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# The Effects of Available Water Upon Populations of Chukar Partridge on Desert Mountains of Utah

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# THE EFFECTS OF AVAILABLE WATER UPON POPULATIONS OF CHUKAR PARTRIDGE ON DESERT MOUNTAINS OF UTAH

WILLIAM W. SHAW

1971

# THE EFFECTS OF AVAILABLE WATER UPON POPULATIONS OF CHUKAR PARTRIDGE ON DESERT MOUNTAINS OF UTAH

by

William W. Shaw

A thesis submitted in partial fulfillment
of the requirements for the degree

of

MASTER OF SCIENCE

in

Wildlife Biology

Approved:

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# ABSTRACT

The Effects of Available Water Upon

Populations of Chukar Partridge

on Desert Mountains of Utah

by

William W. Shaw, Master of Science

Utah State University, 1971

Major Professor: Dr. Jessop B. Low
Department: Wildlife Resources

The importance of surface water to chukar partridges (Alectoris graeca) and the feasibility of rain-catchment devices for improving chukar habitat were studied on the Thomas and Dugway Mountain Ranges in western Utah during 1969 and 1970.

Sources of surface water were removed from one mountain range, and chukar populations on that range were compared with populations on an adjacent range with permanent sources of water.

Providing drinking water did not improve chukar productivity, survival, or availability to hunters. Although most birds concentrated around water supplies in the summer, some chukars appeared to live completely independent of any permanent sources of surface water. Food habits of chukars near water did not differ from those in waterless areas.

It was concluded that in habitats comparable to those studied, installation of rain-catchment devices is not a feasible technique for improving chukar habitat.

(72 pages)

# INTRODUCTION

The human population explosion is resulting in increasing demands on wildlands as sources of recreation. At the same time, much of the existing unspoiled wildlife habitat is being converted to serve other human needs. Resolving the two conflicting trends is taxing the ability of land and wildlife managers.

One of the habitats least exploited by man has been the vast desert regions of the western states. The introduction of chukar partridge (Alectoris graeca) to desert mountains has been a successful technique for providing recreation for hunters in many areas throughout the West. In 1969, 22,529 Utah hunters spent 71,674 days hunting chukars and bagged 80,917 birds. The chukar has already become an important game species, but it is possible that sound management techniques may still improve the status of these birds.

One technique that may improve desert habitat for a number of species has been installation of rain-catchment devices that provide permanent sources of water for animals in xeric habitats. If water availability is a critical factor limiting chukar populations and distribution, such a technique may improve recreation by increasing chukar availability to hunters.

To determine if the installation of rain-catchment devices in Utah is a feasible technique for improving chukar hunting, the Utah Division of Fish and Game installed twelve such devices and released 2,400 chukars on the Thomas

and Dugway Mountains. The purpose of this study was to determine the importance of permanent sources of drinking water to chukars and to evaluate installation of rain-catchment devices as a management technique.

The objectives of this study were:

1. To determine the response of chukar partridge in the Thomas and Dugway Mountains of western Utah to water provided by rain-catchment devices.

2. To determine the effects of available water on the feeding habits of chukar partridge in the Thomas and Dugway Mountain Ranges.

3. To determine the effects of water provided by rain-catchment devices on the hunter success and chukar harvest in the Thomas and Dugway Mountain Ranges.

# LITERATURE REVIEW

Animals that inhabit desert environments must be able to survive and reproduce in spite of the limited availability of sources of water. Many desert species have evolved unique physiological and behavioral adaptations which enable them to obtain and conserve water. Schmidt-Nielsen (1964) and Brown (1968) deal at length with the biology of desert animals and include surveys of literature concerning the subject. The results of a number of laboratory and field observations concerning the water requirements of birds in general have been summarized by Bartholomew and Cade (1963).

Recognizing that water availability may be a major limiting factor for desert species, a promising management technique was developed to provide drinking water for game animals living in xeric habitats. In 1942, the first rain-catchment device which stored rainwater and made it available throughout dry seasons was installed in California (Glading, 1947). Originally conceived to improve habitat for California quail (Lophortyx californicus) and Gambel's quail (Lophortyx gambelii), "guzzlers" have been installed throughout arid regions of the western states in attempts to improve habitat for a variety of species.

The questions of whether various gallinaceous species actually need drinking water and whether the guzzlers improve habitat for them have not been conclusively answered. Some investigators believed that water was a

limiting factor for certain quail species (Grinnell, 1927), and that guzzlers do improve their habitat (Glading, 1947; MacGregor, 1953; Wright, 1953; and Webb, 1958). Others (Vorhies, 1928; Gorsuch, 1934; Campbell, 1960; and Nish, 1964), have questioned the importance of surface water for quail species, citing evidence of populations existing without water and the fact that use of guzzlers does not necessarily mean that water is needed.

Thus, for several gallinaceous species, it appears that the need for drinking water may vary from population to population and habitat to habitat. The discrepancy of opinions points out the complexity of the problem and the danger of basing conclusions concerning water requirements on subjective evidence, such as the use of and concentration around water sources.

Although Bohl (1957, p. 42) cited a previous study in which penned chukars demonstrated an ability to survive without water for as long as 81 days, most field researchers have felt that surface water is important to wild chukars during dry months.

Studies conducted in Washington (Moreland, 1950), Nevada (Alcorn and Richardson, 1951; and Christensen, 1952 and 1970), and California (Harper, Harry and Bailey, 1958), all concluded that water availability seems to be a limiting factor determining chukar range during summer months. Observing chukars in their native habitat in Turkey, Bump noted that water seemed to be necessary at fairly frequent intervals (Bohl, 1957, p. 42).

Development of water sources as a technique for improving chukar habitat was suggested by Christensen after studying the birds in Nevada.

> The development of watering sites in non-utilized areas, which otherwise offer suitable habitat, will be of value in influencing a wider distribution of the birds. The development of additional watering sites adjacent to areas currently being utilized may also tend to create a more even distribution of the birds during the driest portion of the year. (Christensen 1952, p. 75).

In Colorado the effects of guzzlers on chukars was studied by Nicolls (1961). This investigator concluded that survival of released birds near guzzlers was higher than that for chukars released in waterless areas and that the chukars near guzzlers "probably" had a significant advantage in productivity (pp. 168-169).

A survey of the literature reveals that most authorities believe water is essential or important to chukars, and no study presents evidence of wild populations living independently from drinking water.

