

ORGANIZATION AND MOVEMENTS OF COVEYS OF A GAMBEL QUAIL POPULATION

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A study of the Gambel Quail (*Lophortyx gambelii*) conducted in the Las Vegas Valley, Clark County, Nevada, from 1951 to 1953, was directed toward determining: (1) covey organization and movements of this species in a desert valley; (2) sex and age structure and the population dynamics of this desert quail population; and (3) possible management practices to benefit this species of upland game. This paper deals with the first objective. The other aspects of the study have already been discussed (Gullion, 1956).

THE STUDY AREA

The study area was approximately 0.5 miles wide and 2.6 miles long, including about 777 acres of typical desert thorn shrub vegetation, 3 miles east of Las Vegas (Gullion, 1960:528). At the time this study was made this valley was probably representative of the primeval valley habitat occupied by quail in the Colorado River drainage system in Nevada.

The soil in this area is a deep, finely textured alkaline silt. No surface water was available on any part of the study area in the spring of 1951. But with the mushrooming growth of Las Vegas, water from the municipal sewage plant increased steadily in volume, until a stream was flowing through the eastern portion of the study area during the 1952-53 study period (fig. 1).

The dominant vegetation was honey mesquite (*Prosopis juliflora*), with quailbrush (*Atriplex lentiformis*) abundant in areas where the mesquite had not yet encroached (fig. 1). In some areas saltgrass (*Distichlis stricta*) carpeted the ground between bushes, and along intermittent drainage courses inkweed (*Suaeda* sp.), desert-plume (*Stanleya pinnata*), various pigweeds (*Amaranthus* spp.), goosefoot (*Chenopodium* spp.), and a heliotrope (*Heliotropium curassavicum*) provided the herbaceous ground cover and much of the food and succulence utilized by quail in this area. On the northeast side of the study area about 260 acres of cleared land were under cultivation. Crops consisted of corn and pasture grasses. Seasonal irrigation produced an abundant crop of weeds about the margin of the cultivated area, providing additional food for quail.

METHODS

Systematic trapping and banding of quail provided the basis for this study. Traps used during the trapping season of 1951-52 included the Stoddard quail trap (Stoddard, 1931:443), the Ross "capsized canoe," and Enderlin's "Model No. 1" (Enderlin, 1946:138). During the trapping period of 1952-53 a 1 × 4 × 6 foot modification of Enderlin's trap was used. This consisted of panels of 1-inch wire poultry netting stretched over welded frames of 3/8-inch round iron rods.

Trapping for 65 days between December 11, 1951, and April 25, 1952, provided 452 trap-days which resulted in capture of 275 unbanded Gambel Quail; there were at least 1232 recaptures. Twenty-two days of follow-up trapping in this area in November, 1952, and January and March, 1953, included 261 trap-days and resulted in the taking of 197 unbanded and 98 banded quail.

Trapped quail were weighed and examined for evidences of disease and parasites (cf. Gullion, 1957). Most of the quail trapped in 1951 and 1952 were neck-tagged with a modification of the Taber tag (Taber, 1949) developed by Macgregor in California

(Genelly, 1955:265; Gullion, 1956:14). Sex and age determination was by standard plumage characters (Leopold, 1939).

Most of the quail trapped during the winter of 1951–52, in November, 1952, and in January, 1953, were released at the trap site as soon as handling was completed. A few

