FALL-WINTER FOOD OF CALIFORNIA QUAIL AS INFLUENCED BY WEATHER

Don A. Duncan. San Joaquin Experimental Range[1], U. S. Forest Service, Coarsegold, California, and
Paul W. Shields. U. S. Forest Service, Fresno, California

This study of California quail (Lophortyx californica) was carried out on the San Joaquin Experimental Range[1] to obtain data on the fall-winter food of quail on lower foothill rangelands. Information on seasonal diet is limited. Earlier work on quail food habits was done in 1937 on the Experimental Range and reported in detail by Glading et al in 1940[2].

We would like to thank Ben Glading for his advice and encouragement in this and subsequent quail food studies. We are also deeply indebted to personnel of the California Department of Fish and Game Wildlife Investigations Laboratory, namely Carol Ferrel, Bruce Browning and Walter Steinecker, for doing the analysis work. Without their help, the study could not have been completed.

Samples taken in this study from 1960-1963 indicated considerable differences in the proportions of various food items from the 1937 study. The earlier study was conducted in a wet year preceded by wet years, while the results reported here are from collections in a series of dry years. In this paper comparisons between results from quite different weather situations are made. Quail diet differences are attributed to variations in weather conditions and availability of certain major food plants.

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[1]Maintained near O'Neals, California, by the Pacific Southwest Forest and Range Experiment Station, Forest Service, U. S. Department of Agriculture.

[2]Glading, B., H. H. Biswell and C. F. Smith. 1940. Studies on the food of the California quail in 1937. J. Wildl. Management, 4 (2): 128-144.

STUDY AREA AND METHODS

The San Joaquin Experimental Range, located in Madera County, California, is made up of about 4,600 acres of rangeland fairly representative of the lower foothills of the western slope of the Sierra Nevada. Elevation is from 700 to 1700 feet. Shallow soil of granitic origin and a Mediterranean-type climate, hot dry summers and cool wet winters, combine to create favorable conditions for annual plants.

Herbaceous vegetation is composed almost entirely of annuals. The annuals usually produce a heavy seed crop, which is the principal source of food for quail in fall and early winter. Some of the more abundant species are broad-leaf filaree (Erodium botrys), soft chess (Bromus mollis), foxtail fescue (Festuca megalura) and ripgut brome (Bromus rigidus). A number of legumes, including several species each of Trifolium, Lotus and Lupinus are less abundant but are very important for quail food. However, bur clover (Medicago hispida) is rare and of no importance.

Scattered trees, brush, and rock outcrops provide good quail cover. One genus of woody plants, Quercus spp, in some years furnishes an important part of the fall-winter quail diet in the form of acorn fragments.

For the three years of study discussed here, quail were collected during the regular hunting season. Crops of a total of 376 quail were collected. These were grouped each year by month of collection and a total of 171 selected at random (an average of 57 per year). Contents were analyzed by standard food habits determination procedures. Frequency of occurrence of each item was tallied and quantity measured by water displacement. Volumes were converted to percentages and summarized by the aggregate percentage method.

WEATHER AND HERBAGE COMPOSITION

Rainfall on the San Joaquin Experimental Range has averaged slightly under 19 inches since 1934 when weather records were first collected. Extremes have been 10 and 32 inches. Good examples of series of wet years, 1934-38, and dry years, 1958-62, are shown in Table 1. Quail food habits data are available for both of these periods.

The long-term annual daily mean temperature on the study area has been60 degrees, with the lowest, about 40 degrees in December and January and the highest, about 80 degrees, in July and August. Temperatures affect plant growth, of course, but do not seem to be as closely tied to quail food as rainfall.

Rainfall, and in particular the time the rain falls, has a direct influence on both herbaceous vegetation composition and production each year. Thus wide variations in rainfall, and the resultant changes in the annual-plant composition, cause important changes in the seed items available for quail.

Table 1. Monthly rainfall, in inches, 1934-38 and 1958-63. San Joaquin Experimental Range.