# DESCRIPTION OF STUDY AREA

## Geographical Location

The study area is located on land administered by the Bureau of Land Management in Tooele and Juab Counties of western, central Utah. Immediately to the north is Dugway Proving Ground, an Army Chemical Corps installation. The Nevada border lies approximately 50 miles to the west, and the town of Delta is about 50 miles to the southeast. The major access route to the area is by 45 miles of gravel road leading west from the town of Vernon on State Highway 36 (Figure 1).

## Geology and Topography

The Great Basin is characterized by isolated, roughly parallel mountain ranges separated by level desert basins (Fenneman, 1931). The study was conducted on two of these ranges, Dugway and Thomas, that form a contiguous interruption of the desert flats extending about 30 miles in a north-south orientation. The flats surrounding these mountains consist of silty, alkaline soil deposited when Lake Bonneville covered the area. The mountains are primarily rhyolite outcroppings with a considerable conglomeration of minerals. The desert plains surrounding the mountains are approximately 4,500 feet above sea level, and the mountains extend to an elevation of 7,000 feet above sea level.

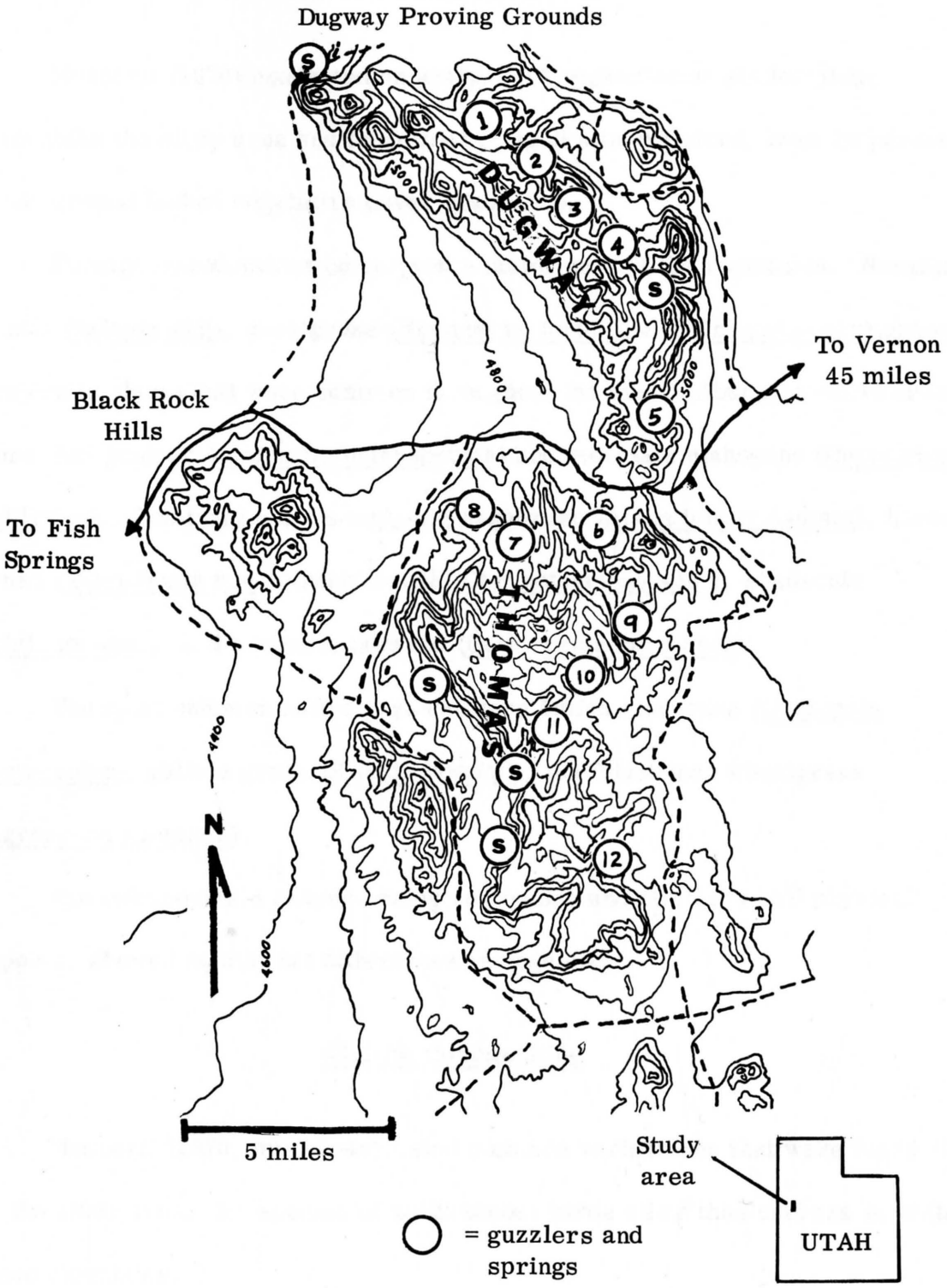



Figure 1. Map of study area in Tooele and Juab Counties, Utah.

## Vegetational Communities

Messerli (1970) conducted an analysis of vegetation at six locations throughout the study area and found that on each site examined, over 30 percent of the ground lacked vegetative cover (Table 13).

Foreign introductions comprised a major part of the vegetation. Russian thistle (Salsola kali), cheatgrass (Bromus tectorum), and Halogeton glomeratus are exotic plants that were common throughout the area. Abundant native trees were Utah juniper (Juniperus osteosperma) and mountain mahogany (Cercocarpus ledifolius). Dominant shrubs were big sagebrush (Artemisia tridentata), horsebrush (Tetradymia spp.), rabbitbrush (Chrysothamnus spp.), shadscale (Atriplex spp.), and broom snakeweed (Gutierrezia sarothrae).

The most common native grasses were Indian ricegrass (Oryzopsis hymenoides), galleta grass (Hilaria jamesii), and bluebunch wheatgrass (Agropyron spicatum).

The two mountain ranges, being contiguous and similar in all physical aspects, showed no distinct differences in vegetation.

## Wildlife Communities

Messerli (1970, pp. 42-44) listed common vertebrates that were found on the study area. No species of gallinaceous birds other than chukars inhabited these mountains.

## Climate

The rain-shadow desert of the Great Basin is characterized by hot summers and moderately cold winters (Dice, 1943). The section of the basin including the study area is part of an arid humidity province with a deficiency of precipitation at all seasons (Thornthwaite, 1931). The monthly temperatures are shown in Table 1. All weather data were recorded at Fish Springs Refuge which is located 20 miles west of the study area.