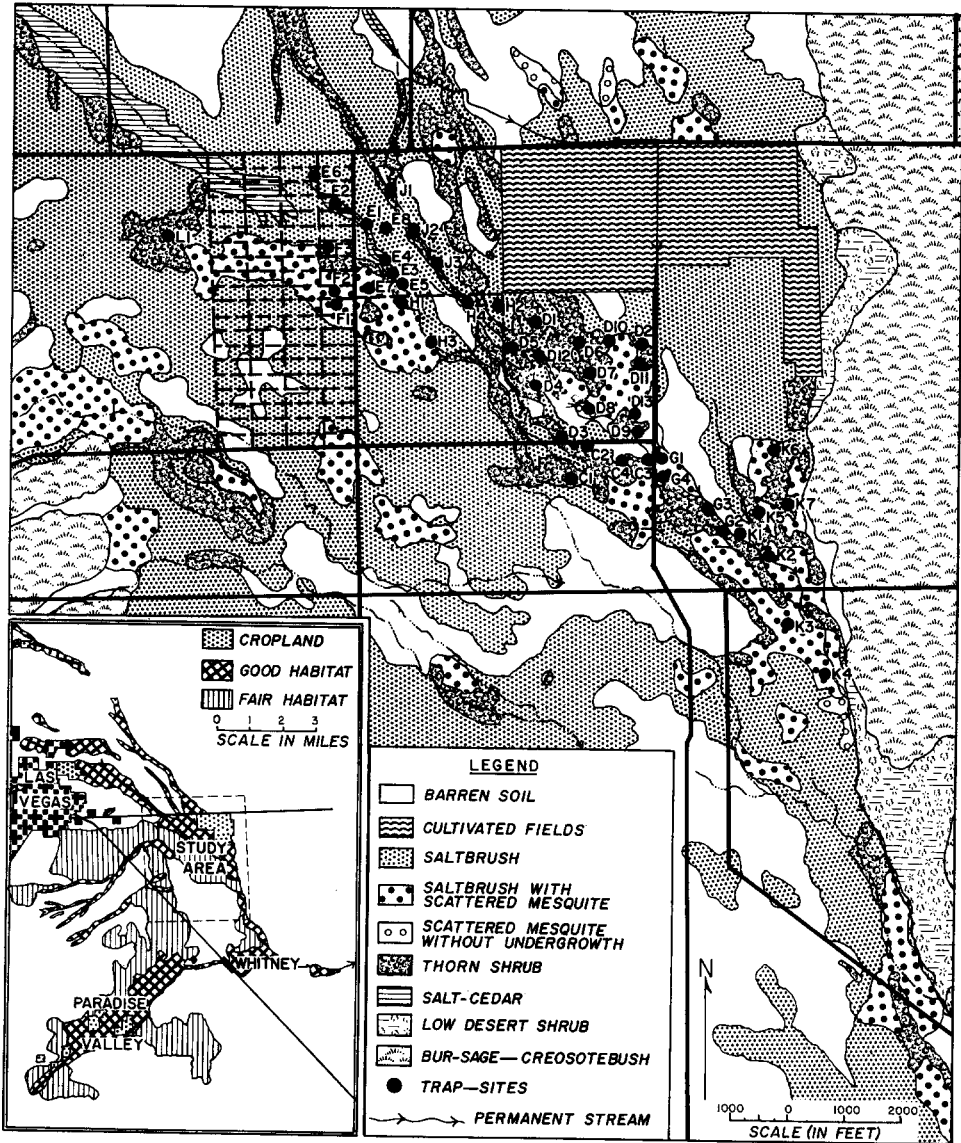


Fig. 1. The Las Vegas Valley study area, showing vegetation types and trap-site locations. Saltbrush is *Atriplex lentiformis* and other *Atriplex* spp., mixed with *Distichlis stricta*, *Suaeda fruticosa*, *Sphaeralcea* sp., and others; mesquite is *Prosopis juliflora*; thorn shrub is composed of *J. juliflora* with undergrowth of *Atriplex* spp., *Lycium Torreyi*, *Sphaeralcea* sp., *Suaeda fruticosa*, and others; salt-cedar is *Tamarix pentandra*; for details of variable low desert shrub and bur-sage—creosotebush see Gullion (1960:529–530). Inset shows location of study area in relation to Las Vegas.

were moved to other parts of the study area as discussed later under "homing," and some were taken into captivity for experimental purposes (Gullion and Gullion, 1961). All quail trapped in March of 1953 were used for experimental stocking of gallinaceous guzzlers in the Nelson area, 36 miles south of Las Vegas (Gullion, 1960:534; guzzlers N-8 and N-11).

COVEYS

Organization of coveys.—Analysis of trap and retrap data indicates that the banded quail could be segregated into persistent groups of birds which appear to constitute natural aggregations or coveys. Among the 277 quail handled during the 1951-52 trapping session, 217 provided at least 1375 records which could be used to determine covey organization and movements. These 217 banded quail belonged to 24 coveys consisting of from 3 to 22 birds each and averaging 9.0. The larger coveys were composed of multiples of basic units of 5 to 7 birds and included 9 to 13 (2×) or from 17 to 22 (3×) quail. Three of the five coveys of more than 15 banded quail were composite coveys made up of 4 or 5 smaller, more or less autonomous units, or subcoveys, of 5 to 7 banded quail each. These smaller units generally remained with the main group, but occasionally strayed away to locations several hundred feet distant for a day or two. However, most members of the composite coveys made major moves with the main group.

Forty random observations in this area in the winters of 1950-51 and 1951-52 gave an average covey size of about 12.5 birds, ranging from 3 to about 40 quail. This figure does not differ too greatly from the calculated average size of 9.0 banded quail per covey.

Covey organization in 1952-53 appeared to be unchanged from 1951-52. Of 58 quail trapped during this later season, 53 could be assigned to 10 coveys, ranging from 3 to 13 birds each.

Although Gambel Quail are monogamous in breeding behavior, a general breakdown of the covey organization did not occur during the early part of the nesting season, nor was there a widespread random dispersal of mated pairs. Through April, 1952, contact was maintained with major portions of at least 18 coveys which remained together in at least loose covey association, even though the weights of the females clearly indicated that they were laying eggs (eggs frequently were deposited in traps). Coveys remained in restricted areas and paired quail nested within the area occupied by the coveys at the beginning of the nesting season.

Composition of coveys.—One or more adult males could be assigned to 18 of the 24 coveys studied in the Las Vegas area in 1951-52. Adult females occurred in 18 coveys and both adult males and females were known to be present in 14 coveys in 1951-52.

There were three classes of covey composition: (1) adult coveys, consisting of as many or more adults than immatures; (2) brood coveys, consisting of two or more immatures for every adult bird; and (3) three or four quail in small groups of variable sex and age composition.

Five coveys (5A, 5D, 5E, 7A, 10E) including 34 banded quail were considered adult coveys in 1951-52. These are believed to have been the remnants of coveys of non-breeding adults which had gathered together during the 1951 nesting season, a notably poor year for reproduction among Gambel Quail throughout the American southwest (Macgregor and Inlay, 1951).

Thirteen coveys (3B, 3C, 4C, 4E, 4F, 4G, 4J, 5B, 5C, 6A, 10A, 10B, 10C), totalling 165 banded quail, were classed as brood coveys. The composition of these coveys suggested family groups, or aggregations of family groups, remaining together following the 1951 nesting season. In each of these coveys immatures (hatched during the spring of

1951) outnumbered adults by two or more to one. The overall young: adult ratio of these 13 brood coveys was 415:100, as compared to 80:100 for the 5 adult coveys.