WEATHER YEAR	MONTH												TOTAL
	SEPT.	OCT.	NOV.	DEC.	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	
1934-35	0.00	2.22	3.39	3.64	5.76	3.21	4.85	6.33	0.00	0.00	0.00	0.00	29.40
1935-36	0.00	1.63	0.52	1.56	3.67	11.20	2.47	1.35	0.15	0.04	0.06	0.00	22.65
1936-37	0.00	2.17	0.10	5.16	3.22	7.08	4.58	0.65	0.00	0.00	0.00	0.00	22.96
1937-38	0.00	0.03	0.50	6.22	6.00	7.74	8.70	2.69	0.02	0.00	0.19	0.00	32.09
1958-59	0.33	T	0.25	0.54	3.26	4.58	0.04	1.02	0.10	0.00	T	T	10.12
1959-60	3.70	T	T	0.36	2.35	4.68	1.98	2.38	0.07	0.00	T	0.00	15.52
1960-61	0.08	0.88	4.08	0.88	2.16	0.95	1.80	0.67	0.76	0.10	0.06	0.08	12.50
1961-62	0.02	0.10	3.31	1.90	2.61	10.04	2.37	0.21	0.06	T	0.06	T	20.68
1962-63	0.14	1.47	0.12	1.27	3.49	4.04	4.14	4.75	0.52	0.10	0.00	T	20.04
30-year Mean (1934-63)	0.23	0.93	1.86	3.27	3.36	3.70	3.13	1.86	0.55	0.07	0.02	T	18.98

Total rainfall per year is not a reliable guide. The 1961-62 weather year provides a good example. The total was 20.68 inches, more than the long-time average. But 10 inches fell in February, when the soil was already wet and temperatures in general too cold for plant growth. Thus most of the 10 inches of February rain was not effective; it went down the creeks. Lack of rain in April resulted in less herbage production than in dryer years.

How do weather variations affect quail diet? Examination of rainfall data provides explanations for large differences recorded in proportions of various quail food items. Usually during extended periods of similar weather conditions, certain types of plants are favored, while others decline in abundance. For example, during the drought years of 1959 and 1960 the proportion of grass declined from over one-half to about one-fourth, and it was 1962 before grass was back to the 1959 level (Table 2). During wet years, important quail food plants such as clover and turkey mullein (Eremocarpus setigerus) are relatively abundant. In extremely dry years, these species are scarce.

Herbage composition figures for 1959-62 in Table 2 are from four range units in a current grazing management study. Each unit is thoroughly sampled each year in the same manner. These ranges are representative of a much larger area of the Experimental Range where quail crops were collected. Grazing use on the entire area has been at a moderate rate since 1959.

Table 2. Herbaceous Species Composition, 1937 and 1959-62, San Joaquin Experimental Range

YEAR	GRASS	FILAREE	CLOVER	OTHER LEGUMES	OTHER FORBS
	- - - -	- - - - -	Per cent	- - - - -	- - - -
1937	52	34	1	1	11
1959	57	38	1	2	1
1960	25	63	1	4	10
1961	35	55	2	1	6
1962	56	22	8	2	8

COMPOSITION CHANGES AND QUAIL DIET

By comparing the proportions of various food items in Glading's 1937 study with those for the same months in more recent dry years, considerable differences become apparent. Also, as Glading aptly pointed out in reporting his earlier work, quail show definite preferences and the abundance of a species may have no relation to the proportion taken by quail.

Good examples are grass and filaree. Although relative proportions vary with weather, these plants always make up the bulk of the vegetation on the area. Yet grass if of minor importance as a seed item in fall-winter. Filaree is important some years but a relatively minor item in others.

Variation in legumes from year to year is better reflected in quail diet. Clovers make their best growth in wet years, and are very scarce in dry years. In the one sample year in the wet cycle, 1937, clover seed made up 12 per cent of the November-December diet, as compared to only one per cent in the dry years 1960-62 (Table 3).

Table 3. Seeds in Quail Diet, 1937 and 1960-1963, San Joaquin Experimental Range.

ITEMS	YEAR				3-Year AVG 1960-1961 1962-1963
	1937[1]	1960-1961	1961-1962	1962-1963	
	- - - - - - - Per Cent by Volume of All Food - - - -				
Erodium spp.	25.9	5.0	4.1	1.4	3
Eremocarpus setigerus	25.4	T	0.7	6.9	3
Acorn fragments	20.0	10.8	0.0	33.2	15
Lotus americanus	3.2	11.0	9.1	19.8	13
Trifolium spp.	12.1	T	1.0	3.2	1
Lupinus bicolor	2.2	2.9	20.6	5.5	10
Lotus strigosus	T	53.1	38.6	3.8	32

[1]1937 figure is for November and December only, others include samples taken in early January.

