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Factors Affecting the California Quail Populations in Uintah County, Utah

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FACTORS AFFECTING THE CALIFORNIA QUAIL POPULATIONS IN UINTAH COUNTY, UTAH

by

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THE SENTINEL

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INTRODUCTION

The California Quail is native to the coastal and semi-arid regions of California extending north into Oregon. Two subspecies are commonly recognized, the California Quail (Lophortyx californica brunnescens Ridgway), and the Valley Quail (Lophortyx californica californica Shaw). The two forms are very similar in coloration and habits and, for the purpose of this study, no effort is made to distinguish the two.

The introduction of California Quail into Utah and their reaction to this climate has been an interesting part of the upland bird history of the state. The earliest known introduction did not specify which subspecies of quail was introduced. From the Deseret Evening News of November 10, 1869, we quote:

> "DON'T SHOOT THE QUAILS.--- We were waited upon yesterday by Captain Zabriskie, of Camp Douglas, who informed us that General Gibbon, a short time since, brought to this territory fourteen pair of California Quails, and set them at liberty for the purpose of propagation. The Captain informs us that the day before yesterday he saw a pair of these birds that had been shot by some person, and he wished us to make a request for parties fond of sport not to interfere with them, at present, at any rate. They are a very beautiful bird, excellent eating, and multiply very rapidly, and if let alone they will soon be plentiful, but if killed off now, an excellent intent will be frustrated."

Other introductions were made, complicating the possibilities that both subspecies of quail may well have been introduced early into the state. This probability is born out by Phillips (1928) who cites an example of two specimens from Utah identified as Valley Quail (L.c. vallicola), while Hellmayer and Connover (1942)

list two specimens from Ogden now in the Field Museum Collection that are identified as the California Quail (L. c. brunnescens). Assuming that these identifications are correct, we may conclude that both subspecies have been introduced.

Following these introductions prior to the turn of the century, the quail reproduced and, in some areas, became quite numerous. The Utah Biennial Reports (1899-1900, 1903-1904) indicated a rise in populations in various counties, with no known previous definite record of introductions into some of the specific areas mentioned. After 1900, quail were transplanted into numerous counties of the state, following a recognition that this bird was reproducing in the areas of its original release in Utah. From this study, and from scattered and incomplete reports, it is evident that this game bird has survived in Utah without much help from man, following early introductions to the present time.

REVIEW OF LITERATURE

Reports on activities of the California Quail date back earlier than 1900. Because of the popularity of quail as game in its native area, this bird has been the object of numerous studies. Unfortunately, however, only one report has been found which had as its main objective the study of the California Quail in Utah. Oddly enough, little is known of this game bird in Utah, or of its food and cover needs. No data known to the writer are available on those factors which limit Utah quail populations.

The life history, foods, cover needs, and methods of censusing the California Quail have been studied in California. Thus it is necessary to confine our review of data on quail to the studies made in California in order to establish a background upon which the quail study in Utah might be based.

Twining (1939) records the decline in numbers of quail in California, which occurred prior to 1900, but was unable to determine the cause for the decline. Grinnell (1927) observed the need of water for quail, which may have been responsible for the later development of a watering device, the "Guzzler". Schwartz and Schwartz (1949) considered the habitat choice and status of quail introduced into Hawaii, however, little data have been found which may serve as a guide in the study of factors affecting populations of quail under the severe winter conditions found in Utah.

Accordingly the status of quail recorded by Bryant (1912), the life history of quail as observed by Sumner (1935), the foods of quail

as reported by Glading (1938), the distribution and activities of quail as described by Grinnell, Bryant, and Storer (1918), and the methods of increasing quail as recorded by Emlen and Glading (1945) may best serve to supply methods by which data may be secured on the factors limiting the increase of quail populations in Utah.

METHODS OF STUDY

The present study of California Quail in Utah began in the early spring of 1950. A few quail in the Uintah Basin were reported to have survived the previous winter.

A total of 50 pairs of wild trapped quail was taken from the foothills in the east part of Salt Lake City and held for a time in a pen near Vernal, Utah, after which they were released and observations made of their movements, feeding habits, cover needs, and nesting efforts. A follow-up was made of the local reports on the native quail within the Ashley Valley and the quail were located wherever possible. Quail thus located were observed throughout the summer and fall. Special note was taken of the habitat choices and needs of the quail and of their reproductive success.

A study area of about 320 acres was chosen in 1951 in Ashley Valley where observations on various aspects of the habitat relationships of quail might more closely be recorded.

Other quail areas were visited within the state where notes were taken concerning their activities and habitat preferences. Crops were collected from birds killed on the roads and from birds in the hunters' bag during the hunting season. These crops were analyzed to determine foods utilized and food preferences during various seasons of the year.

Hunter success data were secured from interviewing the hunters at the checking stations in the Uintah Basin at which time information on weights, age, and sex of the birds were also recorded.

More than 100 quail were marked with "Bow-ties", as described by Wint (1951), and released into the study area near Vernal to determine movements and spread of the quail into new areas. Markers were recovered after having been lost by the quail, precluding the effective use of "Bow-ties" in the study.

GENERAL DESCRIPTION OF HABITAT AND RANGE

A knowledge of the habitat of quail in their native range provides information for recognizing adequate habitat in other areas. An understanding of the choice of habitat by quail in Utah, and particularly in the Uintah Basin, is a requisite to a determination of critical factors affecting quail survival in these areas.

Original quail distribution

The native range of the California Quail extends from southwestern Oregon south to southern Monterey County, California, and, according to Grinnell, Bryant and Storer (1918), it normally varies from an elevation of sea level to 4,000 feet and as high as 8,500 feet. The Valley Quail was found from Klamath Lake, Oregon, south throughout California and Lower California to Cape San Lucas. At higher elevations this species may overlap the range of the Mountain Quail (Oreortyx picta), but the Valley Quail are believed by Sumner (1935) to be limited at higher elevations by a lack of "sufficient and suitable food".

It is suggested by Sumner (1935) that the California Quail is able to survive in California so long as suitable food and cover is available. Their range is described as extending from the coastal fog belt inland to the edge of the arid deserts, where it merges with the range of the Gambel Quail (Lophortyx gambeli), and north to the areas of heavy snows. This includes a considerable land area within the state of California and a small part of southern Oregon.

The general habitat of quail in California provides cover meeting their needs for escape from weather and predators, and also

for roosting. Adequate foods must be available in addition to some source of water. Sumner (1935) lists the requirements of quail under two headings as follows:

> "1. Good interspersion of cover plants (usually of chaparral type plus trees for roosting) with food-bearing plants (herbaceous weeds and grasses), and 2. Some available form of water."

Quail distribution in Utah

The general topography of Utah varies from high mountains and fertile valleys to dry mountains and nearly barren deserts.

Utah is considered an arid state since the over-all average rainfall is only 12 to 13 inches. In addition, a large portion of the land is desert or otherwise unusable for cultivation. The fertile cultivated area of Utah is about two percent of the total land, (United States Bureau of Census, 1946). The less productive lands vary in vegetative growth from the sagebrush-juniper type to the barren deserts.

The more humid and fertile areas of Utah are characterized by the high timbered mountain areas supplying water to fertile valleys. The elevation of the valleys are from 4,000 to 6,000 feet above sea level, however, the mountains may extend as high as 14,000 feet.

The alluvial deposits at the mouth of canyons with surrounding valley floors constitute much of the agricultural land currently being utilized. Growths of cottonwood (Populus spp.), willow (Salix spp.), sage (Artemesia tridentata), yellow bush (Chrysothamnus spp.), and other species have grown up along permanent stream banks, canals, and field borders. Swamps are not uncommon in the areas of lower elevation in the valleys.

California Quail in Utah are found in the fertile valleys and

lower alluvial regions of the Wasatch Mountains which extend in general through the state in a north-south direction. Less extensive populations occur in other areas in and around smaller farming communities where water is available from nearby mountains. These are the areas that typically support growths of cottonwood trees, willows, and various types of brush and weeds along its stream banks, ditches, and canals that have long been so attractive to quail. This is the general type of topography and vegetation that currently supports the largest and most stable quail populations.

Quail are found in Utah in a relatively narrow strip of land running in a north-south direction through the center of the state. The most extensive population areas occur in and around Provo, Salt Lake, and Ogden, extending east into Morgan County. Quail are found less extensively in the southern portions of their range and are often confined here to limited population areas. The distribution of quail as presently known is indicated on the accompanying map, (figure 1), together with locations of recent quail introductions.

Quail distribution in Uintah County. Uintah County, in the north-eastern section of the state, is the general area where a major part of the quail studies was made.

This county covers an area of 2,864,640 acres and has 66,809 acres of irrigated land, (United States Bureau of Census, 1951). Water for culinary use and irrigation is supplied by streams and springs flowing out of the Uintah Mountains on the north.

Ashley Valley varies in elevation from 4,800 feet to 5,600 feet, and is the center of the county's 10,300 human population.

The average length of the growing season in Uintah County is 118

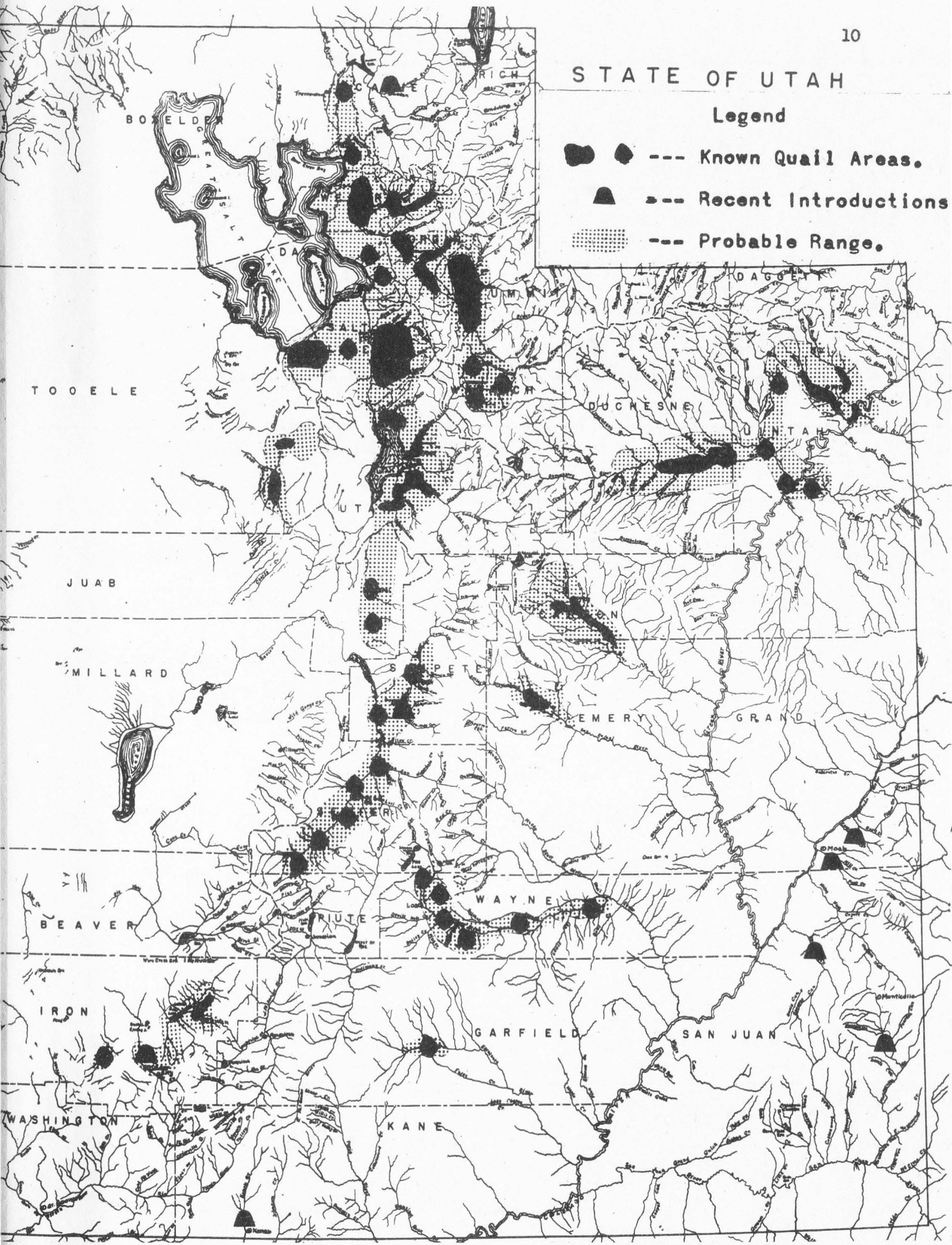

Figure 1. Distribution of California Quail in Utah, Fall 1951.

days. The annual snow depth over a 28 year period averages 23.1 inches, and the annual rainfall is 9.11 inches. Violent winds are rare, although summer thunderstorms are common over the mountains. These occasionally move easterly over the valley.

The California Quail live in and near the edge of cultivated fields, and their distribution is influenced by agricultural practices. Agriculture in Uintah County consists mainly of irrigated cereal crops and alfalfa. Corn and miscellaneous garden crops, such as potatoes, tomatoes, and others are grown for local consumption. Strahorn, Ewing, and Dennings (1924) estimate that 90 percent of the small grains are spring planted. Agriculture provides winter feed for livestock. Grazing of cultivated areas is common in late fall and winter.

The topography in Uintah County is characterized by the famed Uintah Mountains on the north, with its gorge-like canyons extending southward to the valleys. The agricultural areas predominantly are limited to the more or less narrow stretch of irrigable land adjacent to the rivers and streams. The land has a general southeasterly drainage toward Green River which cuts the county somewhat diagonally from northeast to southwest. The fertile areas give way on the southeast to desert areas much dissected with large erosion gullies. The desert vegetation is treeless, with scant cover of low shadscale (Atriplex spp.), sage (Artemesia tridentata), and various grasses.

