nutt.
Goosefoot	Chenopodium spp.
Gray dogwood	Cornus racemosa Lam.
Greenbrier	Smilax spp.
Groundcherry	Physalis spp.
Guar	Cyamopsis psoraloides DC.
Hackberry	Celtis spp.
Hairy vetch	Vicia villosa Roth.
Hawthorn	Crataegus spp.
Hickory	Carya spp.
Hogpeanut	Amphicarpa spp.
Hybrid filbert	Corylus americana Walt. X avellana L.
Indiancurrant coralberry	Symphoricarpos orbiculatus Moench
Japanese rose	Rosa multiflora Thunb.
Japan lespedeza	Lespedeza japonica Bailey, var. intermedia
Johnsongrass	Sorghum halpense (L.) Pers.
Knotweed	Polygonum spp.
Korean lespedeza	Lespedeza stipulacea Maxim.
Lespedeza	Lespedeza spp.
Little bluestem	Andropogon scoparius Michx.
Milkpea	Galactia spp.
Mung bean	Phaseolus aureus Roxb.
Nightshade	Solanum spp.
Northern catalpa	Catalpa speciosa Warder
Oak	Quercus spp.
Osageorange	Maclura pomifera (Raf.) Schneider
Panicum	Panicum spp.
Paspalum	Paspalum spp.
Peanut	Arachis hypogaea L.
Pecan	Carya illinoensis (Wang.) K. Koch
Pennsylvania smartweed	Polygonum pensylvanicum L.
Pink wildbean	Strophostyles umbellata (Muhl.) Britton
Plum	Prunus spp.
Post oak	Quercus stellata Wang.
Pricklepoppy	Argemone spp.
Rafinesque viburnum	Viburnum rafinesquianum Schultes
Ragweed	Ambrosia spp.
Robust lespedeza	Lespedeza robusta
Roughleaf dogwood	Cornus drummondii C. A. Meyer
Roundhead lespedeza	Lespedeza capitata Michx.
Rusty blackhaw viburnum	Viburnum rufidulum Raf.
Rye	Secale cereale L.
Sand paspalum	Paspalum ciliatifolium Michx., var. stramineum (Nash) Fern.
Scribner panicum	Panicum oligosanthes Schultes, var. scribnerianum (Nash) Fern.

Table 8. -- Continued

Common Name	Scientific Name
Scurfpea	Psoralea spp.
Seacoast sumpweed	Iva ciliata Willd.
Sedge	Carex spp.
Shortleaf pine	Pinus echinata Mill.
Showy partridgepea	Cassia fasciculata Michx.
Shrub lespedeza	Lespedeza bicolor Turcz.
Sideoats grama	Bouteloua curtipendula (Michx.) Torr.
Silver bluestem	Andropogon saccharoides Sw.
Small wildbean	Strophostyles leiosperma (T. & G.) Piper
Smooth sumac	Rhus glabra L.
Snakeweed	Xanthocephalum spp.
Snow-on-the-mountain	Euphorbia marginata Pursh
Sorgho	Sorghum vulgare Pers., var. saccharatum (L.) Boerl.
Sorghum	Sorghum vulgare Pers.
Southern catalpa	Catalpa bignonioides Walt.
Spanishclover deervetch	Lotus americanus (Nutt.) Bisch.
Sudangrass	Sorghum vulgare Pers., var. sudanense Hitchc.
Sumac	Rhus spp.
Sunflower	Helianthus spp.
Sweetclover	Melilotus spp.
Switchgrass	Panicum virgatum L.
Tatarian honeysuckle	Lonicera tatarica L.
Texas treadsoftly	Cnidoscolus texanus (Muell. Arg.) Small
Thunberg lespedeza	Lespedeza thunbergii (DC.) Nakai
Tickclover	Desmodium spp.
Trailing wildbean	Strophostyles helvola (L.) Ell.
Treebine	Cissus incisa (Nutt.) Des Moulins
Tumble ringwing	Cycloloma atriplicifolium (Spreng.) Coult.
Tumbling Russianthistle	Salsola kali L.
Weeping lovegrass	Eragrostis curvula Nees
Western ragweed	Ambrosia psilostachya DC.
Wheat	Triticum aestivum L.
Wildbean	Strophostyles spp.
Wild grape	Vitis spp.
Wild lespedeza	Lespedeza spp.
Woollybucket bumelia	Bumelia lanuginosa (Michx.) Pers.
Woolly croton	Croton capitatus Michx.
Woollypod vetch	Vicia dasycarpa Ten.
Yellow Indiangrass	Sorghastrum nutans (L.) Nash

HABITAT MANAGEMENT

Habitat management, commonly called "habitat improvement," usually involves the management of plants, and is used in that sense in this report. Habitat management for wildlife has been practiced to some degree since 700 years before Christ (Luckenbill, 1927), but it has been only recently, in the last 25 years or less, that its practice has increased to any great extent. Many states are now spending a great deal of money on habitat management, and many persons have recommended that even more be spent.

It might be well to inquire at this point, "Does habitat management do any good?" Graham (1947), Davison (1949), Edminster (1950), Gabrielson (1951), and others have stated that habitat management is the most promising present development for the future of wildlife.

There are few studies that show just how and to what extent habitat managements have benefited wildlife. Steen (1950) shows that quail populations were increased by a deliberate management of the environment. The influences from these environmental changes are not apparent immediately, since several years are required for the plants to become established and exert a telling influence.

Some writers have questioned the importance of food and cover as limiting factors for bobwhite populations, and others have been concerned as to whether habitat management is justified in view of its expense and the lack of proof that wildlife is thus increased (Allen, 1952). Habitat management is worthwhile if the land is improved.

Well conceived and applied habitat plantings may increase the carrying capacity of areas where quail already exist and increase the number of suitable bobwhite ranges. They should reduce or check erosion and increase the fertility of the soil.

The Oklahoma Game and Fish Department has taken an active and increasing interest in habitat management. In the period of 1948 to 1950, a large number of "habitat plots" were established. These were small, fenced plots which were located on a wide variety of soil types and in different climatic conditions. While not intended as a solution to the problem, they furnished some useful information concerning the site and cultural relations of some of the plant species. Some of the information in this report was derived from a study of these plots, an example of which is shown is Figure 30.