Table 1. Monthly average maximum, average minimum, and extreme temperatures recorded at Fish Springs Wildlife Refuge, Juab County, Utah, during 1969 and 1970.

| | 1969 | | | | 1970 | | | |
|---|---|---|---|---|---|---|---|---|
| | Average | | Extremes | | Average | | Extremes | |
| | Max. | Min. | Max. | Min. | Max. | Min. | Max. | Min. |
| Jan. | 44.7 | 22.9 | 69 | 7 | 43.0 | 24.3 | 63 | 1 |
| Feb. | 43.0 | 21.8 | 52 | 6 | 50.6 | 25.3 | 63 | 17 |
| Mar. | 48.4 | 28.2 | 76 | 19 | 52.4 | 31.4 | 68 | 21 |
| April | 64.1 | 37.9 | 83 | 27 | 57.9 | 31.3 | 73 | 21 |
| May | 81.4 | 51.8 | 91 | 39 | 71.6 | 45.3 | 92 | 33 |
| June | 78.7 | 52.8 | 94 | 41 | 83.8 | 54.7 | 101 | 40 |
| July | 94.8 | 62.3 | 101 | 49 | 93.6 | 63.1 | 100 | 48 |
| Aug. | 97.3 | 65.4 | 102 | 55 | 94.7 | 65.3 | 101 | 57 |
| Sept. | 85.2 | 45.9 | 92 | 32 | 79.4 | 46.0 | 93 | 29 |
| Oct. | 62.7 | 38.4 | 90 | 27 | | | | |
| Nov. | 51.3 | 24.8 | 70 | 12 | | | | |
| Dec. | 40.9 | 22.9 | 63 | 10 | | | | |

In 1969, the total precipitation was 9.14 inches, well above the nine-year average of 7.66 inches. The first nine months of 1970 had a total of 6.37 inches

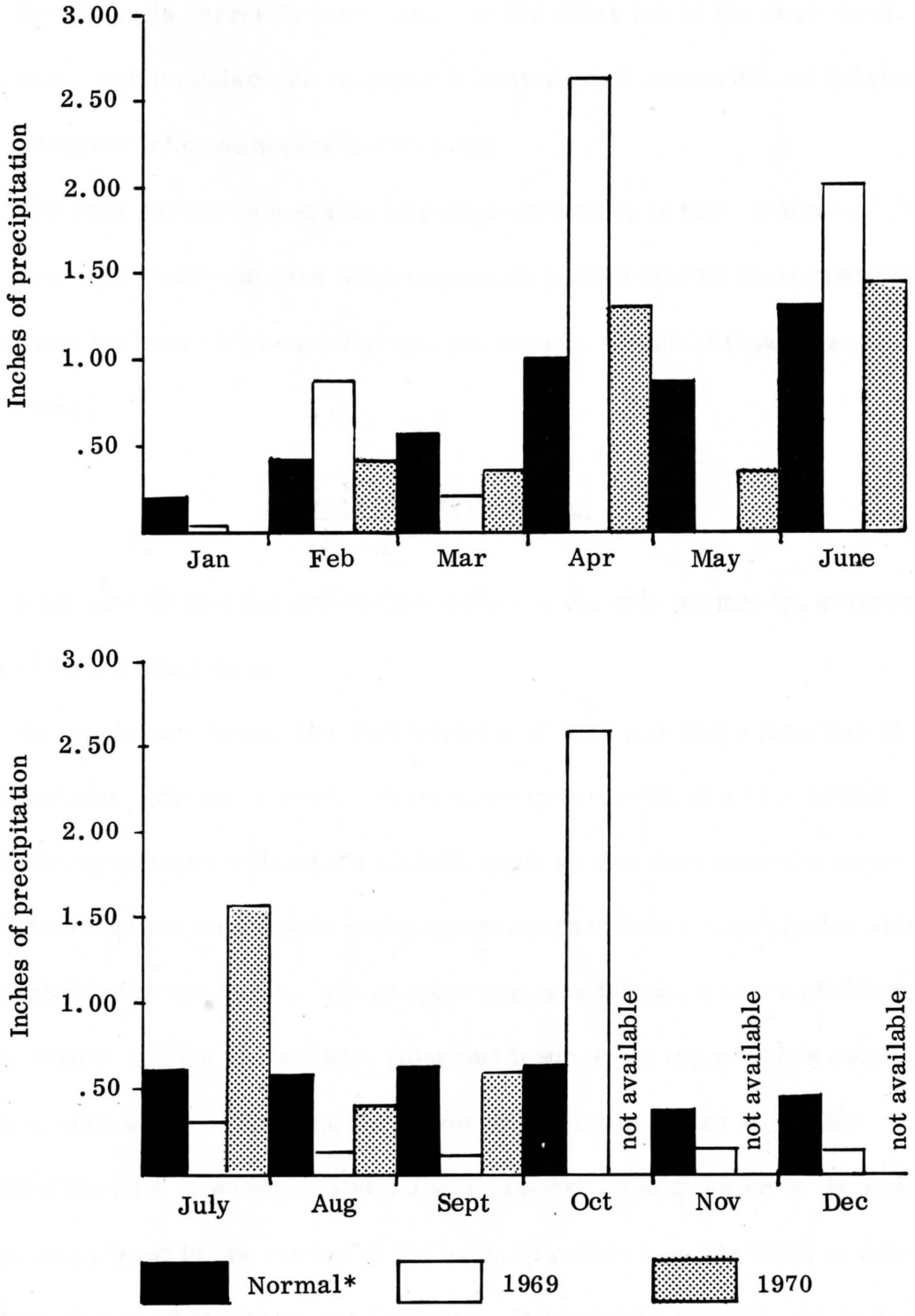
which is slightly above the normal for those months. Figure 2 shows the monthly precipitation totals during the study compared with the normals. Of particular interest in this study was the length of time each summer when no substantial rainfall occurred. Table 2 summarizes these data.