The quail area in Uintah County is not a continuous part of that quail range at the foot of the Wasatch Mountains. Quail are found in Uintah County, however, in the same general type of habitat and elevation range as found elsewhere in the state. Most of the

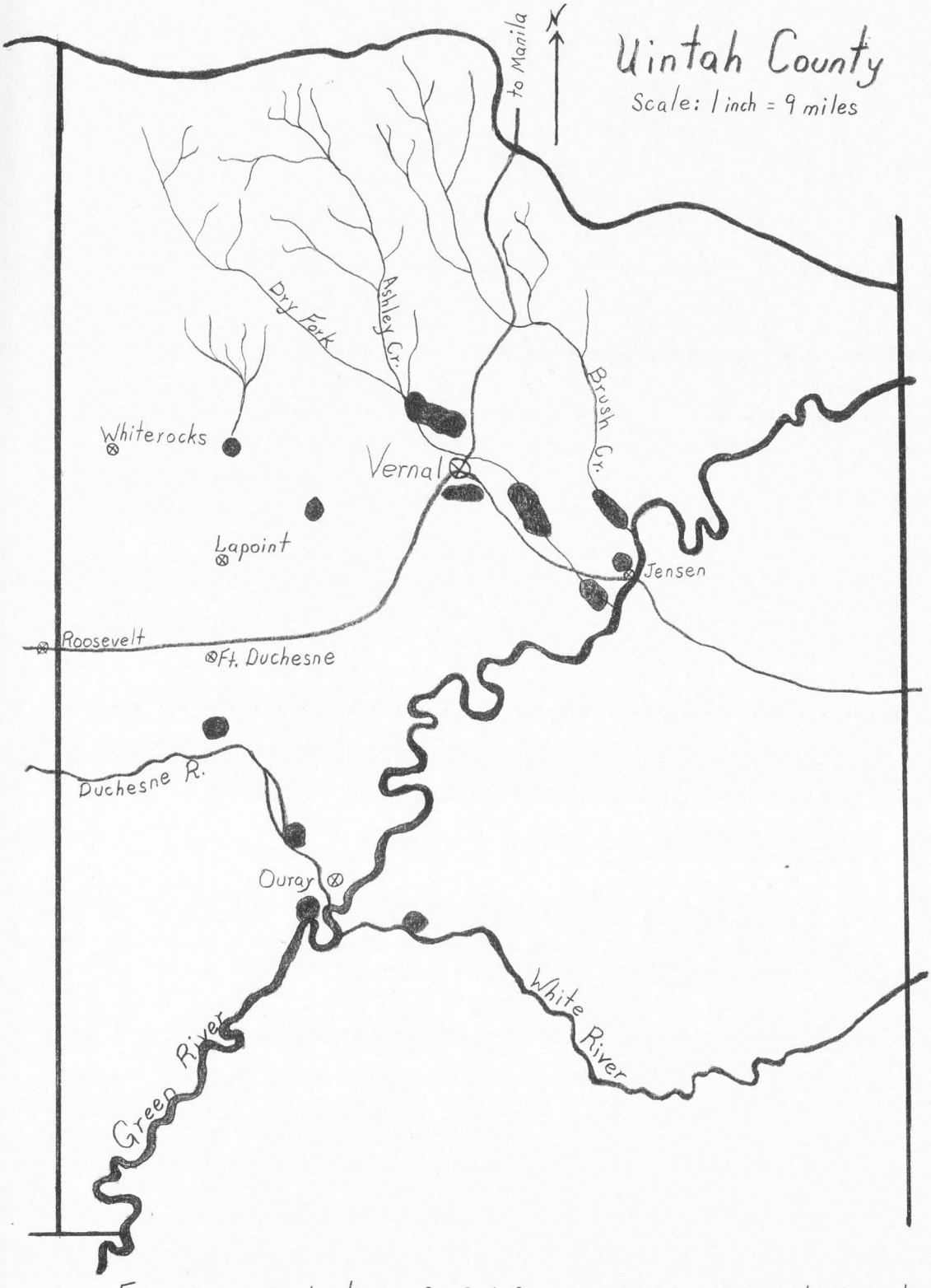

Figure 2. Distribution of California Quail in Uintah County, Utah, Fall, 1951.

populations of quail are found at elevations from about 4,500 to 6,000 feet above sea level (figure 2).

Uintah County does not constitute one of the most extensive quail areas of the state (figure 1).

Quail distribution in the study area. The study area is located near Ashley two and one-half miles north of the city of Vernal and between one and two miles west. The area is bounded on the south by the Ashley Creek which supplies a constant supply of fresh water to this area.

A map of the study area, (figure 3), has been prepared in overlay form from aerial photographic mosiacs of the Soil Conservation Service. The area is bounded on the north, east, and west by county roads. Approximately 320 acres of land is included in the study area. The known coveys and their normal range have been indicated on the overlay for reference.

The climate and general topography of the study area are similar to that of the county. The place chosen for study is within the agricultural area of the valley; however, because of its proximity to the Ashley Creek and the lack of an excessive gradient of slope to the land, a considerable amount of the area is grazed rather than cultivated. Water is plentiful in the study area, producing an abundance of cover and food plants attractive to quail. Dry rocky ridges covered with sagebrush add to the quail habitat. The study area represents some of the typical quail habitat of the state.

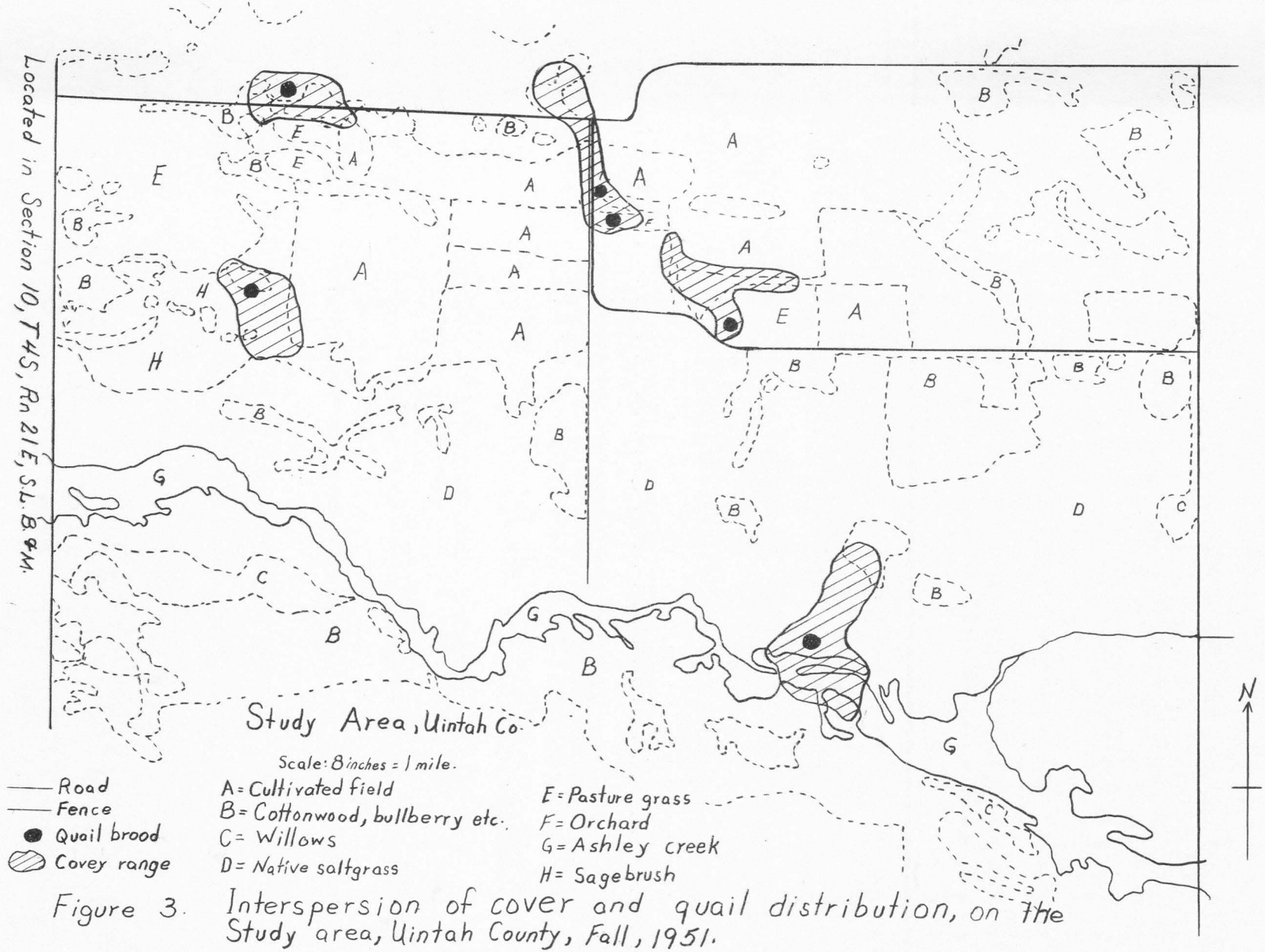

Figure 3. Interspersion of cover and quail distribution, on the Study area, Uintah County, Fall, 1951.

POPULATION TRENDS AND CHARACTERISTICS

Spring counts, brood counts, and data on quail hunting provide information which may be used in determining the trend of a quail population. The interpretation of factors influencing a quail population depends upon a knowledge of population trends.

Pre-nesting spring counts

The field work of this study was begun in April 1950 following successive severe winters (1948-1949 and 1949-1950). Reports from local landowners indicated that very few quail had survived the winter of 1949-1950. The winter of 1950-1951 was mild, which resulted in good quail survival following the 1950 breeding season.

A total of 12 pairs of quail were reported in the Ashley Valley in the spring of 1950. Of these only six pairs were found by the writer and they were scattered in areas from one to six miles apart. It is possible that duplications may have been present in the reports of quail. The inventory of quail in the valley indicated that the population was at an extreme low in the spring of 1950.

The 1951 pre-nesting counts made in the same areas as in 1950 resulted in the location of 12 pairs of quail. This occurred in spite of the complete removal by burning of the habitat from one of the better quail areas originally under observation. If a correct sample of the birds present were counted each year, then the winter survival of brood stock had increased by 100 percent over the previous year (1950).

These population data present two points of interest in connection with the factors affecting quail populations in Utah: (1) the very small population found at the beginning of the study appeared to be on the increase, and (2) the small number of known potential breeders definitely requires a longer time for the population to increase to the density expected during normal years.

The numbers of quail surviving the winter of 1950-1951 in Ashley Valley were small in comparison with the acreage of habitat. An estimate of 4,500 acres and six known pairs of quail would give a calculated density of 750 acres per pair in the spring of 1950 (table 1). This low density, however, is believed to be advantageous to the study, since the factors influencing the survival of the population are more evident under a condition of low numbers.

Brood counts

Pairing of quail occurs in early spring coveys just prior to the time the covey breaks up. The weather appears to be the determining factor controlling the time of year when pairs of quail leave the covey and begin making preparations to nest. In 1950 mating was observed as early as April 11 in the quail held in a pen. This observation coincided quite closely with the breaking up of winter coveys of wild birds under observation. Pairs were commonly seen before nesting was begun, although prior to egg laying the original covey was observed to reassemble in late evening and roost together. These observations agree with those of Trippensee (1948) and with the work done in California by Glading (1938a).

Quail became very secretive in their actions as nesting activities began. Dense cover available to the few quail made observation

difficult. No important mortality factors were observed during nesting, however, one nest was flooded by rising water in the nearby irrigation canal.

Young quail were first observed about June 20, 1950. However, they were not observed in open areas where a count could be made. Quail when very small scattered and hid at the first sign of danger. Observations of June 23, 1950 illustrate the general behavior pattern of a very young quail brood. A pair of adult quail were observed to move slowly through cover of grass and clover in search of food. The use of field glasses assisted in locating young quail with the adults. The young appeared only as they moved, however, no more than two young quail could be seen at any one time. Young quail momentarily appeared in different locations, indicating that a brood of about eight young were present. The young quail were estimated to be two to three weeks old.

Young quail five weeks old or older were nearly as difficult to count as were younger quail. The constantly moving parents and the nervous actions of the young made counts hard to get when the broods were on open ground.

Several methods were tried to get counts of broods of young quail. Flushing the birds from low vegetation in which they were feeding proved unsatisfactory since the young hid and efforts to flush the entire brood were futile.

Glading (1941) and Emlen and Glading (1945) found in California that quail census could easily be taken while riding a horse. This method was found to be unserviceable in Utah, since fences, canals, and heavy cover strips prevented coverage of quail areas on horseback.

Roads passed near most of the quail areas. It was found that

quail broods could best be counted from an automobile by use of field glasses. These counts were aided by a previous knowledge of the location of the adult quail prior to nesting, and by the exact or approximate location of their nests. Quail brood counts could not be satisfactorily made until the adult quail led their broods to the roads or other open areas lacking vegetative cover.

The first complete quail brood counts in 1950 were made on June 30. Young quail at this time were at least three weeks old with an average of 7.7 young for four broods counted in 1950. Counts were considered complete when two or more census agreed as to the number of young in the brood. In addition, the observer had to feel confident in the accuracy of the count before accepting it as complete.

The earliest complete brood census in 1951 was made on July 17. A total of seven broods of young were counted. The average brood in 1951 was calculated to be 7.4 young per brood.

Production. Reproductive efforts in 1950 resulted in the production of 31 young being counted. Four pairs of adults with broods, plus two pairs of adults on which brood data were not obtained, yielded a known summer population of 43 quail observed in the area.

A count was made of 51 young in 1951 plus the seven pairs of adults with broods. An additional five pairs of adults were in the area, however, broods they may have had were not counted. The known population in 1951 was 75 quail. The population counted in 1950 was 43 but in 1951, 75 quail were known to be in the same area. This was a 74 percent increase in 1951 over 1950 for the corresponding period of time (table 2).

A method often used to determine reproductive success is average

brood count compared to known adults. In 1950 the brood average was 7.7 for the six pairs of adult quail counted in the area. These data yield a calculated 46 young produced and with the adults there was computed an early summer population of 58 quail.

Table 1. Calculated habitat range in terms of acres per quail pair from spring and summer counts, 1950-1951.

Year Season	1950 March	1951 March	1950 July	1951 July
Counted number of quail pairs	6	12	6	12
Estimated acreage of quail habitat	4,500	4,500	4,500	4,500
Counted quail young plus adults			43	75
Calculated habitat: acres per quail pair	750	375	105	60

The average brood size in 1951 was found to be 7.4 young. Twelve pairs of adults were counted in the same area that had been covered in 1950, and with the 89 young there was a calculated population of 113 quail or an increase of 95 percent over the computed population in 1950 (table 3).

The rate of increase first considered (74 percent) is a minimum estimate since only data on complete brood counts of young were used. Uncounted broods were omitted from the minimum estimate of population increase (table 2).

The rate of increase of 95 percent assumes the average brood size of 7.7 in 1950 and 7.4 in 1951 is representative of all the quail in the study area. The number of broods counted each year is small, which

increases the possibility of error in the sample. In addition, some adults not observed may have been unsuccessful in nesting or in brood rearing. No observations were made of adult quail failing to raise young although it is felt that this condition may exist, especially when the population density increases. We might conclude then, with some reservation, that the rate of increase in the quail population was perhaps between 74 percent and 95 percent in 1951 over 1950, when based on early brood counts.

Quail broods observed throughout the summer showed losses in the young. One dead quail, estimated to be three and one-half weeks old, was found in a dry irrigation ditch. The specimen was somewhat dried and no immediate cause of death could be determined.

Table 2. Minimum quail populations based on brood count data.

	No. broods counted	Average brood size	Total no. of young	Total no. of adults	Total known population
1950	4	7.7	31	12	43
1951	7	7.4	51	24	75
Increase	3		20	12	32
% Increase	75		64	100	74

Broods of quail were progressively recounted during the summer. An average of two quail were observed to have been lost from each brood from the age of about three weeks to the time when fall coveys began to assemble. No evidence is available on the cause of juvenile losses. The largest brood counted during the study was 12 young. Brood counts prior to the initiation of the study suggested broods of from 17 to 22

were not too uncommon. The average clutch size of nests of quail in other areas is reported by Glading (1938) to be 10.97 and by Grinnell, Bryant, and Storer (1918) to be 14.6 eggs per clutch. Broods of quail in Utah were smaller than might have been expected.

Table 3. Computed potential quail populations in Ashley Valley based on known adult pairs and average brood counts.

	Known number paired quail	Average brood count	Number adults	Calculated no. young	Computed population
1950	6	7.7	12	46	58
1951	12	7.4	24	89	113
Increase	6		12	43	55
% Increase	100		100	94	95

The rise in quail density that occurred during the study may be visualized by the number of acres of habitat available per pair. The acreage of available quail habitat in Ashley Valley was estimated to be 4,500 acres. This would give a population density of one pair of quail per 750 acres at the beginning of the study. The reproduction efforts in 1950 increased the population density of quail and resulted in a calculated 105 acres per quail pair. The following winter brood stock survival was high and, together with 1951 reproductive efforts, the figures gave a calculated quail population density of 60 acres of habitat per pair during the summer of 1951, (table 1).

Roadside counts

Warden roadside counts have been made three times each year from 1949 through 1951. The observed quail were tallied during these counts, varying from no birds counted to as high as 625. Some counties

showed an absence of data during some counts. This occurrence may well be due to the route taken since in all cases the routes were established for counting pheasants. Since quail habitat is limited and quail populations were low, it is to be expected that quail would be missed on some of these routes.