When farmers become acquainted with plants that supplement their income they have a tendency to use them. If the plants benefit the land or the farmer they are worthwhile even though useless or of questionable value to wildlife.

Specific Uses of Desirable Plants

Field and Woodland Borders

The margins of cultivated fields, woods, roadsides, windbreaks, and other such areas present a special problem to the habitat manager and yet provide an opportunity to increase game food and cover. Erosion has been apparent on such areas, and landowners are quite amenable to suggestions on what to do with these margins. The edges of croplands next to wooded areas present a special problem. It was noted in the study that crop yields on the strip adjacent to the woods are reduced considerably, so it is hardly worth the expense to cultivate and plant these strips.

If the border is left untilled it grows weeds and offers expansion for the trees. A border of shrubs and low-growing species will fill in this problem space and prevent the encroachment of the woods. The herbaceous or grass species will also provide space for turning farm machinery but must be able to stand this type of treatment. Plants which seem to be most desirable for borders are given in the following lists. Several other species are also listed in Table 9, but less is known about their potentialities.

Low shrubs
- Flameleaf sumac
- Gray dogwood
- Indiancurrant coralberry
- Rafinesque viburnum

Grasses and herbs
- Chinese lespedeza
- Korean lespedeza
- Pink wildbean
- Sand paspalum
- Scribner panicum
- Sudangrass
- Weeping lovegrass

Medium to high shrubs
- American filbert
- Chickasaw plum
- Dwarf chinkapin oak
- Hybrid filbert
- Japanese rose
- Roughleaf dogwood
- Rusty blackhaw viburnum
- Shrub lespedeza
- Smooth sumac
- Tatarian honeysuckle

Vines
- American bittersweet

Cultivated Fields

Land devoted exclusively to the cultivation of crops would appear at first sight to have little value for wildlife. Cultivated fields are in fact valuable to wildlife for several reasons. For example, the edges of fields, depressions or high spots, or other areas unsuitable for cultivation are well adapted for habitat plantings. Agronomic practices, especially from the soil conservation standpoint, may also be of much value for quail. Such things as strip-cropping, use of cover crops, crop rotations, and use of green manure or soil-improvement crops may add large amounts of highly nutritious foods to an area. Mechanical harvesting of crops, as shown in Figure 31, may also leave considerable quantities of food in the fields, at least for short periods of time.

While there are several other crop species grown in central Oklahoma that furnish food for quail, the following plants are listed mainly for their soil conservation values.

Winter species
- Field pea
- Hairy vetch
- Woollypod vetch

Summer species
- Birdsfoot deervetch
- Chinese lespedeza
- Common cowpea
- Korean lespedeza
- Mung bean
- Sudangrass

Fencerows and Hedges

Hedges and fences of living plants have been used for centuries and appear to have a definite place in agriculture. The hedges on the Midwest landscapes were a familiar sight until a few years ago, but the plants used in these hedges were mostly tree species that sapped the soil and made nearby crops unproductive. Also, they easily grew out-of-hand and became unsightly.

Plants selected for hedges and living fences must, in general, be low-growing species of good form that require little upkeep. They should not spread prolifically and become pests. Fences and hedges composed of desirable species would be useful for permanent guides for contour operations such as strip cropping, for erosion control, and for providing a more attractive landscape. A plant used in a fence to repel livestock must be very dense and compact and should preferably possess thorns. Japanese rose (multiflora), shown in Figure 32, possesses these characteristics and makes a very effective livestock barrier. The plants listed below are believed suitable for hedges and living fences.

Low shrubs
- Gray dogwood
- Indiancurrant coralberry

Vines
- American bittersweet

Medium to high shrubs
- American filbert
- Amur privet
- Chickasaw plum
- Dwarf chinkapin oak
- Hybrid filbert

Figure 31. Harvesting a field of corn with a mechanical picker. Payne County.

Figure 32. A Japanese rose living fence on the left and shrub lespedeza on the right. The pasture in extreme right is mostly bluestems. Okfuskee County.

Trees
- Eastern redcedar
- Woollybucket bumelia

Medium to high shrubs -- Cont'd
- Japanese rose
- Roughleaf dogwood
- Shrub lespedeza
- Tatarian honeysuckle

Gullies

In central Oklahoma gullies are usually a sign of poor land management. The most costly result is the damage done to the land, but they also hinder crop cultivation or make it virtually impossible. They destroy trees in woodlands and endanger cattle grazing in pastures. Gullies increase maintenance costs on highways, railroads, and public and private structures. Badly eroded land is unproductive for wildlife unless it can be restored to a condition where it will grow a greater abundance and variety of plants.

Many plant species may be used in gully stabilization and control. From the list of plants (Tables 4 and 5) recommended for habitat management in central Oklahoma, the following species seem to be the most suitable for gully control. Several other plants are also given in Table 9, but their capabilities for gully revegetation are not known.

Shallow gullies
- American bittersweet
- Flameleaf sumac
- Indiancurrant coralberry
- Japanese rose
- Korean lespedeza
- Pink wildbean
- Roughleaf dogwood
- Rusty blackhaw viburnum
- Shrub lespedeza
- Smooth sumac
- Sudangrass
- Tatarian honeysuckle

Deep gullies
- Birdsfoot deervetch
- Black locust
- Chickasaw plum
- Eastern redcedar
- Gray dogwood
- Scribner panicum
- Shortleaf pine

Vegetated waterways
- Chinese lespedeza
- Switchgrass
- Weeping lovegrass

Hayfields and Meadows

Hayfields and meadows differ from pastures in that they are not normally grazed, but the plants composing them are mowed for hay, silage,

Table 9. Specific Uses and Values of Plants Selected for Environmental Management