Seven "coveys" (3D, 5F, 7C, 7D, 8D, 10D, 11A) belonged in the third group, including one formed in mid-April by banded birds separated from 3 larger coveys. Each of these coveys was first encountered in late March, or in April, and apparently represented small groups, possibly fragments of coveys, wandering in search of suitable nesting areas. Six of these 7 small coveys remained on the study area, apparently to nest.

Seven of the 10 coveys encountered in 1952-53 appeared to be organized around birds banded in 1951-52. In fact, 12 of the 15 adult quail assigned to coveys in the 1952-53 session had been banded in the preceding year. In contrast to the covey composition of 1951-52, all the 10 coveys of 1952-53 appeared to be brood coveys, for immature quail outnumbered adults in every covey, with an average ratio of 254 young per 100 adults.

This prevalence of brood coveys in the fall and winter of 1952-53 followed a spectacularly successful breeding season for Gambel Quail in southern Nevada in the spring of 1952 (Gullion, 1956:37).

Home ranges of coveys.—The distribution and movements of these coveys show the existence of three major groupings of covey ranges in the Las Vegas study area. One is the northwest group, including coveys using trap sites of the E, F, H and J groups (figs. 1, 2). The second is in the center of the area, represented by trap sites of the C, D and G group (figs. 1, 3). A third group of coveys occupied the southeastern end of the study area (the K group of trap sites, fig. 1). From December, 1951, through early February, 1952, not less than 6 coveys (5A, 5B, 5C, 5D, 5E, 6A), including at least 73 banded quail, occupied an area of about 72 acres in the northwest portion of the study area (fig. 2). In early January four of these coveys occurred together quite regularly but later in that month they generally alternated in any one area. By early February members of any two coveys seldom occurred together in the same trap.

Through this period no less than 4 coveys (3B, 3C, 4C, 7A), including at least 46 banded quail, used the central area of about 95 acres one mile southeast of the northwest area (fig. 3). Unlike their neighbors to the northwest, these coveys seldom occurred together, but frequently alternated with one another, moving back and forth between trap sites several hundred feet apart.

The areas encompassed by the ranging of 10 coveys varied from 19 to 95 acres, averaging about 35.7 acres per covey, or 2.95 acres per banded quail. There was no correlation between covey size and size of range. Although the largest covey (5C, 22 quail) had the most extensive range (95 acres), the second largest (5B, 21 quail) covered an area only one-third as large (37 acres). One covey (7A), one-third as large as 5B, ranged over a more extensive area. Coveys did not appear to have exclusive territorial claims (fig. 4).

Several traps were located on the common meeting ground for two or more coveys. Five coveys (5A, 5B, 5C, 5D, 5E, including the two largest) used one trap site (E2) at one time or another during this period. Representatives of more than one covey occurred together on 8 of the 19 days quail were trapped at this site. Site E2 seemed to be located in the center of the range of covey 5B, the area being occupied almost continuously by this covey in 1951-52, and survivors, with juveniles hatched in 1952, were present in this area again during the 1952-53 season. In the spring of 1951 this area was occupied by the predecessors of covey 5A, but contact with this covey was lost about February 9, 1952.

Trap-site D5 represented an intermediate area between the northwest and central

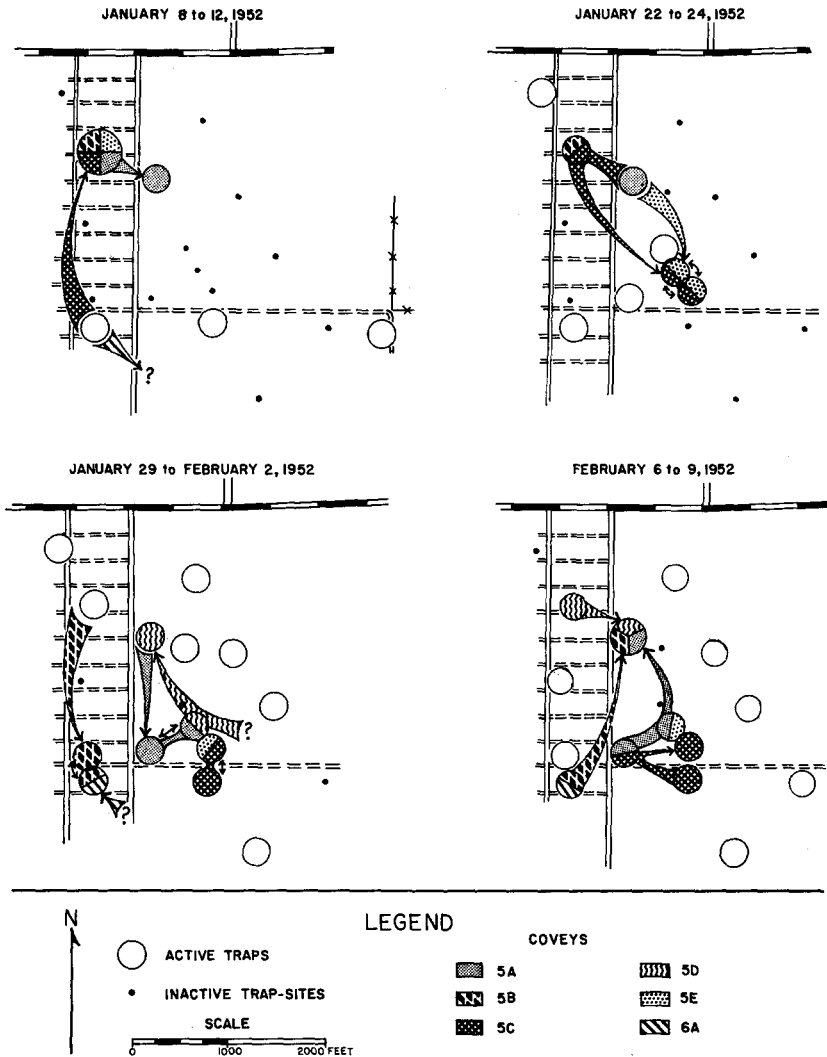


Fig. 2. Movements of Gambel Quail coveys in northwestern portion of study area in winter of 1951-52.

group of coveys, while the G trap sites were occasional meeting grounds between the central and southeastern groups of coveys.

