SCALED QUAIL

FOREWORD

SCALED QUAIL are among the more important upland game birds residing in Colorado, both in regards to numbers and amount of sport they furnish to hunters. As such, it is appropriate that time and effort be expended to determine basic habitat requirements and evaluate various habitat manipulations for the purpose of increasing the numbers of this species.

This study serves as a fine example of interagency cooperation with personnel of the U. S. Forest Service constructing developments and personnel of the Colorado Department of Game, Fish and Parks evaluating the developments.

The results, as interestingly presented by the author, add to our knowledge of the species and should result in better management of scaled quail in Colorado.

This study was made possible through the cooperative efforts of personnel of the U. S. Forest Service and the Colorado Department of Game, Fish and Parks. Appreciation is extended to the Colorado Game, Fish and Parks Commission; Harry R. Woodward, director; Laurence E. Riordan, assistant director of research; and Wayne W. Sandfort, chief of game research, for their approval of this Federal Aid Project.

My sincerest thanks are expressed to Donald M. Hoffman, project leader, for his efforts in originating the study and for his assistance, advice, and guidance throughout the study and preparation of the manuscript. The advice and assistance supplied by Dr. Ronald A. Ryder, Department of Fishery and Wildlife Biology, Colorado State University, and by Wayne W. Sandfort is gratefully acknowledged.

Special thanks are expressed to Elmer E. Miller, former forest ranger on the Carrizo District, who initiated the habitat manipulation efforts; James Hollenback, and others of the Carrizo District Staff for their cooperative assistance.

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Donald M. Hoffman

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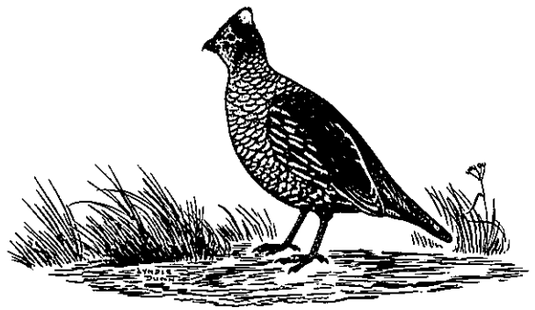


Chapter 1
INTRODUCTION

Scaled quail, *Callipepla squamata* (Vigors), are found throughout the mesas, canyons, and rangelands of southeastern Colorado. Insufficient cover and food-producing vegetation here along the extreme northern edge of the range, prevent these birds from reaching population densities found farther south.

In order to increase numbers of scaled quail, habitat improvements must provide or increase some factor which is limiting. For instance, if food is more important in limiting quail numbers than resting cover, additional resting cover alone would not make the birds more abundant.

Habitat improvements are often difficult to evaluate in that they attract and, therefore, concentrate birds that existed in the area prior to development. However, if sites are created that provide year-around needs of the species, birds so attracted there should remain and increase.

In 1960, personnel of the United States Forest Service's Carrizo District began experimenting with ways of improving habitat conditions for scaled quail and other wildlife. The Colorado Department of Game, Fish and Parks offered recommendations for habitat development and agreed to conduct evaluation studies. Efforts were centered on 256,000 acres in Baca and Las Animas counties (Fig. 2). This paper reports 4 years of experimentation and evaluation.

Since completion of this study, the above mentioned agencies have begun a cooperative habitat development program on the Carrizo District. Many of the findings and recommendations presented in this bulletin are being used.

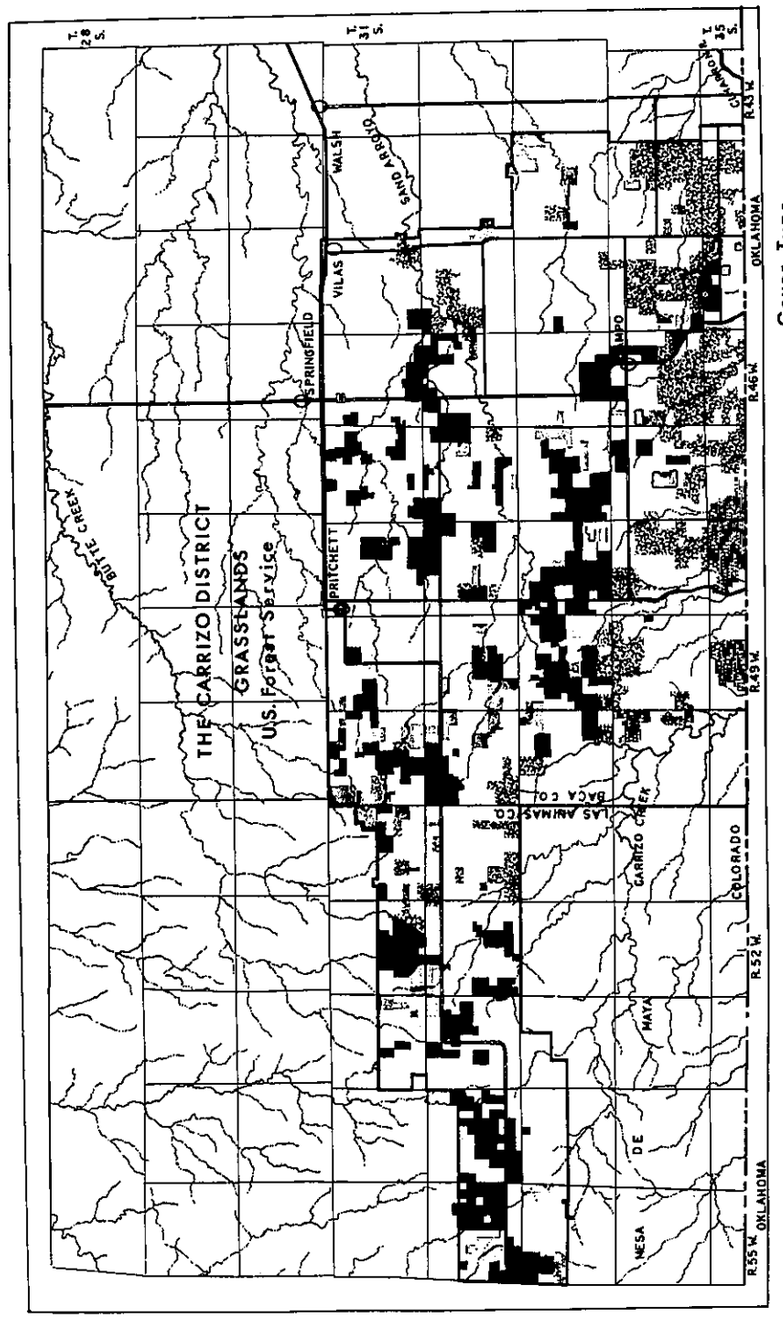
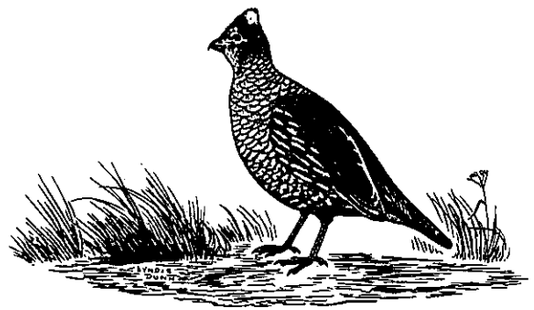


FIG. 2. Vegetative types on lands administered by the U. S. Forest Service, Carrizo District, Comanche National Grasslands.



Chapter 2

THE SITUATION

HISTORY

Lands in the Carrizo District were purchased by the Federal Government during the late 1930's when drought and "dust-bowl" conditions existing in the region caused their abandonment. Revegetation efforts on land unsuited for cultivation were begun by the U. S. Soil Conservation Service. Administration and management responsibilities were transferred to the U. S. Forest Service in 1953.

Past use and misuse of the land are revealed by land form and vegetation. Soils exposed and loosened by farming and over-grazing were blown and sifted by ever present winds. The fine soils buried fences and accumulated around farm lots and other locations. These sites became readily discernible as ridges and mounds containing early successional forms of vegetation. Yucca *(Yucca glauca)*, a primary invader of old fields and farm yards, served as an important soil stabilizer (Fig. 3).

Blowouts were also created, many of which are still active in the region (Fig. 4). The aridity of the region has made revegetation a difficult and frustrating process, but one which is being accomplished through substained effort.

VEGETATION

Cover types in the scaled quail range of southern Baca County are highly variable. Sand sagebrush *(Artemisia filifolia)* and yucca exist in near pure stands or are mixed in infinite proportions and densities on sandy soils. The presence of numerous forbs and grasses has been influenced by variations in erosion, grazing, reseeding, and climatic conditions.

FIG. 3. Symbolic of a rugged and mistreated land in which the scaled quail lives — Yucca plants provide valuable cover for upland birds.

FIG. 4. An active blowout six miles east of Campo. Annual vegetation covering the dunes on the leeward sides of blowouts attract scaled quail brood coveys.

Pure stands of mid- and short-grasses are characteristic of the tighter soils. Since high scaled quail populations are associated with shrub cover, these grasslands rank far below sandsage-yucca ranges in carrying capacity for scaled quail. Cover types on the Carrizo District are shown in Figure 2.

In spite of wind erosion problems that are further aggravated by widely fluctuating annual precipitation (Fig. 5), Baca County is primarily a farming county.

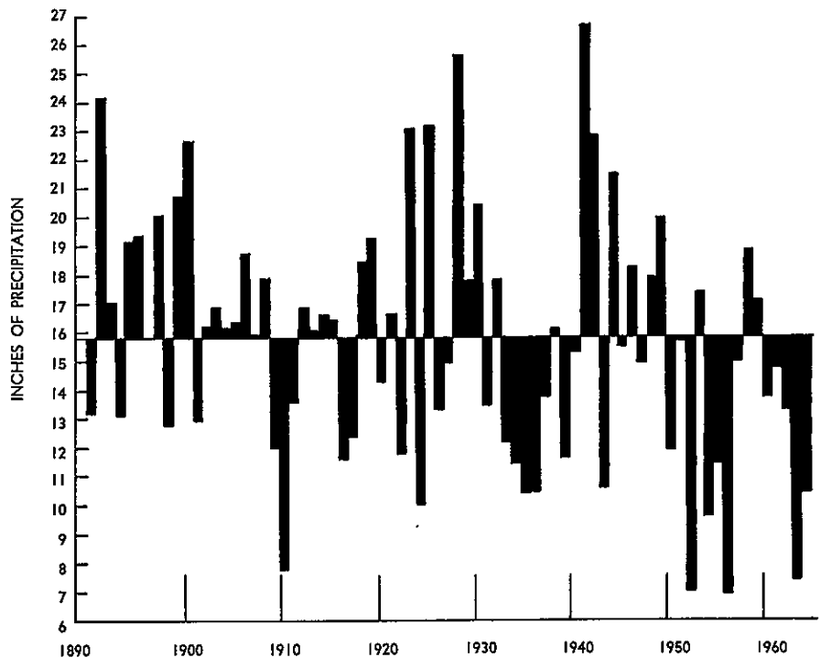


FIG. 5. A 75-year record showing precipitation departures from the annual mean in central Baca County.

Broom corn *(Sorghum vulgare)*, which responds rapidly to any available moisture, is the major crop raised on sandy soils. Grain sorghums *(Sorghum vulgare)* and wheat *(Triticum aestivum)* are also planted.

Many of the cultivated fields and farms were placed in the Conservation Reserve Program established by the Federal Government during the late

1950's. These deferred "Soil Bank" acreages for the most part contained sunflowers *(Helianthus sp.)*, thistles *(Salsola kali)*, and other annual and perennial forbs. Where conscientious efforts were made to reestablish grass, the transition to grass was quite evident during the study period.

A CLIMATE OF EXTREMES

Ever changing precipitation patterns and amounts, annual temperature extremes, and variable but persistent winds characterize southeastern Colorado climate. All of these factors affect scaled quail, either directly or indirectly. Spring droughts restrict plant growth and reduce plant carotene — the source of vitamin A needed for reproduction of quail (Lehman, 1952). Summer rains are essential to production of seeds that comprise the main diet of adult quail throughout the year.

Annual precipitation was consistently below the 15-inch average during this 4-year study (Fig. 5). Repetitious spring droughts, which were outstanding climatic features (Fig. 6), apparently did not restrict reproduction of

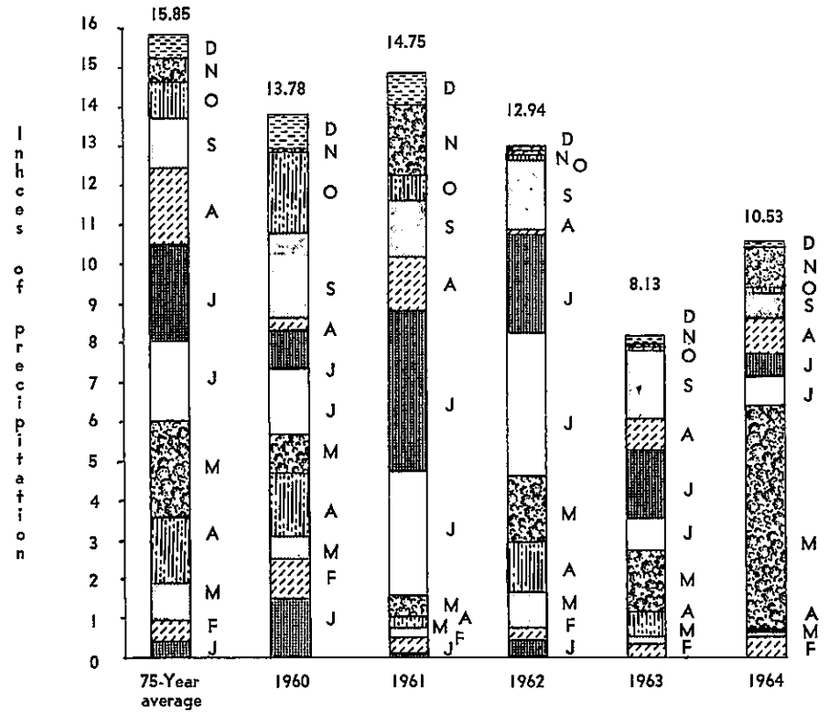


FIG. 6. Monthly precipitation (recorded 8 miles south of Springfield, Colorado in comparison to the 75-year average).

scaled quail as was reported in Texas (Wallmo, 1957) and other southwestern areas. The species was moderately successful in bringing off a hatch each year of the study. Fortunately, severe winter storms were lacking.