Table 2. Periods from May-September, 1969 and 1970, during which no more than .05 inches of precipitation fell at Fish Springs Refuge, Juab County, Utah.

| 1969 | | | | 1970 | | | |
|---|---|---|---|---|---|---|---|
| Dates | | | Days | Dates | | | Days |
| May 1+ | - June 16 | | 47+ | May 2 | - May 6 | | 4 |
| June 19 | - June 24 | | 6 | May 9 | - June 6 | | 29 |
| June 26 | - July 12 | | 17 | June 8 | | | 1 |
| July 14 | - July 24 | | 11 | June 12 | | | 1 |
| July 29 | | | 1 | June 14 | - July 8 | | 25 |
| July 31 | - Aug. 5 | | 6 | July 10 | - July 20 | | 11 |
| Aug. 7 | - Sept. 30+ | | 55+ | July 23 | - July 25 | | 3 |
| | | | | July 27 | - July 28 | | 2 |
| | | | | July 30 | - Aug. 16 | | 18 |
| | | | | Aug. 18 | - Aug. 19 | | 2 |
| | | | | Aug. 21 | - Aug. 28 | | 8 |
| | | | | Aug. 30 | - Sept. 5 | | 7 |
| | | | | Sept. 8 | - Sept. 30+ | | 23+ |

## Other Uses

Between November 1 and April 30, 16,000 sheep are grazed on the study area. Twenty-eight thousand additional sheep trail through the area each year en route to other grazing lands. Grazing permits are issued and controlled by the Bureau of Land Management.




*Ten-year averages except October, November, and December which are nine-year averages.

Figure 2. Monthly precipitation during 1969 and 1970 compared with normals. Recorded at Fish Springs Refuge.

Beryllium is currently being mined in the south end of the study area. In the past, uranium also was removed in commercial quantities, and substantial prospecting for other minerals is underway.

The area serves as a source of public recreation in two capacities. In 1970, over 400 chukar hunters were estimated to have visited these mountains. Throughout the year, rock-hounds visit the area in search of topaz, geodes and other rocks.

## Sources of Surface Water

Four natural springs and one pit-mine are the only permanent sources of water on the study area.

To supplement these, the Utah Division of Fish and Game installed 12 rain-catchment devices in 1967. These devices consisted of a 16 x 16 foot corrugated metal apron placed on a slight slope so that rain and snow water drains into a gutter on one side of the apron and then into a 1,000 gallon storage tank buried below the apron. Water from this tank follows a one-inch diameter plastic pipe to a 1 x 2 foot square, fiberglas basin about three inches deep and partially covered by a fiberglas lid. Beneath the lid is a float valve that regulates the flow of water, maintaining a constant level of water in the basin. A rock was placed in one corner of the basin to enable juvenile birds to drink with less chance of falling in and drowning. Between the storage tank and the basin, a valve was installed enabling the water to be shut off during the winter months. (Figures 3 and 4)

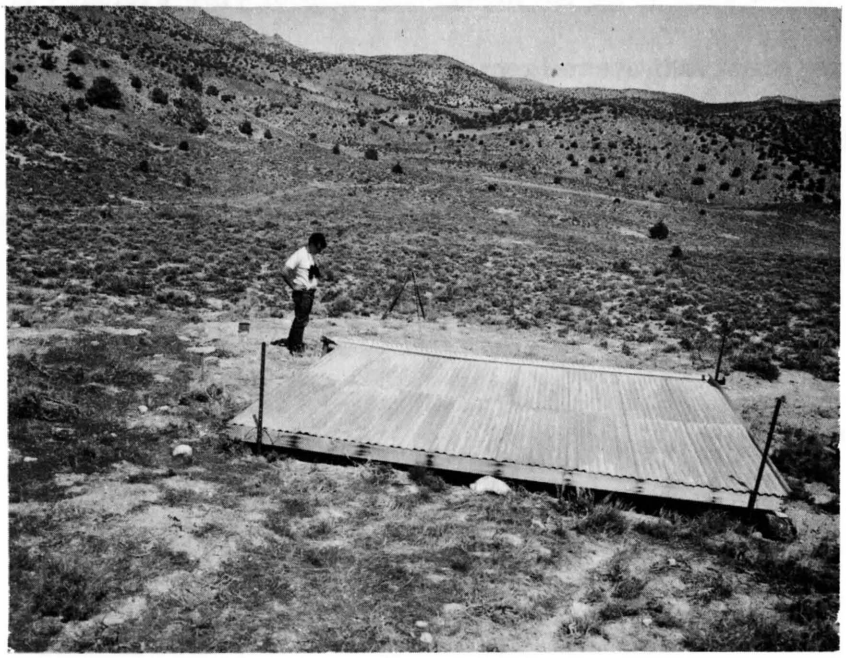


Figure 3. Metal rain-catchment apron used in guzzlers on the Thomas and Dugway Mountains.

Figure 4. Drinking basin typical of those used in guzzlers on the Thomas and Dugway Mountains.

The 12 guzzlers were located throughout the study area where automobile access to chukar habitat was available. In most cases they were placed in canyons that extend into the mountains and are believed to provide adequate food as well as escape habitat for chukars.

# PROCEDURES

## Distribution in Relation to Water

### Spring census

A series of 18 census transects was conducted during the early mornings and late afternoons of May and June each year of the study. The rugged terrain and limited access precluded the possibilities of using straight and random transects or carefully planned contour transects. Consequently, censusing was done during hikes in which a circuit was made from a beginning point, typically at the foot of the mountains, to the crest of the range, and down again by a different route. Any biases resulting from a greater coverage of accessible and traversable terrain were unavoidable. However, by covering as much of the study area as possible, information concerning the relationship of chukar distribution to distance from water was obtained. Figure 5 shows the coverage of the study area in one series of census hikes.

The location of each visual or audio observation of chukars was recorded on a map. Since it was often impossible to obtain an accurate count of the number of chukars at one location, all observations, regardless of the size of the group were recorded as one location and equally treated.