Movement patterns of coveys.—Analysis of records of 10 coveys followed during most of the winter of 1951-52 indicated that their movements were erratic. Some coveys remained fairly stationary for several weeks, then moved to another area, while others remained in one area only briefly. Some coveys moved back and forth in one particular area, whereas others wandered in a nomadic fashion with little apparent direction to their movements. From late December, 1951, to April, 1952, these 10 coveys ranged over areas with diameters varying from 1500 to 4200 feet, with an average of 2340 feet.

The variation in movement patterns is apparent in the records of several coveys. Covey 4C remained in one area throughout January, then moved 1200 feet to another

TABLE 1
 MOVEMENTS OF COVEY 5C AND INTER- AND INTRA-COVEY RELATIONSHIPS,
 LAS VEGAS VALLEY, 1952¹

Date	Trap site	Distance from last occurrence (feet)	Bird groups present in trap									
			A	5C sub-coveys		D	6A	5A	Other coveys		4E	5F
Jan. 2	F1		—	—	X	—	X	—	—	—	—	—
8	E2	300	—	X	—	—	—	X	X	—	—	—
9	E2	0	—	X	—	—	—	X	X	—	—	—
11	E2	0	—	X	—	—	—	X	X	X	—	—
12	E2	0	X	X	—	—	—	—	X	X	—	—
14	E1	600	—	X	—	—	—	—	NONE		—	—
15	E1	0	—	X	X	—	—	X	—	—	—	—
16	E1	0	X	X	—	—	—	X	—	X	—	—
17	E1	0	X	—	X	—	—	X	—	—	—	—
17	E2	600	—	X	—	—	—	—	X	X	—	—
18	E1	0-600	X	X	X	—	—	X	—	X	—	—
22	E1	0	—	X*	—	—	—	—	X	—	—	—
22	E3	1000	—	X*	—	—	—	—	—	X	—	—
23	E5	1400	X	X	—	—	—	—	NONE		—	—
24	E2	1800	—	X	—	—	—	X	—	—	—	—
24	E5	0	X	—	X	—	—	—	—	X	—	—
29	H1	2200	—	X	—	—	—	—	NONE		—	—
30	H1	0	—	X	—	X	—	—	NONE		—	—
30	E5	0	—	—	X	—	—	—	NONE		—	—
31	H1	0-300	—	X	X*	—	—	—	NONE		—	—
31	E3	200-500	X	—	X*	—	—	—	—	X	—	—
Feb. 1	H1	0	—	X	—	—	—	—	NONE		—	—
1	E5	0	X	—	—	—	—	—	—	X	—	—
1	E3	0	—	—	X	X	—	X	—	—	—	—
2	H1	0	—	X	X	X	—	—	NONE		—	—
7	E7	700	—	—	X	—	—	—	NONE		—	—
7	E3	500	X	—	—	—	—	—	—	X	—	—
7	E5	300	—	X	—	X	—	—	NONE		—	—
8	E7	0-600	—	X	X	X	—	—	NONE		—	—
9	H1	700	—	—	X	—	—	—	NONE		—	—
9	E3	0	X	—	—	—	—	—	—	X	—	—
16	D5	2200	—	X	X	—	—	—	NONE		—	—
19	D5	0	—	—	X	—	—	—	NONE		—	—
20	D5	0	—	X	—	—	—	—	—	—	X	—
22	D5	0	X	X	X	X	—	—	NONE		—	—
26	D5	0	—	X	X	X	—	—	—	—	X	—
27	D5	0	—	X	X	—	—	—	—	—	X	—
Apr. 14	E5	2400	—	—	X	—	—	—	—	—	—	X
15	E5	0	—	—	X	—	—	—	NONE		—	—
16	E5	0	—	—	X	—	—	—	—	—	—	X
17	E5	0	—	—	X	—	X	—	—	—	—	X
19	E5	0-2400	X	—	X	—	—	—	—	—	—	X
22	E5	0	X	—	X	—	—	—	—	X	—	X
23	E5	0	X	—	—	—	—	—	—	X	—	X
25	E5	0	X	—	X	—	X	—	—	X	—	X

¹ See also figures 2, 3, and 4.

* Part of sub-covey at two or more sites, as noted.

site in early February and remained there into the nesting season. Covey 5A, after remaining in one small area throughout most of January (the same area occupied by parts of this covey in May, 1951) started wandering at the end of January and in six days moved 3400 feet and was then lost from contact.

Illustrative of the movements of one of the larger composite coveys is the record of covey 5C. This covey, including at least 22 banded quail, consisted of no less than four distinct smaller groups of 7, 5, 5, and 3 banded quail each, and 2 birds of indefinite association. This covey was also the most nomadic of all the coveys for which a long record was available. Table 1 gives the record of this covey, showing extent and period of movements, disposition of the four subcovey units, and known intercovey contacts (see also figs. 2, 3). Covey 5C moved back and forth over an area of about 63 acres, 2200 feet across, and then moved enmasse into another area (D5) 2200 feet distant (fig. 4). After moving into the D5 area in mid-February and remaining there for at least 10 days, most of this covey was lost from contact, not being retrapped again during the trapping sessions of 1951-52 or 1952-53. However, at least three birds from this covey moved back to the general area of original trapping (E5) and two more joined with birds from at least two other coveys to occupy an area (H4) unoccupied by quail prior to the middle of April. Two survivors from this latter covey were taken by hunters during the fall of 1952, which concluded contact with covey 5C.