Data appear more consistent for Morgan County than for any of the counties. A definite reduction in quail numbers in Morgan County appeared in 1950 (figure 4). This reduction in Morgan County agrees with observations by the writer and the reports from all areas even though the data are not complete enough in each county to be demonstratable (table 4).

Quail counts are incidental information and, as such, are not intended to be as complete or extensive as those made for pheasants. The data on roadside counts, together with field reports and observations by the writer, substantiate the contention that California Quail in Utah fluctuate in numbers.

Quail hunting returns

Quail in Utah are not an important bird from the sportsman's point-of-view. There are a few hunters who know the sporting qualities of this game bird. The quail hunting seasons for the periods 1948-1951 have been opened in most areas of Utah where hunting was feasible. Occasionally the season remained closed following severe reductions in populations from heavy winters or other decimating factors.

Game department personnel operated pheasant checking stations in the Uintah Basin during the years 1948-1951. Data were collected on quail at the same time since the quail season began with the

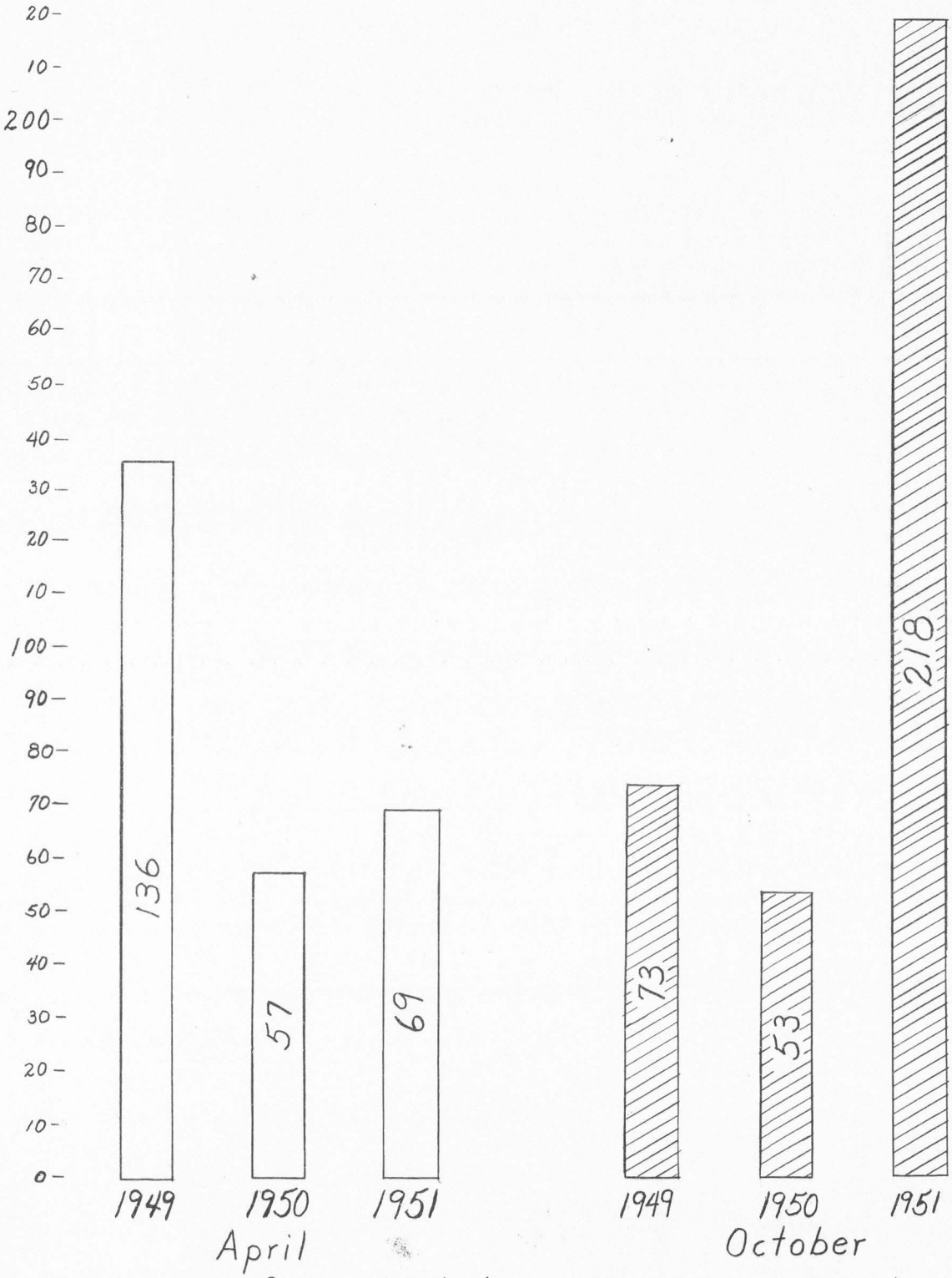

Figure 4 Quail roadside count in Morgan County, 1949 - 1951.

Table 4. Quail roadside counts made by game wardens in Utah, 1949-1951.

County	1948 Oct.	1949 Jan.	1949 Apr.	1949 Oct.	1950 Jan.	1950 Apr.	1950 Oct.	1951 Jan.	1951 Apr.	1951 Nov.
Carbon		168	8	77		8	44	8	6	
Davis	7	14			4					
Iron	17	14	9					9		
Juab				3						
Millard	8	166	20	10	8		57		3	
Morgan			136	73	625	57	53	148	69	218
Salt Lake						38				23
Sanpete	17					7			9	
Sevier		53								
Summit							43	52	13	
Uintah						12	102	3		12
Utah	32	59	13		9	4				6
Wasatch			30		8	10		8	7	
Wayne		152						137	110	
Weber		107	6	13	38	3		16	22	

opening of the pheasant season and ran concurrently with it. The checking station personnel were able to record numbers, sex, and age of quail taken by the hunters in the Uintah Basin. In addition, quail crops were collected, with the permission of the hunter, and these, together with wing samples, made up a large part of the collections for the food habits studies, and in supplying age ratio data.

A twofold purpose prompted efforts in securing data on quail taken by hunters: (1) the possibility of over-hunting, which might be gauged from checking station records, and (2) sex and age ratio data which might indicate seasonal quail productivity.

The hunt during the fall of 1950 was held on Saturday afternoon and Sunday of two week-ends, November 11-12 and 18-19. A total of 22 quail were examined at the three checking stations in the Uintah Basin. In 1951 these checking stations were again maintained on November 3, 4, 5, and 6 where the personnel examined 27 quail.

Aging of quail. The technique used to separate juveniles from adults has been described by Emlen and Glading (1945) and Leopold (1939), who followed the moulting pattern outlined by Dwight (1900). It consists essentially of noting the presence or absence of white edges on the greater primary wing coverts. The white edging and mottled appearance is characteristic of juveniles, whereas only a uniform coloration is typical of adults (figure 5). Pointedness of the outer two primaries has been unreliable in Utah. Leopold (1939) also noted variations of this character. Spring observations indicated juvenile characteristics were still present on primary wing covert feathers of some quail that had survived the winter.

Age and sex ratios in the bag. The 19 quail in the hunters' bag

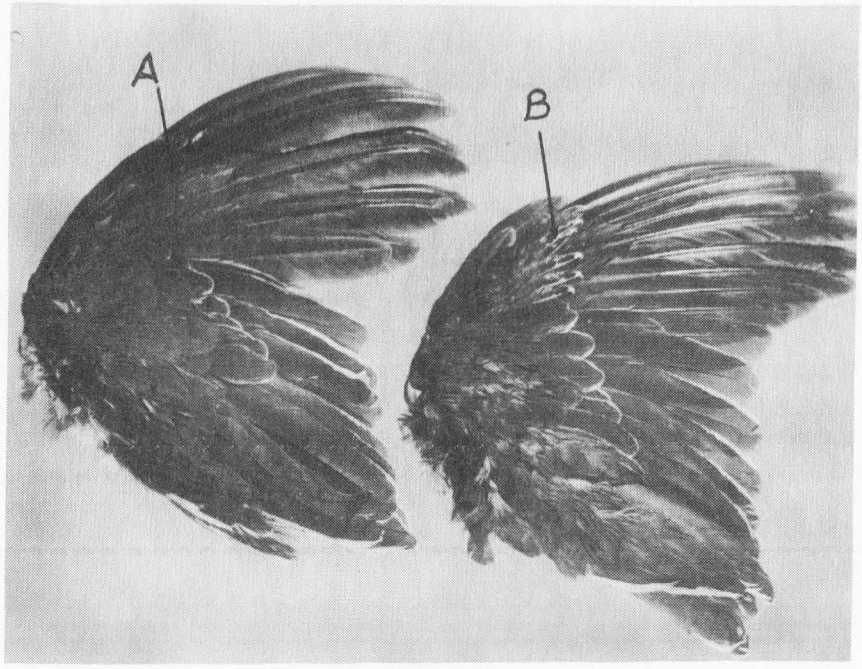

Figure 5. California Quail wings, (A). adult with uniform coloration of primary wing coverts, (b). juvenile wing showing mottled appearance of covert feathers and white edges.

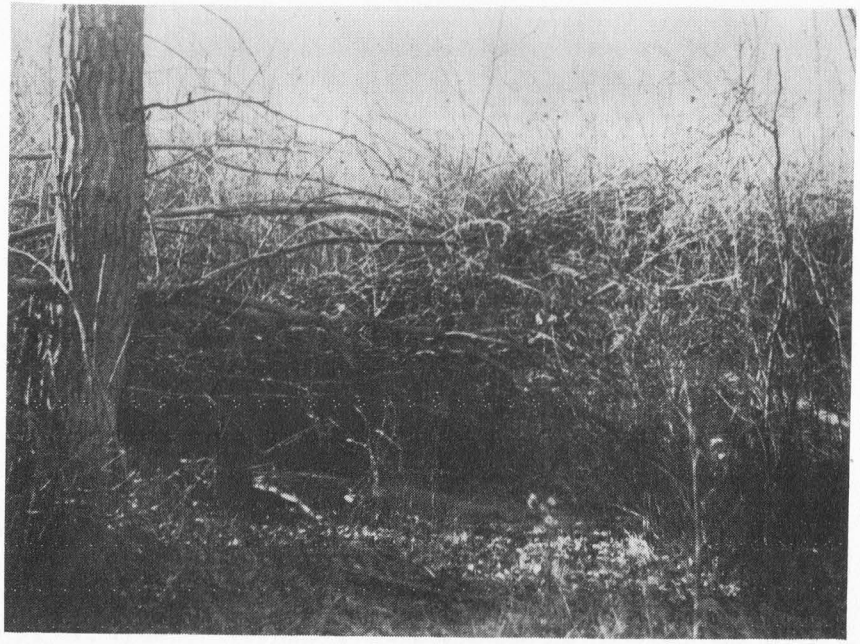

Figure 10. Overhanging willow thicket which illustrates a roosting site, Duchesne County, Utah.

on which complete age and sex data were available in 1950 indicated that 84 percent of all quail taken were juveniles. Of the 26 quail examined during the 1951 hunting season, the percentage of juveniles in the hunters' bag was 81 percent, which indicates considerable similarity between the two years (table 5).

The sex ratio of fall quail populations was believed to have been 50 percent males since brood observations in late summer indicated that the sex ratio of the young was equal. However, less than half (42 percent) of the quail killed in 1950 were males, whereas in 1951 the kill of males increased to 61 percent. No explanation of this difference is available beyond the possibility that sampling error may have influenced the results.

Table 5. Age and sex ratios of California Quail killed by hunters in the Uintah Basin, 1950-1951.

1950	Male	Female	Total Number	Total Percent
Adult	1	2	3	15.8
Juvenile	7	9	16	84.2
Total	8	11	19	
Percent	42.1	57.9		100.0

1951	Male	Female	Total Number	Total Percent
Adult	4	1	5	19.2
Juvenile	12	9	21	80.8
Total	16	10	26	
Percent	61.6	38.4		100.0

The total number of quail on which age ratio data are available prevents definite conclusions, however, assuming that the age ratio in the bag is equal to the age ratio of our population, then these data would indicate an 84 percent and 81 percent juvenile ratio for the two years respectively.

If we refer again to early summer brood count averages, we may compare the estimate of juvenile ratios (table 6).

Table 6. Comparison of juvenile ratios from brood counts and hunter bag checks.

	Spring estimate of young	Number of adults	Spring population, young plus adults	Percent juvenile	Juvenile in bag (percent)
1950	46	12	58	79.3	84
1951	89	24	113	78.7	81

We might assume that the percentage of juveniles in the hunters' bag should coincide with spring juvenile ratios. A number of factors might alter these relationships: (1) loss of adults because of age or in the hazards associated with rearing young may reduce the number of adults during the summer, which would increase the fall juvenile ratio, (2) juvenile quail may be easier bagged by the hunter than adults, (3) counts of spring broods were small and were taken only in a limited area, and therefore are subject to sampling errors.

It is interesting to note the similarity that exists in the age ratio data, either when compared for the two years, or between field counts and kill. Percentages of juveniles based on brood counts were very slightly lower in 1951 than in 1950. The percentage of juveniles

in the hunters' bag is lower in 1951 than in 1950. This would suggest that, while study area brood counts were small, they appeared to follow the same trend in juvenile ratio that the hunter bag check data do.

If 80 percent of the harvestable quail are juveniles, then it follows that hunting prospects may possibly be based on early summer brood count data. It has been noted that in 1950, 57.9 percent of the kill was females and in 1951, 38.4 percent females were killed (table 5). This, however, did not seem to have reduced the brood stock survival, based on pre-nesting brood stock surveys. Twelve pairs of quail were observed in 1951 for an increase of 100 percent over spring brood stock survival in 1950.

Hunting pressure. Data have been taken on quail and pheasant hunters in the Uintah Basin since 1948. The hunting pressure has increased each year in this area with the exception of 1951. In 1948, 17 quail were examined. The kill increased to 27 in 1951. The hunting season was two and one-half days in 1948 and 1949 but was extended to three days on a split season of one and one-half days each in 1950 and three and one-half days in 1951, (table 7).

The increased kill in 1951 appears to follow the increase in quail populations which occurred in 1951 rather than being due to hunting pressure which decreased this same year.

The length of the season seems to be relatively ineffective as a factor in the number of quail killed, since 24 were taken in 1949 during a two and one-half day season, in contrast to 22 quail bagged in 1950 during a three day split season. The kill figures appear to follow population fluctuation, since the number of hunters in the field both years was approximately the same.

Table 7. Number of quail examined at checking stations in the Uintah Basin, Utah, and length of Utah quail seasons, 1948-1951.

Year	Quail examined	Length of season	Dates
1948	17	2½ days	Oct. 30, 31, Nov. 1
1949	24	2½ days	Nov. 5, 6, 7
1950	22	split season of 1½ days each	Nov. 11-12, 18-19
1951	27	3½ days	Nov. 3, 4, 5, 6

The hunter returns indicate that hunting the relatively small populations of quail in the Uintah Basin has not been a factor affecting materially their increase. This agrees with Glading and Saarni (1944) who found in California that moderate hunting pressure on the California Quail was not a factor limiting their seed stock survival.

Dogs trained for pheasants occasionally flush quail out of the heavy cover where they are normally found. However, more often hunters and dogs will by-pass coveys of quail unmindful of their presence. Even if the call of an alarmed quail is heard, the hunters do not take the time to flush the covey. Quail populations fluctuate in Utah offering good quail hunting only during periods of high densities (table 8).