When a series of censuses was completed, the results were analyzed by determining the distance covered in each half-mile interval from water and combining that data with the total number of observations in each of those

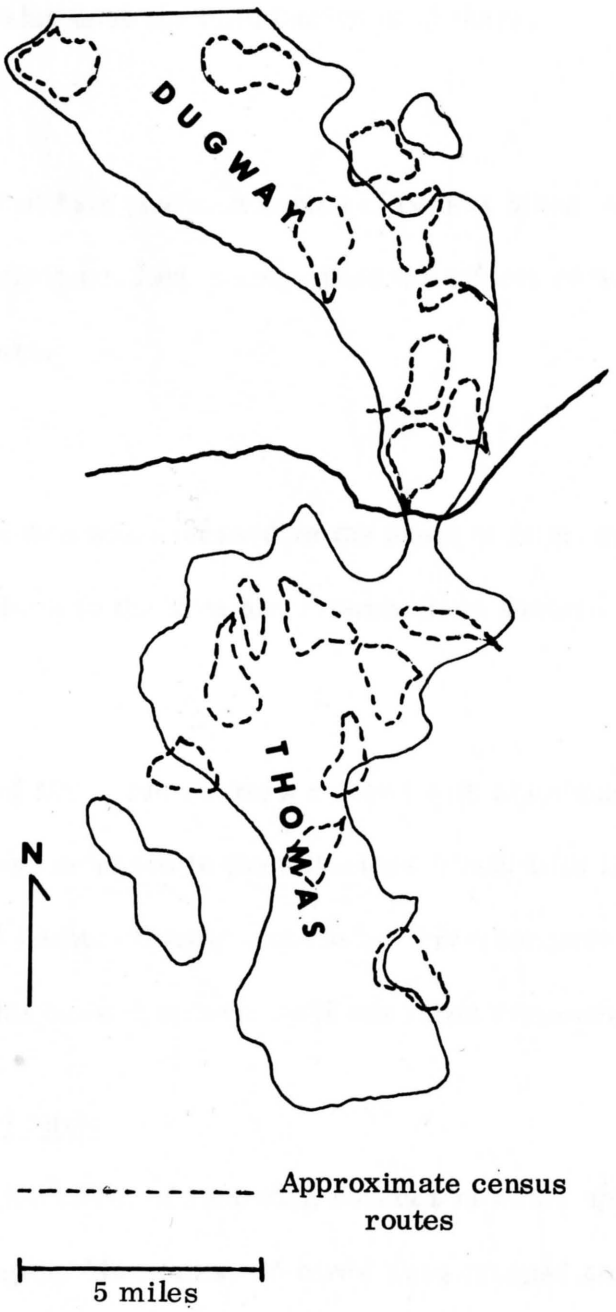



Figure 5. Map of study area showing approximate census routes during one series of censuses.

categories. Statistical comparisons of these figures were then used to determine the effect of water upon the distribution of chukars.

Summer census

During August of both years, a series of census hikes was conducted in the manner previously described to determine the effects of water on the summer distribution of chukars.

Winter distribution

Winter distribution was assessed on the basis of information obtained during three brief visits to the area and reports from hunters during that period.

Control area

In the spring of 1967, 200 chukars marked with aluminum leg-bands and plastic back-tags were released in the waterless Black Rock Hills by the Utah Division of Fish and Game. During this study, three comprehensive searches were conducted in this area to determine if any birds remained.

Movement of marked birds

To determine the effect of removing sources of water upon the population of chukars in the Dugway Mountains, 95 birds were trapped and marked at guzzlers 1, 2, and 4 during July, 1969.

The traps were made by combining two 3 x 3 x 1 foot wire-mesh quail traps to form one 3 x 6 x 1 foot trap with a funnel entrance on each end (Figure 6). This trap was placed directly over the basin part of the guzzler and held in place by rocks placed on each corner. No bait other than water

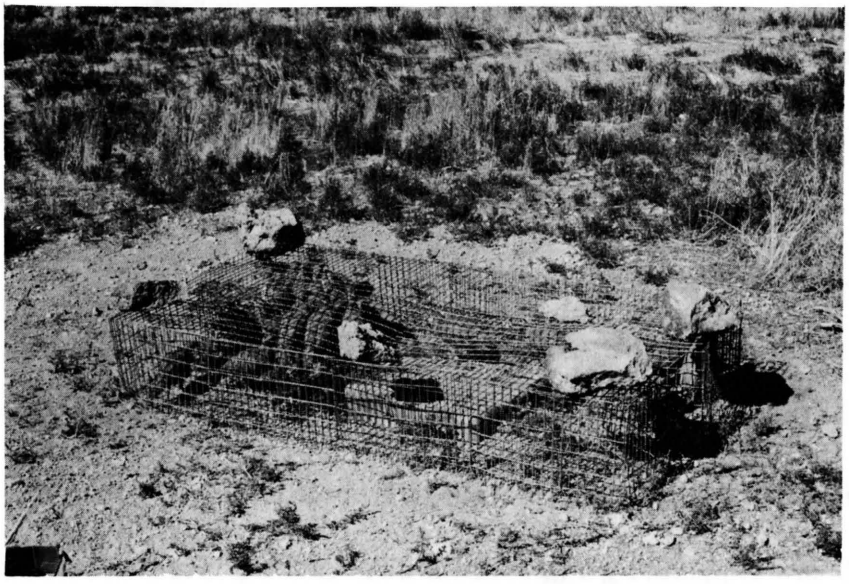


Figure 6. Chukars caught in a trap placed over a drinking basin.

Figure 7. Chukars using guzzler #6, Thomas Mountains.

was used. The traps were set shortly before dawn and removed no later than noon. In most cases, the trapping process was watched from a nearby hillside and the trap was emptied as soon as several birds were caught. Chukars that were trapped were marked with aluminum leg-bands and plastic back-tags. The back-tags were made by stapling 3 x 1/2 inch strips of colored plastic flagging material to small safety pins (Figure 8). These markers were then pinned through the loose skin along the spinal feather tract on the back of the chukars' necks. The tags placed on most birds were color-coded to indicate the location of trapping. In addition, six birds at #6 guzzler were given unique color patterns for individual recognition. A similar tagging technique was described by Gullion (1951).

On August 4, 1969, all guzzlers on the Dugway Range were turned off and remained non-functional throughout the remainder of the study. Subsequent observations of birds marked at those guzzlers were used to evaluate the effects of removing the availability of water on chukar distribution. In addition, guzzlers #3 on the Dugway Range and #9 on the Thomas Range had been turned off in previous years. Number 3 remained off throughout this study. Number 9 was made functional in 1970.