Seasonal movements.—Coveys remained relatively sedentary during January of 1952. Records of 8 coveys, based on 113 trap-days, showed an average movement of only 96 feet per day. But in late January movement increased, and 56 contacts with 6 coveys showed average daily movements of 180 feet. Also, during this period five other coveys shifted their areas of activity by an average of 1580 feet. Through mid-February the tempo of movement tapered off, with 42 contacts with 6 coveys showing an average daily movement of 112 feet. No trapping was done in this area from February 27 to March 25. When trapping was resumed, 3 coveys were found to have shifted an average distance of 1800 feet, while 2 other coveys remained in the area they had occupied earlier. Seventy-two contacts with 7 coveys during late March and early April showed an average daily movement of 225 feet. This was the period of the pre-nesting shuffle, and coveys were actively seeking suitable nesting areas. After about April 8 most of the coveys became sedentary as nesting commenced. Only two small coveys (5F, 7D), new arrivals in the study area, moved during this period, evidently in search of suitable nesting sites. These two coveys were moving at average rates of about 165 and 310 feet per day in their quest for sites.

During late March and early April at least 7 coveys (3D, 4F, 4G, 4J, 5D, 5F, 8D), totalling 58 banded quail, suddenly appeared in areas where they apparently had not been present previously. Four of the newly arrived coveys (4G, 4J, 5F, 8D) remained to nest in their respective areas, and members of 2 coveys (4G, 5F) were still present during the 1952-53 trapping season. Also, contact was abruptly lost with 4 coveys (4E, 5A, 4F, 5C), totalling 46 banded quail, after periods of almost continuous contact lasting for as long as 49 days. This suggests a period of general shuffling prior to the nesting season.

The pattern of trapping was such that movements of coveys along the length of this study area could be readily traced, but the movements of coveys at right angles to the drainage line were not so readily detected, and evidently this was of some consequence. While longitudinal sampling of this area extended for 2.6 miles, the transverse sampling did not exceed one-half mile which coincided with the maximum breadth of continuous good mesquite cover (fig. 1).

In spite of considerable evidence indicating movements of coveys onto and off the

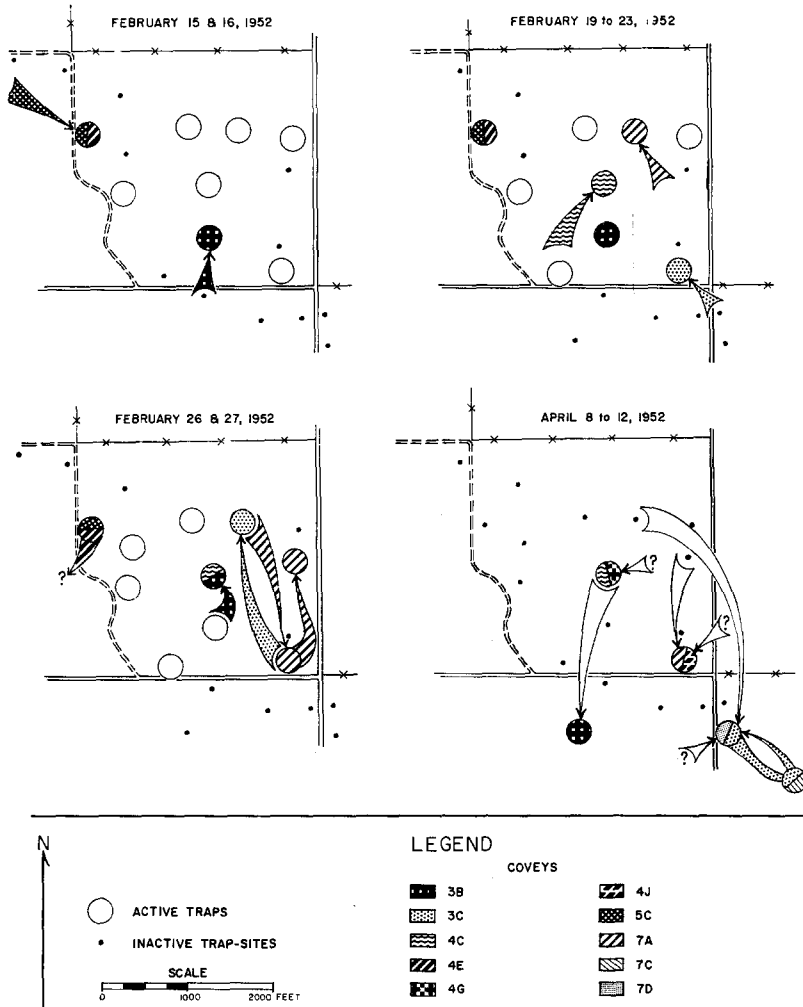


Fig. 3. Movements of Gambel Quail coveys in central portion of study area in winter and spring of 1952. The April locations of coveys represent the distribution of eight coveys as nesting season began. Arrows show movements of these coveys from their positions at end of February, except covey 3C, which moved as shown during this period.

study area, there was not one record of a covey moving for any considerable distance the length of the study area. None of the coveys shown in figures 2, 3 and 4 was detected outside of those areas. Except for covey 5C, all coveys found in the area sampled by traps in the E, F, H and J group of sites (fig. 2) were detected only in that area and did not occur in the areas farther to the southeast.