ASSOCIATED SPECIES

The variety and interspersion of cover combined with relatively mild winters permit a number of upland game birds and other wildlife to reside in southern Baca County. Among them, scaled quail are the most abundant.

Bobwhites *(Colinus virginianus)* are closely associated with and often intermingle with scaled quail. Although both use much the same cover, bobwhites seem to prefer denser cover.

Although a few ring-necked pheasants *(Phasianus colchicus)* live on the grasslands, higher population densities are found on soil bank acreages and better farm lands. Areas between grasslands and cultivated fields in the eastern half of Baca County also contain moderately dense populations.

The lesser prairie chicken *(Tympanuchus pallidicinctus)*, once nearly extinct, showed dramatic increases in numbers and expanded its range during the study period (Fig. 7).

FIG. 7. Lesser prairie chicken — Once nearly extinct in Colorado, these natives are now repopulating the sandsage-yucca ranges of southern Baca County.

The region is a transition zone between the Great Plains and the semi-arid southwest plateaus, supporting a variety of wildlife species. Among them, the long-billed curlew *(Numenius americanus)* and the road runner *(Geococcyx californianus)* are two of the more interesting. Horned toads *(Phrynosoma sp.)*, Collared lizards *(Crotaphytus collaris)*, and prairie rattlers *(Crotalus viridus)* are a few of the Reptilia. Wild turkeys *(Meleagris gallopavo)*, pronghorn antelope *(Antilocapra americana)*, mule deer *(Odocoileus hemionus)*, coyotes *(Canis latrans)*, gray fox *(Urocyon cinereoargenteus)*, red fox *(Vulpes fulva)*, kit fox *(V. velox)*, and bobcats *(Lynx rufus)* offer still more variety.

This southeast corner of Colorado is also a wintering area for numerous avian predators. While marsh hawks *(Circus cyaneus)* and rough-legged hawks *(Buteo lagopus* and *B. regalis)* are most common, prairie falcons (Falco *mexicanus)*, duck hawks *(F. peregrinus)*, sparrow hawks *(F. sparverius)*, golden eagles *(Aquila chripaetos)* and bald eagles *(Haliaetus leucocephalus)* are also frequently observed.

SCALED QUAIL

It may be asked: Why should this study concentrate on scaled quail, when bobwhites, pheasants, and lesser prairie chickens all were present? There are several reasons for placing primary emphasis on scaled quail. Higher numbers of scaled quail and their presence in the pinon-juniper and cactus-covered ranges to the west emphasizes their adaptability to the region and conditions existing there. They are also more tolerant than other species to grazing practices on these lands. Their reproductive capability during dry years appears to be much better than that of other species. In addition, scaled quail respond readily to artificially supplied habitat, and therefore, can be increased with a minimum of manipulation without materially affecting other land uses.

Many more scaled quail are produced on the public lands of south-eastern Colorado than are available to the hunter because a majority of the quail move early each fall to nearby ranch and farmyards. There they concentrate in large coveys often numbering into the hundreds. Shelterbelts, machinery, post piles, and other materials provide cover for the birds. Since few farmers or ranchers permit hunting around their livestock and buildings, the species is thus afforded a "pet status".

This creates public relation problems between landowners and hunters. Winter concentrations, intraspecies competition for food and cover, and association with domestic fowl increase survival and disease problems.

Why don't scaled quail remain where they nest and rear their young? Many coveys do, but most of these dwell at locations where natural cover is supplemented. Abandoned machinery, building sites, fallen trees, and other debris offer needed protection from wind, weather, and avian predators (Fig. 8). Although existing shrubs are adequate for quail during most of the year, apparently they are insufficient during the winter months.

STUDY LIMITATIONS AND ASSETS

Before habitat for a wildlife species can be effectivly manipulated, the requirements of the species should be known. The environment in which it lives and the limitations of this environment should also be understood. Unfortunately, too many of these factors are frequently unknown.

In spite of the limited knowledge available at the start of the Carrizo development program, habitat improvement work was moderately successful. Knowledge gained in the evaluation indicates habitat manipulations are economically feasible.

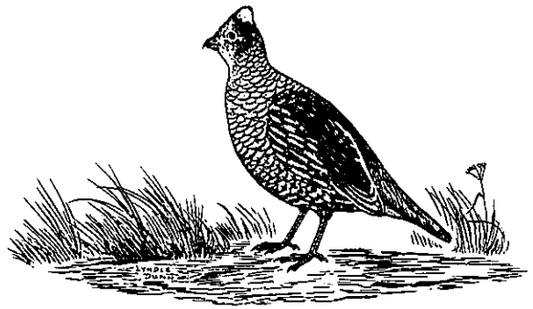
An ecological study of scaled quail completed by Schemnitz (1961) in the Oklahoma Panhandle only a few miles from the Carrizo District provided additional information.

Environmental conditions of the two studies were similar and so were many of the results, thus providing a much stronger foundation for conclusions and recommendations.

Insufficient knowledge of the year-around nutritional requirements of scaled quail was one important limitation to the study. Although Schemnitz (1961) collected a large quantity of data covering the diet of scaled quail

FIG. 8. A prime cover attraction for scaled quail. Forty to fifty birds consistently used this old machinery and post pile through the late summer, fall, and winter months.

within sandsage, short-grass, and pinon-juniper types, his collections were limited to November and December. Year-around collections and analyses are needed. To be effective, such a food habits study should include samples from locations where quail do and do not have access to free water through wet and dry climatic cycles. Feeding movements of coveys, pairs, and broods should be observed and recorded. Comparison of the moisture content of foods consumed at locations with and without free water might yield evidence of water requirements and the capacity of the environment to naturally provide them. Hungerford's (1962) studies of Gambel's quail in Arizona could serve as an excellent model for such an investigation.



Chapter 3

TREE and SHRUB PLANTING

The U. S. Forest Service and the Colorado Game, Fish and Parks Department began habitat manipulations for wildlife. In 1960, Donald M. Huffman, wildlife researcher for the department, provided technical advice, assistance, and initiated the evaluation study.

FOREST SERVICE PLANTINGS

Carrizo District personnel planted trees and shrubs at several old homestead sites within the sandsage-yucca grasslands. Blowouts, where weed competition was reduced and sandy soils readily absorbed and retained available moisture, were the only sites where plants showed significant survival (Table 1). Asphalt sheeting placed around some of the plants possibly reduced weed competition and boosted plant survival.

STATE PLANTINGS

The State concentrated its planting efforts on the short- and mid-grass ranges, which occupy a major portion of the Carrizo District, to determine if woody vegetation could be established there. If so, would these plantings attract and hold scaled quail coveys on these barren ranges? Five plots of ¼ to 1 acre in size were located at windmills where it was hoped that overflow from stock watering tanks would provide water for the plantings and quail. Although these plots were fenced to exclude livestock, the animals still had access to water.

Unfortunately, livestock concentration virtually eliminated any excess water for either the plantings or the quail.

Two types of windmill sites, one with a pond and another with a metal tank, are shown in Figures 9 and 10.

A square mile surrounding and including each site was used as a census zone. Summer and winter censuses of the better cover within these zones revealed occasional use, but no permanent residency by coveys.

Planting of trees and shrubs began during the spring of 1960 after fencing was completed. Few plants survived because of the warm, dry conditions existing at the time. The plots were replanted in February 1961. Water collection basins up to 3 feet in diameter were dug around each plant to retain water and reduce competition from short-grass sod. These were cultivated during the 1961 and 1962 growing seasons. Dead plants were again replaced in March 1962.

Dry spring weather that persisted throughout the early 1960's prevented the establishment of woody cover. Buffalo grass *(Buchloe dactyloides)* rhyzomes which spread back into the basins after every rain competed for moisture and further hampered tree survival.

A list of species planted and their survival to May 1963, is presented in Table 2. The poor survival rate is quite apparent.

In addition to the above, tree cacti *(Opuntia arborescens)*, natives of the pinon-juniper and short-grass regions, were transplanted to the study plots (Fig. 11). All transplants placed on plot No. 5 in February 1961 survived. These were small specimens 6 to 12 inches high. In April 1963, an additional 249 tree cacti were placed within the development plots. These cacti, varying in height up to 2½ feet and possessing only a remnant of their roots, were used to determine if larger transplants of this slow-growing species would survive. These plants showed excellent survival even though they were transplanted into dry ground and received no moisture for a month after transplanting.

TABLE 1. Survival of trees and shrubs planted at old homesteads.*

Species	Planted	Survived	Per cent survival
Skunkbush (Rhus trilobata)	269	115	42.8
Wild plum (Prunus americana)	361	126	34.9
Eastern red cedar (Juniperus virginiana)	19	6	31.6
Russian olive (Elaeagnus angustifolia)	35	0	0.0
TOTAL	684	247	36.1

*Survival recorded May, 1963.

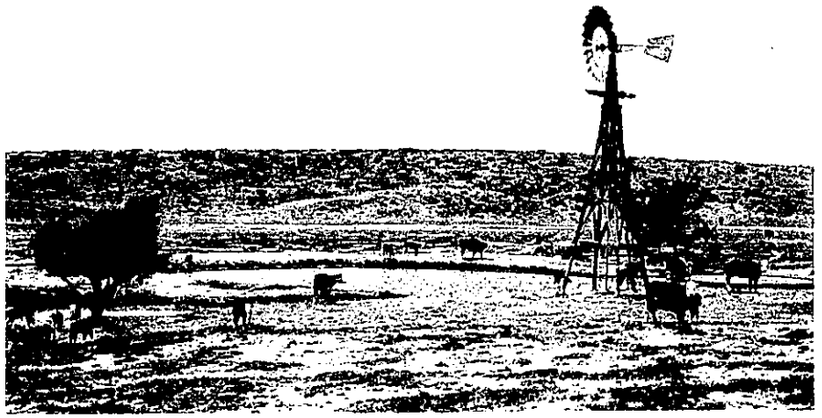


FIG. 9. Livestock and scaled quail both use the pond at this site. Efforts to increase scaled quail here would not damage the area's livestock potential.

TABLE 2. Survival of trees and shrubs planted at windmills.*

Species	Planted	Survived	Per cent survival
Red cedar (**Juniperus spp.**)	418	71	17.0
Plum (**Prunus spp.**)	410	27	7.0
Skunkbush (**Rhus trilobata**)	272	1	Trace
Peashrub (**Caragana sp.**)	164	0	0.0
Osage orange (**Maclura pomifera**)	157	39	24.8
Sand cherry (**runus besseyi**)	150	0	24.8
Black locust (**Robinia pseudo-acacia**)	128	6	4.7
Mulberry (**Morus alba**)	128	20	15.6
Chinese elm (**Ulmus parvifolia**)	95	3	3.0
Buttonbush (**Cephalanthus occidentalis**)	106	10	9.4
Russian olive (**Elaeagnus angustifolia**)	86	0	0.0
Monosperm juniper (**Juniperus monosperma**)	39	13	33.2
Winterberry (**Euonymus bungeanus**)	5	0	0.0
New Mexican elderberry (**Sambucus sp.**)	20	0	0.0
Fontanesia (**Fontanesia fortunei**)	29	0	0.0
New Mexican forestiera (**Forestiera neo-mexicana**)	18	20	42.5
Hybrid rose (**Rosa sp.**)	3	0	0.0
TOTAL	2,228	210	9.4

*Survival recorded May, 1963.

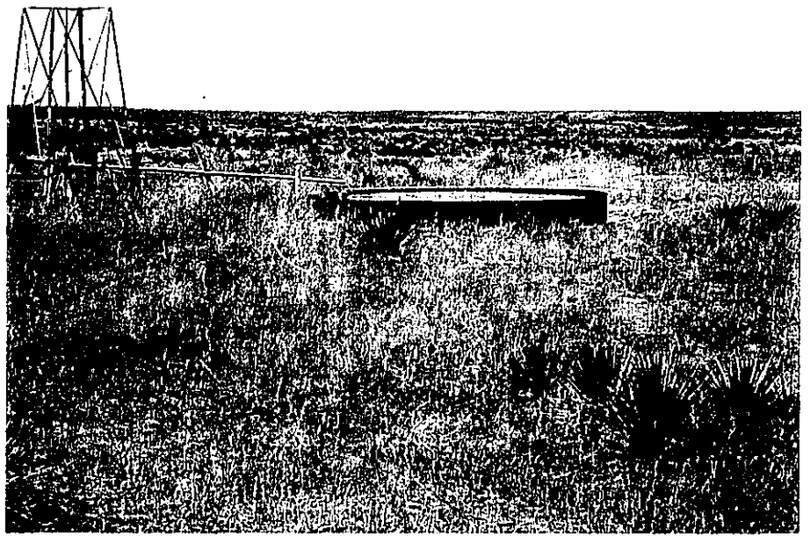


FIG. 10. Water is not always available to quail at stock tanks, but development efforts should still be considered if any food and cover exist.

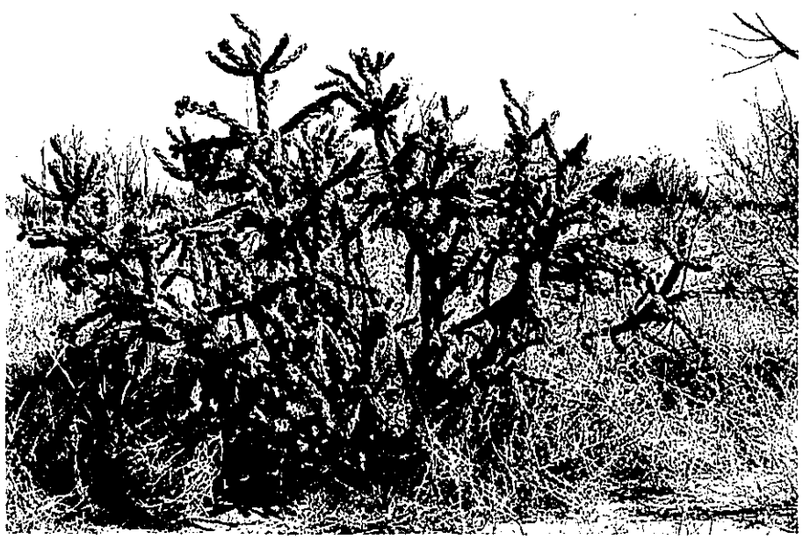


FIG. 11. Tree cactus serves as excellent scaled quail cover and holds high potential as a transplantable species.