Just the opposite was true for Lotus strigosus, a small legume that is normally most prevalent on shallow soils on south slopes. In the dry years of 1960 and 1961, this species was unusually abundant, even though it still made up probably less than one per cent of the total herbage on the area. Records are not available, but in 1937, a wet year preceded by several wet years, this species was probably scarce. It appeared as only a trace in the 1937 quail diet. However, Lotus strigosus made up 53 per cent of the 1960-61 November-January diet! For 3 dry years, 1960-61 through 1962-63, it averaged 32 per cent.

Two other legumes important as quail food, Lotus americanus and Lupinus bicolor, showed differences between the wet and dry periods not as striking or easy to explain. Data collected subsequent to that reported here may give us a better idea on the differences in intake of these species in wet and dry years.

The importance of two major quail foods, acorn fragments and turkey mullein seed, can be rather simply explained from the available data. If they are available, the quail take them. Acorn fragments were important in 1937, 1960 and 1962. In 1961, acorns were very scarce; none showed up in the quail diet. Weather influences the acorn crop, of course, but no figures on acorn production are available. Turkey mullein is a late-growing summer annual that makes its best growth when soil moisture is available after the other annuals have completed growth. It was evidently abundant in the wet year of 1937, for the seed made up 25 per cent of the fall quail diet. In the dry years 1960 and 1961, turkey mullein was very scarce and absent or minor in quail diet. 1962 was not quite as dry, and some turkey mullein was present. The moderate amount of this plant in 1962 was reflected in the seed making up about 7 per cent of the quail diet.

The degree of importance of filaree seed in the fall diet is a little more complicated to explain. As previously discussed, filaree seed is always abundant. The key to the relative importance of filaree as a seed item in quail diet is the date of the first major rain in the fall that causes general germination of the annual plants. When this "germinating rain" occurs late, filaree seed is available longer, as in 1937, when it made up 26 per cent of the fall diet. After the first germinating rain, filaree seed rapidly becomes unavailable for quail food as it burrows into the ground and germinates. In 1960-62, earlier germinating rains resulted in filaree seed averaging only 3 per cent of the diet for the 3-year average.

Too, all seeds, including filaree, even if they don't germinate immediately, are rather rapidly hidden and made less accessible for quail food by the new plant cover that develops soon after the first germinating rain. These new plants, as shown in our results and previous work, soon become an important part of the quail diet as what we shall term green leafage.

IMPORTANCE OF FIRST FALL RAINS

The date of general plant germination is directly related to quail diet. From results to date, as soon as green leafage is available, the quail

utilize it. This is readily apparent when the data from Glading's 1937 study is compared to that for 1960-62.

The weather records show that a germinating rain came rather late in 1937, on December 9. Germinating rains in the "dry cycle" reported here came, on the average, much earlier in the fall. This is shown by an average of 18 per cent of the diet being green leafage in 1960-62 as compared to one per cent in 1937 (Table 4).

Table 4. Green leafage in quail diet, 1937 and 1960-1963, San Joaquin Experimental Range.

YEAR	MONTH			AVERAGE
	NOV.	DEC.	JAN.	NOV.-JAN.
	- - - Per cent by volume of all food - - - - -			
1937	2.2	0	--	1.1[1]
1960-61	0.4	11.8	16.4	9.7
1961-62	T	15.3	54.9	20.1
1962-63	18.2	18.7	52.5	23.4
1960-63 AVERAGE	6.2	15.3	41.2	17.7

[1]1937 figure is for November and December only, others include samples taken in early January.

The actual month in which green leafage became important ties in well with the date of the first germinating rain. In 1960-61, when the first germinating rain fell on November 6, only one per cent of the diet in November was green leafage, while December and January were 12 and 16 per cent respectively. A relatively late germinating rain in 1961-62, November 20, resulted in only a trace of green leafage in November, but green leafage became an important part of the quail diet in December and January. The 1962-63 season illustrates an early germinating rain, October 11, and green material was taken in substantial amounts beginning in November.

In conclusion, examination of weather and vegetation data collected on the San Joaquin Experimental Range provides explanations for rather wide differences in proportions of food items in the fall-winter diet of Cali-

fornia quail collected in wet and dry years. Data presented in this paper should be available soon, in greater detail than time allowed today, in a manuscript entitled "Fall and Winter Food of California Quail in Dry Years", to be submitted for publication in California Fish and Game.