Species	Borders	Cultivated Fields	Fencerows, Hedges	Gullies	Hayfields, Meadows	Pastures, Range	Postlots	Shelterbelts, Windbreaks	Woodlands	Erosion Control	Honey Plant	Human Food	Ornamentals	Soil Improvement	Wood Products
American bittersweet	+	o	+	+	o	o	o	+	+	o	o	o	+	o	+
Blackjack oak	o	o	o	o	o	o	o	+	o	o	o	o	o	o	+
Black locust	o	o	+	+	o	o	+	+	+	+	+	o	+	+	+
Blue panicum	o	o	o	o	+	+	o	+	o	+	o	o	o	o	o
Chickasaw plum	+	o	+	+	o	o	o	+	+	+	o	+	o	o	o
Dwarf chinkapin oak	+	o	+	o	o	o	o	+	o	+	o	o	o	o	o
Eastern redcedar	o	o	+	+	o	o	o	+	+	+	o	o	+	o	+
Flameleaf sumac	+	o	o	+	o	o	o	+	+	+	o	o	+	o	o
Gray dogwood	+	o	+	+	o	o	o	+	+	o	o	o	+	o	o
Korean lespedeza	+	+	o	+	+	+	+	o	+	+	o	o	o	+	o
Northern catalpa	o	o	o	+	o	o	+	+	+	o	o	o	+	o	+
Pink wildbean	+	o	o	+	o	o	o	+	o	+	o	o	o	+	o
Post oak	o	o	o	o	o	o	o	+	+	o	o	o	o	o	+
Roughleaf dogwood	+	o	+	+	o	o	o	+	o	+	o	o	+	o	o
Rusty blackhaw viburnum	+	o	o	+	o	o	o	+	o	o	o	o	+	o	o
Sand paspalum	+	o	o	o	o	+	o	o	o	o	o	o	o	o	o
Showy partridgepea	+	o	o	o	o	+	o	o	+	+	+	o	o	+	o
Smooth sumac	+	o	o	+	o	o	o	+	o	+	o	o	+	o	+
Southern catalpa	o	o	o	o	o	o	+	+	+	o	o	o	+	o	+
Switchgrass	o	o	o	+	+	+	o	o	o	+	o	o	o	o	o
Woollybucket bumelia	o	o	+	o	o	o	o	+	+	o	+	o	+	o	o
American filbert	+	o	+	o	o	o	o	+	+	+	o	+	+	o	o
Amur privet	o	o	+	o	o	o	o	+	+	+	o	o	+	o	o

Table 9. -- Continued

Species	Borders	Cultivated Fields	Fencerows, Hedges	Gullies	Hayfields, Meadows	Pastures, Range	Postlots	Shelterbelts, Windbreaks	Woodlands	Erosion Control	Honey Plant	Human Food	Ornamentals	Soil Improvement	Wood Products
Birdsfoot deervetch.	o	+	o	+	+	+	o	o	o	+	+	o	o	+	o
Chinese lespedeza.	+	+	o	+	+	+	o	o	+	+	+	o	o	+	o
Common cowpea.	o	+	o	o	+	+	o	o	o	o	+	+	o	+	o
Field pea.	o	+	o	o	+	o	o	o	o	+	o	o	o	+	o
Hairy vetch.	o	+	o	o	+	+	o	o	o	+	+	o	o	+	o
Hybrid filbert	+	o	+	o	o	o	o	+	+	o	o	+	+	o	o
Indiancurrant coralberry . .	+	o	+	+	o	o	o	+	+	+	o	o	+	o	o
Japanese rose.	+	o	+	+	o	o	o	+	+	+	o	o	+	o	o
Japan lespedeza.	+	o	+	+	o	o	o	o	+	+	+	o	+	+	o
Johnsongrass	o	o	o	o	+	+	o	o	o	o	o	o	o	o	o
Milkpea.	o	o	o	o	o	o	o	o	+	+	o	o	o	+	o
Mung bean.	o	+	o	o	+	o	o	o	o	o	o	+	o	+	o
Rafinesque viburnum.	+	o	o	+	o	o	o	+	+	o	o	o	+	o	o
Robust lespedeza	+	o	+	+	o	o	o	o	+	+	+	o	+	+	o
Scribner panicum	+	o	o	+	o	+	o	o	+	+	o	o	o	o	o
Shortleaf pine	o	o	o	+	o	o	o	+	+	+	o	o	o	o	+
Shrub lespedeza.	+	o	+	+	o	o	o	o	+	+	+	o	+	+	o
Small wildbean	o	o	o	o	o	+	o	o	o	+	o	o	o	+	o
Spanishclover deervetch. . .	o	o	o	o	o	+	o	o	+	+	o	o	o	+	o
Sudangrass	+	+	o	+	+	+	o	o	o	+	o	o	o	o	o
Tatarian honeysuckle	+	o	+	+	o	o	o	+	+	+	o	o	+	o	o
Thunberg lespedeza	+	o	+	+	o	o	o	o	+	+	+	o	+	+	o
Trailing wildbean.	o	o	o	o	o	+	o	o	+	+	o	o	o	+	o
Weeping lovegrass.	+	o	o	+	+	+	o	o	o	+	o	o	o	+	o
Woollypod vetch.	o	+	o	o	+	+	o	o	o	+	+	o	o	+	o

or for soiling crops and are later fed to livestock. Some meadows are quite permanent in that they are composed of perennial species maintained on a long-term basis. Others are temporary, and may even be made up of annual species. Leguminous plants, either alone or in grass mixtures, produce a high-quality hay and help to enrich the soil. Several of the meadow grasses furnish very good nesting cover for quail. It was observed during this study that weeping lovegrass (Figure 33) provided excellent quail nesting cover. This fact has also been reported by DeArment (1950).

Some plants useful for hayfields and meadows, beneficial both to the land and wildlife, are listed below.

Birdsfoot deervetch
Blue panicum
Chinese lespedeza
Common cowpea
Field pea
Hairy vetch
Korean lespedeza
Mung bean
Sudangrass
Switchgrass
Weeping lovegrass
Woollypod vetch

Another species, Johnsongrass, is not recommended for increased plantings, since it is difficult to eradicate and is considered a noxious weed in Oklahoma. It should be noted, however, that Johnsongrass makes a very good hay if properly managed and is a desirable food and cover plant for quail. Better utilization of the Johnsongrass already in existence will help the landowner recoup some of the loss attributed to this plant.

Pastures and Ranges

Our native pastures and rangelands, although difficult to manage for upland game, offer great opportunity to improve the quail habitat. Competition for the forage plants and for seeds varies from light to severe in different areas. Sometimes quail nests in pastures are damaged by livestock as shown in Figure 34 in which a nest has been trampled and partially destroyed.