TABLE 3. Survival of trees and shrubs planted at blowouts.*

Species	Planted	Survived	Per cent survival
Skunkbush (Rhus trilobata)	600**	294	——
Sand cherry (Prunus besseyi)	230**	165	——
Russian olive (Elaeagnus angustifolia)	200	124	62.0
Tamarisk (Tamarix sp.)	120	3	3.0
Colutea (Colutea sp.)	120	33	27.5
Hackberry (Celtis occidentalis)	100	1	1.0
Chinese elm (Ulmus parvifolia)	94	11	1.0
Wild plum (Prunus americana)	80	23	28.7
Red cedar (Juniperus virginiana)	60	20	33.3
Ponderosa pine (Pinus ponderosa)	50	1	2.0
Hybrid rose (Rosa sp.)	50	0	0.0
Crabapple (Malus sp.)	30	14	46.6
New Mexican elderberry (Sambucus sp.)	30	0	0.0
New Mexican locust (Robinia neo-mexicana)	23	4	17.3
Grape (Vitis sp.)	20	0	0.0
New Mexican forestiera (Forestiera neo-mexicana)**	**		——
Total	1,837**	710	——

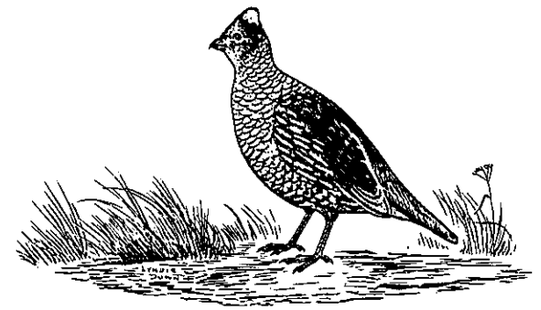
*Survival recorded May, 1963.
**Planting records incomplete.

Attempts to establish and maintain surviving trees and shrubs on the study plots were discontinued in 1963 because survival and growth rates were too low to make such efforts economically feasible.

COOPERATIVE PLANTINGS

A sandy blowout southwest of Campo, Colorado, which is within a lesser prairie chicken development site, was planted to a large quantity of trees and shrubs by personnel of the U. S. Forest Service, the Colorado Department of Game, Fish and Parks, and the Campo Sportsmen's Club. State efforts (Hoffman, 1961) on this area came under habitat improvement studies for lesser prairie chickens. Because of the pertinence of the information to this study, the survival results were included here (Table 3). Some plantings survived here because competing vegetation was absent or sparse.

Of the many species planted at blowouts, Russian olive showed the greatest growth and cover development. Skunkbush, sand cherry, and wild plum also survived well. Evergreens, although considered highly desirable as winter cover, failed to survive.



Chapter 4

OLD HOMESTEAD STUDY

HISTORY

Nearly every quarter-section of Baca County was homesteaded in the early 1900's. Many of the settlers soon learned the climate of the region was not well suited for farming and their numbers dwindled. Half-dead trees, old building foundations, and dirt ridges and mounds that were once fence lines and farmyards, provide mute evidence of the misfortunes of these early homesteaders.

Many abandoned homesteads retained a high capacity as habitat for scaled quail, bobwhites, and other wildlife. Old machinery, fallen trees, building foundations, and other debris provided protection from the weather and avian predators. Since wind deposited soils were not suited to revegetation by grass, early successional vegetation still exists. Use by cattle has destroyed much of the former wildlife potential of these abandoned homesteads.

SITE SELECTION, DEVELOPMENT, AND STUDY

Elmer Miller and the Carrizo District Staff attempted to improve conditions for scaled quail and other wildlife on several of these homesteads. Fences were constructed to exclude cattle. Rainwater collection and retention structures called "guzzlers" were installed to provide drinking water and resting cover (Fig. 12-14).

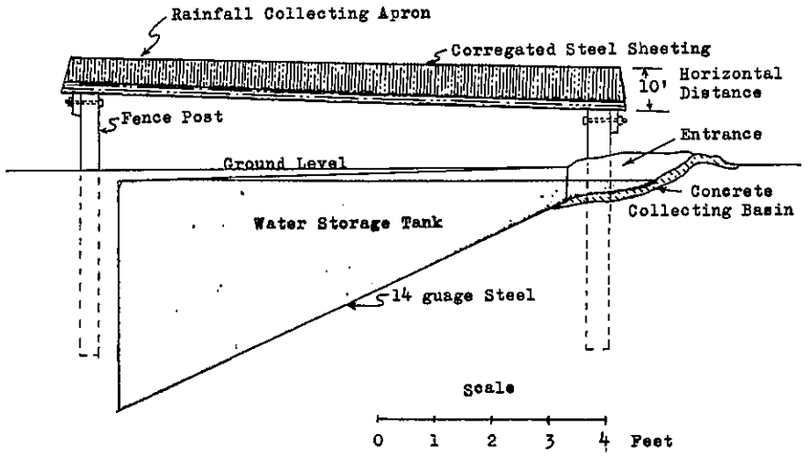


FIG. 12. Line drawing showing vertical cross-section of a guzzler.

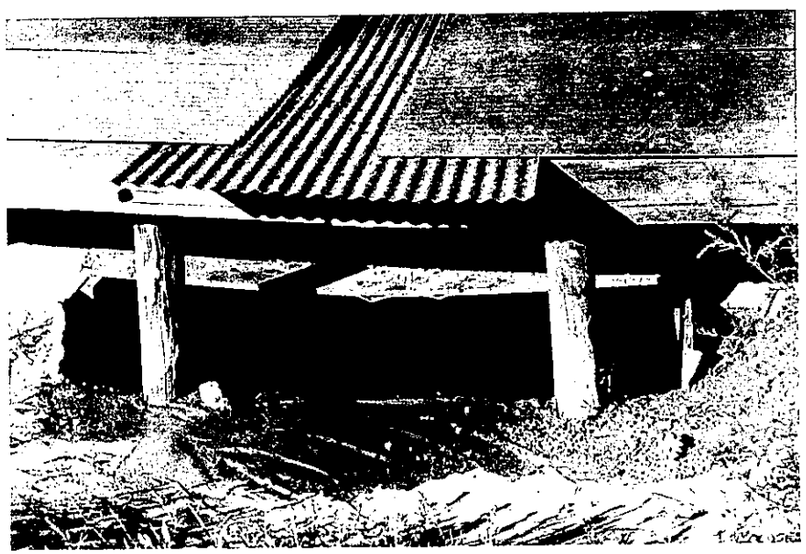


FIG. 13. Rainwater collected on the steel sheeting apron drains into the mouth of the tank. Quail and other wildlife enter the tank to obtain water.

FIG. 14. A guzzler surrounded by high quality yucca habitat at old homestead development No. 4.

TABLE 4. History of habitat manipulations at old homesteads.

Activity	AREAS					
	1 Dye-Glover 1.7 Acres	2 Shell Oil 7.0 Acres	3 East Campo 21.2 Acres	4 Miller 22.3 Acres	5 South Pritchett 4.6 Acres	6 Alamo 24.5 Acres
Last grazed	1960	1957	1957	1960	1959	1961
Fenced	August 1961	April 1961	March 1960	March 1960	March 1960	Feb. 1962
Guzzler Installed	August 1961	April 1961	June 1961	Oct. 1961	Sept. 1961	——
Shelter Constructed	April 1961	April 1961	April 1961	March 1960	March 1960	Jan. 1962
Cover Planted	March 1961	March 1961	March 1961	March 1961	April 1961	May 1962

Dead and dying trees on old homesteads furnished a good source of material for construction of resting shelters. Dead limbs were cut from standing trees and leaned against tree trunks to form shelters (Fig. 15). Fallen trees often provided natural shelters.

Cooperating with the U. S. Forest Service, the Colorado Game, Fish and Parks Department agreed to evaluate the effects of the habitat manipulations on scaled quail and other upland game birds.

Six sites selected for development by the Forest Service were included in the evaluation (Table 4). Area No. 6 was later excluded from the evaluation.

Developed areas were diverse in respect to their size, location, conditions within and around them, and existing quail populations. Some were completely surrounded by sandsage and yucca range while others were associated with short-grass prairie, cultivated fields, and weedy Conservation Reserve acreages (Table 5). Water was intermittently available on some of the sites prior to development.

Six control areas were selected during the winter of 1960-61 which had conditions and scaled quail populations closely approximating those of the development group (Fig. 16). These were not altered in any way. Comparison of quail populations on the two groups were made to evaluate development efforts.

TABLE 5. Cover types on old homestead study areas, expressed in per cent.

Cover type	Areas 1	2	3	4	5	6	Group average
Developed Areas							
Sandsage	52.3	15.0	32.2	26.0	20.3	—	20.16
Dense yucca	37.7	58.8	0.9	3.7	—	—	20.20
Sparse yucca	9.3	8.8	18.6	5.2	0.5	—	8.48
Annual weeds	—	0.9	4.6	—	6.6	—	2.42
Soil Bank*	—	—	11.3	8.3	31.1	—	10.14
Cultivation	—	10.0	30.7	48.3	25.0	—	22.80
Mid-grasses	0.7	3.1	—	6.2	15.1	—	5.02
Short grasses	—	3.4	1.7	2.3	1.4	—	1.76
Miscellaneous	—	—	—	—	Tr.	—	Tr.
Control Areas							
Sandsage	8.7	14.0	12.0	8.2	2.4	49.2	15.75
Dense yucca	17.5	15.5	21.5	6.8	6.6	28.2	16.02
Sparse yucca	15.1	14.1	24.6	9.4	15.1	10.7	14.83
Annual weeds	—	—	—	—	—	0.4	Tr.
Soil Bank*	25.5	25.9	—	7.3	19.0	5.9	13.93
Cultivation	22.7	11.8	14.6	38.0	25.1	5.0	19.53
Mid-grasses	8.2	12.2	3.0	6.4	9.2	0.6	6.60
Short-grasses	1.9	6.1	24.3	20.5	22.6	—	12.57
Miscellaneous	0.4	0.4	—	3.4	—	—	0.70

*Lands deferred from cultivation which have been permitted to grow sunflower, thistles, and other forbs.

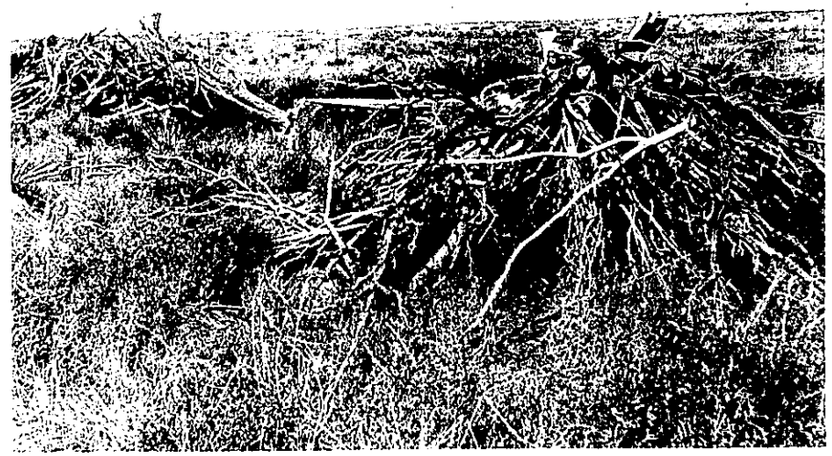


FIG. 15. Limbs from a standing tree were cut and placed against the trunk to form the brush shelter in the foreground.

FIG. 16. Old homestead sites used as a control. This is a high priority site for future development.

CENSUS OF STUDY AREAS

Pre-development censuses were conducted during the winter of 1960-61 to determine numbers of scaled quail, bobwhites, and pheasants on developed and control areas. Post-development censuses were made on both study groups during the following 4 years. These inventories were conducted during three seasons: summer, late fall (prior to hunting season) and winter. Areas under study were examined at 10-day to 2-week intervals during the summer and winter seasons and 2-to-5-day intervals during the pre-hunting season censuses. A trained hunting dog was used to locate birds (Fig. 17).

The maximum number of each species counted on an area during a census period was recorded as the population index. This index was used in preference to average occurrence per count because difficulties involved in locating the birds varied considerably among the areas.

The two species of quail were separately recorded in the census although they occasionally intermingled and were difficult to distinguish. Scaled quail consistently used specific resting cover locations and were thus much easier to find and count. Bobwhites, on the other hand, were likely to be found almost anywhere within the home range of the covey. Scaled quail were widely distributed throughout the rangelands, whereas bobwhites were restricted to the sandsage-yucca and farmland cover types. While census figures for scaled quail were believed to closely approximate the actual scaled quail population on each study area, bobwhite and pheasant counts did not provide this level of confidence.

Pheasants were only occasionally flushed because few birds were present at the start of the evaluation period. And they continued to decline during the 4-year study.

BANDING OPERATIONS

Many characteristics of scaled quail, especially extent of mobility, were unknown at the origin of this study. Therefore, trapping and banding operations were conducted to obtain movement data. Small traps, baited with grain sorghum, were used in the operation (Fig. 18). Each quail was banded with aluminum leg bands, and a few were back-tagged with fabric-backed vinyl plastic.

Bands were placed on 316 scaled quail and 60 bobwhites during 1962 and 1963. Recoveries, representing about 5% of the banded quail, indicated the birds were not sedentary within the study areas during spring, summer and fall periods (Table 6). Results were similar to those obtained by Schemnitz (1961), who found summer home ranges varied from 720 to 2,180 acres in size and averaged 1, 370 acres.

CENSUS RESULTS FOR SCALED QUAIL

Census data gathered prior to and after development showed that habitat manipulations increased quail populations only during the fall and winter periods. Populations on the two study groups were similar during summer

TABLE 6. Scaled quail band recovery information.