Similarly, the several coveys using the C and D group of traps (fig. 3) were retaken only in that group of trap sites. The same is also true of the coveys sampled in the K series of trap sites. This would seem to suggest that movements of coveys onto or off the study area must have been at right angles to the alignment of the highest quality habitat available to quail in the area.

Comparing movements of the several classes of coveys encountered in 1951-52, the adult coveys consistently moved farther and faster than the brood coveys (table 2).

However, the same proportion of both groups moved out of the study area, and both groups ceased their wandering in mid-April.

TABLE 2
A COMPARISON OF THE MOVEMENTS OF TWO CLASSES OF COVEYS,
LAS VEGAS VALLEY, WINTER 1951-52

Period	Extent of movements (in feet)			
	5 Adult coveys		13 Brood coveys	
	Average for period	Average per day	Average for period	Average per day
Dec. 11-Jan. 24	1400	103	1340	63
Jan. 24-Feb. 9	2000	264	1360	131
Jan. 23-Feb. 16	2400 ¹	1375
Feb. 16-Feb. 27	2400 ¹	343	460	59
Feb. 27-Mar. 25	2350
Mar. 26-Apr. 12	7200 ¹	1029	1200	104
Apr. 8-Apr. 25	0	0	0	0

¹ Record for one covey only.

The distribution and movements of coveys encountered in 1952-53 appeared to be much the same as noted in 1951-52, even to the extent that one covey followed the same general movement pattern recorded for covey 5C (table 1). Eighteen of the 19 banded adult quail recaptured in 1952-53 were in the covey ranges they occupied when last trapped in the winter or spring of 1951-52, showing an average movement of only 1114 feet in intervals ranging from 7 to 13 months but averaging 10 months. The nineteenth bird, a young female in 1951-52, moved 5180 feet over an 11-month period. Little evidence of general over-summer or early fall shifting among coveys or adult quail was apparent from these records.

On November 26, 1952, a dog killed 24 quail in one trap (G4) including at least 4 survivors from the spring of 1952. Three of these birds were identified as being in the area they had occupied the preceding season, although they represented three different coveys of 1952 (3B, 3C, 10A) which found a common meeting ground at this site.

Daily movements.—Three birds taken twice in the same day provided information on the voluntary movements of Gambel Quail for one day from between 10 to 11 a.m. and 3 to 4 p.m. These quail moved distances of 400, 1100, and 1250 feet. Records of 42 quail gave information on voluntary movements during a 24-hour period. These movements ranged from 300 to 2800 feet, averaging 755 feet. Fifteen of these records of 24-hour movement involved parts of coveys. One was a group of 5 birds moving 600 feet, another of 3 birds moving 600 feet, one of 3 birds moving 300 feet, and two of 2 birds each moving 300 feet. These movements averaged 420 feet.

One quail (♂ no. 802) moved at least 2400 feet in one 48-hour period, and another (♂ no. 280) moved at least 3800 feet in 96 hours.

Covey interchange.—Twenty of the 217 quail assigned to coveys changed from one covey to another in the winter and spring of 1951-52. Five of these birds shifted in January and February, and one changed again during a spring shuffle. The other 15 quail shifted coveys in the course of a pre-breeding season spring shuffle. It is not possible to pinpoint the exact time of shift for 9 birds, since this may have occurred between early February and mid-April when the areas occupied by these birds were not being trapped. Another 6 quail shifted in April, taking from 5 to 14 days to make the change and involving movements of up to 2800 feet with a mean distance of about 1570 feet.