The legumes which occur in pastures furnish a very nutritious part

Figure 33. A meadow of weeping lovegrass which has been mowed and baled. Note the density of the grass and the oak savannah in background. Payne County.

Figure 34. Quail nest containing 13 eggs in native pasture. One had hatched, and seven had been trampled by livestock. Okfuskee County.

of the diet for livestock. It is these plants that are usually the first to be eliminated when an area is too heavily grazed. This observation was also noted by Hanson (1955) in western Oklahoma. In the revegetation of overgrazed rangelands, adapted legumes should be included in the planting mixtures. It has even been considered worthwhile to supplement the pastures which are in good condition with leguminous forage plants in order to increase livestock production. These practices would also be of benefit to the land and to wildlife.

Johnsongrass, usually found on the more productive bottomlands in pastures, provides good grazing for all classes of livestock. The same recommendations for Johnsongrass that were mentioned under hayfields and meadows apply here in regard to increasing the acreage of this grass.

Stock-watering ponds, seeps and springs, and eroded areas should be fenced as recommended by the Soil Conservation Service and others. The areas would be of great benefit to quail if planted with the proper kinds of cover. Japanese rose (multiflora) has been used to advantage for fencing such areas. In addition to other adapted woody plants, species which would be of benefit to both livestock and quail are listed below.

Birdsfoot deervetch
Blue panicum
Chinese lespedeza
Common cowpea
Hairy vetch
Korean lespedeza
Sand paspalum
Scribner panicum
Showy partridgepea
Small wildbean
Spanishclover deervetch
Sudangrass
Switchgrass
Trailing wildbean
Weeping lovegrass
Woollypod vetch

Postlots and Woodlands

A postlot is an even-aged stand of trees managed for post production. A farm woodlot is almost always of uneven age and may not be managed for wood products. Many woodlands are grazed and may be burned under the impression that this practice benefits grazing. Uncontrolled

burning may or may not be a beneficial tool in woodland forage production, but it was not found to be of benefit to timber production on my study areas. In fact, burning is recommended in very few instances where woodlands are managed for timber production (Westveld, 1939). The management of a woodland for timber and other wood products would seem to be the most economical practice in most cases, as the demand is usually heavy for such products.

Clear cutting of trees is usually practiced in even-aged stands, while selective cutting is usually done in uneven-aged stands. Selective cutting is also of benefit to wildlife, since the composition of the stand is quite varied. Opening up the stand to permit better timber production and the planting of desirable species in openings and on the borders of woods is known to increase quail in the Southeast (Stoddard, 1931). It apparently has not been adequately tested in Oklahoma.

The following are plants which appear to be desirable for woodland plantings.

Vines
- American bittersweet

Low shrubs
- Flameleaf sumac
- Gray dogwood
- Indiancurrant coralberry
- Rafinesque viburnum

Medium to high shrubs
- American filbert
- Amur privet
- Chickasaw plum
- Hybrid filbert
- Japanese rose
- Shrub lespedeza
- Tatarian honeysuckle

Grasses and herbs
- Chinese lespedeza
- Korean lespedeza
- Milkpea
- Scribner panicum
- Showy partridgepea
- Spanishclover deervetch
- Trailing wildbean

Trees
- Eastern redcedar
- Post oak
- Shortleaf pine
- Woollybucket bumelia

Postlots:
- Black locust
- Northern catalpa
- Southern catalpa

Shelterbelts and Windbreaks

In open country where wind velocities are high, windbreaks are an

established land-use device. On the windward side of cultivated fields, around farm buildings, and other such places, windbreaks can be effectively used to check the force of air currents. Shelterbelts are not used extensively in central Oklahoma but appear to have considerable value in providing food and shelter for bobwhites.

Plants which appear to be adapted for shelterbelt plantings, besides furnishing valuable food and shelter for wildlife in open areas, are mentioned below.

Trees
- Blackjack oak
- Black locust
- Eastern redcedar
- Northern catalpa
- Post oak
- Shortleaf pine
- Southern catalpa
- Woollybucket bumelia

Vines
- American bittersweet

Grasses and herbs
- Blue panicum
- Pink wildbean

Low shrubs
- Flameleaf sumac
- Gray dogwood
- Indiancurrant coralberry
- Rafinesque viburnum

Medium to high shrubs
- American and Hybrid filbert
- Amur privet
- Chickasaw plum
- Dwarf chinkapin oak
- Japanese rose
- Roughleaf dogwood
- Rusty blackhaw viburnum
- Smooth sumac
- Tatarian honeysuckle

Other Uses

Table 9 lists some additional uses of the 48 plants selected as being potentially suitable for habitat management for quail in central Oklahoma. These include erosion control (both wind and water), honey plants, human food, ornamentals, soil improvement, and wood products such as timber, pulpwood, flooring, and so on. Where such values are recognized wider acceptance and greater use of the plants can be expected. There are apparently few landowners who have the incentive to make plantings solely for wildlife purposes. Such work will probably be left to public agencies and other interested groups.

There are, of course, other areas than the specific ones discussed

previously that can be improved for wildlife. Such sites as streambanks, rough spots, "odd" corners, marshy areas, ditches, roadsides, and spoilbanks may all be planted with species that would both benefit the land and improve conditions for game. A cash return might even be realized from some of these areas. In the end, however, wildlife will benefit the greatest from practices which are integrated with sound land management techniques. Conservation farming is generally good "wildlife farming."

Summary of Plants Selected for Habitat Management

Most of the material presented in the following annotated list has been given in the tables and preceding discussions. Although the criteria for evaluation of useful plants have already been outlined and species selected on the basis of those criteria, it was considered appropriate to summarize the important characteristics of the species recommended for habitat improvement in central Oklahoma. Pertinent information not discussed previously is also given in the list. Much of the detailed information shown in Tables 4-7 is not presented in the following list; the reader is referred to those tables for such information. All of the plants discussed in the preceding sections are not recommended for general habitat management; some are presented as being appropriate for limited, special, or experimental purposes.