Band number	Date banded	Age banded	Sex	Date killed or retrapped	Time interval (Months)	Distance traveled (Miles)
716	2-21-62	Adult	M	1-30-63*	11½	0
722	3- 7-62	Adult	M	1-30-63*	10	0
				11- 9-63	9½	2
13	1-17-63	Young	M	11-10-63	9½	2
14	1-17-63	Adult	M	11-10-63	9½	2
29	1-25-63	Adult	M	7-11-64*	18	1¼
37	1-25-63	Young	F	7-11-64*	18	1¼
51	1-29-63	Adult	F	11-15-64	22	3
70	1-29-63	Young	F	11- 9-63	9½	2
84	1-29-63	Young	M	10-16-63*	8½	0
97	1-30-63	Adult	M	10-16-63*	8½	½
110	2- 1-63	Adult	F	11- 9-63	9	2
159	2-21-63	Adult	F	11- ?-63	8½	½
207	3-27-63	Young	M	11- ?-63	7½	7
220	2-29-63	Adult	F	11- 9-63	7½	1¼
326	10-11-63	Young	M	11- ?-63	1	½

*Retrapped

FIG. 17. On Point! A trained Weimaraner proved a real asset in locating scaled quail, bobwhites and pheasants during census work.

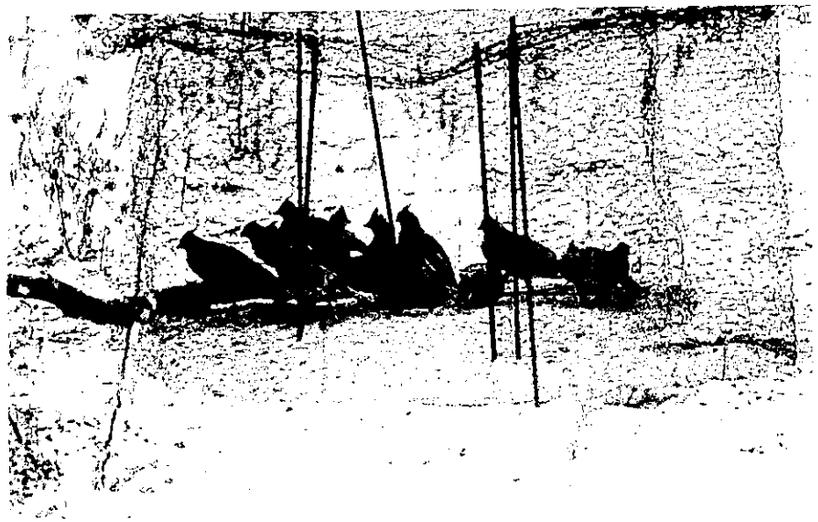


FIG. 18. Small traps baited with grain sorghum proved effective in capturing quail for banding.

periods. As the study progressed, reasons for the increased fall and winter populations on developed sites became apparent.

As previously mentioned, analyses included data from five developed and six control areas. Development area No. 6 was excluded because habitat manipulations were too late and no guzzler was installed. Evidence of illegal hunting and lack of nearby quail populations were also factors in excluding this area. All control areas were near existing quail populations.

Summer Census Results

Scaled quail were almost equal in number on the development and control groups through the successive summers of study (Fig. 19).

Occurrences of scaled quail per area, which showed greater variance, are summarized in Table 7. During the summer, when quail dispersed for brood rearing, cover and water supplements on the altered sites apparently were not important attractions.

Population Changes to Pre-hunting Season

A pronounced change in quail numbers occurred between the end of summer counts in mid-September and pre-hunting season counts in late-October. This was a period of quail movements when many coveys not already located, apparently traveled in search of suitable wintering sites. Much of this movement was from open range toward farmyards.

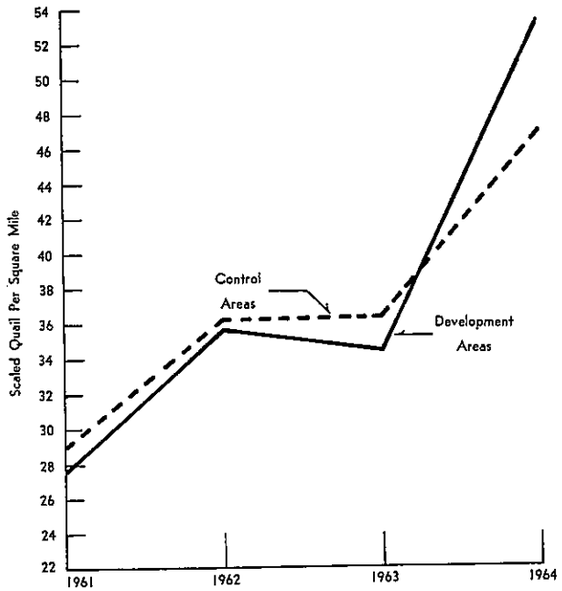


FIG. 19. Summer populations of scaled quail, old homesteads, 1961 to 1964.

TABLE 7.

Summer populations of scaled quail on old homestead study areas, 1961 to 1964.

Area Number	1961	1962	1963	1964
	Developed group			
1	34	101	66	72
2	23	3	20	63
3	27	16	8	31
4	16	37	41	53
5	38	21	37	47
Total	138	278	172	266
	Control group			
1	66	63	76	91
2	27	45	16	42
3	28	48	51	51
4	45	46	16	51
5	1	15	35	0
6	7	0	24	46
Total	174	217	218	281

Changes in populations between summer and pre-hunting seasons are illustrated in Figure 20. Populations declined markedly each fall on the control areas, whereas the developed sites retained most of their summer populations or increased.

Scaled quail counted during the pre-hunting season censuses are illustrated in Figure 21, and tabulated in Table 8. Since these were birds available to hunters, this census was believed the most valuable index of habitat manipulation efforts.

A combination of probabilities test was used to determine if differences in scaled quail numbers on developed and control sites occurred by chance or resulted from habitat manipulations. The test was based on the assumption that scaled quail numbers on study areas each fall provided a valid index to the suitability of the habitat.

A test was made of the population changes between summer and pre-hunting season censuses from 1961 to 1964. It showed a 0.995 expectation that the developed group retained significantly more scaled quail than the control group (Chi-square=25.90, 8 df). A second test showed a 0.925 probability that development area populations were significantly greater than those

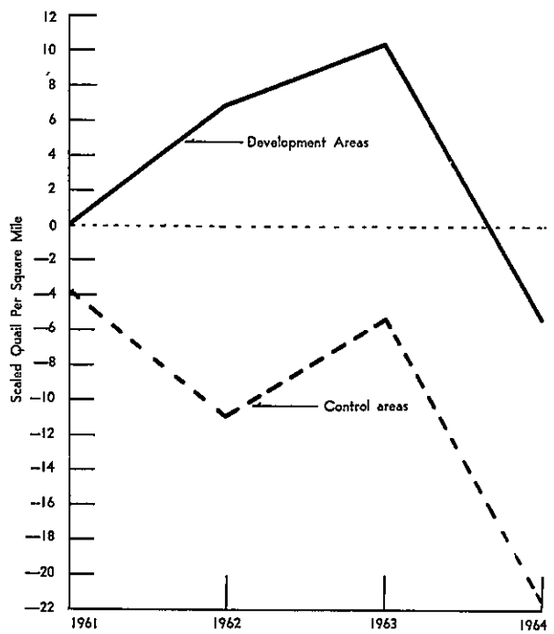


FIG. 20. Mean changes in scaled quail populations between summer and fall census periods, old homesteads, 1961 to 1964.

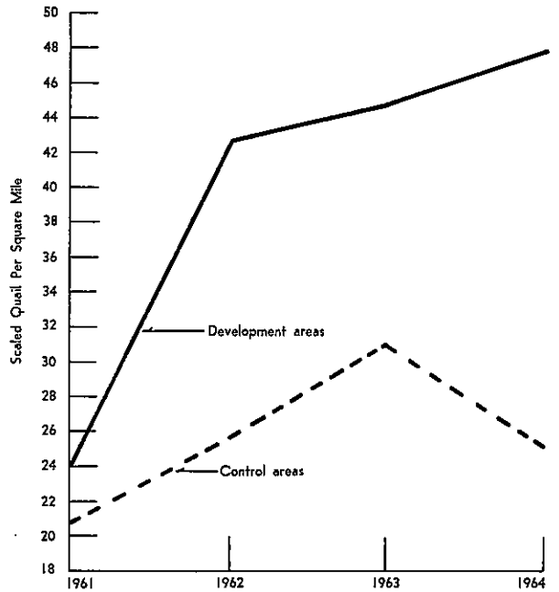


FIG. 21. Fall populations of scaled quail, old homesteads, 1961 to 1964.

TABLE 8

Fall populations of scaled quail on old homestead study areas, 1961 to 1964.

Area Number	1961	1962	1963	1964
	Developed group			
1	59	99	78	71
2	22	17	20	44
3	25	11	19	21
4	6	58	62	56
5	8	28	45	47
Total	120	213	224	239
	Control group			
1	35	52	55	80
2	36	39	22	18
3	19	40	43	36
4	23	23	31	3
5	11	0	17	0
6	0	0	18	14
Total	124	154	186	151

on the controls (Chi-square=14.432, 8 df). The two tests in combination showed habitat manipulations were influential in retaining a considerably greater number of scaled quail on the developed sites — birds immediately available to be hunted. Furthermore, the tests showed that the population differences did not occur by chance alone. The statistical tests are illustrated in Appendices A-1 and A-2.

The Influence of Hunting Seasons

The newly altered areas were known to only a few local hunters during the 5-day 1961 hunting season. Hunting appeared equally light on developed and control study groups.

As quail populations increased, more liberal seasons attracted more hunters who became increasingly aware of the improved sites. Hunting, therefore, became disproportionately greater on developed areas. Differences in pressure and harvest could not be accurately measured, since all areas and hunters could not be contacted. Harvest of quail on developed sites probably was not in proportion to the greater pressure they sustained because increased pressure made birds more difficult to find and kill.

If scaled quail resided with relative stability inside study areas, unequal rates of harvest between the two study groups would be reflected in population levels in subsequent years. If the birds possessed a "homing instinct," returning to wintering sites each year, this too would seriously bias the study. Band recoveries (Table 6) and back-tag observations failed to show evidence of any pronounced "homing instinct." Instead, birds appeared to reoccupy the study areas in fall in numbers somewhat relative to the quality of the sites. A bias due to unequal hunting pressure between study groups apparently did not carry over from one year to the next.

Most hunters were able to kill only a few birds out of each covey (Fig. 22). Coveys did not usually return to their main resting areas after being flushed and shot. Instead, coveys used shrub cover a short distance away and flushed or ran much sooner when approached again.

Crippling loss was high, especially within the sandsage-yucca range, where downed birds had optimum hiding conditions. At least seven scaled quail were crippled during hunting that yielded 50 scaled quail in 1961; and 37 were reported crippled during the harvest of 159 in the 1962 season. The 1962 loss of between 20 and 25% of the kill is about average for the region as a whole. Those hunters who used dogs had much lower losses (Fig. 23).

The quality of hunting was revealed by the success of hunters. Table 9 shows numbers of scaled quail, bobwhites, and pheasants bagged per hunter and per hour, 1961 through 1964 seasons.

The simultaneous opening of pheasant and quail seasons curtailed quail hunting since higher pheasant populations northeast of the study region attracted hunters away from the better quail areas. Waterfowl seasons during the quail seasons were less influential in this respect, but were of some signi-

Photo courtesy Kip Hinton, U. S. Forest Service

FIG. 22. A single explodes from cover in a tense moment for man and dog. Recreation of this order is the ultimate goal of the habitat manipulation efforts.

Photo courtesy Kip Hinton, U. S. Forest Service

FIG. 23. Smiles of satisfaction blossom on this trio as they inspect the results of a successful hunt. The dog was a valuable asset in finding and retrieving downed birds.

TABLE 9. Hunting success in the Campo Region, 1961 through 1964.

Year	Season length (Days)	Number of hunters checked	Hours hunted	Birds in possession	Birds/ hunter	Birds/ hour
1961	4½	28	42.8	53 Scaled quail	1.9	1.2
				7 Bobwhites	0.3	0.2
				2 Pheasants	—	—
				62	2.2	1.5
1962	8½	45	167.5	159 Scaled quail	3.5	0.9
				12 Bobwhites	0.3	0.1
				3 Pheasants	—	—
				174	3.9	1.0
1963	15½	73	210.0	244 Scaled quail	3.3	1.2
				10 Bobwhites	0.1	—
				254	3.5	1.2
1964	16½	54	161.0	144 Scaled quail	2.7	0.9
				14 Bobwhites	0.3	0.1
				1 Pheasant	—	—
				159	2.9	1.0

ficance. The majority of the hunters went afield during the opening weekend of the combined pheasant and quail season. Hunting pressure dropped sharply on weekdays and increased slightly during successive weekends.

Quantity of birds was the leading factor in hunting success, with weather conditions considered a close second. Heat, cold, snow, high winds, dust storms, and combinations of these were observed during the 4 November seasons. Snow during the short 1961 season limited favorable hunting conditions to about 2 days.

Weather conditions also influenced scaled quail. Hot, calm, dry weather permitted birds to hear approaching hunters, thus increasing the tendency of quail to run. Scaled quail have often been berated for their tendency to run rather than flush. Observations indicated this characteristic was related to their environment and hunting pressure as resident bobwhites responded similarly. In open canyon cover and short-grass ranges, this running characteristic was more obvious.

Age ratios of scaled quail obtained during hunting seasons indicated low reproductive success during the 4-year study. Sex and age data are provided in Appendix Table D-1, and weight data are contained in Appendix Table D-2.

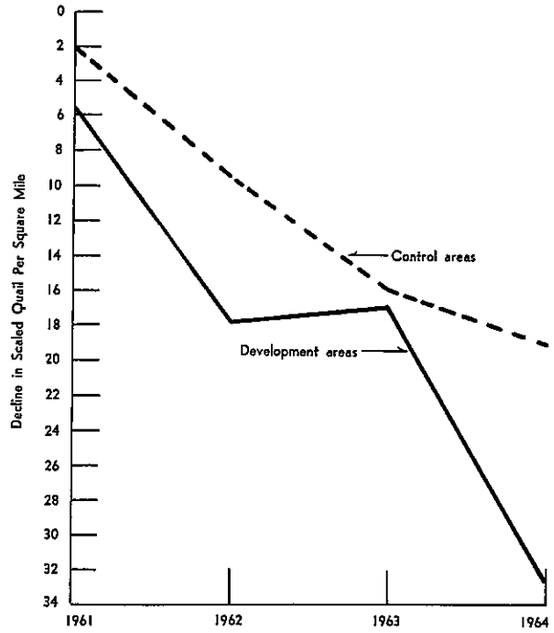


FIG. 24. Mean changes in scaled quail populations between early fall and winter census periods, old homesteads, 1961 to 1964.