Use of calls in censusing

Numerous experiments were conducted throughout the study to determine the effectiveness of employing an Olt Brand, hand operated chukar call to elicit response from birds during censuses. The use of recorded calls in censusing as suggested by Bohl (1956) was attempted during the spring, 1970. Recordings

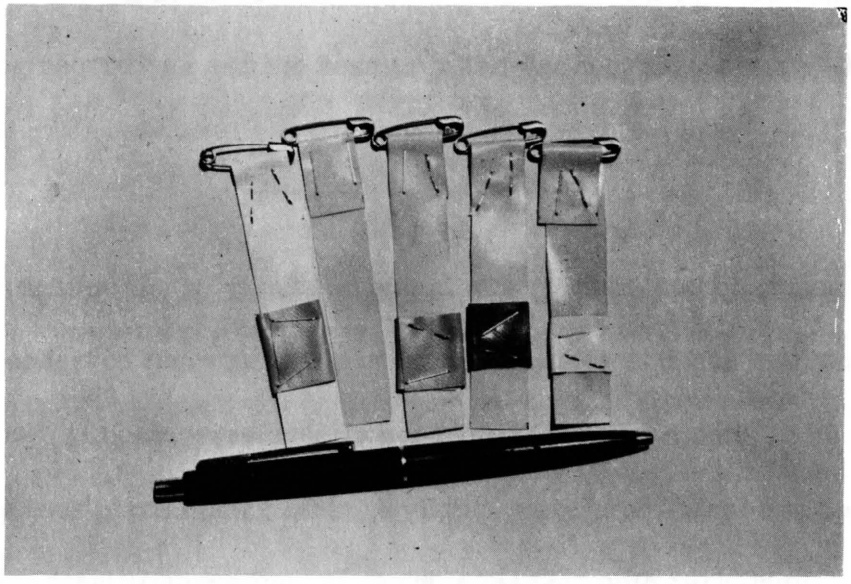


Figure 8. Colored backtags used to identify individual chukars and the locations where they were trapped.

Figure 9. Chukar with backtag. This bird was collected 1 1/2 years after it was released.

of chukar rally calls were played periodically on a portable, battery-operated tape recorder during six census transects. Duplicate hikes were conducted without using recordings and the results of the two techniques were compared.

## Use of Surface Water

To determine the patterns and extent of waterhole use by chukars, the birds were observed from hillsides overlooking water sources or from a truck parked nearby. Counts were usually conducted from dawn until 11:00 A.M., but some counts took place during other daylight hours. Individual use pattern data were obtained from observations of chukars marked with back-tags. Thirty-one waterhole counts were conducted during the summer. Of these, 13 were made simultaneously with trapping attempts and consequently yielded only partial data.

## Food Habits

Throughout the study, chukars were shot and the contents of their crops saved for later analysis. In addition, a number of crops were collected from birds killed by hunters. These food samples were either dried in the sun or in an oven at 150° F. Crops saved for over one month were sprayed with an insecticide to prevent damage by invertebrates.

In the laboratory, the contents of each crop were separated according to food types and the volumes of each determined by water displacement in a small, graduated cylinder. The data were then grouped according to season and location where collected. Percentages of succulent food types as described by Hungerford (1960) were determined for each mountain range and a statistical

comparison made of the two. Hungerford (1960) found that most foods classified as succulent contained over 60 percent water. The dry foods were mostly seeds which contain less than 10 percent water (Bartholomew and MacMillen, 1961).

## Hunter Success

After the guzzlers on the Dugway Range were made non-functional, a comparison of the hunting success on the two ranges was used to evaluate the effects of the guzzlers on the chukars and the success of hunters. These data were collected during the opening weekend of hunting season both years at a checking station on the main access road to the study area. Hunters were asked a series of questions (Appendix B) and a wing was collected from each bird for age ratio data. The same format shown in Appendix B was printed on large, wing-collection envelopes and left at an unmanned station on the secondary access road from the town of Delta. A large sign asked hunters to stop and a box was provided for the completed questionnaires and one wing from each chukar. Wings were aged according to the key published by Weaver and Haskell (1968).

## Life History Information

Throughout the study, note was made of all life history information that might add to an understanding of chukar ecology. In May, June, and August of each year, every observation was recorded along with notes on the number, age, sex, habitat, and behavior of the birds.

# RESULTS

## Distribution in Relation to Water

### Spring census

During the months of April, May, and June, individuals and pairs of chukars were found widely distributed throughout the mountainous parts of the study area. Assuming that spring observations of individual chukars are usually indicative of mated pairs, a high proportion of the population appeared to be paired during both spring seasons. Of 33 observations made during May and the first week of June in 1969, only two involved more than one pair of birds. One group of five and another of three adults were the only evidence of unpaired birds during this period. In the same period of 1970, only four of the 53 observations involved more than two adults. Three of these consisted of three adults and one involved four adults.

The availability of water appeared to have no influence on the distribution of chukars during the spring months. Figure 10 shows the relationships of observations of birds to their distance from water during 134 miles of censuses in May and June. An analysis of variance of the observations/mile for the four half-mile categories was calculated. At the 90 percent confidence level, this statistical test fails to reject the hypothesis that there are no differences among these groups. A planned comparison of the group nearest water with the other three taken as one unit also fails to reject the hypothesis of no differences at the 90 percent confidence level.

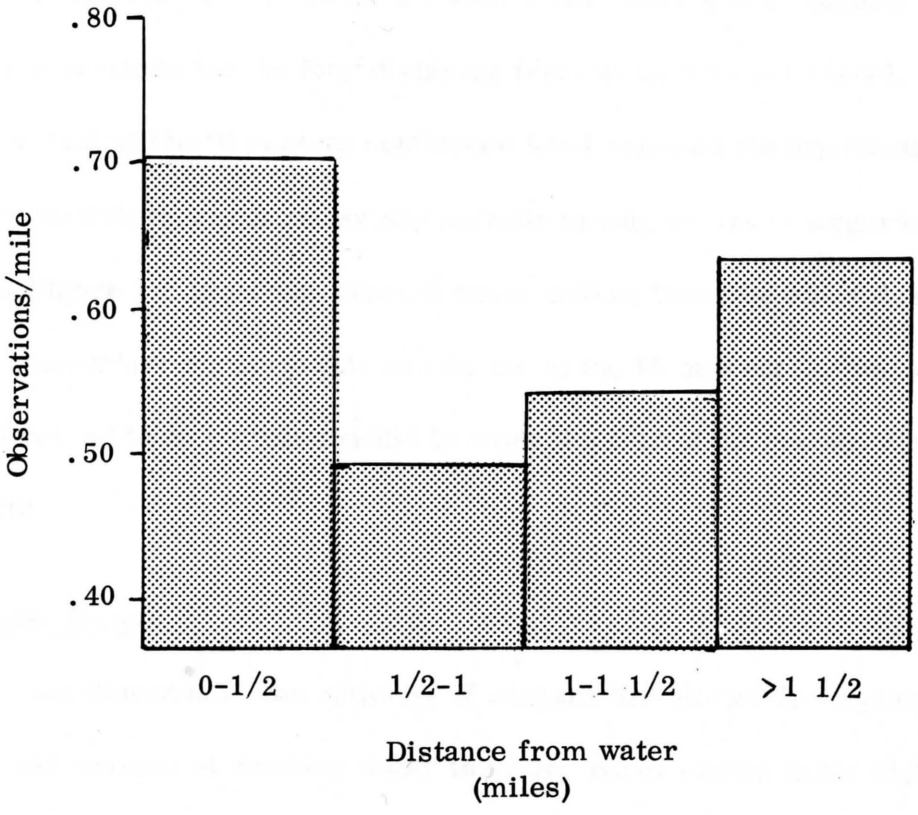



Figure 10. Observations/mile during 134 miles of chukar censuses during May and June, 1969 and 1970.