Approximately 100,000 potential quail hunters are in the field hunting pheasants during the pheasant and quail hunting seasons. The fluctuations of quail populations in Utah appear to reduce materially the hunting pressure that might otherwise be present and to discourage the development of quail hunting as a sport in Utah.

A ten percent sample of the resident upland game bird hunters is

Table 8. Kill of quail as reported by a ten percent sample of Utah upland game bird hunters, 1948-1951.

County	1948		1949		1950		1951	
	Quail	%	Quail	%	Quail	%	Quail	%
Cache	2	.6	0	-	0	-	0	-
Carbon	46	14.6	0	-	15	20.2	10	6.45
Davis	18	5.7	0	-	18	26.8	18	11.6
Duchesne	36	11.4	0	-	0	-	4	2.58
Emery	0	-	0	-	2	2.98	0	-
Millard	12	3.8	0	-	1	1.49	0	-
Morgan	6	1.9	0	-	5	7.45	27	17.4
Salt Lake	23	7.2	0	-	0	-	6	3.87
Sanpete	13	4.1	0	-	3	4.47	6	3.87
Sevier	28	8.8	0	-	0	-	0	-
Summit	0	-	0	-	0	-	10	6.45
Uintah	60	19.0	3	16.7	2	2.9	6	3.87
Utah	52	16.5	7	38.9	20	29.8	43	25.8
Wayne	0	-	0	-	0	-	2	1.29
Weber	18	5.7	7	38.9	0	-	16	10.3
Mixed Counties	1	.3	1	5.5	1	1.49	7	4.51
Total	315	100.0	18	100.0	67	100.0	155	100.0

sent kill questionnaire cards each year by the Game Department in an effort to determine hunter success. These data indicate that Carbon, Davis, Morgan, Uintah, Utah, and Weber counties are the more important areas of quail hunting over the four year period for which data are available.

Most of the quail areas in Salt Lake County are closed to hunting because of the numerous homes in the quail range. Hunting returns in Duchesne County may be an evidence of wider fluctuations in quail numbers due to adverse factors such as cover and weather.

The greatest return of quail to hunters on which we have data appeared in 1948 when 315 quail were taken by 2,178 reporting hunters. The 1949 season resulted in a report of only 18 quail bagged, however, an increase in 1950 to 67 quail and in 1951 to 155 quail shows a general increase in the kill of quail following the 1949 minimum kill (table 8). The decline in quail kill which occurred in 1949 is believed to have been caused by the failure of quail brood stock to survive the severe winter of 1948-1949.

Quail weights

Weight samples from trapped quail were taken whenever possible. Populations were low and, because of this, trapping operations were discontinued during the summer in order to avoid the possibility of killing the young.

The critical survival period may well be indicated by the seasonal weight fluctuations of quail. In addition, records of quail weight indicate what variation in weight might normally be expected. The weights of quail from other areas were obtained when possible for comparison with quail weights in the Uintah Basin.

Juvenile weights. An opportunity was presented to obtain a small amount of weight data on known-aged young quail. (These young quail were more or less hand raised along with chukar partridges at the game farm.) No extensive effort is made to raise quail at the game farm. The quail raised there were hatched from eggs laid by females coming into breeding pens for food. These young quail were weighed at every opportunity. Young males were heavier than the females every time comparative weights were secured from two weeks to nine weeks of age. The average weight of a two week old quail was found to be 21.5 grams and for a three week old quail 35.5 grams. The most rapid growth in weight occurred between the third and fourth week when the weight of captive quail tripled. This growth rate tapered off, resulting in less rapid weight increases during the remaining weeks before the quail reached adult size, (table 9).

Table 9. Weights of California Quail in grams for known aged young (Utah).

Source	Bird No.	Age 2 wks. Male	Age 2 wks. Fem.	Age 3 wks. Male	Age 3 wks. Fem.	Age 4 wks. Male	Age 4 wks. Fem.	Age 8 wks. Male	Age 8 wks. Fem.	Age 9 wks. Male	Age 9 wks. Fem.
Game Farm	1	24	21	-	34	106	-	140	94	136	-
Game Farm	2	-	20	-	37	-	-	149	-	-	-
Wild Quail	3	-	-	-	-	(41)	-	-	-	-	-
Wild Quail	4	-	-	-	-	(43)	-	-	-	-	-
Average		24	20.5	-	35.5	106 (42)	-	144.5	94	136	-

Only two young quail were wild trapped and weighed. These birds were from the same brood and both males. An estimate of age of these birds was made by use of moulting primaries as described for pheasants

by Buss (1946) and following the moulting pattern described by Dwight (1900) for game birds. This technique indicated that these birds were about four weeks of age. Their weights were 41 and 43 grams respectively. By comparison with the foregoing table of weights, the wild quail were comparable in weight to the three week old known aged quail. The semi-domesticated birds are believed to be heavier than the wild quail.

Adult weights. The pre-nesting weights of quail near the study area indicated that the cock weighed 154.5 grams and was about 7 grams heavier than the hen, (table 10). The rise in weight of the hen during April, however, may be explained as a reaction brought about because of the egg production period, because in April the hen averaged 7.5 grams heavier than the cock. The weight of the hen is less in June as egg laying tapers off and her weight nearly approaches that of the cock. The rearing of young might be suspected as the cause of hen weight loss during August with a subsequent weight increase as late fall approaches. The peak in the weight of the hen occurs in April while cocks appear heaviest in August when the average weight of the cock was observed to be 178 grams while the hen weight at this time averaged 167 grams, (figure 6).

Winter trapping operations supplied weights from other areas, (table 11), which indicated that the average adult male in Carbon County weighed 225 grams and the adult female 216 grams. The average adult cock in Salt Lake County weighed 206 grams and the hen 190 grams. This is a weight difference of 19 grams for the cocks and 26 grams for the hens of winter trapped adult quail in Carbon and Salt Lake counties. Unfortunately no winter weight data are available for the Uintah Basin. It seems reasonable to suppose, however, that so far as the weight data

Table 10. Weight in grams of California Quail trapped in 1950-1951 in the Uintah Basin.

Month	Age	Sex	Number Weighed	Heaviest Weight	Lightest Weight	Total Weight	Average Weight
March	Adult	Male	21	198	131	3,244	154.5
		Female	22	175	124	3,253	147.8
April	Adult	Male	9	194	146	1,505	167.2
		Female	13	187	157	2,771	174.7
June	Adult	Male	19	195	125	3,146	165.6
		Female	15	203	106	2,529	168.6
August	Adult	Male	8	193	162	1,421	177.6
		Female	3	184	152	500	166.7
November	Adult	Male	5	187	152	867	173.4
		Female	3	191	150	516	172.0
	Juvs.	Male	18	207	129	3,154	175.2
		Female	20	189	117	3,335	166.8
Average	Adult	Male	62	-	-	10,183	164.2
		Female	56	-	-	9,569	170.9
Average	Adult		118	-	-	19,752	167.4

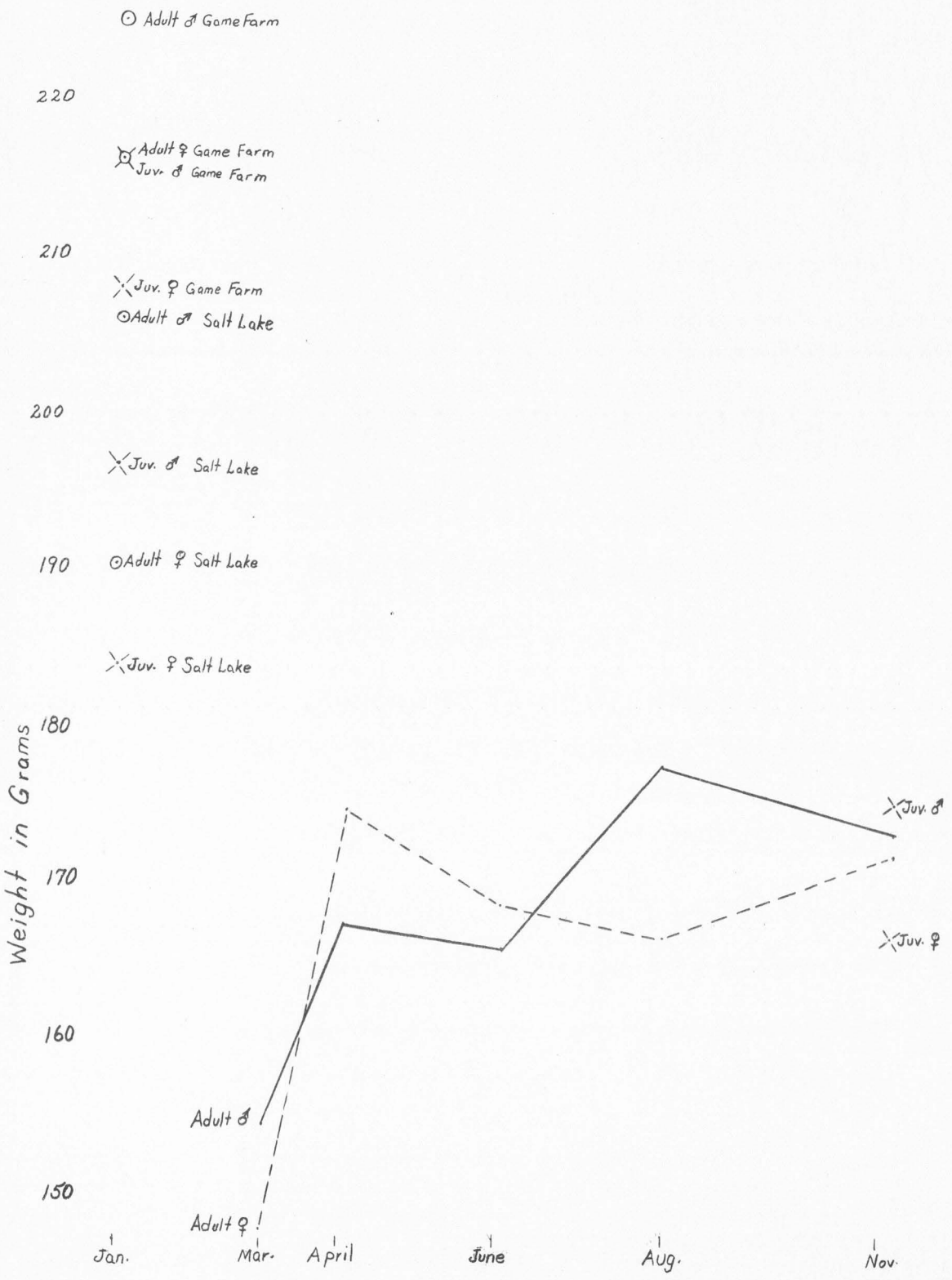

Figure 6 Variations in weight of Ashley Valley Quail, 1950-1951

are concerned, the late winter weather may find quail in their most critical weight condition. This would suggest that the winter weather may possibly be one of the important factors limiting the populations of quail in the Uintah Basin.

Table 11. Weight in grams of California Quail trapped in Salt Lake and Carbon Counties, Utah, 1951.

Month	Age	Sex	Number Weighed	Heaviest Weight	Lightest Weight	Total Weight	Average Weight
Salt Lake County (in Cottonwood Canyon)							
January	Adult	Male	4	208	204	824	206.0
		Female	4	204	170	761	190.3
	Juv.	Male	8	213	187	1,575	196.8
		Female	6	202	167	1,103	183.8
Carbon County (at Game Farm)							
January	Adult	Male	23	256	197	5,187	225.5
		Female	15	245	192	3,239	215.9
	Juv.	Male	32	243	177	6,912	216.0
		Female	25	230	163	5,199	207.9

It is entirely unreasonable to suppose, on the basis of weight samples presented, that averages from birds trapped at the Game Farm and at Salt Lake City are comparable with data from the Uintah Basin. Weight data alone are of limited value in determining critical survival periods when it is not known what weight fluctuations normally occur in quail. Errington (1931) presents data, however, which indicate that severe losses may be expected if more food isn't made available when the weight

loss of bobwhites reach 30 percent of the weight of the same birds in good flesh condition.

The weight of 118 adult quail weighed in the Uintah Basin averaged 167.4 grams. This is 3.6 grams less than an average of 80 quail on which weights were reported by Woodbury, Cottam, and Sugden (unpublished manuscript). If we apply weight loss data to average Uintah Basin quail weights, then quail would be expected to be in serious flesh condition when reaching an average of 117 grams or less.

Uintah Basin quail weights in March averaged 154 grams for the male and 147 grams for the female. This represents a weight loss of 10 percent of the average weight of the adult and does not appear to have been severe.

Transplanting

A factor influencing the distribution of quail populations is the introductions and transplantings which have been made. Specific data appear unavailable on early introductions but, as referred to earlier, undoubtedly it has resulted in the release of both the California Quail (Lophortyx californica brunnescens) and the Valley Quail (L.c. californica) into Utah.

Quail have been frequently trapped from concentrated areas in or near Salt Lake, Ogden, Provo, and occasionally elsewhere during winter months when their numbers became excessive in areas that could not be hunted. These birds have been released to support other small and unstable groups of quail in less favorable areas.

Quail have been transplanted into eight counties in Utah during the study period, (table 12).

Table 12. Transplants of California Quail during the period of study, 1950-1952.

Area	Number of quail released	Date released
Cache County	22	January, 1952
Grand County	42	February 10, 1952
Iron County	28	April, 1950
Kane County	51	February 27, 1951
San Juan County	40	February 10, 1952
Sanpete County	6	February 27, 1951
Sevier County	52	February 4, 1951
Uintah County	100	March 28, 1950

Quail were not present in the following counties prior to release made during the period of this study: Kane, Grand, and San Juan. Transplanted quail are surviving in Kane, Iron, Sanpete, and Uintah counties. Reports indicate that Kane County had good reproduction, although survival through the winter will be a greater measure of their success in establishing themselves. Other releases have been too recent to determine the results.

Natural spreading

The status of the California Quail cannot be fully understood unless it is known whether the populations have increased their range. Accordingly, a fall survey was made to determine the potential expansion of their range.

Quail were reported to be spreading in only four of the 17 counties in which known coveys existed. The increase in range was reported around the densest of the quail populations in Morgan, Utah,

Salt Lake, and Summit counties. Coverts formerly supporting quail have again become frequented by the birds. Only in Utah County have quail been observed in entirely new areas.

A comparison of the probable range of quail in 1951 with the probable range as outlined by Popov (1949) indicates that little spreading has occurred over the three year period. The fluctuations in quail numbers observed during the period of this study appear to be the result of weather and factors of the quail habitat rather than an increase in the normal distribution of the bird.

QUAIL FOOD HABITS

Studies of the foods of the California Quail have been made by Sumner (1935) and Glading, Biswell, and Smith (1940) which have assisted materially in the understanding of problems relating to the quail in California. Since plant associations in Utah differ from those found in the bird's native range, a food habits study was made as a part of this project. It is perhaps even more important that Utah quail food preferences were studied for possible food deficiency periods that may be of importance in connection with their survival or increase.

A total of 40 crops was analyzed in this study. These do not include samples which were empty. A majority of the crops was collected during hunter bag checks in the fall. A breakdown of numbers studied and dates collected is indicated in Table 13.

Table 13. The crops of quail by sex and date of collection, Uintah Basin, Utah, 1949-1951.

Year	May		June		July		November		Total
	Male	Fem.	Male	Fem.	Male	Fem.	Male	Fem.	
1949	-	-	-	-	2	2	-	-	4
1950	-	1	-	-	-	-	4	6	11
1951	-	-	1	1	1	-	13	9	25
Total	-	1	1	1	3	2	17	15	40

The quail population was not high enough to justify taking specimens for food habits studies. The crops included during summer months

were taken from road kills.