In the annotated list small shrubs are those which are generally less than six feet in height. The species are considered to be deciduous unless noted as evergreen, perennial unless noted as annual, and not tolerant to shade unless noted otherwise. The food values are based upon degree of use derived from food habits studies. The cover values are based upon personal field observations and supported by the observations of others. The specific uses of the selected plants in habitat management

are presented in detail in the preceding section and are not repeated here.

1. American bittersweet. This high-climbing or thicket-forming, woody vine reproduces by layering and stolons but not prolifically. Although the seeds are not eaten frequently, this plant furnishes satisfactory cover. Seed dispersal is from about September to February and sometimes later. Good seed crops are borne nearly every year, and fruiting begins about the fifth year. Although this species occurs on many soil types, the growth is limited on poor soils. American bittersweet is shade tolerant. It is damaged by livestock grazing and too much competition.

2. Blackjack oak. This species is usually a small tree, 20-30 feet tall, but may be shrubby or grow up to 60 feet, depending on the site. The acorn is an important food. This plant furnishes poor cover except in shrubby form when it is used heavily as a loafing ground. The acorns, which take two years to mature, are available from September to March. Although this oak occurs on many sites, it is usually found on poor, dry, upland soils. Blackjack oak is disease resistant, slow growing, and long lived.

3. Black locust. This fast-growing, medium-sized, leguminous tree may grow up to 70-80 feet on some sites and coppices freely after cutting. The fruit is a fair food. This tree furnishes poor cover except when small. Black locust postlots, though, seem to provide good quail cover as coveys were frequently observed in such plantings, especially during fall and winter. Seed dispersal is from September to April. Good seed crops are borne every one to two years, and fruiting begins about the sixth year. Black locust prefers moist, rich soils but is hardy on poor, dry sites. It is drought tolerant, shade tolerant, and somewhat

alkali tolerant. This plant is easily grown from seed and transplants well when young. Black locust is valued for erosion control, as a honey plant, as an ornamental, and for soil improvement. The wood is valuable for posts (Figure 27), ties, poles, and fuel. The shoots and bark are somewhat poisonous to livestock.

4. Blue panicum. This erect, vigorous, deep-rooted grass with broad leaves and heavy basal growth grows up to eight feet tall. It was introduced from India. Blue panicum furnishes good cover; the food value is unknown. Seed dispersal starts in August. Although this grass is adapted to heavy soils it requires fairly fertile sites. This species produces a large amount of forage and is a good seeder but will not stand close grazing. Blue panicum is valued for streambank protection and for hay and seed production.

5. Chickasaw plum. This thicket-forming, somewhat thorny shrub (Figure 6) or small tree usually grows to a height of 4-10 feet. The fruit is a fair food; fruit dispersal occurs from May to August. This plant furnishes excellent cover in summer and fair cover in winter. Hanson (1953) has also commented on the cover value of this species and considered it to be the most important quail cover plant in northwestern Oklahoma. This drought tolerant plum is found mostly on sandy soils but occurs on other sites. This plant is useful for erosion control and the fruit as human food.

6. Dwarf chinkapin oak. This thicket-forming, large shrub is occasionally found as a small tree and is comparatively fast growing. The acorn is an important fall and winter food. This species furnishes good cover in summer and fair cover in winter. The acorns are available from September to April. This plant is usually found on sandy soils, sometimes on other sites. This oak is valuable for erosion control.

7. Eastern redcedar. This small to large, evergreen tree generally does not grow more than 40-50 feet tall. The fruit is occasionally eaten by quail (Korschgen, 1952). Redcedar provides good shelter for quail, particularly in winter. Fruit dispersal occurs from mid-September to March, and even later. Good seed crops are borne every two to three years with light crops intervening. Fruiting begins in about 10 years. Adapted to almost all soils, this tree is slow growing and long lived. Although this species is partially shade tolerant, drought tolerant, and resists grazing, it is easily killed by fire. As it is a host to apple rust, it should not be planted near orchards. Eastern redcedar is useful for control of erosion and as an ornamental, and the wood is valuable.

8. Flameleaf and Smooth sumacs. These thicket-forming shrubs or small trees furnish fair food and good summer cover. During periods of critical weather, quail coveys are frequently found in or around sumac thickets. This observation has also been reported by Williams (1952). The fruit is persistent from September to early summer; fruiting begins about the fourth year in flameleaf sumac. These sumacs are usually found on dry, well-drained, slightly acid sites, although smooth sumac prefers somewhat more moist sites than flameleaf. These shade tolerant shrubs (Figures 6 and 11) are useful for erosion control and as ornamentals.

9. Gray dogwood. This thickly-branched, upright, thicket-forming shrub grows 4-8 feet tall. Some reproduction is by stolons, but this is not prolific. The species has fair food and good summer cover values. Fruit dispersal is from August to early winter, and fruit is produced about the fifth year. This partially shade tolerant plant is adapted to most all soils except wet ones. This dogwood is valued for erosion control and as an ornamental.

10. Korean lespedeza. Introduced from Korea, this erect, leafy,

annual, summer legume reseeds itself. The seed which is available from August to May is an important food, especially in winter. This species will grow on almost any soil except high-lime or extremely wet or sandy ones and is suitable for acid soils of low fertility. Although shade tolerant and drought resistant, it is killed by severe frosts. The feeding value to livestock is nearly equal to alfalfa. This lespedeza is valued for conservation cropping systems, erosion control, green manure and soil improvement, hay and seed production, and temporary grazing.

11. Northern and Southern catalpas. Medium-sized trees growing up to 40-50 feet tall, southern catalpa is usually the smaller. They furnish fair food and poor cover except when small. Seed dispersal is from September to April. Northern catalpa bears good seed crops every two to three years with light crops intervening. The commercial seed-bearing age is 20 years. They grow best on well-drained, moist, fertile soils but will grow on overflow land if flooding lasts less than about 10 days. They are rapid growing, short lived and coppice freely. The wood is valued for posts (Figure 21) and other wood products, and the trees are used as ornamentals.

12. Pink wildbean. This herbaceous legume with trailing stems frequently climbs over other plants and shrubby thickets. The fruit is an important food for quail. This plant provides poor cover except when growing in thick stands. This species occurs primarily on surface soils of medium to coarse texture and is usually found in sandy woods, old fields, and clearings. The seed is available from October to March. This plant might be useful for erosion control and soil improvement.