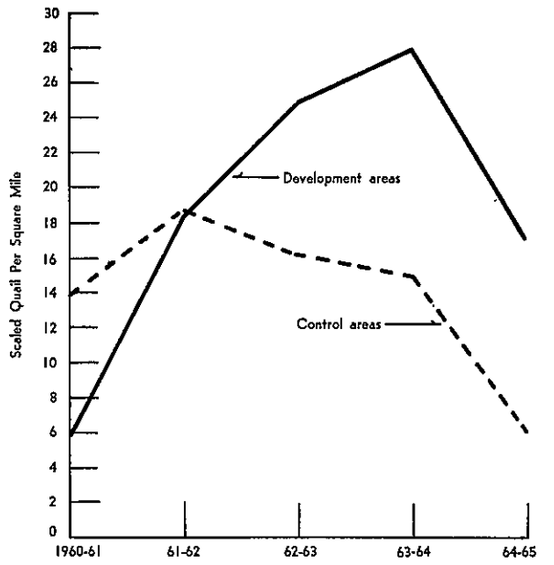


FIG. 25. Winter populations of scaled quail, old homesteads, 1960-61 to 1964-65.

Hunting season contacts and observations indicated less than 30% of the birds were harvested. A comparison of pre-hunting season and winter populations revealed a decline in scaled quail numbers much greater than could be attributed to hunting losses. The difference was attributed to emigration. Populations increased in a few instances because quail moved from nearby hunted sites onto study areas. However, major movements were toward farmyards, where hunting usually was not permitted. It was not known whether this was a continuation of the regular fall movements, or if movements were accentuated by hunting.

A statistical test conducted to determine if declines in scaled quail numbers between fall and winter on improved sites was significantly greater than on control sites failed to reveal any significant difference (probability of 0.761, Chi-square = 10.465, 8 df). Therefore, hunter preference for developed areas over control areas may have affected quail numbers in winter. Data for this test are shown in Table A-3 (Appendix).

Winter Census Results

The only pre-development censuses were conducted during the winter of 1960-61 (Table 10). Although the 1960 hunting season could have biased these figures, several factors indicated little, if any, bias existed.

TABLE 10.

Winter populations of scaled quail on old homestead study areas, 1960-61 to 1964-65.

Area Number	1960-61	1961-62	1962-63	1963-64	1964-65
			Developed group		
1	2	55	41	55	26
2	0	11	20	18	5
3	0	12	13	4	7
4	21	3	21	40	14
5	5	11	29	23	33
Total	29	92	124	140	85
			Control group		
1	18	25	25	39	16
2	25	29	11	0	0
3	19	28	36	43	0
4	21	30	25	0	20
5	0	0	0	0	0
6	0	0	0	8	0
Total	83	112	97	90	36

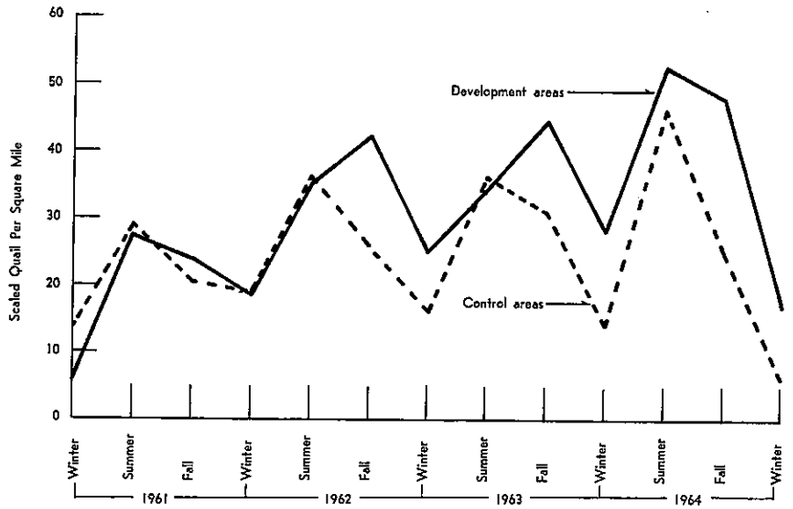


FIG. 26. Seasonal fluctuations in scaled quail populations, old homesteads, 1961 to 1964.

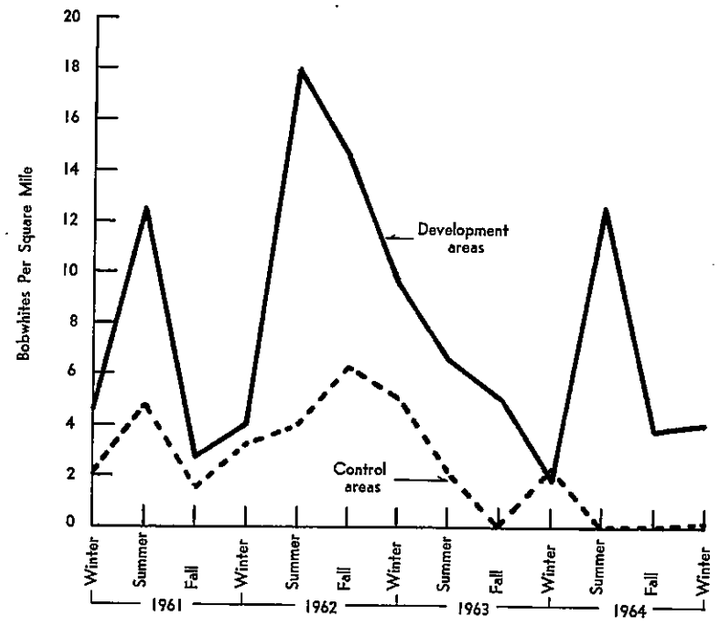


FIG. 27. Seasonal fluctuations in bobwhite populations, old homesteads, 1961 to 1964.

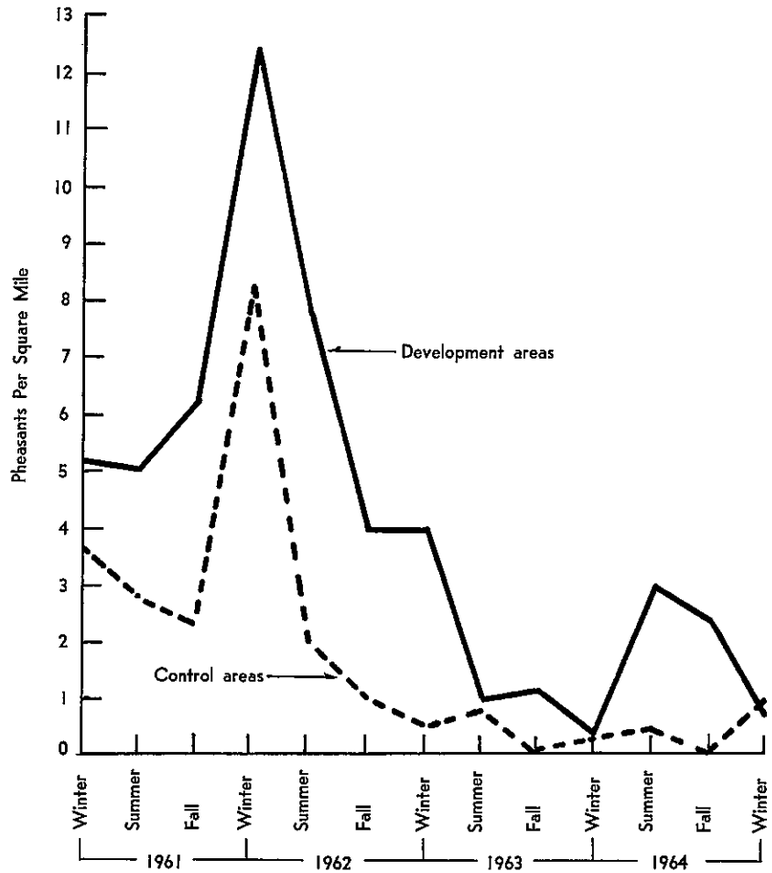


FIG. 28. Seasonal fluctuations in pheasant populations, old homesteads, 1961 to 1964.

Population changes from fall to winter were small in 1961 because the short 5-day hunting season had little effect on low scaled quail numbers (Fig. 24). Therefore, a similar 5-day season in 1960 probably produced comparable results.

Habitat manipulations were not begun until 1961, so all sites had the same general appearance. Therefore, hunting intensity was probably similar on the two groups.

Scaled quail populations on control areas remained nearly stable during the first 4 winters, while development populations increased substantially (Fig. 25). Comparable trends existed during the fall season censuses from 1961 through 1963 (Fig. 21). If these pre-hunting season census trends were

regressed back to the fall of 1960, it is likely that populations on the developed and control areas would have been similar.

The combination of probabilities test was well suited to the data and assumptions of the preceding population comparisons and changes. However, it cannot be used as well on the winter census data since control populations exceeded developed area populations during the pre-development winter (1960-61) censuses and were near equal during the second winter of study (1961-62). A hypothesis stating that total populations on development areas exceeded those on the controls would result in a negative t value or there would be less than a 50% expectation that the development populations could exceed those of control groups (Appendix Table A-4). In actuality, the data show 0.895 probability that the control populations were significantly greater than the development populations during the pre-development winter census ($t=1.342$, 9 df).

If census data for the second winter (1961-62 were excluded, a combination of probabilities test on the census data of the three ensuing years would show a 0.953 expectation that quail populations on developed areas were significantly greater than those on the control areas (Chi-square=12.834, 6 df, See Appendix Table A-4).

The opposing probabilities from pre-development to post-development winters place high confidence in the trend effect (Fig. 25) of the habitat manipulation — confidence that is strengthened by the summer to pre-hunting season results. Figure 26 illustrates population changes through 13 census periods.

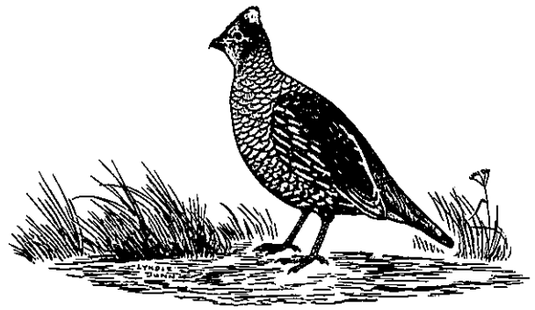
CENSUS RESULTS FOR BOBWHITES

Low densities and inconsistent occurrences of bobwhites made population analyses difficult. Higher bobwhite populations were evident (Fig. 27) on the development group than on the controls at the start of the study and this pattern continued throughout most of the 4-year study. Development area No. 6 was excluded in the comparison shown in Figure 27. The denser, higher cover of developed areas appeared to be a major attraction for bobwhites. Although there is insufficient data for a statistical test, habitat improvements appear to have benefited bobwhites more than scaled quail.

CENSUS RESULTS FOR PHEASANTS

Pheasants, which occurred in even lower densities than bobwhites (Fig. 27 and 28), paralleled population declines in bobwhites. Poor reproduction was evident throughout the region. It appeared that development areas as a group provided slightly better sites for pheasants than controls, but there is no indication that the developments increased pheasant numbers.

A coeffecient of correlation test of pheasant crowing-count data with winter census information by area revealed no correlation ($r=0.48$, 9 df). Since neither of these inventories was believed an accurate representation of study area populations, no analysis of the results was attempted.



Chapter 5

BRUSH SHELTER DEVELOPMENT STUDY

The value of resting cover was apparent early in the study. Scaled quail were observed to use fallen trees, old car bodies, abandoned farm machinery, and post piles as resting cover. Commenting on the value of resting cover to scaled quail, Schemnitz (1961, p. 41) stated:

> *The construction of artificial resting cover in vacant areas of the potential range would permit the establishment of additional home ranges and the survival of new coveys, providing a more uniform quail distribution over the suitable range.*

The current study was started to determine if supplying of resting cover alone would provide the missing link in the year-around habitat needs of the scaled quail on the yucca-sandsage ranges of southeastern Colorado. The natural cover of this vegetative type is apparently inadequate for wintering of scaled quail.

Six sections of land within the yucca-sandsage type were selected for study. Three of these were developed and three were left undisturbed as controls. Each section was subdivided into quarter sections, or 160-acre parcels. These parcels were considered adequate for the winter home range of a covey which isn't supposed to exceed 80 acres (Schemnitz, 1961).

A brush shelter was constructed near the center of each developed quarter section. These shelters consisted of a frame work 8 to 12 feet square and 3 feet high built of tree limbs and fence posts, which were covered with deciduous tree limbs to form dense canopies (Fig. 29). Old Christmas trees were sometimes used to form the canopies.

CENSUS PROCEDURES

A pre-development winter census (1961-62) showed scaled quail were not wintering on the areas to be developed and only one small covey was found at a blowout in one of the control areas (Table 11). A summer search of the same areas, completed in late July of 1962, showed quail were occupying nearly all the development and control areas. Routine censuses of scaled quail were made each summer on the developed areas (Table 12).

Time limitations prevented adequate fall censuses of the areas prior to hunting seasons. However, at least one census of each area was conducted each fall (Table 13). Most of these counts were made in early October before coveys had established stable winter residences.

TABLE 11. Winter populations of scaled quail on brush shelter development and control areas, 1961-62 to 1964-65.

Area	1961-62	1962-63	1963-64	1964-65
		Development Group		
1-D-1	0	0	16	0
2	0	0	0	0
3	0	0	0	0
4	0	13	15	0
2-D-1	0	0	18	0
2	0	0	20	6
3	0	16	22	0
4	0	0	0	0
3-D-1	0	0	0	0
2	0	0	17	0
3	0	0	0	0
4	0	0	0	0
Total	0	29	108	6
		Control Group		
1-C-1	0	0	0	0
2	0	0	0	0
3	0	0	0	0
4	0	0	0	0
2-C-1	13	0	0	0
2	0	0	0	0
3	0	14	0	0
4	0	0	19	0
3-C-1	0	0	0	0
2	0	0	0	0
3	0	0	0	0
4	0	0	0	0
Total	13	14	19	0

TABLE 12.

Summer populations of scaled quail on brush shelter development areas, 1962 to 1964.

Area	1962	1963	1964
1-D-1	13	19	14
2	2	0	16
3	0	0	7
4	3	19	4
2-D-1	15	0	25
2	14	0	20
3	3	31	39
4	2	17	23
3-D-1	0	0	0
2	8	42	0
3	0	0	0
4	0	0*	7

* Quail tracks were found, but no quail.