The crop contents when collected were placed in a solution of approximately 70 percent alcohol in two ounce bottles. Each crop was labeled for reference and the analysis of foods was made as time permitted.

A total volume of 108 cc of food contents was separated. One species of seed belonging to the family Compositae was found to occur in 17 percent of the crops studied, and made up 1.6 percent of the total volume of food eaten. It has not been possible to identify further this particular food.

A total of 24 species of plants made up the major part of the volume of foods eaten. This information would indicate that five species of plants amounted to 78 percent of the volume of food eaten by quail. The species are: bullberry (Elaeagnus argentea), wheat (Triticum spp.), clover (Melilotus spp.), alfalfa (Medicago sativa), tumbleweed (Salsola kali), and wild oats (Avena fatua).

Bullberry ranks number one in supplying 26 percent of the total volume of foods eaten. Wheat supplied 23 percent of the volume and a combination of clover and alfalfa provided 14 percent. Other species of plants which were taken as food consisted mostly of weed species. These normally grow in waste places and along field borders. The seeds of clover and alfalfa were not separated in this food habits work. Both were eaten readily. Clover appeared in greater quantities, most likely because of its abundance over a longer period of time, (table 14).

From these data, we conclude that the California Quail in the Uintah Basin are predominantly seed eaters, at least in the fall of the

Table 14. Volume in cc of food species eaten by California Quail, Uintah Basin, Utah, 1950-1951.

Plant Species	14 crops 1950	25 crops 1951	Vol. cc Total	% Total Volume
Bullberry seed (Elaeagnus argentea)	18.6 cc	10.01 cc	28.61 cc	26.49
Wheat seed (Triticum spp.)	15.3	9.9	25.2	23.33
Alfalfa and clover seed (Melilotus & Medicago spp.)	12.0	3.8	15.8	14.63
Tumbleweed seed (Salsola kali)	5.5	2.4	7.9	7.31
Wild oats seed (Avena fatua)	5.7	1.7	7.4	6.85
Purple bee flower (Cleome serrulata)	0.6	2.5	3.1	2.87
Misc. plant fibre	0.6	1.8	2.4	2.22
Sunflower (Helianthus annuus)	1.9	0.25	2.15	1.99
Black amber cane	-	2.1	2.1	1.95
Milkweed (Asclepias speciosa)	1.6	0.2	1.8	1.67
Compositae (unidentified)	1.2	0.56	1.76	1.63
Alfalfa and clover leaves	0.8	0.9	1.7	1.57
Misc. seed	1.4	T	1.4	1.30
Milo Maize	-	1.2	1.2	1.11
Geum (Geum ciliata)	0.9	0.2	1.1	1.02
Wild millet (Setaria viridis)	0.9	0.05	0.95	0.88
Wild buckwheat (Polygonum convolvuvus)	-	0.6	0.6	0.56
(Polygonum spp.)	-	0.3	0.3	0.28
Squawbush (Rhus trilobata)	-	0.3	0.3	0.28
Ladies thumb, Knotweed (Polygonum aviculare) (P. persicaria)	0.1	0.1	0.2	0.19
Marsh elder (Iva xanthifolia)	0.2	T	0.2	0.19
Witchgrass (Panicum capillare)	0.2	T	0.2	0.19
Grass seed (unidentified)	T	0.1	0.1	0.09
Barley (Hordeum vulgare)	-	0.05	0.05	-
Pigweed (Amaranthus retroflexus)	T	T	T	-
Lambs quarters (Chenopodium album)	T	T	T	-
(Polemoniaceae)	T	-	T	-
Panic grass (Panicum spp.)	T	-	T	-
Squawbush hulls (Rhus trilobata)	-	0.1	0.1	0.09
Misc. seed hulls	-	T	T	-
Insect pupae	-	T	T	-
Ants (Formica spp.)	1.4	-	1.4	1.30
Misc. insects	T	-	T	-
Total	68.9	39.12	108.02	100.00

year. This agrees well with Sumner (1935) who found the fall food habits in California to be mainly seeds.

The food species are listed in Table 15 according to the frequency with which they appeared in the crops. Clover and alfalfa, tumbleweed, and wheat seed appeared again among the first five species of plants listed. Clover and alfalfa occurred in 77 percent of the crops, tumbleweed in 62 percent, wheat, millet, and bullberry occurred in 37, 30, and 30 percent of the crops. This would indicate that these plants were more universally present over the range and were found acceptable by the majority of quail.

A list of food species according to the numbers taken showed that clover, tumbleweed, wheat, and bullberry were among the five most important species utilized so far as numbers taken are concerned. Clover and alfalfa made up 40 percent of the total numbers of seeds eaten while tumbleweed amounted to 20 percent. Other species of plants appeared less important from the point of view of numbers eaten, (table 16).

An analysis of foods, considering volume, numbers taken, and their occurrence in crops of quail indicated that clover and alfalfa seeds are major fall food items of quail in the Uintah Basin. Tumbleweed, bullberry, and wheat follow close as stable foods of quail. These seeds are most often abundant, being produced by the plants in large numbers.

An effort was made to list the important plant species observed on the study area. The incomplete list was prepared during a short period of time and included 34 plant species. From this list of plant species observed on the area, 12 species are represented in the quail

Table 15. Occurrence of food species for 40 California Quail Crops, Uintah Basin, Utah, 1950-1951.

Plant Species	1950 14 Crops		1951 26 Crops		Total 40 Crops	
	Crops	%	Crops	%	Crops	%
Clover and alfalfa seed (Melilotus & Medicago spp.)	11	78.6	20	76.9	31	77.50
Tumbleweed (Salsola kali)	7	50.0	18	69.0	25	62.50
Misc. plant fibre	8	57.1	10	38.4	18	45.00
Wheat seed (Triticum spp.)	6	42.9	9	33.6	15	37.50
Wild millet (Setaria viridis)	4	28.6	8	30.7	12	30.00
Bullberry seed (Elaeagnus argentea)	3	21.4	9	33.6	12	30.00
Unidentified seed	1	7.1	10	38.4	11	27.50
Misc. seed	7	50.0	4	15.4	11	27.50
Milkweed seed (Asclepias speciosa)	3	21.4	6	23.0	9	22.50
Pigweed seed (Amaranthus retroflexus)	3	21.4	5	19.4	8	20.00
Compositae (unidentified)	3	21.4	4	15.4	7	17.50
Sunflower (Helianthus annuus)	4	28.6	3	11.5	7	17.50
Geum (Geum ciliata)	3	21.4	4	15.4	7	17.50
Marsh elder (Iva xanthifolia)	3	21.4	2	7.7	5	12.50
Witchgrass (Panicum capillare)	4	28.6	1	3.8	5	12.50
Lambs quarters (Chenopodium album)	1	7.1	3	11.5	4	10.00
Knotweed (Polygonum aviculare)	1	7.1	3	11.5	4	10.00
Misc. animal material	4	28.6	-	-	4	10.00
Purple bee flower (Cleome serrulata)	3	21.4	1	3.8	4	10.00
Misc. grass seed	1	7.1	3	11.4	4	10.00
Wild oats seed (Avena fatua)	2	14.3	2	7.7	4	10.00
Ants (Formica spp.)	4	28.6	-	-	4	10.00
Alfalfa and clover leaves	1	7.1	3	11.5	4	10.00
Buckwheat seed (Polygonum convolvuvus)	-	-	3	11.5	3	7.50
Ladies thumb (Polygonum persicaria)	1	7.1	2	7.7	3	7.50
Black amber cane	-	-	2	7.7	2	5.0
(Polemoniaceae spp.)	2	14.3	-	-	2	5.0
Squawbush seed (Rhus trilobata)	-	-	2	7.7	2	5.0
Panic grass seed (Panicum spp.)	1	7.1	-	-	1	2.5
Insect pupae	-	-	1	3.8	1	2.5
Barley seed (Hordeum vulgare)	-	-	1	3.8	1	2.5
Milo Maize	-	-	1	3.8	1	2.5
Misc. seed hulls	-	-	1	3.8	1	2.5
Squawbush hulls (Rhus trilobata)	-	-	1	3.8	1	2.5

Table 16. Numbers of seeds eaten, as indicated, from 40 crops of quail, Uintah Basin, Utah, 1950-1951.

Plant Species	Number of seeds eaten 1950 14 crops	1951 25 crops	Total	Percent
Alfalfa and clover seed (Melilotus & Medicago spp.)	2,660	1,253	3,913	40.37
Tumbleweed (Salsola kali)	892	1,075	1,967	20.29
Bullberry seed (Elaeagnus argentea)	497	267	764	7.88
Wild millet (Setaria viridis)	375	60	435	4.49
Unidentified seed	3	422	425	4.38
Wheat seed (Triticum spp.)	250	161	411	4.24
Compositae (Unidentified)	254	18	272	2.81
Purple bee flower (Cleome serrulata)	43	171	214	2.2
Geum (Geum ciliata)	135	67	202	2.08
Sunflower (Helianthus annuus)	124	19	143	1.48
Witchgrass (Panicum capillare)	129	1	130	1.34
Oats (Avena fatua)	71	29	100	1.03
Marsh elder (Iva xanthifolia)	66	4	70	0.72
Black amber cane	-	65	65	0.67
Misc. seed	40	24	64	0.66
Buckwheat (Polygonum spp.)	-	63	63	0.65
Milkweed (Asclepias speciosa)	38	22	60	0.62
Knotweed (Polygonum aviculare)	1	51	52	0.54
Pigweed (Amaranthus retroflexus)	18	34	52	0.54
Lambs quarters (Chenopodium album)	9	31	40	0.42
Ladies thumb (Polygonum persicaria)	13	25	38	0.39
Milo Maize	-	32	32	0.33
Grass seed	-	11	11	0.11
Panic grass (Panicum spp.)	5	-	5	0.05
Barley (Hordeum vulgare)	-	1	1	0.01
Squawbush (Rhus trilobata)	-	8	8	0.08
(Polemoniaceae spp.)	57	-	57	0.59
Ants (Formicidae)	78	14	92	0.95
Beetle (Coleoptera)	-	7	7	0.07
Insect pupae	-	1	1	0.01
		Total	9,694	100.01

foods found by an analysis of crops. The quail food species found to occur on the study area were: clover (Melilotus spp.), alfalfa (Medicago sativa), tumbleweed (Salsola kali), bullberry (Elaeagnus argentea), squawbush (Rhus trilobata), milkweed (Asclepias speciosa), marsh elder (Iva xanthifolia), lambs quarters (Chenopodium album), sunflower (Helianthus annuus), pigweed (Amaranthus retroflexus), knotweed (Polygonum aviculare), and purple bee flower (Cleome serrulata). This list failed to include wheat (Triticum spp.), wild millet (Setaria viridis), wild oats (Avena fatua), and barley (Hordeum vulgare), plus some of the various species of knotweeds (Polygonum spp.). Most of these species have relatively universal distribution within the valley and are not uncommon in many other parts of Utah.

Sumner (1935) lists 92 species of plants utilized by quail in California. Seven of these species are present on the study area. All seven were represented in the foods of the Uintah Basin quail. This would suggest that quail in Utah prefer the same foods as are utilized in California within the known limits of their choice.

Bullberry and squawbush ripen and drop to the ground usually in September. This characteristic makes these foods available only for relatively short periods of time in the fall.

The variety of weed seeds eaten by quail makes foods readily available to quail during the summer.

Quail were observed to utilize a wide variety of foods but winter snows rapidly made all of their major foods unavailable except the tumbleweed seed. This forced quail in winter to utilize more of the weed seeds, (Chenopodium, Amaranthus, Iva, etc.). These, too, became unavailable, however, as winter became severe.

Quail in the Uintah Basin fed in and around livestock feed yards, and often became coprophageous in winter as foods became hard to find. Trampling of snow by livestock permitted the quail to move upon the ground in search of food.

The presence of green leafy foods occurred in 10 percent of the crops. Clover and a small amount of alfalfa leaves and miscellaneous blades of grass were found to be the major species supplying this need. Green foods are doubtless more important during early spring and summer months to supply possible Vitamin A needs of nesting pairs.

Insect foods played a small part in the fall foods of quail and occurred only as traces. The data indicated that the 2.5 percent of insect material occurred only in summer crop samples. This observation agrees with Sumner (1935) and Glading, Biswell, and Smith (1940) who found in California that insects were more important in the food of quail in the late spring and summer months.

The variety of foods eaten may be an important factor in quail survival. No data known to the writer have dealt with the possible necessity for food variety in a quail diet. In view of the numerous species represented in their diet, and the extremely small size that is characteristic of some of the weed seeds eaten, it would seem possible that variety is a necessity in the diet of quail.

QUAIL IN RELATION TO WEATHER

The northern limits of the native range of quail are determined by the heavy snows and the winter weather (Sumner, 1935). The present trend in making evaluations of climate in anticipation of introducing game birds is to compare the climate of the proposed introduction area with that of the native range of the bird by means of comparing hythergraphs[1] of each area. Should these hythergraphs coincide closely, especially as concerns winter weather, nesting season, and other critical periods, then the climate might be expected to favor the proposed introduction (Twomey, 1936). A better understanding of the conditions under which quail live in Utah may be had in making some comparisons between the weather in Utah with that of their native range.

Weather records were consulted and hythergraphs drawn for Salt Lake and Vernal. Utah has less seasonal variation in precipitation than their native California range, never exceeding a monthly precipitation of 2.1 inches, which normally occurs in the period March to May. California has areas which, in December to March, may expect precipitation as high as 5.5 inches. This is observed to be more than twice the maximum monthly average in Utah.

It appears that weather in Utah can adversely influence quail. We must be cautious, however, in adhering strictly to hythergraphs alone as an estimate or comparison of climate. In their native range quail have

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1. The hythergraph is a graphic means of evaluating climate by plotting average temperature against average precipitation for each month of the year.

exhibited abilities to withstand variations in habitat and climate. A composite hythergraph has been prepared of the extremes only of a number of superimposed hythergraphs from various extremes of weather from a number of widely scattered localities within their native range, (figure 7). This composite is an indication of the variation in climate in which quail might be anticipated to survive.

The hythergraphs of Utah climate coincide fairly close with similar data in California during the nesting, hatching, and young rearing periods. They are, however, at extreme variance during the critical winter period.

Hythergraphs may be misleading, however, since averages of rainfall and temperature are used. For example, normally unexpected cold, damp weather during the hatching season may be a serious decimating factor during a particular year, yet by averaging nesting weather data over a period of years, this characteristic would not be shown on the hythergraph. Accordingly, the lowest temperatures recorded for the winter months are presented for comparison of two Utah areas along with similar data from the type localities in the native range of quail, (figure 8). It appears that the minimum winter temperatures which were observed to go as low as -29 degrees in 1950-1951 may be expected to be critical for quail survival in Utah.