13. Post oak. A medium tree (Figure 15) growing up to 50-60 feet tall, it is sometimes shrubby on poor sites. The acorn is an important fall and winter food. This tree furnishes poor cover except when shrubby

or small. The acorns are available from September to about March. Good seed crops are borne every two to three years with light crops intervening. Commercial seed bearing age is about 25 years. This species is usually found on dry, well-drained sites with poorer soils but will make better growth on more fertile soils. Shade tolerant when young, it is long lived and slow growing. The wood is useful for rough lumber, ties, and posts.

14. Roughleaf dogwood. A large shrub growing 8-15 feet tall, it is sometimes found as a small tree. Its value for food and summer cover is fair. Fruit dispersal is from August to November, sometimes later. This dogwood prefers well-drained, moist, sandy soils but will grow on drier sites. It is valuable for erosion control and as an ornamental.

15. Rusty blackhaw viburnum (Southern blackhaw). This slow-growing, long-lived, large shrub may become a small tree on good sites. Usually it is found on dry, well-drained, neutral soils such as sandy loams, but will grow on others. It has fair food and good summer cover values. Fruit dispersal occurs in October and November, but the fruit is sometimes persistent until March. This species is disease and insect resistant. The plant is useful for erosion control and as an ornamental.

16. Sand paspalum. The seed of this short, semiprostrate, bunch grass is an important food. This plant provides fairly good cover for quail. The seeds are available from August to March. This species is commonly found on sandy lands and even on loose, shifting sands. The foliage is very palatable to livestock.

17. Showy partridgepea. This annual, erect or spreading, herbaceous legume grows 1-3 feet high. It will reseed and volunteers after light discing. It provides good food and summer cover. This species occurs in sandy, open soils of low fertility in dry fields and meadows and is

commonly found in cultivated fields after harvest. The seeds are available from October to March. Tolerant to shade, this plant grows best in the sun (Figure 13). Valued as a honey plant, it is potentially useful for soil improvement and erosion control.

18. Switchgrass. This deep-rooted, sod-forming grass grows 3-5 feet tall. Reproduction is by short, vigorous rhizomes. The seed is a fair food, and the plant provides good cover. The seed is available from September to December and later. This species which grows on nearly all soil types is usually found on sandy soils. Selected strains of switchgrass are resistant to stem rust. It is valuable for hay and seed production, seeding drainage ways and terrace outlets, grass mixtures on sandy and poorly drained land, and for dune stabilization.

19. Woollybucket bumelia (Chittam wood). This large, spiny shrub or small tree (Figure 14) is semievergreen and thicket forming. The fruit is a good quail food, and the plant furnishes good cover when shrubby and small. Fruit dispersal is from September to winter, the fruit often being persistent until May. Adapted to most soils, this species prefers dry, well-drained sites. This plant is partially shade tolerant and is extremely drought resistant. It is valued as a honey plant and as an ornamental.

20. American and Hybrid filberts. These filberts, or hazels, are upright, thicket-forming shrubs growing 8-12 feet tall with dense foliage, the hybrid usually being somewhat taller. The hybrid is a cross between the American and European filberts. They provide fair food and good summer cover. Fruit dispersal is from August to March. Good seed crops are borne every two to three years with light crops intervening, and the fruit is produced in about seven years. They prefer dry, well-drained soils, not sterile or wet. They make rapid growth on good sites

and are partially shade tolerant. These plants usually do not bear fruit in the shade. Edminster (1950) found no difference between the hybrid and American as to site and climatic adaptations. The hybrid has superior nuts; the American should be included in plantings for cross-pollination. They are useful for erosion control, as ornamentals, and for the edible nuts.

21. Amur privet. This upright, thickly branched shrub growing up to about 15 feet in height provides fair cover; the food value of the fruit is unknown. It grows best on fertile, well-drained soils. Introduced from China, the plant is shade tolerant and makes rapid growth on good sites. It is used for erosion control and as an ornamental. It is recommended for experimental use; some other privet, such as the European, might be better.

22. Birdsfoot deervetch (trefoil). This upright or spreading, long-lived legume with a deep, spreading root system grows up to three feet high. Introduced from Europe, it provides good food and summer cover. This plant will grow on heavy, acid soils of low fertility and on wet areas. It is drought resistant, salt tolerant, withstands close grazing, and stays green during hot summer periods. This species is useful for erosion control, soil improvement, a honey plant, and for hay and seed production.

23. Chinese lespedeza. Commonly known as sericea, this vigorous, branching, herbaceous, deep-rooted legume was introduced from Asia. The fruit is a poor food (Davison, 1945). This plant provides excellent summer cover and good nesting cover, especially when young. Although this species prefers well-drained, loamy soils, it will grow on most soils, even poor, alkaline, or very acid ones. It is shade tolerant, drought resistant, and is fairly winter hardy. Chinese lespedesa is valuable

for erosion control, soil improvement, a honey plant, hay and seed production, and planting waterways.

24. Common cowpea. This prostrate to erect, annual, summer legume was introduced from Africa. It is a fair food and provides good summer cover (Figure 23). Adapted to practically all soil types, it will grow on poor, sandy sites. Cowpea appears to grow well in mixture with Johnsongrass. This species is partially shade tolerant and fairly drought resistant. This honey plant is useful for human food, green manure and soil improvement, and hay, silage, and seed production.

25. Field pea. The variety commonly used is known as the Austrian winter pea. This weak-stemmed, half-viny, annual, winter legume furnishes fair food and good winter cover. Although this species grows on most soils except poorly drained types, it does best on neutral or slightly acid clay loams. It is valuable for green manure and soil improvement, hay and silage production, and for a winter cover crop.

26. Hairy and Woollypod vetches. These taprooted and fibrous-rooted species are slender, twining, weak-stemmed, winter legumes. The stems will grow up to 12 feet long. They are usually grown as annuals; hairy vetch is sometimes grown as a biennial. Introduced from Europe these plants provide good food and winter cover. Food habits studies and field observations (Baumgartner, 1947) have shown that bobwhites frequently eat the green vegetation in the winter. They prefer well-drained, sandy and sandy loam soils and are acid and alkali tolerant. Woollypod supposedly makes better growth than hairy. These vetches are valuable for green manure and soil improvement, honey plants, hay and seed production, silage, and for temporary terraces, water outlets, and dune control.