TABLE 13. Fall populations of scaled quail on brush shelter development and control areas, 1962 to 1964.

Area	1962	1963	1964
	Development Group		
1-D-1	27	18	25
2	4	0*	6
3	13	0	8
4	44	30	1
2-D-1	7	12	0
2	4	0	12
3	1	22	0
4	0*	18	0
3-D-1	0	0	0
2	0	23	0
3	0	0	0
4	0	0*	0
Total	100	123	52
	Control Group		
1-C-1	0	0	0
2	0	0	0
3	0	11	0
4	0	0	0
2-C-1	11	22	0
2	0	0	0
3	14	5 bobwhites	0
4	0	14	0
3-C-1	0	0	0
2	0	1	0
3	0	0	0
4	0	0	0
Total	25	48 & 5 bobwhites	0

* Quail tracks were found, but no quail.

FIG. 29. Brush shelters like this are considered one of the most economical habitat improvements for scaled quail.

HARVEST

The study areas were such a homogeneous group, that they did not contain conditions attractive to hunters. Hunters or evidence of their presence were not found on any of the controls. Since shelters on the developed areas were not easily noticed and were not publicized, they did not immediately attract hunters. It was not until the 1963 and 1964 hunting seasons that hunting occurred on two of the three development sections.

POPULATION CHANGES

Inadequacy of pre-hunting season censuses due to instability of coveys in early fall made it necessary to rely on winter censuses to evaluate brush shelters (Table 11). Such data did not represent the birds that were available to hunters because some quail were harvested or scared from the developed areas during the 1963 and 1964 seasons.

A regression comparison of the pre-development (1961-62) to 1963-64 winter scaled quail populations indicated a significant difference between development and control groups ($F = 7.08$, 1 & 68 df). However, this trend did not persist through 1964 (Fig. 30). Although summer populations on development areas in 1964 exceeded those of previous years (Table 12), a rapid decline in quail during the fall nearly brought the development group populations back to pre-development winter levels. Similar population declines were

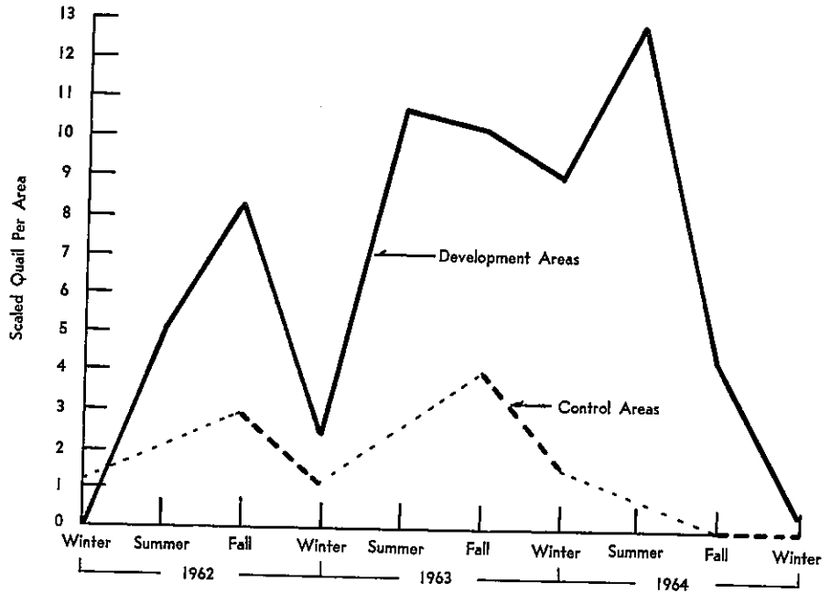


FIG. 30. Seasonal fluctuations in scaled quail populations, brush shelter development and control area, 1962 to 1964.

observed on the old homestead controls (Fig. 21), the block development site, and at many other wintering locations within the range. Much of this decline occurred prior to the November (15-30) hunting season. Reasons for the accentuated drop will be discussed later.

Immigration of scaled quail to farmyards provides evidence that a major die-off did not occur. Apparently there was some deficiency in the natural habitat other than resting cover.

QUAIL-VEGETATION CORRELATIONS

Numbers of scaled quail on 12 developed areas varied considerably. A study was conducted to determine if there was any correlation between quail numbers and vegetative composition.

Vegetative sampling was completed during the summer of 1964, using ocular estimates on square-foot plots along line transects radiating from brush shelters (See Appendix Table B-1). This technique intensified the sampling around shelters where scaled quail were similarly concentrated.

An index of quail use of each developed area was determined by averaging all census figures for the area. Percentages of vegetative types were then plotted into a scatter diagram with quail indexes to determine if any correlations existed. Where correlations were indicated, coefficients of correlation (r) were computed. Results of these evaluations are shown in Table 14.

FIG. 31. Clammy weed (Polanisia trachysperma) is one of the more common forbs in the sandsage-yucca range.

FIG. 32. Buffalo-bur (Solanum rostratum) is both a common forb and a good food for quail.

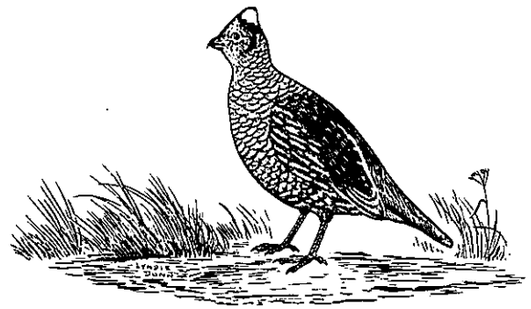
TABLE 14. Correlations between vegetative composition and quail abundance, at brush shelters expressed as coefficients of correlation.

Type of vegetation or ground cover	Coefficient of Correlation
Forb cover	+0.58
Grass cover	—0.65
Grass and litter	—0.74
Bare ground	No apparent correlation
Litter	Ditto
Shrub cover	Ditto

Correlations showed quail were more abundant on areas having higher percentages of forbs than grasses. Since grass is a climax vegetative type for this area, pioneer successional types that have an abundance of forbs have provided the best habitat. Quail were apparently attracted to the areas high in forbs by the food provided. Schemnitz (1961), working a few miles away in the Oklahoma Panhandle, found the fall and winter diet of scaled quail was largely composed of forb seeds (Fig. 31 and 32). Within the sandsage-yucca grasslands where he was working, Russian thistle *(Salsola pestifer)*, pigweed *(Amaranthus graecizans)*, evening star flower *(Mentzelia nuda)*, sunflower *(Helianthus sp.)*, Texas croton *(Croton texensis)*, buffalo-bur *(Solanum restratum)*, western ragweed *(Ambrosia psilostachya)*, and purslane *(Portulaca orleracea)*, were the major fall and winter foods used by scaled quail. Only grain sorghums exceeded these foods in the diet. Since this cultivated crop was not available to quail in the brush shelter areas in Colorado, the importance of forbs was undoubtedly increased.

Is it possible that food could limit scaled quail numbers? The correlation data provide some evidence that such might be the case. Additional information on this subject is presented in the next Chapter.

Problems encountered in this study point out the need for having a complete knowledge of the ecological requirements of a species before attempting habitat development.



Chapter 6

BLOCK DEVELOPMENT STUDY

In an attempt to reduce development costs, the Forest Service began habitat developments on several unfenced sites within the sandsage-yucca range. Fifteen guzzlers were installed within a block of approximately 4 sections. This treatment as a whole was referred to as a block development. Individual developments were located about ½ mile apart. One or two brush shelters were placed at each guzzler and a quail feeder was included at each of six sites (Fig. 33). Tree cacti transplants were placed around guzzlers and feeders to ward off cattle.

Wood rats, attracted to the guzzlers, cut and carried cacti under the collecting aprons for nest construction. This not only destroyed the cacti, but also decreased the areas under the aprons available to resting quail.

Unprotected brush shelters within the block development were nearly all knocked down and trampled by cattle, but some continued to provide limited resting cover for quail.

CENSUS AND POPULATION CHANGES

Routine censuses on the block development area were conducted by U. S. Forest Service personnel. These censuses were started during the summer of 1963 and continued through the winter of 1963-64. Censuses were resumed later in 1964. Results of these counts showed 150 to 200 scaled quail and a few bobwhites were occupying the fifteen guzzler sites and one old homestead site during the summer and early fall of 1963. Gradual declines in the numbers of scaled quail were observed prior to and following the 1963 hunting season. The following summer, quail numbers increased to 225 birds.

FIG. 33. A block development unit, showing transplanted tree cacti, feeder, guzzler, and brush shelter.

Population declines on the block development during the early fall of 1964 paralleled the sharp declines on brush shelter development areas, old homestead control areas, and other locations. Counts showed population declines of a third or more from mid-October to mid-November. Only a small percentage of the original population remained during the winter of 1964-65.

Since a pre-development census was not conducted, it can't be said that development efforts increased scaled quail numbers on the block development. However, *the fact that* sandsage-yucca grasslands lacking such developments were usually devoid of quail during the winter months, indicates the developments significantly improved the suitability of such range for scaled quail.

TRAPPING, BANDING AND BACK-TAGGING

Trapping and marking operations during the fall of 1963 netted 140 scaled quail and 17 bobwhites. Back-tags, which were color coded to denote trapping locations were placed on 76 scaled quail and 7 bobwhites. Observa-

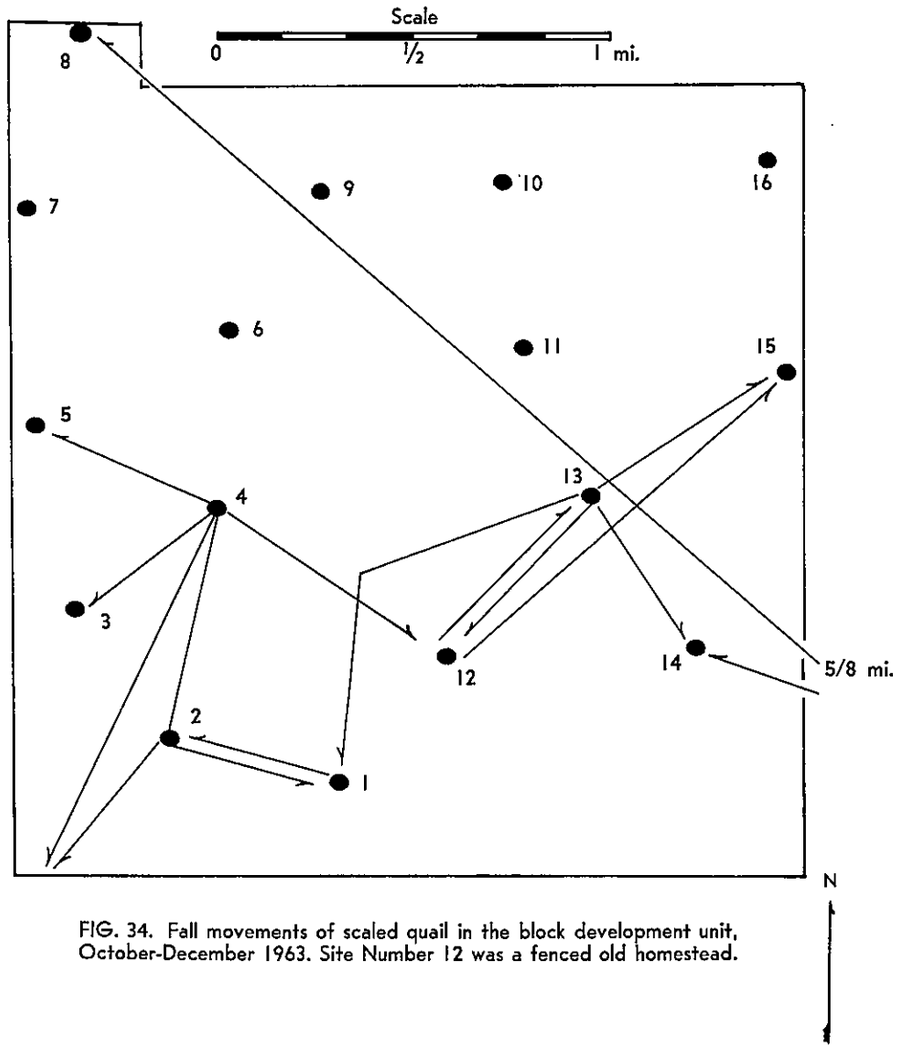


FIG. 34. Fall movements of scaled quail in the block development unit, October-December 1963. Site Number 12 was a fenced old homestead.

tions of these birds from October to December of 1963 showed considerable interchanges between guzzler sites on the block development (Fig. 34). A mixing of birds between coveys was also observed.

SUPPLEMENTAL FEEDING

Feeders at six of the guzzlers within the block development were placed well above the ground to exclude rodents and livestock(Fig. 33). So little feed was placed in these feeders during the summer and fall of 1963 that,

for the purposes of study, feed was assumed to be absent. Milo was continuously supplied through the next summer and fall in an effort to determine if the feed attracted and retained quail at the sites.

A dramatic decline in scaled quail numbers in the fall of 1964 had no parallel in earlier years of study. Except for developed old homesteads and block developments with artificially supplied feed, quail sharply declined throughout the sandy ranges of southeastern Colorado. Meanwhile, farmyard populations of scaled quail increased over what they had been the previous year. Thus, there was a major shift in quail populations from the rangelands to the farmyards. Any deficiency in cover was ruled out as a possible cause since cover conditions in 1964 were similar to those in 1963.

The availability of water was also considered as a possible cause for this movement of scaled quail. Quail were available to hunters around many windmills during 1963, but not during 1964. Since water was available at windmills during both of these years, a water shortage was not believed responsible for the decline in birds in 1964.

Seeing scaled quail around windmills, many persons have assumed that the availability of drinking water is the main attracting factor. Observations by the author, Schemnitz (1961), and others have indicated that food — not water — is the primary attraction at windmills. Gorsuch (1934, p. 41) reported the following from his Gambel's quail investigations in Arizona:

> *An average morning count, when the birds were actively moving, showed an even six hundred visiting a tank during a two and one-half hour period. Of this number two hundred and ten, approximately one third of the whole, drank. Continued observations of this kind definitely proved that the principal reason the quail visited the location was not the water, but the mesquite and other seeds the birds were getting from the livestock droppings about these tanks.*

Rotation of grazing between several pastures on the Carrizo District permitted forb growth at windmills within ungrazed pastures. The food thus provided attracted scaled quail.