Summer census

By mid-July, the distribution of chukars began to show a concentration around sources of drinking water. However, some birds could still be found in almost any part of the study area including areas one to five miles from surface water.

Figure 11 shows the relationship of observations/mile to the chukars' distance from water in 119 miles of census routes during both Augusts. An analysis of variance for the four distances from water was calculated. This statistical test at the 90 percent confidence level rejected the hypothesis that there are no differences in observations/mile among the four categories. As shown in Figure 11, the group nearest water differs from the other three and a planned comparison supports this conclusion at the 90 percent confidence level. There appeared to be no relationship between the size of coveys and distance from water.

Winter distribution

By mid-November, the majority of chukars had shifted from grassy canyon bottoms and sources of drinking water to steep, rocky slopes in the higher parts of the study area. From November through January, the birds were in large coveys that seldom left the high slopes. In February and March, the large coveys broke into pairs and breeding territories were established in a general distribution throughout the study area. During these months, availability of water appeared to have no influence on chukar distribution.

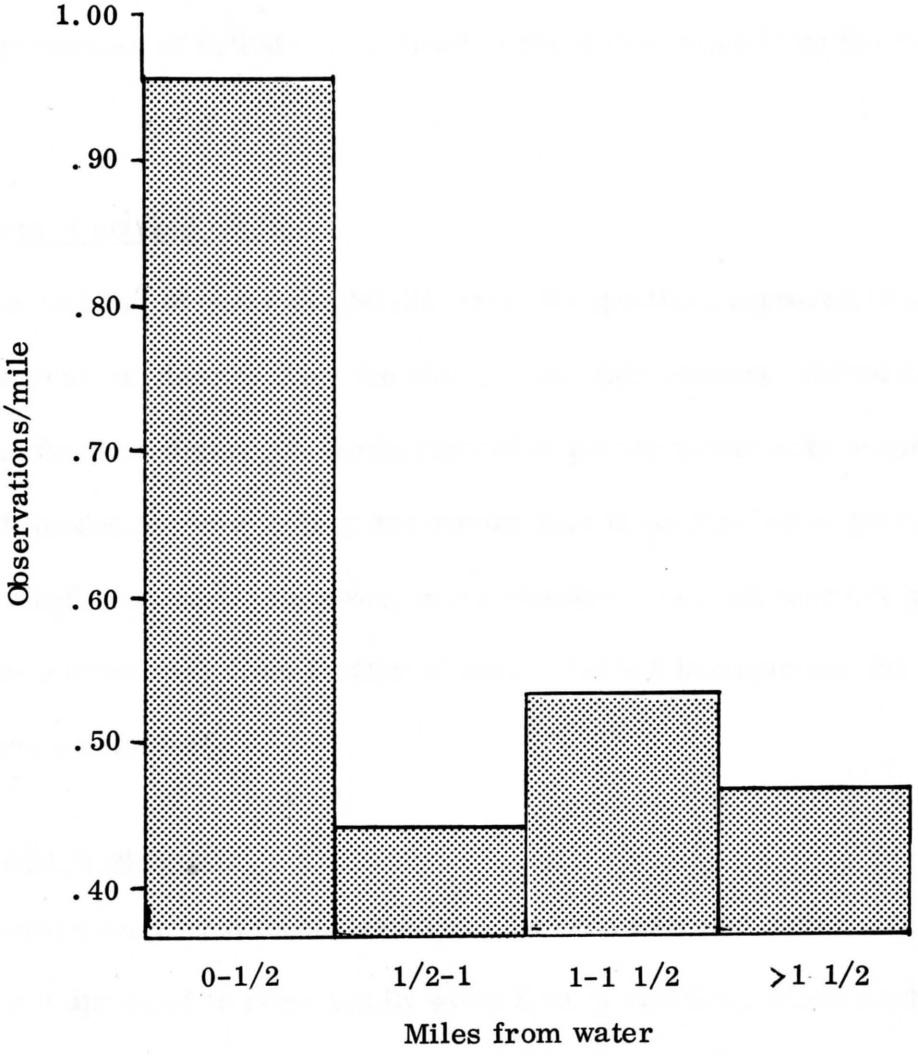



**Figure 11.** Observations/mile during 119 miles of chukar censuses during August, 1969 and 1970.

Control area

In spite of several searches throughout the waterless Black Rock Hills, no evidence of the 200 color-marked chukars released in 1967 was found. One uncertain identification of a bird wearing a red tag was made one quarter of a mile from guzzler #7 in 1969, a distance of about five miles from the release site.

Movements of marked birds

The removal of water availability from the guzzlers appeared to cause some dispersal of chukars from the vicinity, but this response varied considerably. As shown in Figure 12, birds marked at guzzlers that were subsequently turned off tended to move farther and sooner than those marked at guzzlers that remained functional. However, some chukars remained near dry guzzlers and others moved away from functional ones. Table 3 summarizes the results of trapping operations.