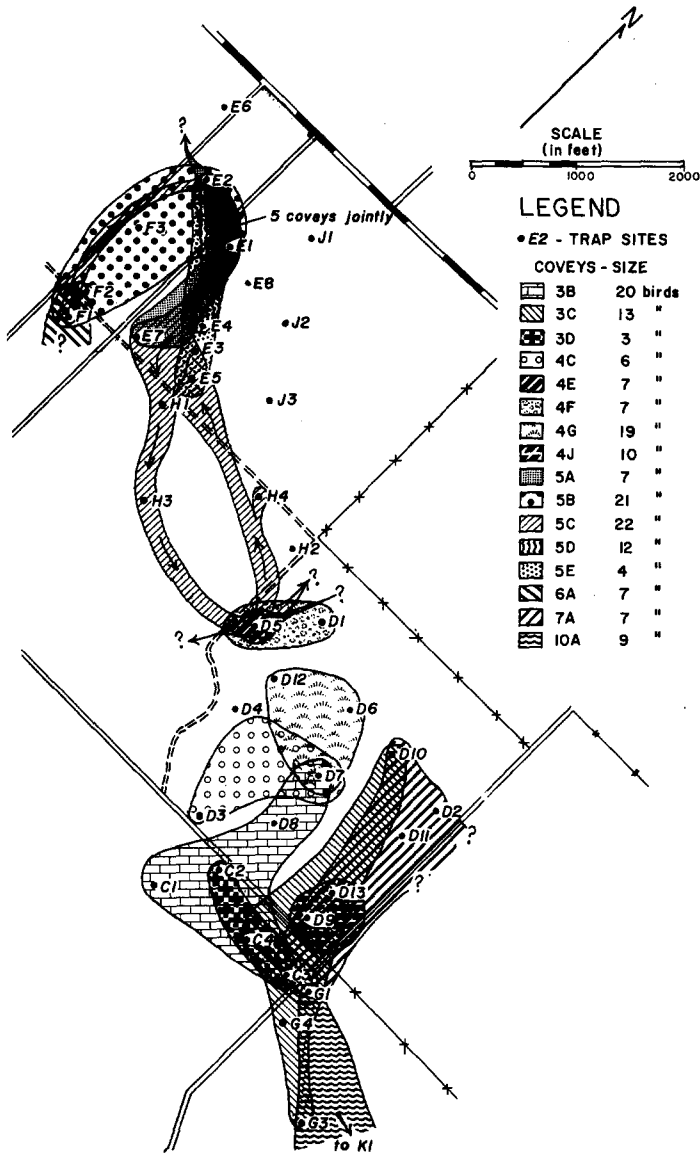


Fig. 4. Ranges of sixteen Gambel Quail coveys during winter of 1951-52.

Nine of the 20 interchanges followed known or probable extended contact between the 2 coveys involved. In the other 11 shifts the birds moved distances ranging from 1200 to 4800 feet to join another covey, with a mean movement of about 2030 feet. Of the birds shifting from one covey to another, 11 were immature males, 4 adult males (including 1 which joined with other birds to form a new covey), and 5 immature females.

With one exception these 20 quail remained within the general area they had occupied earlier. Only one quail moved from the northwest part of the study area to the central portion. However, 9 moved (5 from the northwest area, 4 from the central area) to join coveys in the D5-H4 area, intermediate between the two major groups of covey ranges (fig. 4).

Dispersal movements.—Reports of banded quail recovered by hunters were generally too vague to permit pinpointing the site where the birds were taken, but at least 10 of these 14 records gave some information on dispersal movements. One male (no. 827) had moved 4.7 miles northwestward between April 12 and November, 1952. Another male (no. 869) had moved to an area "5 miles south of Las Vegas," or about 5 to 6 miles southwest of the study area, between April 25 and October 19, 1952. Seven more quail were shot in the general vicinity of the study area, with three of these having been taken within one-half mile of where they were last handled in the spring of 1952. One of these males (no. 238), transplanted from Overton in March, 1952, was killed in October, 1952, within one-quarter mile of its release site.

The most extensive movement was recorded on November 1, 1953, when a female (no. 661) banded on April 8, 1951, and not recaptured, was taken by a hunter in Paradise Valley, 6.5 miles from its banding site. This female also provided the longest survival record for quail in this area, having been at least 4.5 years old when bagged.

HOMING

In the course of this study 13 quail were transplanted to other parts of the Las Vegas study area, at distances varying from 1500 to 7200 feet from their normal ranges.

In May, 1951, 12 quail were trapped for use in a temporary wildlife display at a Las Vegas celebration. After four days of exhibition they were returned to the study area and released, 4 at the site of capture, 3 at a distance of 3000 feet, and 4 at 5700 feet away. Only two of these quail were found again, both being retrapped repeatedly in the winter of 1951–52. A female (no. 673, immature at time of banding) was released at her original trap site, and that is where she was most frequently retaken in 1952, as a member of covey 5A. The other bird, a male (no. 670, adult at time of banding), was released 5700 feet from the trapping site, but by January 8, 1952, he had crossed the intervening distance and was back with female 673, being taken with her each of the 10 times he was retaken during the winter of 1952.

On January 15, 1952, 6 birds were moved from their normal ranges, 4 from covey 5B being moved 7200 feet and 2 from 4C only 1500 feet. Of the two quail from covey 4C, adult male no. 728 rejoined his covey in less than 48 hours while a young male (no. 718) was not retaken after being moved. Among the birds moved 7200 feet, two immature females (nos. 694, 695) remained in the area of their release and soon became members of a covey (3C) occupying this area at that time. Female no. 695 was killed in a trap by a dog on November 26, 1952, within 400 feet of the site where she was released 10 months earlier.

Another young female (no. 707) from covey 5B moved 1600 feet from her release site and in less than a month had become a member of covey 3B. Again she was moved 800 feet from this covey's area but she rejoined covey 3B within 24 hours. The following day she was returned to the area occupied by her original covey (5B) and she was lost from contact. The fourth bird moved from 5B, a young male (no. 722), was retaken only once, the day after being moved, and was only 200 feet from his release site.

Among the 4 birds moved from 5B, female no. 694 and female no. 695 both belonged to the same sub-covey, while female no. 707 belonged to a different sub-group, and male no. 722 to a third sub-group. This may account for their separation after being released in an unfamiliar area.

Another bird (female no. 774) well established as a member of covey 5E, was retaken 4000 feet from this covey's known range, 18 days having intervened since last being taken in her home area. However, during the next 49 days she covered 2700 feet of the distance back to her home range and in 3 more days covered the remaining 1300

feet to be retaken with other members of covey 5E on their normal range. The circumstances causing the initial separation of this bird from her covey are unknown.

ESTABLISHMENT OF TRANSPLANTED QUAIL

On March 6, 1952, 7 quail wild-trapped in an agricultural area near Overton, Nevada, 46 miles northeast of Las Vegas, were released in the Las Vegas study area. Five of these 7 birds promptly disappeared (although one, male no. 238, was taken by a hunter on October 20, 1952, within $\frac{1}{4}$ mile of his release site). One young male (no. 231) was retrapped 7 times in the next 50 days, as he moved from area to area. Forty days after his release and 5200 feet from the release site he finally joined a covey (5C) and ceased wandering. Another young male (no. 242) was retrapped once, 50 days after release 1500 feet from his release site.