An analysis of scaled quail populations on the block development during the fall of 1964 (Appendix Table C-1) indicates a food shortage might have been the reason for increased quail movements to farmyards. While water was available at all developed sites within the block development, food was available at only a portion of these. Declines at developed sites without feeders were significantly greater than those where feed was artificially provided.

The extent of seed production by native forbs was not determined in 1964. However, there is a strong possibility there was some deficiency here in that summer rainfall was far below the 75-year average (Fig. 6). Regardless of the cause for any food deficiency that might have existed, it is significant that developed areas with feeders were able to hold quail populations through the hunting season.

Evaluation of supplemental feeding experiments in New Mexico (Campbell, 1959), Florida (Frye, 1954), and several other states have shown resulting increases in wild quail. However, researchers in these states concluded

that increases in quail were insufficient to justify large-scale feeding programs. Results in Colorado are too limited at this time to say whether supplemental feeding in normal moisture years is of any benefit to quail. Only further repetitions of the current study would provide the information needed for a valid evaluation of supplemental feeding.

WATER DEVELOPMENTS

The value of water developments in scaled quail management has not been established. In fact, little is known of the water requirements of this species. Hungerford (1962) found Gambel's quail in Arizona consumed more succulent vegetation where no water was available than those having access to water. He also reported that those birds living where water was absent maintained normal body weights and reproductive success. Hungerford (1964), Lehman (1952), and Wallmo (1957) accumulated evidence showing a direct correlation between breeding success of southwestern quail (Gambel's, bobwhites, and scaled) and the amount of precipitation. They also reported Vitamin A, an essential prerequisite for successful reproduction, was significantly more abundant in quail livers during wet years than in dry years. Since Vitamin A is derived from the carotene in green plants, they postulated quail must have green forage to reproduce. Hungerford (1964) suggested that any method to concentrate rainfall run-off would stimulate vegetative growth and thus might be more beneficial than guzzlers.

In southeastern Colorado, the reproductive success of pheasants and bobwhites varied with the amount of moisture as mentioned by the foregoing workers; however, scaled quail failed to follow this pattern. Population trend data on scaled quail, collected in southern Baca County by Hoffman (1965), showed small but consistent population increases occurred in spite of spring droughts in the early 1960's. Substantial increases were also recorded by Schemnitz (1961) and Nolting (1952) during the drought period in the 50's in Oklahoma and Colorado, respectively.

Numerous small coveys of scaled quail were found during the current study where water was not available. Repeated checks showed these birds seldom, if ever, traveled to obtain drinking water during dry fall and winter periods. Water was only intermittently available to coveys residing at and near windmills because windmills were operated only during the grazing period from May 15 to November 15. Even then, water was not always available, since quail seldom drink directly from stock tanks.

Apparently this species is able to survive and reproduce without free drinking water. Since it seems possible that living on natural succulence alone might restrict quail densities, guzzlers were provided in the block development and evaluated.

Guzzlers designed, constructed and installed by Carrizo District personnel cost approximately $225 per unit and were estimated to last for 25 years

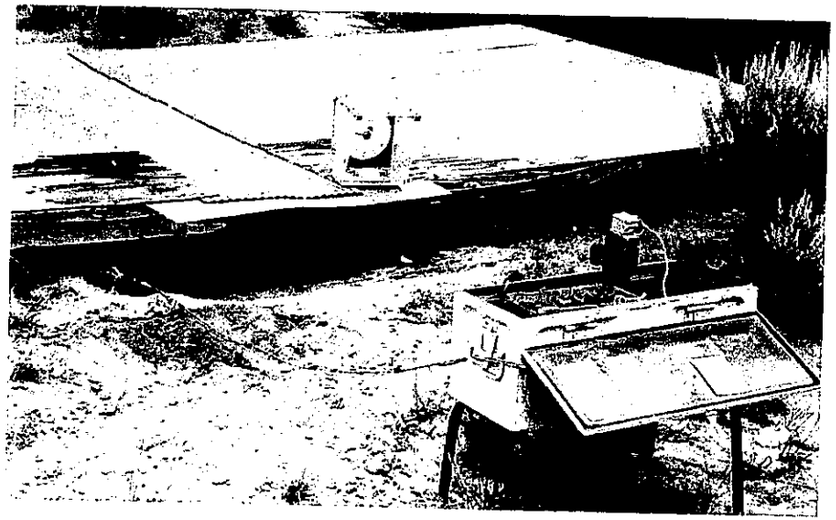


FIG. 35. Camera recording equipment set at mouth of guzzler to record animals going in to drink. Transistorized clock showed time of activity.

without any major maintenance (Fig. 12-14). These guzzlers proved to be very efficient in collecting and storing water for the use of quail and other wildlife.

In addition to providing water, the elevated, sheet metal collecting aprons afforded good resting cover that was consistently used by scaled quail and bobwhites. This complicated the evaluation of guzzlers as watering places because counts of quail at these sites did not show whether the primary attraction was cover or water.

Camera recording units (Dodge and Snyder, 1960), were installed at entrances of two guzzlers to determine if scaled quail consistently utilized water in the guzzlers (Fig. 35). Each photographic recording unit consisted of an 8 mm, spring-wound, electric-eye movie camera; an artificial light source; a photo-electric system to automatically activate the camera shutter when birds or animals came to drink; and a wet-cell battery for electric energy.

The movie camera was adjusted to take single-frame exposures when activated by the photo-electric system. The latter system projected a light beam across the entrance to the guzzler so that any animal breaking this beam would activate the camera through a solenoid system, thus taking its own picture.

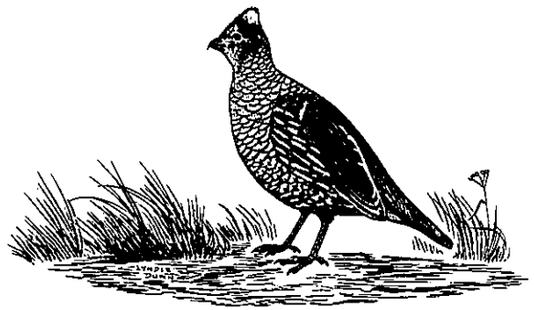
One of the camera recording units was further equipped with an impulse counter to record the number of times the equipment was activated and a

transistorized clock to show the time of activations. These modifications worked well in recording a high percentage of the activity at the guzzler from July 1964 through January 1965.

The recording camera showed that scaled quail came to the guzzlers in pairs and brood coveys during the summer but were rather inconsistent visitors. Activity increased during the dry September-October period, when quail came to drink daily. The cameras were removed during the November hunting season and were reinstalled in December. Active use of the guzzlers for drinking continued in December.

Use of the recording cameras afforded positive proof that scaled quail consistently used guzzlers as a source of drinking water. Bobwhites, mourning doves, cottontails, and a variety of song birds were also frequently recorded at mouths of guzzlers. Pheasants, although permanent residents where there were recording cameras, were never shown to use the guzzlers for drinking. Lesser prairie chickens that lived near both guzzlers also failed to show evidence of drinking.

Although it was apparent that scaled quail consistently drank water from guzzlers during dry periods, the availability of water at guzzlers could not be related to increased numbers of birds. The results obtained from the camera recording units suggest that such devices might have other practical applications in the wildlife field.



Chapter 7

CONCLUSIONS

1. A reduction in the migration of scaled quail from public ranges to farmyards, where the birds are not available to hunters, was a direct result of habitat development on the native range.

2. Scaled quail need brush cover and an abundance of seed-producing forbs. Since these needs are closely met along roads, at abandoned homesteads, and at blowouts, habitat improvements at such sites will produce the best results with a minimum of expense.

3. Scaled quail habitat improvement potential is great on public lands where there is a minimum of conflict with landowners and livestock grazing. Furthermore, beneficial improvements are economically feasible.

4. Cover plantings offer little promise except around blowouts, where Russian olive, tree cactus, wild plum, sand cherry, and skunkbush have been successfully established.

5. Artificially supplied cover is readily used by scaled quail and there is conclusive evidence that such cover benefits the species.

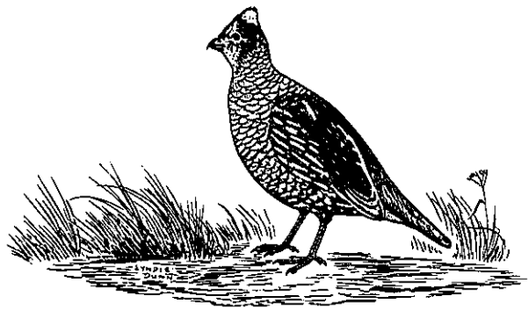
6. Artificial feeding of scaled quail, although not thoroughly evaluated, is believed to have some value in retaining birds on public lands where they are available to hunters.

7. A drastic decline in scaled quail numbers on public ranges in the fall of 1964 was partially caused by a mass migration of birds to farmyards. A reduction in forb seed production due to a drought was believed the cause.

8. Gallinaceous guzzlers were consistently used by scaled quail as a source of water and shelter. Although drinking water apparently is not essential, it is considered a desirable supplement if it can be economically provided.

9. Fencing of habitat developments to protect them from livestock is expensive, but is desirable when such developments are situated within ½ mile of windmills or other livestock concentration areas.

10. Extensive development of scaled quail habitat on public lands is limited by the multiple-use management concept. Even though elimination of livestock grazing might be desirable, it is not possible.



Chapter 8

MANAGEMENT RECOMMENDATIONS

ESTABLISHMENT OF NATURAL COVER

Efforts to establish natural cover for scaled quail in southeastern Colorado could better be channeled into developing other types of cover. A possible exception to this might be at blowouts where some plants can be successfully established. Livestock should be excluded from such sites by fencing to protect plants while they are becoming established and to reduce erosion by soil disturbance.

Since low brushy cover is preferred by quail, species selected for planting should conform to this growth form or be pruned periodically to produce this form.

ARTIFICIAL RESTING COVER

Artificial resting cover is a proven asset to scaled quail. Therefore, more effort should be expended in developing this type of cover.

The shade quail seek during summer months is usually provided by existing shrub cover on occupied ranges. The real need for additional resting cover is for the remainder of the year, when quail need protection from wind, weather, and avian predators. Resting cover should provide maximum protection from above and the sides and yet allow freedom of movement underneath. Soil sterilants should be used under brush shelters to prevent weed growths that would hamper quail movement.

Two problems inherent to brush shelters as resting cover for scaled quail are damage by livestock and occupancy by wood rats. Any brush shelters

situated within ¼-mile of windmills or other livestock concentration areas must be fenced. Because tree cacti attract wood rats, fencing is considered more practical than the planting of tree cacti.

FENCING

Fencing is an expensive item that should be avoided in habitat improvement work unless absolutely necessary. A good example of where fencing is absolutely necessary to habitat improvement is around blowouts and brush shelters.

Weed growth is another problem associated with fencing. Although seed-producing weeds and forbs are valuable sources of quail food, these plants often become so dense under complete protection that quail access and use is obstructed. One possible solution to this problem is the creation of narrow paths by the use of soil sterilants.

WATER DEVELOPMENTS

Of the three habitat requirements — food, cover, and water — water is believed to be the least important to scaled quail insofar as habitat improvement is concerned. Although scaled quail will utilize guzzlers for drinking, it remains to be proven that guzzlers are necessary or will increase quail. Therefore, money spent on water developments could better be spent on other habitat improvements.

If it should ever be determined that guzzlers are needed by scaled quail, a simpler and less expensive guzzler than those used in the current study should be developed. Altered 55-gallon barrels and small collecting aprons would probably suffice, since it was evident that quail did not need the several hundred gallons of water provided by guzzlers used in this study.

SUPPLEMENTAL FEEDING

The limited study of supplemental feeding indicates that such a practice might have some practical application in quail management. If several dollars worth of feed, which is believed adequate to sustain a covey of 20 to 30 birds from mid-summer to hunting season, could retain quail on public ranges where they are available to hunters, then feeding efforts would be worthwhile. Additional testing of a supplemental feeding program is recommended before adopting this practice as a management tool.

PLACEMENT OF DEVELOPMENTS

It is known that food and resting cover are the two most important habitat needs of scaled quail. These are normally provided by forbs and shrubs. Any habitat improvements should concentrate on improving these two items where they currently exist in insufficient quantities. The conversion of native grasslands to suitable quail habitat by providing both the above needs would be too costly and of doubtful success. Therefore, a majority of the short- and

mid-grass cover types of southeastern Colorado are immediately eliminated from any habitat improvement consideration. This leaves the sandsage-yucca type as the best possible place to concentrate habitat improvement practices.

Within the sandsage-yucca type there are many preference locations where a minimum effort would make the range suitable for scaled quail. In many of these, supplemental resting cover alone would hold coveys that would otherwise migrate to farmyards and be unavailable to hunters. Several locations within the sandsage-yucca type that warrant special mention are discussed below.

Draw Bottoms

Sandy draws, where sandsage is a dominant plant and forbs are abundant, are best suited to habitat improvement for scaled quail. Resting shelters here should make it possible to support a wintering covey about every ½ mile. However, resting shelters should be placed every ¼ mile to permit maximum use of the range. Water developments, if supplied, should not be placed at closer intervals than ½ mile. Three-quarters to 1-mile intervals might be more practical.

Windmill Sites

Windmill sites within the sandsage-yucca range have a high potential for development. Because of cattle concentrations, any improvements would have to be fenced. Small triangular areas of ¼-acre or less including several brush shelters should be placed 100 to 200 yards from windmills. Tree cacti could be transplanted to protect corner posts from cattle rubbing.

Old Homestead Sites

Many old homesteads have food and shrub cover, plus abandoned farm machinery and other items that provide additional resting cover. The existing conditions at such sites can often be improved for scaled quail with a minimum of effort and expense. Protection from livestock is often all that is needed at such sites. This can often be done by improving and repairing existing fences. Periodic disturbance of the soil within such areas might be necessary to maintain food-producing forbs.

Blowouts

The value of blowouts as potential habitat development sites was previously discussed at the first of this chapter.

Other Locations

Within the sandsage-yucca type, common borders between pastureland and cultivated lands, roadways, or conservation reserve acreages offer excellent potential for habitat development. Wind-blown sands that accumulate along such borders prevent plant succession from reaching a climax, thus preserving vegetation of more value for scaled quail. Resting shelters along such borders may greatly improve the capabilities of such sites for holding coveys of quail.