There normally is no snow during winter months in the type localities of quail, whereas deep snow is characteristic of winters in Utah. In 1949-1950 snowfall of 18.2 inches during January was recorded. Superimposed on the graph presented in Figure 8 is the snow depth averages of the two Utah areas over a 28 and 56 year period. From a combination of minimum temperatures and snow depth, the season from

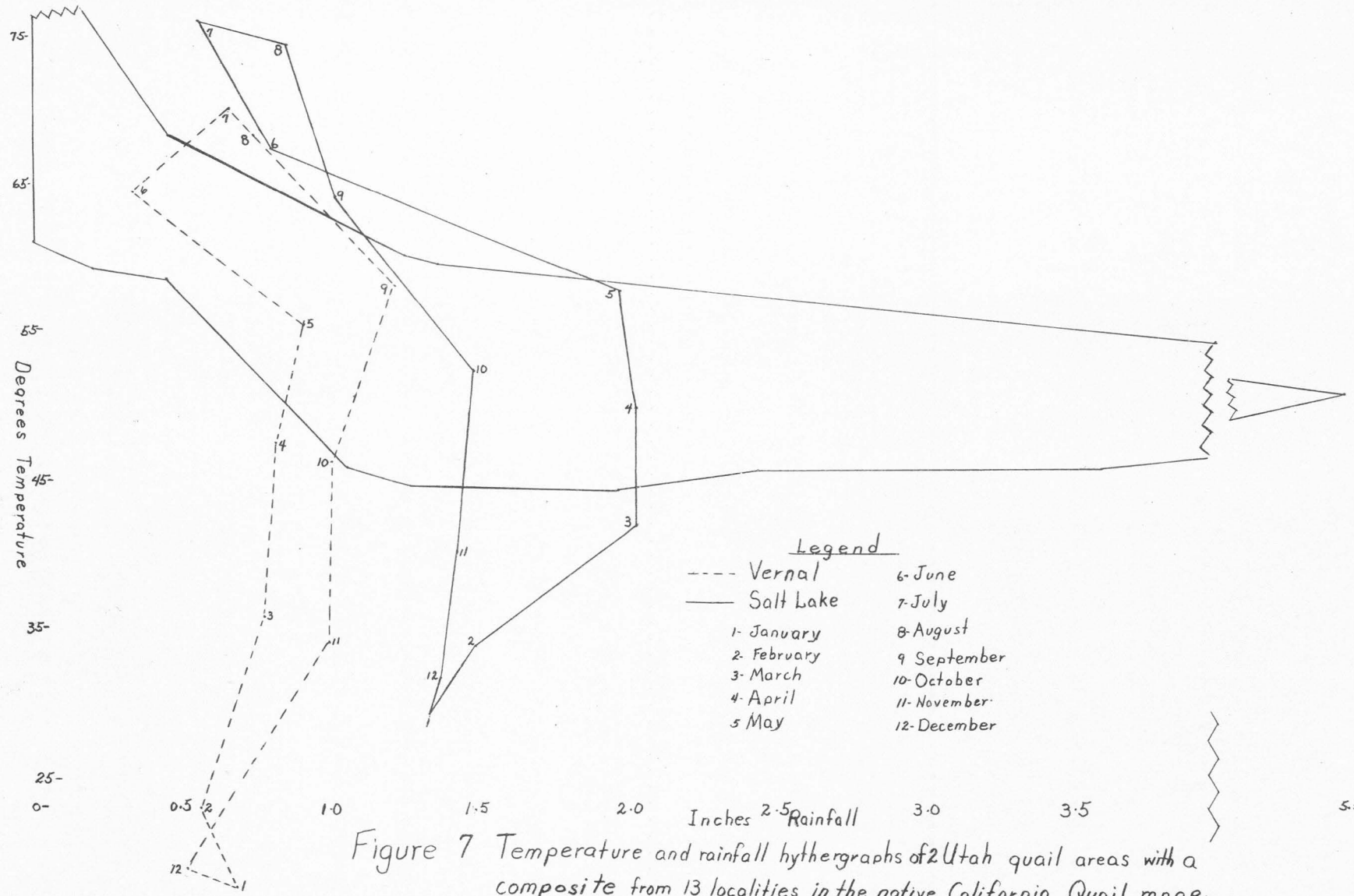
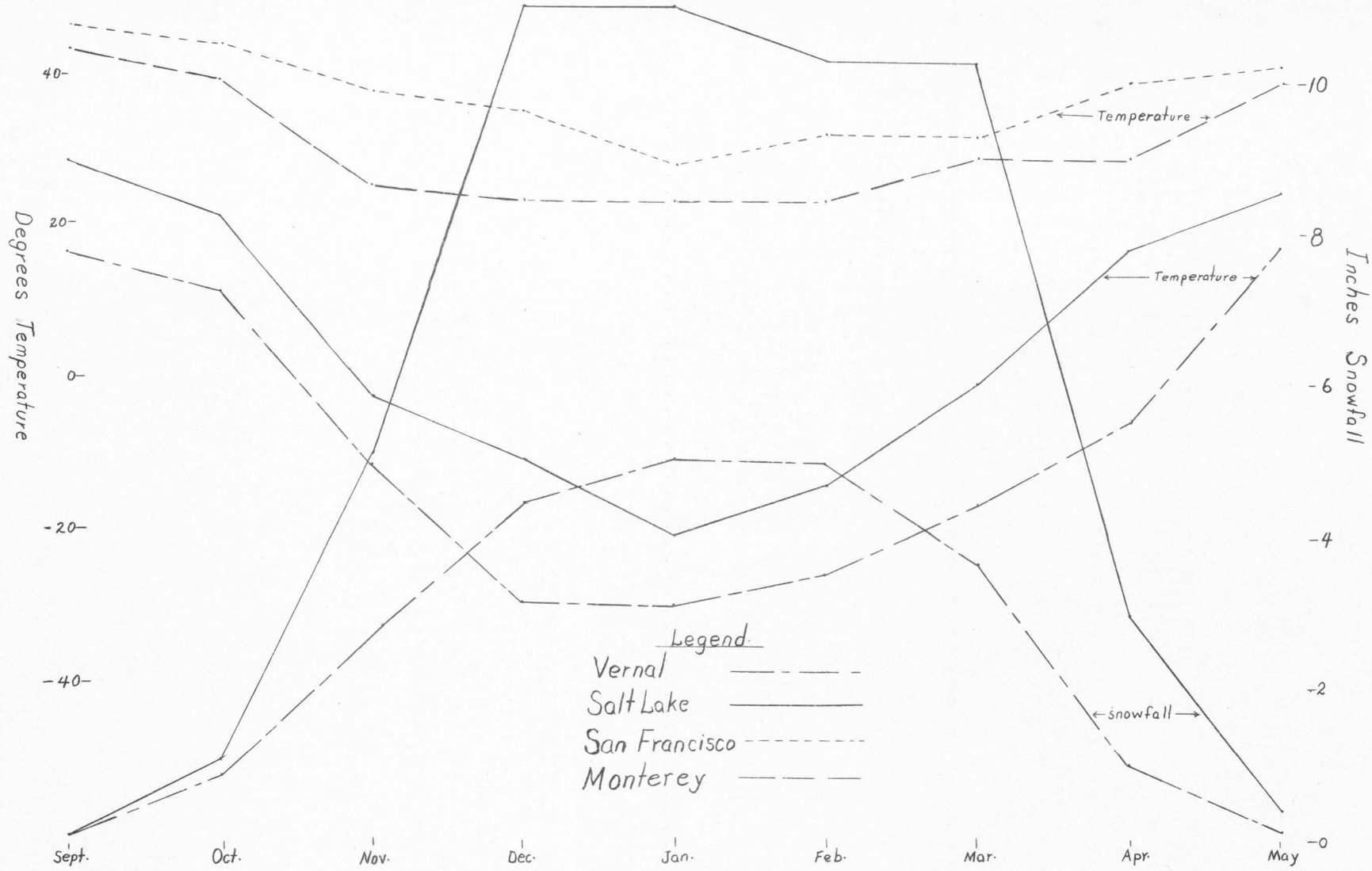


Figure 7 Temperature and rainfall hythergraphs of 2 Utah quail areas with a composite from 13 localities in the native California Quail range.



Fiaure 8 Average minimum temperatures and maximum snowfall comparison between quail ranges in Utah and California.

November to about March 15 in normal years can be considered critical for quail survival in Utah. However, here again, we are using averages. This means that we should expect considerable losses of quail during winters that are more severe than normal.

Tribe (1937) recorded observations in Utah of quail frozen in good flesh and with full crops following extreme sub-zero temperatures. The snow depth data over the years indicate deeper snows in Salt Lake than in Vernal, but minimum temperatures are more severe in Vernal than in Salt Lake, (figure 9). In 1949-1950 the heavy snowfall in December-January resulted in more snow on the ground in Vernal than in Salt Lake. This unusually deep snow and cold weather at Vernal shows (1) the unpredictable weather in Vernal, and (2) a probable reason for the extremely small population of quail in Vernal.

Data on weather comparisons suggest that quail in northern and central Utah are probably living near the limit to their tolerance of winter climate.

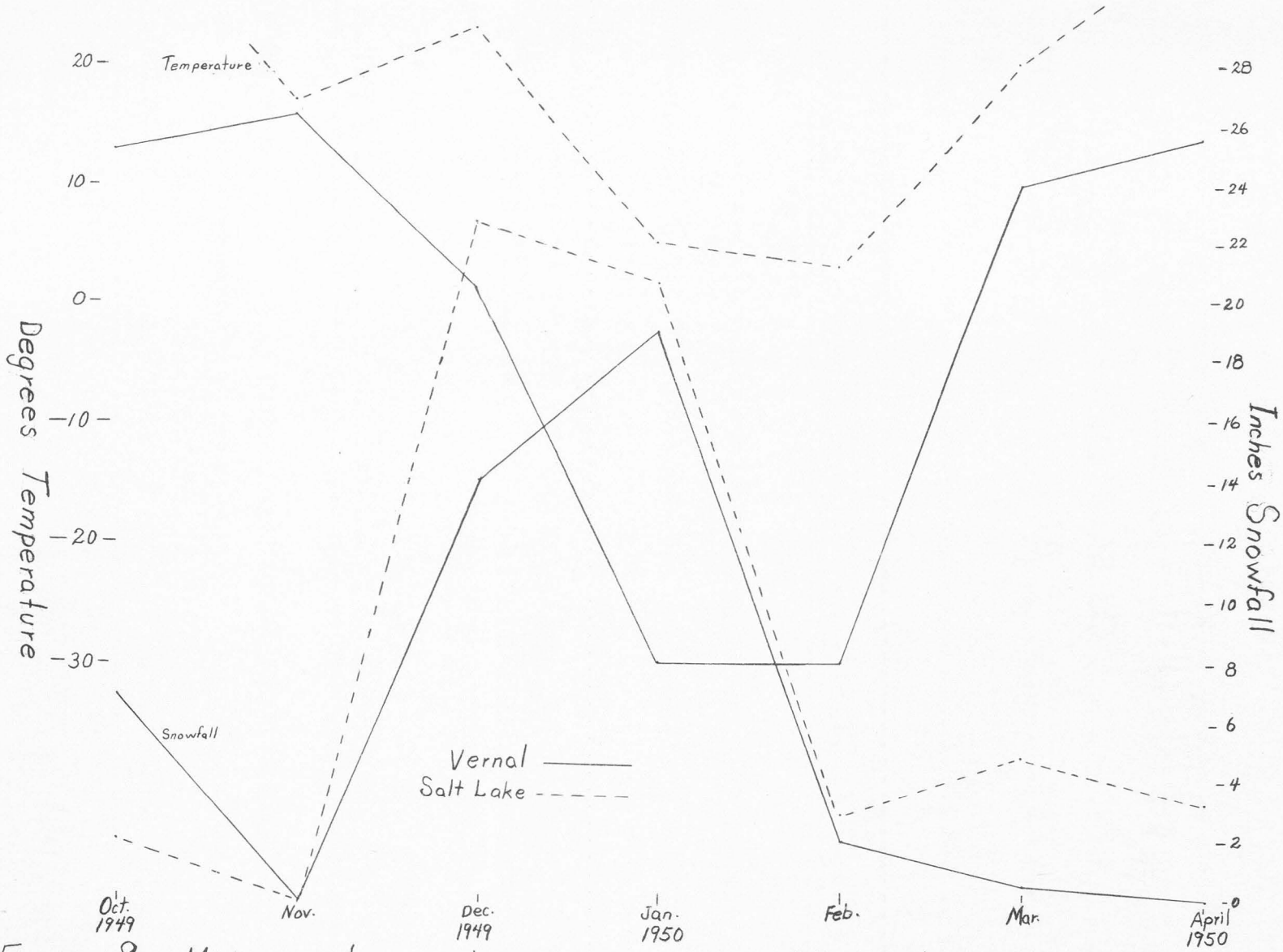


Figure 9 Minimum temperature and maximum snowfall, Vernal and Salt Lake, 1949-1950.

HABITAT PREFERENCES

Earlier studies have outlined the specific habits and life histories of most species of our game. More recent studies of our wildlife have been concerned with the environment in which our game must live instead of the characteristics of the game itself. However, both are important factors which need to be understood in order to appreciate the critical factors influencing and possibly controlling their numbers.

The habitat of quail in Utah is a close approximation to the habitat in which quail were found in California. Because of the general topography of Utah, along with its climate and weather, the amount of habitat found acceptable by quail is definitely limited to a small fraction of the total acreage.

A better appreciation of the quail habitat in Utah may be gained in a more intimate consideration of the species of plants used and apparently required by the bird. This will include growth characteristics which are found to be acceptable, preferred, or avoided.

Quail cover

Sumner (1935), Emlen and Glading (1945), and others have subdivided the cover requirements of quail into (1) feeding, (2) roosting, (3) escape, (4) resting, and (5) nesting cover. The following discussion proposes to consider the cover types separately, followed by an over-all evaluation of quail habitat.

Roosting cover. Roosting cover was observed to be an important part

of the habitat requirements of quail in the area studied. A review of field notes of observed roosting habits indicate that most of the roosting cover of quail consists of dense willow thickets or the combination of willow (Salix spp.), alder (Alnus spp.), and birch (Betula spp.). Cottonwood trees (Populus spp.) were also commonly used as roosting cover and were often associated with patches of willows.

Three pairs of quail provided ideal conditions for a study of roosting habits. These birds were known to be using a cover area which consisted of a fencerow delimiting a property boundary, beyond which was a canal about 12 feet wide and six to eight feet deep running the full length of the fence, and adjacent to a dirt access road. The canal and fence were overgrown mainly with willows. Weeds were abundant next to the willows and interspersed among the willows where the latter had not grown too abundantly.

Six cottonwood trees were growing within the cover area most used by the quail. The trees were about 35 to 40 feet high. Quail used the tangle of sucker-like dead limbs which still remained attached in a cluster-like fashion to the tree trunk of these cottonwood trees. This typical cluster of dead limbs is characteristically formed about six to eight feet above the ground. The quail in this area were observed going to roost many times. Normally they would walk along the top fence pole in the late evening. After looking cautiously about for a time, a short flight carried them one at a time to the outermost branches of the cottonwood tangle. The birds then jumped from limb to limb, and eventually settled down for the night near the trunk of the tree. Quail, thus roosting, could not be reached by

anything their own size or larger without the noisy rattle of dead limbs.

The cottonwood cover was found to be a chosen spring and late summer roosting site for many quail under observation. This roosting cover provided a horizontal perch for roosting. In addition, the birds were out of sight under most light conditions from above, below, and from the side. This cover seemed to offer adequate protection from winged and ground running predators.

The willows chosen as roosting sites were characteristically old growths and bent over, arch-like, generally providing horizontal perching sites on the limbs near the apex of the arch, (figure 10). Willows bent over in this fashion are commonly so dense that they will support the weight of a man. Quail were found to roost within these branches out of sight. Willow cover of this nature provides a roost for quail two to four feet above the ground. Observations of this study agree with Baker (1940) who found that older growths of cover were more attractive to bobwhite quail in winter than younger cover.

Wintering quail were most often found in Utah in the dense over-hanging willows. The cover was frequently so thick that it was necessary for the birds to wedge their way into a perch for roosting. This provided an unbroken mantle of snow overhead. In many cases the cover was located in a canal or other depression which further protected the quail from winter winds. Willows were the dominant species of winter cover used by quail. Occasionally vines and roses were associated with willows in the winter quail cover. Conifers have been observed to offer roosting cover in some locations. These occurred less extensively and provided the same roosting features

referred to above. An interesting variation in roosting cover consisted of a dense willow patch which lacked the bent-over or arch-shaped cover. Instead, the willows were covered by a dense network of vines (Clematis spp.) in which quail habitually roosted.