27. Indiancurrant coralberry (Coralberry). This upright, spreading, thicket-forming shrub grows 4-6 feet tall but is usually small. It forms

dense thickets by layering and should be used only on special areas. The fruit is a poor quail food. This shrub provides good summer and fair winter cover. Fruit dispersal is from September to late winter; fruiting begins about the third year. This species grows on a wide variety of sites, even very poor ones, and is shade tolerant. Sometimes planted as an ornamental, it is most useful for erosion control.

28. Japanese rose. Commonly known as multiflora, this vigorous, reclining, thorny shrub grows 6-10 feet tall and about eight feet wide. It reproduces some by layering of branch tips. This rose was introduced from Japan. Although it is a poor quail food, multiflora furnishes excellent winter and summer cover (Figures 24 and 32). It is adapted to most soil conditions except poorly drained sites and is partially shade tolerant. This species must have a good seed bed; competition during early growth stages seriously limits its survival. A survey of 60 plantings involving 8,090 individuals on a wide variety of sites in Okfuskee and Hughes Counties showed a survival of about 85 per cent after two years of growth. It has some tendency to spread on good sites; cultivation or grazing will keep it in check. Multiflora is sometimes used as an ornamental. This rose is especially valuable for erosion control and as a living fence. It probably will do best in the central and southern parts of the region.

29. Johnsongrass. This stout, erect grass (Figure 8) with vigorous rootstocks grows 3-6 feet high. Introduced from Turkey, it provides good food and summer cover. Although it occurs on many soil types, it does best on the more fertile and moist ones. This grass is considered a noxious weed by many people since it invades cultivated areas and is difficult to eradicate because of its agressive rootstocks. Johnsongrass is partially shade tolerant. It occasionally causes prussic acid poisoning in

cattle. It is useful for hay, silage, temporary grazing, and is an excellent sand stabilizer. Johnsongrass is not recommended for increased plantings, but perhaps better management could be practiced on that already in existence.

30. Milkpeas. Represented by at least two species these prostrate, slender, herbaceous legumes are frequently found climbing over bushes. These shade tolerant plants usually occur on somewhat dry, sandy soils in thickets and woods. Their seeds provide fair quail food. These species furnish poor cover except in heavy stands. These plants might be suitable for soil improvement and erosion control.

31. Mung bean. This erect or slightly twining, annual, herbaceous legume growing 1-3 feet high was introduced from Asia. Although it will grow on most soil types, it is best adapted to sandy loams, loams, and silt loams. This plant provides fair food and good summer cover (Figure 20). There are two varieties used in Oklahoma, the golden and the green. The golden is more erect and bushy and may grow to 3-4 feet in good soil. The golden is grown mainly for hay, silage, forage, and soil improvement. The green is used for commercial seed production (bean sprouting and canning) and for soil improvement.

32. Rafinesque viburnum. This slow-growing, long-lived shrub usually does not exceed six feet in height. It furnishes fair food and good summer cover. The fruit is available from September to November and is often persistent until late winter. This species prefers dry, well-drained sites, is shade tolerant, and disease and insect resistant. The plant is useful as an ornamental.

33. Scribner panicum. This erect grass grows 1-2 feet tall; the basal leaves form a winter rosette. It is an important food and provides good cover in the thicker stands. The seed are available until about

March. This grass usually occurs on sandy soils and dry prairies. This species is shade tolerant and drought resistant.

34. Shortleaf pine. This medium-sized, evergreen tree occasionally grows to 80-100 feet tall. It is a fair food and furnishes fair cover when small. Fruit dispersal is from November to December, but some cones persist for a long time. Good seed crops are borne every five to ten years with light crops in most intervening years. Commercial seed-bearing age is about 16 years. This species is adapted to most sites except those too high in lime or too fertile. This pine makes rapid growth on better sites. This tree is useful for erosion control, and the wood is valuable for lumber and pulpwood.

35. Shrub lespedezas. Shrub lespedeza, commonly known as bicolor, is a slender, upright, leguminous shrub growing 4-10 feet tall. This species reproduces by seed only. It was introduced from Japan. The seed is an important quail food; the shrub provides good summer cover (Edminster, 1950). The fruit is available from October to about May. This plant matures seed in about three years, sometimes in two years. It is adapted to most sites except very acid or wet ones and makes rapid growth in good soils. It is shade tolerant. A survey of 60 plantings involving 44,825 individuals in Okfuskee and Hughes Counties showed about a 90 percent survival after two years growth. Plantings were made on wide variety of sites. Seed production and drought resistance have generally been low in central Oklahoma. Since marked variation occurred in these two traits, it appears that selection would produce superior strains for this region. The plant is very palatable to livestock. Valued as an ornamental, it is useful for a honey plant, erosion control, and for soil improvement. Experimental plantings should be confined to the central and southern parts of region. This species is shown in Figures 17 and 32.

The other three shrub lespedezas, Japan, robust, and Thunberg, are also recommended for experimental use. Japan lespedeza is small, maximum height usually being 5-6 feet. It matures seed two to three weeks ahead of shrub lespedeza. Robust lespedeza also matures seed somewhat earlier than shrub lespedeza, Thunberg somewhat later. Edminster (1950) states that these lespedezas are quite similar to shrub lespedeza in respect to climatic and site adaptations and food and cover values. Little is known about their adaptability to Oklahoma conditions, however.

36. Small and Trailing wildbeans. These annual, herbaceous, viny legumes frequently climb over shrubby thickets. Although they are important foods, they provide poor cover except in the thicker stands. Trailing wildbean has a larger seed than the other wildbeans, but the seed is frequently infested with weevils. Trailing wildbean volunteers well. These plants are usually found on medium to coarse-textured surface soils. The seed is available from about September to March. These species might be useful for erosion control and soil improvement. Trailing wildbean is shown in Figure 26.