Unlike pheasants, which are often killed on roads, scaled quail are agile birds that are seldom hit by motor vehicles. Therefore, habitat improvement along roadways would not bait scaled quail into a dangerous situation so far as vehicles are concerned. One hazard of attracting birds to such sites would be the ease with which the birds could be hunted from vehicles.

INTENSITY OF HABITAT DEVELOPMENT

Cost is the limiting factor in any habitat development program. With unlimited funds, almost any habitat can be made suitable for a species for which the habitat needs are known. Unfortunately, state and federal agencies don't have unlimited funds and, therefore, must be realistic in expending funds for habitat improvements.

A low intensity of developments is a must until it can be seen that such developments are producing the desired results. This means that a priority must be established in selecting sites for development. A high priority site would be one in which scaled quail numbers could be increased or birds held on the public range through hunting season with a minimum expenditure of time and money.

Predation is usually not serious enough to warrant any remedial action if satisfactory resting cover is available to scaled quail. However, as habitat improvements are intensified, the resulting higher densities of quail will attract predators that might need some control.

HUMAN ASPECTS OF HABITAT DEVELOPMENT

The potential for improvement of the Carrizo Grasslands for scaled quail and other game birds is great. Too great to be overlooked and ignored! Stop, and consider some of its qualities. Foremost is the existing vegetation within the sandsage-yucca range. Its capability to support four species of game birds, in itself, illustrates the quality of the cover and food. This type of situation is not found many places within the semi-arid High Plains region.

The District is open to hunting, so access is no problem. The farms and ranches interspersed within the District pastures are scattered and the resident human population is low.

Habitat improvements that result in increased numbers of quail on public lands will also increase hunting pressure and accompanying problems that can't be overlooked. The problem is not one of over-shooting the quail so much as protection of the habitat. Unfenced habitat developments pose a special problem as vehicles can't be excluded. This is a factor to be considered in development planning. Improvements at old homesteads, windmills, and near roadways and fence lines are usually accessible by vehicles. Developments along draw bottoms, at blowouts and other locations pose similar problems. The question then arises as to how to keep hunters and their vehicles from damaging these sites.

Although hunters should not be required to walk unreasonable distances to gain access to prime hunting sites, they should be required to search cover and hunt birds afoot. Regulations restricting vehicle travel to designated access roads may be justified. Providing maps showing locations of these roads would be helpful to the hunters. Other pertinent information could be printed on these maps.

Fire is a formidable and dangerous threat on the dry, windswept scaled quail ranges. Measures to prevent and suppress fire are especially needed during hunting seasons, when a hunter-caused fire could wipe out valuable quail habitat as well as costly habitat improvements.

SCALED QUAIL VERSUS LIVESTOCK INTERESTS

Livestock grazing has been a long established land use on the Carrizo District and will continue as such in the future. Under the multiple-use management of the U. S. Forst Service, wildlife and wildlife habitat on public ranges are also considered in management planning.

There is no major conflict on the Carrizo District between livestock and quail at the present time. Modest habitat improvements for quail or livestock should not cause any serious conflicts in management beween the two. On the other hand, intensive developments or improvements for either livestock or quail could materially damage the other. For example, sagebrush and yucca, which in combination comprise only 8% of this vegetative type, occupy space and compete with grasses. Therefore, sage and yucca are undesirable from a livestock management point of view and should be removed to provide more grass for livestock. Such eradication would wipe out existing populations of quail, prairie chickens, and other wildlife that depend upon these plants for food and cover.

A slow and moderate approach to habitat development and improvement for both livestock and wildlife is recommended. Economic and aesthetic benefits from the two resources managed in combination can be far greater than from intensive single-use management of one or the other.

HABITAT DEVELOPMENT ON PRIVATE LANDS

Recommendations have thus far pertained to public ranges since these ranges are open to hunting. Privately-owned lands comprise even a higher percentage of the scaled quail habitat in southeastern Colorado and have an equal or even higher potential for habitat improvement. Although there is little reason for landowners to improve quail habitat on their own properties, some may wish to do so for aesthetic reasons or to provide hunting for their families and friends. There is no reason why habitat improvements recommended for public lands can't be applied to private lands.

ECONOMICS OF HABITAT DEVELOPMENT

Returns from wildlife habitat development seldom justify the costs. Nevertheless, such practices should not be completely ignored. Rapidly increasing demands for out-door recreation, accompanied by a decreasing amount of land available for such pursuits of leisure, are changing concepts of economic feasibility. This is particularly true of upland game bird hunting. All this means just one thing — available public lands suitable for upland game bird hunting will have to be developed and improved to handle increasing demands for this form of outdoor recreation.

The type of gallinaceous guzzler used in this study cost $225 completely installed. Based on an estimated life of 25 years, it would cost almost one dollar per bird if each guzzler would increase the quail population by 10 birds per year. Obviously, such a cost-benefit ratio would make guzzlers of this type too costly. Until it can be proven that guzzlers can substantially increase scaled quail populations, no further use of guzzlers as a management measure is recommended at this time. Experimentation should continue, however, to ascertain the water needs of scaled quail and how these needs can be most economically met.

Brush piles constructed for resting shelters are of proven value in improving scaled quail habitat. If these shelters, which cost less than $30 each, would provide an annual increase of five birds per year over a 15-year period, the cost per quail would be 40 cents. From the information obtained in this study, these figures seem reasonable.

The costs of installing habitat improvements can be readily determined, but the value of additional quail produced and harvested is not easily obtained. Expenditures of hunters, numbers of birds bagged per hunter, and the increase in harvest resulting from developments can only be approximated. Furthermore, no monetary measure of pleasures derived from hunting or the aesthetic value of seeing unharvested birds can be estimated. Hunting expenses, license fees, et cetera, probably exceed a dollar per bagged quail. Estimates based upon a recent survey indicate 5,281 quail hunters spent $149,083 while hunting quail in Colorado, or $28.23 per hunter.

Results of this study indicate that habitat manipulation efforts approach economic justification. With improved design, construction, and installation techniques, along with increased knowledge of quail needs, habitat improvement should become an even more valuable tool in scaled quail management.

APPENDIX

TABLE A-1. A combination of probabilities comparing changes in scaled quail numbers on the old homestead development and control study areas from summer to pre-hunting season census periods.

Year	d f	t Value	Probability	Log10 P
1961	9	0.43	0.34	9.528 —10
1962	9	3.15	0.01	7.796 —10
1963	9	2.26	0.03	8.398 —10
1964	9	1.92	0.05	8.653 —10
	Sum		or	34.375 —40
				—5.625

Loge P = (2.303) (—5.625) = —12.95
Chi-square = —2 loge P = 25.90 d f = 8
Probability of a greater value is less than 0.005*

* This indicates 0.995+ expectation that the scaled quail numbers on the control areas declined at a greater rate than those on the development areas.

TABLE A-2. A combination of probabilities comparing scaled quail populations on the old homestead development and control study areas during the pre-hunting season census periods.

Year	d f	t Value	Probability	Log10 P
1961	9	0.30	0.34	9.525 —10
1962	9	0.95	0.19	9.267 —10
1963	9	1.10	0.16	9.193 —10
1964	9	1.47	0.08	8.881 —10
	Sum		or	36.866 —40
				—3.134

Loge P = (2.303) (—3.134) = —7.216
Chi-square = —2 Loge P = 14.432 d f = 8
Probability of a greater value is less than 0.075*

* This indicates 0.925 expectation that the development study area scaled quail populations were greater than those on the control study areas.

TABLE A-3. A combination of probabilities comparing changes in scaled quail numbers on the old homestead development and control study areas from pre-hunting season to winter census periods.

Year	d f	t Value	Probability	Log10 P
1961	9	—0.77	0.23	9.367 —10
1962	9	—0.64	0.28	9.449 —10
1963	9	0.17	0.44	9.638 —10
1964	9	0.96	0.19	9.273 —10
	Sum		or	37.728 —40
				—2.272

Loge P = (2.303) (—2.272) = —5.233
Chi-square = —2 Loge P = 10.465 d f = 8 P = 0.24*
Chi-square at the 0.05 Probability level = 15.51

* This indicates a 0.76 probability of a greater change in scaled quail populations on the development areas than on the controls.

TABLE A-4. Statistical comparisons of wintering scaled quail populations on the old homestead development and control study areas.

Year	d f	t Value	Probability
Part I. The test probability that the control populations exceeded the development populations during the predevelopment (1960-61) winter census.			
1960-61	9	1.34	0.90
Part II. The t test probabilities that the development populations exceeded the control populations during the five winter census periods.			
1960-61	9	—1.34	0.05
1961-62	9	—0.03	0.49
1962-63	9	1.08	0.85
1963-64	9	1.06	0.84
1964-65	9	1.70	0.94

Part III. A combination of probabilities comparing scaled quail populations on the old homestead development and control study areas during the 1962-63 through 1964-65 winter census periods.

Year	d f	t Value	Probability*	Log10 P
1962-63	9	1.08	0.16	9.190 —10
1963-64	9	1.06	0.16	9.204 —10
1964-65	9	1.70	0.07	8.813 —10
	Sum			—2.793

Loge P = (2.303) (—2.793) = —6.43
Chi-square = —2 Loge P = 12.834 d f = 6 P = 0.05**

* The probability of a greater value

** This indicates a 0.95 expectation that the development study area scaled quail populations were greater than those on the control study areas.

TABLE B-1. Vegetative cover percentages indicies and mean occurrence of scaled quail per area on the brush shelter development areas.

Area	Bare Ground	Litter	Mid Grass	Short Grass	Forbs	Half Shrubs	Mean quail use
1-D-1	53.45	11.20	4.80	1.75	19.65	9.15	9.86
2	66.25	10.25	6.50	7.25	5.90	3.85	2.54
3	60.75	12.15	6.00	8.35	7.25	5.50	1.50
4	60.35	6.55	4.05	.30	20.85	7.90	8.14
2-D-1	56.15	14.50	10.30	5.60	7.05	6.40	5.41
2	44.60	12.50	12.25	.30	18.90	11.45	5.14
3	52.10	7.95	1.90	5.15	16.65	16.25	10.95
4	49.20	10.90	5.80	.85	22.50	10.75	3.91
3-D-1	58.55	11.80	5.60	9.45	8.70	5.90	0
2	54.15	13.95	6.10	4.75	16.35	4.70	4.09
3	42.55	22.30	9.90	1.50	11.65	12.10	0
4	58.85	12.35	4.55	6.95	11.80	5.50	0
	54.75	12.20	6.48	4.35	13.94	8.29	4.30

TABLE C-1. A comparison of the block development guzzler units with and without supplemental feed, based upon mean scaled quail occurrences throughout the summer and fall period.

Areas	Without Feeders			With Feeders		
	1963	1964	Change	1963	1964	Change
1	14.80	6.22	—8.58	0.67	5.89	5.22
2	8.67	8.56	—0.11	1.33	11.88	10.55
3	1.73	0.44	—1.29	9.67	33.22	23.55
4	9.07	10.85	1.78	17.00	20.77	3.77
5	12.92	9.63	—3.29	8.80	37.11	28.31
6	3.83	5.71	1.88	7.57	21.66	14.09
7	0.00	1.11	1.11			
8	10.08	2.66	—7.42			
9	5.00	0.44	—4.56			
Sum =			—20.48			85.49
Mean =			—2.275			14.25
S x =			1.7125			16.31
t =	4.56 with 13 d f		t .05 = 1.771			

TABLE D-1. Comparative age and sex ratio information on scaled quail collected in the Campo Region of southern Baca County from 1961 through 1964.

Year	Age Information			
	Adult	Young	Total	Young-adult ratios
1961	17	42	59	247 : 100
1962	50	109	159	218 : 100
1963	114	195	309	171 : 100
1964	68	143	211	210 : 100
Year	**Sex Information**			
	Male	Female	Total	Male-female ratios
1961-62	41	30	71	137 : 100
1962-63	160	169	329	95 : 100
1963-64	145	139	284	104 : 100
1964-65	40	42	82	95 : 100

TABLE D-2. The average weight of quail in southern Baca County as checked during the 1962 hunting season.*

Scaled quail	Adult male	Adult female	Young male	Young female	Species average
Weight in ounces	7.56	6.84	7.27	6.85	7.08
Number weighed	23	19	61	37	140

* The average weight of 12 bobwhites was 6.43 ounces.

LITERATURE CITED

Campbell, H. 1954. Use of oil dust baths by quail. J. Wildl. Manage. 18:543.

——. 1959. Experimental feeding of wild quail in New Mexico. Southwest Naturalist. 4:169-175.

Dodge, W. E., and D. P. Snyder. 1960. An automatic camera device for recording wildlife activity. J. Wildl. Manage. 24:340-342.

Frye, O. E., Jr. 1954. Studies of automatic quail feeders in Florida. N. Amer. Wildl. Conf., Trans. 19:215-298.

Gallizioli, S., and W. Swank. 1958. The effects of hunting on Gambel's quail populations. N. Amer. Wildlfl Conf., Trans. 23:305-309.

Gorsuch, D. M. 1934. Life history of the Gambel quail in Arizona. Univ. of Arizona. Biol. Sci. Bull. 2. 89 p.

Hoffman, D. M. 1961. Experimental habitat improvement for lesser prairie chickens. Fed. Aid Quart. Rep. W-37-R-14. Colo. Dept. of Game and Fish. April :203-208.

——. 1965. The scaled quail in Colorado - Range, population, status, and harvest. Colo. Dept. of Game, Fish and Parks. Tech. Bull. No. 18. 47 p.

Hungerford, C. R. 1962. Adaptations shown in selection of food by Gambel's quail. Condor 64:213-219.

——. 1964. Vitimin A and productivity in Gambel's quail. J. Wildl. Manage. 28:141-147.

Lehmann, V. W. 1952. Vitamin A — Vital element for bobwhites. Texas Game and Fish. 10(6):9-11.

Nolting, D. H. 1952. Quail and partridge population trend checks. Fed. Aid Quart. Rep. W-37-R-5. Colo. Dept. of Game and Fish. July :156-157.

Schemnitz, S. D. 1961. Ecology of the scaled quail in the Oklahoma Panhandle. Wildl. Monograph No. 8. 47 p.

Wallmo, O. C. 1957. Ecology of the scaled quail in West Texas. M. S. Thesis, Texas A & M Univ., College Station, 143 p.