Quail used only the densest cover for winter roosting, apparently avoiding as much of the direct effect of the weather as possible. Quail were not observed to be using the cottonwood type of roosting cover in any instance in winter weather. During extreme weather conditions quail were known to have roosted in the interior of unoccupied buildings.

Escape cover. Many types of cover tangles will supply the escape cover needs for quail. Figures 11 and 12 illustrate the general characteristics of plants which are preferred by quail for escape cover in the Uintah Basin. Bullberry (Elaeagnus argentea) is an example of available fall food, (figure 13). However, this plant species is known also to provide escape cover when other better cover is lacking.

The species of plants are relatively unimportant in supplying escape cover for quail. The best and most effective escape cover plants were those offering numerous small sized branches in the form of a dense thicket or tangle. The cover must be close at hand when needed. Escape cover near feeding and dusting areas was found to be most used. A pile of tree limbs against a fence or in a small rocky portion of land was readily accepted by quail because of its proximity to their exposed feeding areas.

Resting cover. Resting cover for quail appeared in the Uintah Basin to present no particular problem. Wherever resting quail were observed they were found with some degree of overhead cover. Often this need

Figure 11. Brush-pile used as escape cover by California Quail in the study area, Uintah Basin, Utah.

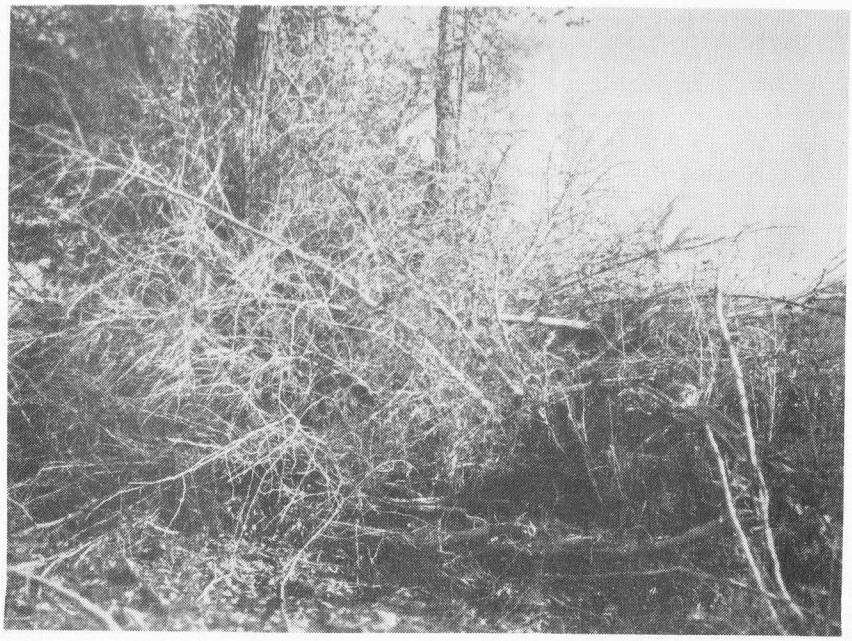


Figure 12. Brush-pile used as escape cover, study area, Uintah Basin, Utah.

Figure 13. A quail food plant, Bullberry (Elaeagnus argentea), much used for roosting cover in the Uintah Basin, Utah.

Figure 14. Typical quail feeding and resting area. Study area, Uintah Basin, Utah.

was fulfilled by sagebrush areas which were open and dry enough to permit the quail to dust or sun themselves. Occasionally the edges of escape and roosting cover areas were utilized for this purpose. One observation was made of a small weed patch which was used regularly by quail as both a feeding and a resting area, (figure 14).

Some variations were noted in resting cover choices which appeared somewhat puzzling at the outset of the study. Instances were noted when quail sought shade under which to rest, at other times a secluded sunny spot was preferred. Subsequent observations indicated that quail were mostly loafing. The resting period appeared to be a semi-inactive period between meals. Their choice of cover at this time seemed to be a matter of convenience.

The resting cover use is altered in the Uintah Basin at the onset of winter snows. A change in habits of quail occurs at this time. The roosting, resting, and escape cover quite frequently become one and the same for the wintering covey. Quail normally move very little during inclement weather. A variation to this pattern will often occur during periods of thawing and sunshine when quail may be observed perched on the top pole of a fence near cover, or some other dry elevated spot, sunning themselves. Winter observations point up the variation in resting cover to which quail were found capable of adaptation.

Nesting cover. A definite need for cover occurs during a portion of the year when quail are nesting. Cover choices for this purpose were found to be quite variable. A form of overhead cover invariably was found to have been present. Nests were found hidden among the dense dry grasses along the banks of canals, (figure 15), and also beneath branches of low-growing but fairly dense sagebrush (Artemesia tridentata).

Figure 15. Quail nest in grass showing concealment.

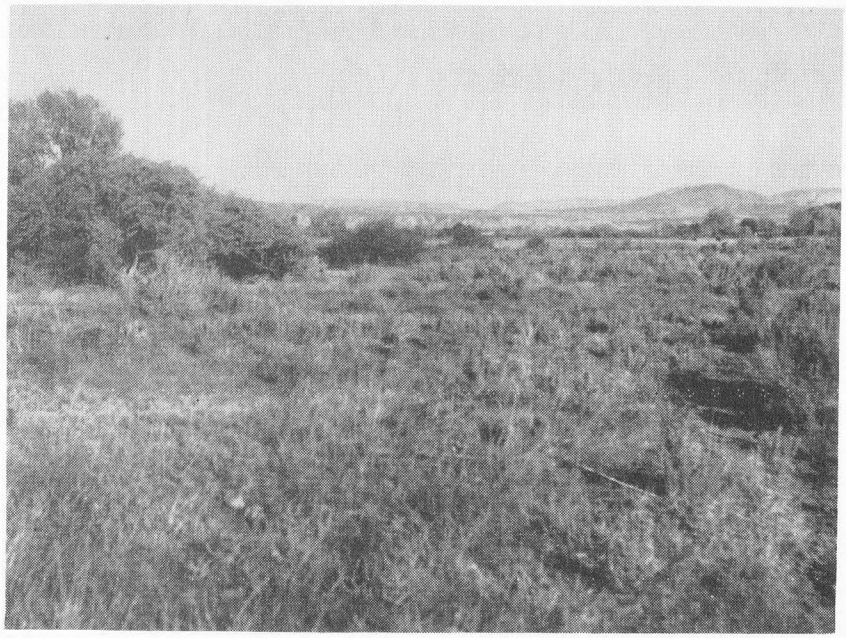


Figure 16. The cover area of a typical California Quail brood in the Uintah Basin.

There were no apparent dominant plant species involved in the nesting habitat choices. Bluegrass (Poa spp.), quackgrass (Agropyron repens), and bluebunch wheatgrass (Agropyron spicatum) were commonly used for this purpose, especially where windfallen limbs, brush piles, or natural features of the terrain offered additional protection. This latter occurrence may well have been the cause of the grasses being ungrazed and, hence, dense enough for nest concealment rather than to have been chosen as an additional protection by the nesting quail.

An interesting variation in quail nesting was noted during the summer of 1951 in two broods which in late July were about two or three weeks old. The nests had not been under observation and the cause for the late broods was not determined.

The studies of nesting quail yielded little information on the topic which would indicate that a lack of nesting habitat adversely affected quail populations. Nesting habitat needs were capable of wide adaptation to existing conditions, provided that some seclusion was offered. Studies in Utah agree with Sumner (1935) who found that quail appear to have little difficulty in finding adequate nesting cover. Emlen and Glading (1945) indicates the importance of interspersion of cover or "edge effect" for quail. The same is true of quail habitat in Utah, however, this did not appear important in the choice of nesting cover. Quail were not observed to nest deep in heavy cover. The tendency seemed to be a choice of semi-open cover areas offering concealment near the ground but usually with little of the taller cover of the type used for roosting.

Interspersion of cover. Observations in the Uintah Basin agree very well with the findings as reported by Sumner (1935), and Emlen and

Glading (1945) on the requirements of interspersion of quail cover. A preliminary survey of the quail areas in the Ashley Valley suggested an adequate and often an abundance of quail cover. However, later study revealed deficiencies in many of these so-called "abundance" cover areas which either prevented or effectively limited the potential quail increases.

A large area in the Uintah Basin was traversed to locate quail coveys. Cover areas were examined for dusting signs, tracks, or other landmarks which might isolate the possible cover area in which the few remaining quail might be found. The populations of quail increased during the progress of the study and some of these less desirable, or sub-marginal, areas were then utilized by quail.

Quail were observed to remain within 200 feet of escape cover. An exception to this occurred only where foods became hard to get.

Uintah Basin quail were frequently flushed from sagebrush areas interspersed with grasses and outcropping of rock. This cover apparently offers adequate concealment, (figure 16).

The common habitat deficiency in the Ashley Valley is a lack of feeding areas sufficiently close to adequate cover. Ideal locations for excellent roosting and escape cover were observed. When few or no quail were found in these areas, a deficiency of food bearing plants was most often found to exist.

Lands in the Ashley Valley that are suitable for cultivation have long since lost their native vegetation. Boulder strewn river banks support a low grade of quail cover and swamps are deficient in quail food plants. Somewhere between these extremes the right soil and water conditions are present to support a good growth of the cover plant

species such as willows, cottonwood, bullberry, squawbush, birch, and alder. Adjacent to this cover must be found lands fertile enough to produce the numerous weed plant species which will provide an adequate subsistence diet for quail.

The need then is apparent for two definite and distinct conditions of soil-water relationship lying adjacent to each other. In addition, the soils must be so laid out among surrounding soils as to be of little or no use to man. Otherwise, without assurance that the habitat will be permanent, no expectations could be had for a stable quail population.

The normal conditions of soil and moisture adequate for production of desirable quail habitat occur in two ecological situations in the Ashley Valley: (1). Adequate areas of quail habitat occur along old canal banks eroded to a depth of four to six feet normally by high waters cutting through relatively deep soils. The canal banks and bottoms supply the soil-moisture relationship conducive to the adequate growth of the desirable cover species. The fertile land above and along the canal banks offer soil-moisture conditions favoring weedy plant growth with cultivated areas near by. Finally the entire niche is normally unmolested by man for a number of years because of its lack of value to him at the time in a form other than it exists. (2). Adequate quail habitat production occurs along well established rivers where floods have piled rocks and debris over at least fair soils, making the land unattractive for cultivation. This condition has permitted the growth of cover species. The edges of these cover areas often are cultivated, preventing reliable food production but, if marshy land has resulted from the uneven piling of rocks and debris, there is provided edge areas for weedy growth and suitable quail habitat

may result.

Combined with the relatively infrequent occurrence of one or the other of the above two cover types is the infrequently used cover supplied by an abandoned ranch house. This condition may well be important, however, in quail survival through unusually heavy winters. The unused buildings may be used for cover and a source of wasted grains for food during emergency periods.

The cover relationship requirements have reduced the possible quail areas to a mere scattering of quail habitat here and there along the water courses, (figure 17). However, nearly every year spring ditch cleaning activities have resulted in the burning of cover areas. Figure 18 illustrates an area where burned out cover eliminated an ideal quail area. Quail in this area in the past normally survived severe winters. However, quail have disappeared from this area following the burning of their cover.

The quail habitat in Ashley Valley provides usually an abundant and staple supply of water. The water requirement is not considered serious to quail increases in the Ashley Valley because it must be present to maintain the habitat.

A real difference appears in quail habitat in and around metropolitan areas. Summer foods are usually abundant in unused corners of the lot, raspberry patches, cemeteries, and similar areas. Escape cover in almost any tree or bush is always near. Roosting cover may be the back fence hedge or the spruce (Picea pungens), juniper (Juniperus spp.), arbor vitae (Thuja spp.) or many other species that very commonly provide beautification around the home.

Figure 17. A two-brood quail range. (Note willows along canal.) Study area, Uintah Basin, Utah.

Figure 18. Typical quail habitat, the first summer following spring burning of cover.

Hunting is not permitted within the residential districts. When severe winters arrive kind hearted humans provide easily found foods. Shelters of garages and other buildings are available in which quail may take refuge during emergencies. The delicacy of fancy flowers may supply early spring green feed for quail, to the occasional consternation of the owner.

Quail become friendly in the cities and early spring quail calls may often be heard. Quail are quite common on the campus of universities where "landscaped cover" is in abundance.

Populations of quail in and near metropolitan areas are estimated to amount to more than half of our total quail population.

A very limited quail population lives around game farms. These quail are even more domesticated than quail in metropolitan areas because feed is always available and there is often intentional provision of habitat. These populations of quail are not, however, felt to be indicative of the ability of quail to live under wild and adverse conditions, to withstand hunting pressure, deep snows, and sub-zero temperatures that are a requisite to an existence in Ashley Valley and numerous other similar areas in Utah.

OTHER FACTORS AFFECTING QUAIL NUMBERS

Weather, food habits, and habitat requirements are the most influential factors in the survival of quail in Utah. Other potential decimating factors such as predation, parasites, and disease cause loss of quail but are not considered significant from this study.

Predation

The question of predation has thus far been omitted. All possible evidences of predation on quail were recorded. Predators may be considered abundant in Ashley Valley. The predators which were observed in and around quail areas during the study were:

skunk	(Mephitis occidentalis)
weasel	(Mustela frenata)
dog	(Canis spp.)
goshawk	(Accipiter gentilis)
sharp-shinned hawk	(Accipiter striatus)
great horned owl	(Bubo virginianus)
raven	(Corvus corax)
badger	(Taxidea taxus)
cat	(Felis spp.)
magpies	(Pica pica hudsonia)
Cooper's hawk	(Accipiter cooperii)
prairie falcon	(Falco mexicanus)
shrike	(Lanius ludovicianus)

A partial list of other animals usually not considered as predators upon quail are:

prairie dog	(Cynomys leucurus)
marsh hawk	(Circus cyaneus)
red tailed hawk	(Buteo jamaicensis)
long eared owl	(Asio wilsonianus)
kingfisher	(Megaceryle alcyon)
gray squirrel	(Citellus varigatus)
rough legged hawk	(Buteo regalis)
Swainson's hawk	(Buteo swainsoni)
sparrow hawk	(Falco sparverius)

Three observations were made of quail kills which were recorded as predation: (1). A banded quail was killed by a sharp-shinned hawk. The flesh had been imperfectly removed from the bones. The skeleton was intact and the leg band was recovered. (2). The remains of a banded quail marked with "Bow-ties" were found. Evidence indicated the kill was made by a Cooper's hawk. This predator was known to frequent the area. (3). Two quail were found dead in one of the writer's traps. Unmistakable evidence of a skunk remained.

Observations indicated that quail were alert to enemies. Quail detected predators in the vicinity more rapidly than did the observer.

A pair of long-eared owls raised two young in a tree nest overhead from the roosting and escape cover of a brood of quail. An examination of 28 pellets from in and below the owl nest indicated that the food of these raptors was made up of mice (Microtus and Peromyscus). No signs of quail predation were evident. The quail were observed to have had excellent survival when fall coveys began to assemble.

The two cases of suspected hawk activity were believed to have been caused by three factors: (1). Foods were scarce near escape cover. The quail were forced to move into areas some distance from cover to obtain food. The losses were, therefore, felt to have been caused by a deficiency in the habitat. (2). The quail had been trapped and "Bow-ties" affixed to the birds. This factor, together with the previous one, is felt to have made these quail more conspicuous and susceptible to predation. (3). Trapping operations may possibly have caused injuries to the quail, making them more easily caught by predators.