37. Spanishclover (American) deervetch. This slender-stemmed, herbaceous, annual legume growing 1-3 feet tall is loosely branched and quite variable in habit. It provides fair food and summer cover. It is usually found on dry, sandy, acid soils in pastures and abandoned fields. The seed is available from June to October. This species might be useful for erosion control and soil improvement.

38. Sudangrass. This species is quite similar in appearance to Johnsongrass but is an annual and more leafy. It grows 4-7 feet tall with fine, erect stems. Introduced from Africa it will grow on many types of soil except muggy ones. This plant is drought resistant. It is an important food, and it provides good summer cover. It occasionally causes

prussic acid poisoning in cattle. This species is valuable for hay, silage, and seed production, as a soiling crop and green manure, and for temporary dune control.

39. Tatarian honeysuckle. This large, upright shrub growing 6-12 feet high is much branched and has a good growth form. This species furnishes good summer cover. Its food value to quail is unknown. Good seed crops are borne nearly every year. It will grow on most sites except very wet, dry, or unfertile areas. Good growth occurs on the more favorable sites. Fruiting begins in three to four years. This plant is partially shade tolerant. It is grazed by cattle but withstands grazing well. Valued as an ornamental, this honeysuckle is potentially useful for erosion control.

40. Weeping lovegrass. This bunchgrass growing 2-5 feet tall has a deep, fibrous root system. Introduced from Africa it is adapted to a wide range of soils. This species will grow on poor, sandy, acid soils but will not grow on seepy ones. Easy to establish it makes a rapid, vigorous growth. This grass resists heat, drought, and moderate cold and remains somewhat green at base of clumps in winter. It provides excellent cover for quail, especially for nesting. The value of weeping lovegrass for quail nesting has also been reported by DeArment (1950). The food value of this species is unknown. This plant is valuable for cover on land too poor for field crops, for vegetation of broad, shallow waterways, sand dunes, and blow-outs, and for hay production (Figure 33), supplemental grazing, and soil improvement.

DISCUSSION

The bobwhite is a product of the land, just as our cultivated crops, livestock, and timber. Food and cover for bobwhites are thus greatly affected by what man does to the land. Food habits studies have shown that many of the leading quail foods are produced by plants which are a result of "undesirable" land-use practices such as intensive grazing, promiscuous burning, and abandonment of farmlands. It is believed that such foods can be replaced by others that are just as palatable, nutritious, and available, or more so, by proper habitat management practices.

The objective of quail habitat management is to increase the total population of bobwhites by increasing the carrying capacity of areas where quail already exist and creating new covey ranges suitable for quail. Well conceived and applied habitat plantings appear to be a possible solution in accomplishing this objective. There is very little proof that such plantings will increase quail numbers, but the habitat modifications should be considered worthwhile if the fertility of the soil is increased, or erosion is reduced or checked, or the land is otherwise improved. Quail were observed using for food or cover many of the habitat plantings made during the course of this investigation. These quail may merely have shifted their ranges or, if they represented a population increase in the area, may have been produced by some favorable environmental condition or sum of such conditions. Without an intensive, long-term study such evidence cannot be construed as being proof that quail numbers were increased.

Most of the bobwhite habitat management will have to be accomplished with the active cooperation of the private landowner. Therefore, the plants used for habitat plantings should be of primary benefit to agriculture. Practices which have become, or are apt to become large-scale, such as the use of Korean lespedeza in pastures, should be intensively studied and made the target of habitat management. Few landowners will be interested in managing quail habitat if they do not realize an economic return, directly or indirectly. Thus, economy in the planting program is a prime factor, and all plans should include a thorough evaluation of the costs involved. Agricultural operations and quail habitat management should proceed hand in hand.

We must as a nation and as individuals take a long-range view of the problems dealing with our natural resources. The way in which we use the land, one of our most valuable resources, will greatly affect our future as a nation. Wise husbanding of the land is, therefore, not only a moral responsibility but a matter of national survival. The role of the proper kinds of plants to be used on the land then becomes of paramount importance. If the bobwhite and other wildlife also derive benefit from these plants, then so much the better.

SUMMARY

1. The present study was conducted to find which plants seemed most suitable for managing quail habitat in central Oklahoma. A relatively small number of plant species appeared to be suitable for wide-scale use.

2. The 10 leading fall and winter foods, on the basis of volume, comprised more than 75 per cent of the total eaten by quail in the "post-oak-blackjack forest game type."

3. The top 10 fall and winter foods, on the basis of volume, also made up more than 75 per cent of the total in the "tallgrass prairie game type."

4. The 10 leading foods, on the basis of volume, made up about 83 per cent of the total in the central region; the top 5 comprised about 62 per cent of the total volume.

5. In view of the figures given above, it seems apparent that a small number of plants provide the bulk of the late fall and winter bob-white foods in the central region. According to the food habits data, changes in the ranking quail foods in most years are minor in character. Marked changes in the major foods may take place during years of extreme weather conditions.

6. Some of the higher ranking quail foods, such as ragweed and Johnsongrass, are considered to be pests by landowners.

7. A total of 48 plants, 21 for general use and 27 for limited or special or experimental purposes, were selected as being potentially

suitable for management of quail habitat and the land.

8. Several of the species considered to be desirable provide food for quail throughout the winter.

9. None of the plants judged potentially suitable is abundant in the region, and less than one-half are common.

10. Several of the selected species are adapted to wide ranges of soil fertility, and several are very acid tolerant.

11. Many of the selected plants are adapted to very coarse textured soils, and several are shade tolerant.

12. Perennial species are generally more useful than annuals, and native plants are usually better than exotics.

13. There is little proof that habitat management will increase quail populations but such efforts would appear to be justified if they benefit the land.

14. Very little habitat management for bobwhite will probably be done by anyone except the private landholder. Thus, the management practiced must offer him an economic return either directly or indirectly.

15. Many places exist on the farms and ranches of central Oklahoma which offer an opportunity for improvement of habitat management practices. Plants adapted for specific sites were discussed in detail. If the care of the land is improved, then bobwhite and other wildlife will probably also benefit.

16. Our national survival depends partially on the way we use the land. The employment of certain plants will help achieve wise husbandry of this resource and man, wildlife, and the land itself will profit.

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