TRAP MORTALITY

During the winter and spring trapping in 1952, a total of 16 quail died while in traps, including 13 banded birds. Seven, including 4 banded quail, were killed in traps by predators such as dogs, Sharp-shinned Hawks (*Accipiter striatus*), and unknown species. Among the remaining 9 trap casualties, 7 occurred when birds from 2 coveys were taken in the same trap; the dead bird was often in a site remote from its normal covey range. These casualties were most numerous in mid- and late April, and in 7 of 9 instances only 2 or 3 quail were in the trap together. Also, 7 of these 9 losses were males.

DISCUSSION

Most of the winter coveys appeared to be based on associations developed during or immediately following the preceding nesting season. In 1951-52 several coveys consisted of aggregations of adults, probably nonbreeding quail of the preceding year. Other coveys of 1951-52 probably consisted of family groups, or aggregations of two or more family groups, each of which maintained some degree of autonomy while remaining with the covey.

In 1952-53 this picture became clearer, with banded adults from the 1952 season comprising the nucleus of 7 of the 10 coveys encountered. The 1952 breeding season produced a spectacular population upsurge on Nevada's southern desert areas (Gullion, 1956:37) and this was reflected by the lack of coveys during the 1952-53 season which appeared to be aggregations of nonbreeding adults. Immature quail outnumbered adult birds among the quail banded during this trapping season for an overall ratio of 331 young per 100 adults, as compared to 294 young per 100 adults in 1951-52.

Several of the coveys of Gambel Quail studied in the Las Vegas Valley in the winter of 1951-52 showed little tendency to remain confined to a definite home range, as described for this species by Gorsuch (1934) and Sowls (1960). These coveys occupied areas on a temporary basis, moving in a more or less nomadic fashion from one area to another. However, when the nesting season arrived, a covey either remained in whichever area it occupied at that time or it moved fairly rapidly to another area. Nesting by members of each covey was accomplished within the area selected by that covey as a general nesting area.

Whether or not extensive fall dispersal of single quail occurs could not be determined in the Las Vegas area. However, a definite spring dispersal was evident. This dispersal, or shifting from one covey to another, was done mostly by young males, although a few adult males also shifted. Only 5 of the 20 birds shifting coveys early in the spring were females, and all of these immatures.

The apparent affinity to a definite covey exhibited by the homing of the two adult quail transplanted from their coveys in the 1951 and 1952 seasons suggests fairly strong social ties. This fact, plus the distribution of banded adults retrapped in the 1952-53 period, leads me to believe that the quail taken by hunters in areas relatively remote from the study area (at distances of 4.7 to 6.5 miles) represented movements of coveys rather than any type of random dispersal or movement of individual birds. All three of these hunter-taken birds were adults (2 ♂♂, 1 ♀) at the time of banding. These records, plus the abrupt appearance and disappearance of entire coveys in areas undergoing prolonged trapping, suggests a rather considerable amount of shifting of coveys in this area throughout the fall and spring months. These movements could carry coveys fairly considerable distances in a few months' time. Records of entire coveys (including at least 7 quail) moving over distances of at least 3400 feet (0.64 mile) in a six-day period certainly indicate that movements 10 times that great would not be unreasonable to expect in a period 30 times as long. All three of these remote records were obtained at sites connected to the study area by more or less continuous suitable quail habitat (see inset in fig. 1).

The intercovey relationships exhibited by the Gambel Quail handled in this study vary somewhat from those reported for similar species. Sumner (1935:245) indicates a considerable amount of overlap between adjacent covey territories among the California Quail (*Lophortyx californicus*), and notes (*op. cit.*:210) occasional meetings of these coveys and repeated splitting and recombining, "the groups being largely a matter of chance and often resulting in the more or less permanent transference of some individuals from the range of one covey to that of another."

Emlen (1939:119), studying a low density population of California Quail, noted that each of the four coveys he had under observation "restricted its winter wanderings quite closely to a well-defined covey territory, the boundaries of which were crossed only on rare occasions."

Similarly, Schemnitz (MS, thesis Okla. State Univ., 1958) found well defined winter home ranges ("homesteads") among Scaled Quail (*Callipepla squamata*) in the Oklahoma panhandle. He noted (p. 84) only two instances of range overlap among the five winter coveys under observation.

On the other hand, behavior of Gambel Quail coveys in the Las Vegas Valley, Nevada, corresponds closely to that reported for the Bobwhite (*Colinus virginianus*) in Wisconsin by Errington and Hamerstrom (1936:314-316). Summarizing behavior of Bobwhite coveys, these authors accurately describe several characteristics of behavior of Gambel Quail coveys when they note the occurrence of: "Interchange of birds with neighboring coveys; splitting and recombinations of coveys and covey fragments; daily movements of coveys on account of living routine or random impulse or disturbance; population shifting in search of territories, food, or to escape harassing predators (man included), or for no discernible reason."

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SUMMARY

A two-year trapping study of Gambel Quail in the Las Vegas Valley of southern Nevada provided information on the organization of coveys and movements of 472 quail in a desert valley situation.

Winter coveys were composed either of congregations of nonbreeding adults or of apparently combined broods. Movement patterns and extent of occupied area varied considerably from covey to covey, with none of the coveys studied occupying completely exclusive areas.

A definite pre-nesting season shuffle occurred, predominantly involving young male quail.

Pairs remained to nest within the general area occupied by the covey to which they belonged when the nesting season commenced.

Evidence was obtained suggesting a considerable interchange of coveys between adjacent areas, with a possibility of fairly extensive movements of covey groups.

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