Skunks are normally too slow to be effective predators on quail, except where they might find eggs in a nest. The effect of skunks as predators of quail is believed to be negligible, even though in some areas skunks were quite numerous.

In general, quail areas are typically near irrigated land and close to small towns or farming communities. Numerous cats, many appearing to be feral, were noted as commonplace. No specific instances of cat predation on quail were recorded. Quail were observed alert in the presence of cats and very cautious. Experimentation with tame pets indicated that quail are a very desirable prey for a hungry cat. The writer feels that cats in Utah may well be one of the more important predators of a quail population.

The food habits of the feral house cat in California were studied by Hubbs (1951). His study area contained very few quail, however, the data indicated that quail were eaten by cats. This adds support to the writer's observations concerning the threat of cats as a predator of quail.

Evidence gathered in this study has not given any indication that predation is a factor in limiting quail populations. There seems no reason to suppose that predation can be held responsible as a factor seriously influencing Ashley Valley quail populations.

Data of this study agree with Errington (1934) who contends that predation upon a population of bobwhites varies with the ratio between the carrying capacity of the environment and the population. He explains this further by citing an example:

> "Should the bob-white population for some reason be lower than the carrying capacity of the land, the predation rate is greatly lessened."

This apparent condition existed during the present study, wherein a low population level in a normally productive environment evidenced little predation. Errington (1933e) prefers to look upon bobwhite winter predation as a reflection of the ". . . inadequacy of the environment to accommodate existing densities".

Parasites and disease

No detailed study of parasites and disease was possible in the Ashley Valley during the period of the study. Road-killed quail were examined, however, whenever possible for evidence of parasites and disease. No internal parasites were collected. Three of the quail that were examined were found to be harboring bird lice (Mallophaga). The infestations were fairly heavy. In consideration of the many birds handled during the period of the study, this uncommon occurrence of parasites suggests that the infection rate is low.

Parasites appear, from what limited observations were obtained, to be ineffective on wild quail populations in Utah.

Coccidiosis is known to have occurred in Utah in captive quail. The infected birds appeared highly susceptible to infection. Mortality did occur because of the disease or its resultant causes. Infections of coccidiosis in quail are reported by Henry (1931) to have been caused by one of three species of Eimeria. Sulfa quinoxaline was found to be effective in the control of the infection in Utah.

Bird malaria (Haemoproteus Lophortyx O'Roke) has been found by O'Roke (1928, 1930, 1932), Herman (1942), and Herman and Bischoff (1949) to be present in the quail of California. O'Roke (1932) found evidence of the infection in most of the native quail sampled.

A 65 percent infection rate was the heaviest found in native wild birds in California, while 100 percent of one captive flock had the disease.

Infections of Haemoproteus Lophortyx O'Roke are transmitted from bird to bird by the louse fly (Lynchia hirsuta Ferris). Studies by Herman and Bischoff (1949) indicate that the infection persists over a long period of time. The disease may be present and has been observed to reoccur in quail when blood smears failed to indicate a positive existence of the disease.

Infections of gapeworm, caused by the nematode Syngamus trachae, have been observed in other birds in Utah. Herman (1945) reports that quail are susceptible to this disease. No evidence has been found in this study which would indicate that wild populations of quail in Utah are troubled by this parasite. This nematode attaches to the interior wall of the trachae, most often just anterior to the branch of the bronchial tubes. It causes the birds to sneeze and gasp intermittently for air.

Workers have not found conclusive evidence that disease is a critical factor in quail populations. Quail disappear rapidly in Utah during limited periods of time. This might possibly suggest disease as the cause of mortality. However, since greatest reduction in numbers appears only at critical survival periods, it is felt that disease, if responsible at all for mortality, is of secondary importance only.

MANAGEMENT CONSIDERATIONS

There is no evidence to indicate that hunters have killed too many quail in Utah, regardless of their scarcity or abundance. Quail populations increase under the relatively light hunting pressure they have been subjected to in Utah.

It is recommended that all areas on which hunting is feasible may be opened to the hunting of quail during the short pheasant and quail seasons as in the past without undue concern over the survival of quail. Adequate cover will insure good quail survival following seasons with reasonable hunting pressure. Observations in Utah agree with Glading and Saarni (1944) who failed to find adverse effects on the potential breeding population following a 25 percent kill of the quail population in California.

Snow cover is not normally encountered by quail in their native range. Many of the quail foods are covered by snow during winter months in Utah. Winter trapping operations have shown that quail in good flesh and with plenty of food are unable to walk through six inches of light snow. The reaction of quail to winter conditions appears to be one of remaining inactive in heavy cover, waiting for a break in the weather. When deep snow and sub-zero temperatures extend for a week or more, quail were observed to search for food at the base of trees and under heavy cover where snows normally were not so deep.

Observations showed that loose unpacked snows remaining on the

ground in Ashley Valley were not an uncommon occurrence and were more frequent than in the Salt Lake area. This quality of snow cover was perhaps more influential in preventing quail survival during the winters of 1948-1949 than any one factor.

A correlation appears to exist between the kill of quail and the weather conditions. State averages of minimum temperatures and snowfall from November through March of 1947 through 1951 have been assembled. This is the period of time on which statewide samples of kill data on quail are available. Kill figures were derived from a sampling of 10 percent of the upland bird hunters of the state each year. Cross-checking the accuracy of this kill sample technique has indicated consistent reliability in the data.

The winter of 1947-1948 was mild. The quail kill in 1948 was 315. Deep snows in January 1949 and extreme sub-zero temperatures were followed by a kill of 18 during the fall of 1949. The succeeding two winters progressively were observed to have been milder with a kill of 67 quail in 1950, and 155 quail reported killed in 1951, (figure 19). Weather data are not yet available for 1952, however, preliminary observations indicate that severe winter weather will probably reduce the quail kill in the fall of 1952.

We might infer from the above data that quail kill is varied by the population density and that population density is largely dependent upon severity of winter weather.

Food preferences show that non-cultivated plants supply winter food for quail. This indicates that quail populations will decrease when grazing or cultivation is extensive in the quail area.

Coverts supplying winter food and protection are major factors

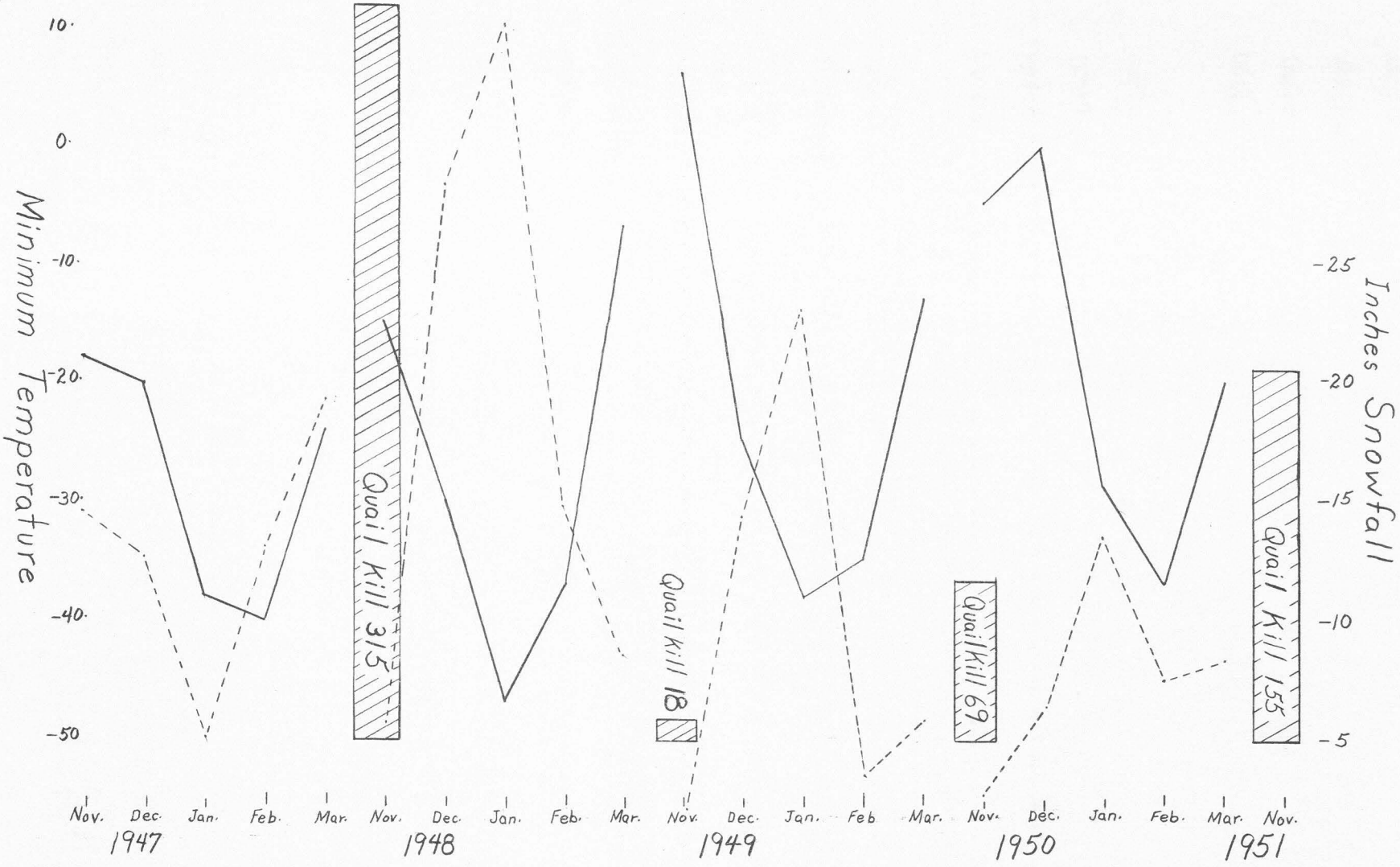


Figure 19. Snowfall, minimum temperature and quail kill in Utah, 1947-1951.

in the status of our quail populations. Quail have failed to survive sub-zero weather with an adequate food supply. This points up the importance of cover as a major requirement for wintering quail in Utah.

It is possible to increase quail populations in Utah. Careful evaluations would need to be made of presently used habitat and provide, where possible, an increase in the deficient portions. It appears improbable that an extensive effort of this sort is justified because quail are not important to Utah hunters.

The evaluation of quail habitat requires a knowledge of plants and of an interrelation of plant species. Landowners cannot be expected to consider quail habitat in this much detail. However, it is easy for him to know where his quail have been living. Thus he can determine the presence of acceptable habitat in these areas. On the other hand, he soon learns that burning out that old willow patch, spraying with chemicals, or overgrazing the area will cause the quail using this area to disappear.

In order to stabilize and increase quail in Utah we must: (1) provide suitable habitat in order to offer maximum protection and food availability to quail during the winter, and (2) maintain the habitat over a prolonged period of time.

The most practical approach to a maintenance and improvement of quail populations appears to rest with the interest of farmers and landowners. If they are informed of the known needs of quail, they can, in their every day planning, arrange to preserve adequate quail habitat. When deep winter snows bury the poorer quail coverts it is too late to attempt re-establishment of food supplies and needed cover.

The management of waste areas near cultivated fields will determine the future of wild populations of Utah quail.

SUMMARY

1. The study of California Quail in the Uintah Basin was carried on from April 1950 through November 1951. The Utah quail distribution was found to extend in a narrow band through the center of the state in a north-south direction with small populations more widely scattered where patches of quail habitat were present.

2. The quail population in Ashley Valley, Uintah County, was extremely low in the spring of 1950. Only six pairs of quail were located on the study area. The brood stock had increased 100 percent by the spring of 1951.

3. A calculated 750 acres of quail habitat were available for each pair of quail in the spring of 1950. The quail density increased to one quail pair per 60 acres in the fall of 1951.

4. An average of 7.7 young per quail brood was found in 1950. In 1951, 7.4 young per brood was obtained for a computed population increase somewhere between the minimum of 74 percent and a maximum of 95 percent.

5. Young quail were first observed June 20, 1950. Brood counts were difficult to get. Best results were obtained from an automobile with the aid of field glasses.

6. Uintah Basin hunting returns on quail provided sex, weights, and age ratio data on 22 quail killed in 1950, and 27 in 1951. In 1950, 42 percent of the quail bagged were males and 84 percent were juveniles. In 1951 an average of 61 percent males and 81 percent

juvenile quail were killed by hunters.

7. Statewide returns of hunter questionnaires indicated that the quail population densities, rather than length of season or hunting pressure, determined the kill. Kill data suggest that six counties are important producers of harvestable quail populations in Utah.

8. Progressive weight data on young quail indicate that most rapid growth occurs during the three to four week old period. Wild juveniles were smaller than semi-domesticated juvenile quail.

9. The average adult female quail in March weighed 148 grams, which was 7 grams less than the average weight of the male. In April the hen weight increased to 7.5 grams heavier than the cock, with weight reductions in August when the adult female was 12 grams lighter than the 178 gram average of the cock. March weights in the Uintah Basin were the lowest recorded. Losses in weight were ten percent of the 167 gram weight average of 118 adult quail.

10. A fall survey in 1951 indicated that quail populations were increasing. Quail were observed to be spreading into new areas, however, in only one county.

11. Roadside count data for Morgan County over a three year period indicated a severe quail decline in 1950. This reduction in numbers was reported in general throughout Utah quail areas.

12. A total of 108 cc of food materials from 40 crops of road killed and hunter bagged quail was analyzed. Twenty-four species of plant foods were identified. The five most important food species were: clover (Melilotus spp.), alfalfa (Medicago sativa), tumbleweed (Salsola kali), bullberry (Elaeagnus argentea), and wheat (Triticum spp.). A number of weed species was represented in foods of Utah quail.

13. Hythergraphic comparisons of Utah climate with that of the native California range indicated a wide variation during the winter months. Winter snow depths and sub-zero temperatures may be expected to adversely affect quail survival in Utah. Abnormally heavy losses are to be expected during severe winters.

14. Dominant cover requirements in winter appeared to be the dense arch-shaped willows providing an overhead snow mantle. Nesting, resting, and escape cover needs can be varied widely to meet existing conditions. The common habitat deficiency was found to be a lack of suitable food sufficiently close to cover areas.

15. Suitable quail habitat in Utah is found in two ecological situations: (a). along old canal banks where cover is available in the bottoms, and food species along the margins of the cover, and (b). along rivers and streams where debris makes land of little value to agriculture and permits growth of cover and food species.

16. Quail in and around metropolitan areas find ideal habitat. Food and cover are provided by well meaning humans. Hunting is not permitted in cities and quail become semi-domesticated under these conditions. Quail in metropolitan areas make up more than an estimated half of the total quail populations in Utah.

17. Predation was not found to be an important factor in quail populations.

18. Three of the numerous quail examined in the study area were found infested with bird lice. Coccidiosis is known to have occurred in quail held in captivity. No evidence was found of coccidiosis or other diseases occurring in wild quail in Utah.

19. It is recommended that all quail areas in Utah may be hunted

similar to past seasons. Hunting, as conducted in the past, was found to be no threat to quail survival in Utah.

20. From 1948 to 1951, quail hunter kill in Utah is correlated with the severity of winter weather. Kills vary with quail population density, not hunting pressure or length of season.

21. Adequate cover is a major need for winter survival of California Quail brood stock in Utah.

22. Quail populations may be stabilized by providing adequate habitat over extended periods of time. Quail need dense cover in Utah. Burning of cover, use of spray chemicals, and grazing threatens present and potential quail cover.

23. The future of wild populations of quail in Utah depends upon the landowner's management of waste areas near cultivated fields.

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