Use of calls in censusing

Chukars responded inconsistently to the hand operated caller. On certain occasions it appeared to successfully elicit a rally call from silent birds, but usually no response was observed. The recorded calls produced satisfactory results when care was taken to insure that the observer was not within sight of the birds. Often chukars did not respond until the recording had been played periodically for several minutes from the same location. As a result, it was not effective in covering a large area in a limited interval of time, but was useful in locating birds in local areas. In three of the six censuses that were

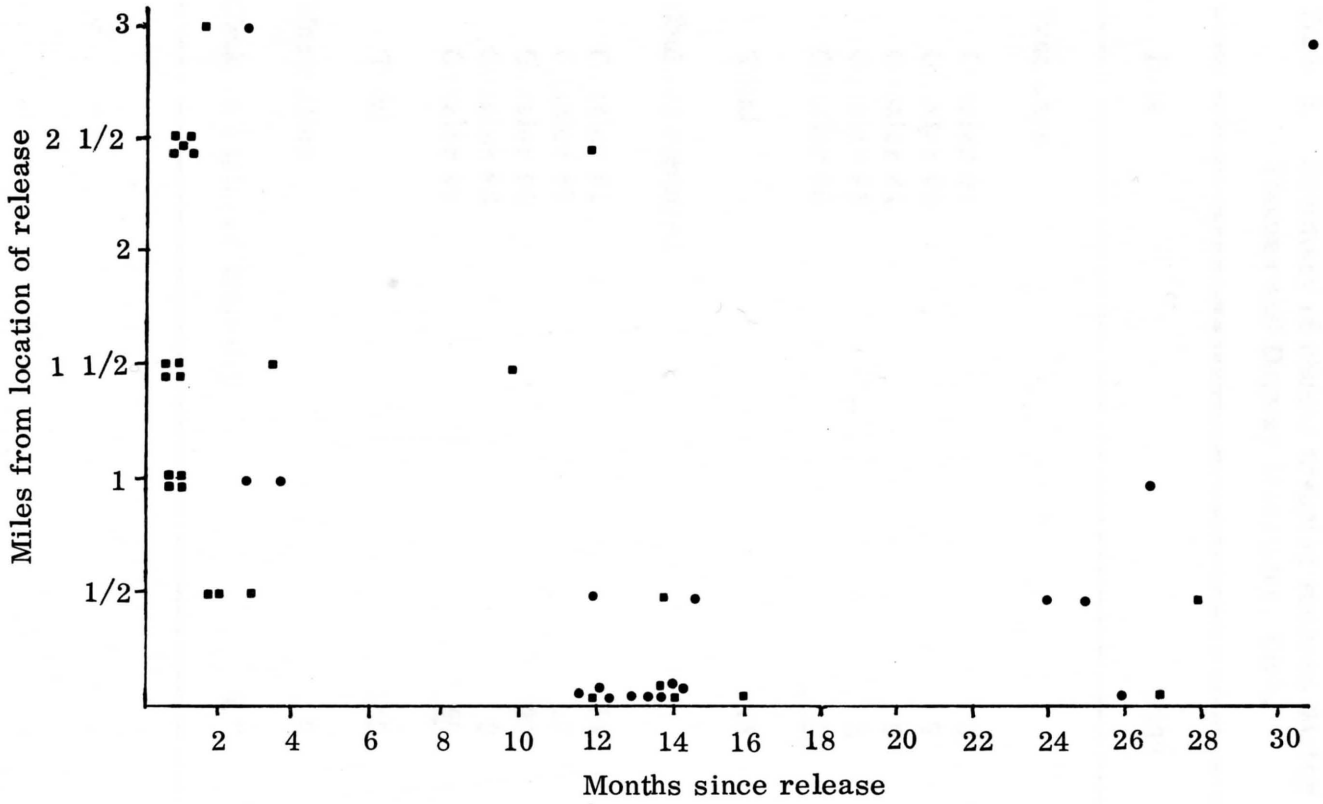



Figure 12. Distances from trapping locations moved by chukars correlated with months since release.

Table 3. Summary of chukar trapping success during 1969 and 1970, Thomas and Dugway Mountains, Utah.

| Data | 1969 | 1970 |
|---|---|---|
| **Trap days** | | |
| Guzzler #1 | 3 | 0 |
| Guzzler #2 | 7 | 0 |
| Guzzler #4 | 6 | 0 |
| Guzzler #5 | 2 | 0 |
| Guzzler #6 | 5 | 6 |
| Total | 23 | 6 |
| **Chukars captured** | | |
| Guzzler #1 | 54 | 0 |
| Guzzler #2 | 17 | 0 |
| Guzzler #4 | 24 | 0 |
| Guzzler #5 | 0 | 0 |
| Guzzler #6 | 60 | 12 |
| Total | 155 | 12 |
| **Mortalities** | 0 | 0 |
| Chukars captured/trap-day | 6.7 | 2.0 |

duplicated using recordings, more observations were obtained when the recordings were played. The other three pairs showed equivalent results, with or without use of recordings (Table 4).

Table 4. Results of duplicate censuses run with and without use of recorded rally calls during April and May, 1970.

| Pair Number | Without Recordings Total Observations | With Recordings Total Observations |
|---|---|---|
| 1 | 2 | 3 |
| 2 | 3 | 4 |
| 3 | 2 | 2 |
| 4 | 4 | 6 |
| 5 | 2 | 2 |
| 6 | 2 | 2 |

## Use of Surface Water

Chukars were observed drinking at all 11 functional guzzlers as well as at four of the five other permanent sources of surface water. Droppings found nearby indicated use of the fifth source, the open-pit mine on the Thomas Range.

### Use of saline water

One of the natural sources of water used by the chukars was the salt water spring at the north end of the Dugway Range. A sample of this water was analyzed for chloride ions and its salinity found to be approximately 20 percent that of sea water. The other natural sources all contained less dissolved minerals.

Seasonal trend of waterhole usage

Figure 13 shows the seasonal trend of usage for guzzler #6. Use prior to mid-July was limited and no birds younger than two weeks of age were observed drinking. During June and July, guzzler use fluctuated greatly but during August, more consistent use was made of the water sources. Table 5 lists the results of all waterhole counts in this study.

Daily use pattern

Although chukars were observed at water during all daylight hours, most drinking was during mid-morning. Figure 14 shows the average daily use pattern for guzzler #6 on two consecutive days in August, 1969. Not indicated by this graph is the fact that approximately 10 percent of the birds observed at the guzzler did not actually drink. The few birds that drank before 8:00 A. M. were typically single adults. Only during August and September was it common to find birds at guzzlers between noon and 7:00 P. M. But during dry periods in these two months, chukars could be found near the guzzlers at almost any daylight hour.

On each of two consecutive days in August, 1969, no more than 63 percent of the birds that had been marked at guzzler #6 during the preceding month came to the guzzler before 1:00 P. M. Of six chukars that were marked for individual recognition, only two drank on one morning and three different ones on the following morning (Table 6). Since guzzler use later in the day was slight, it appears that many chukars did not drink at a regular hour on a daily basis.

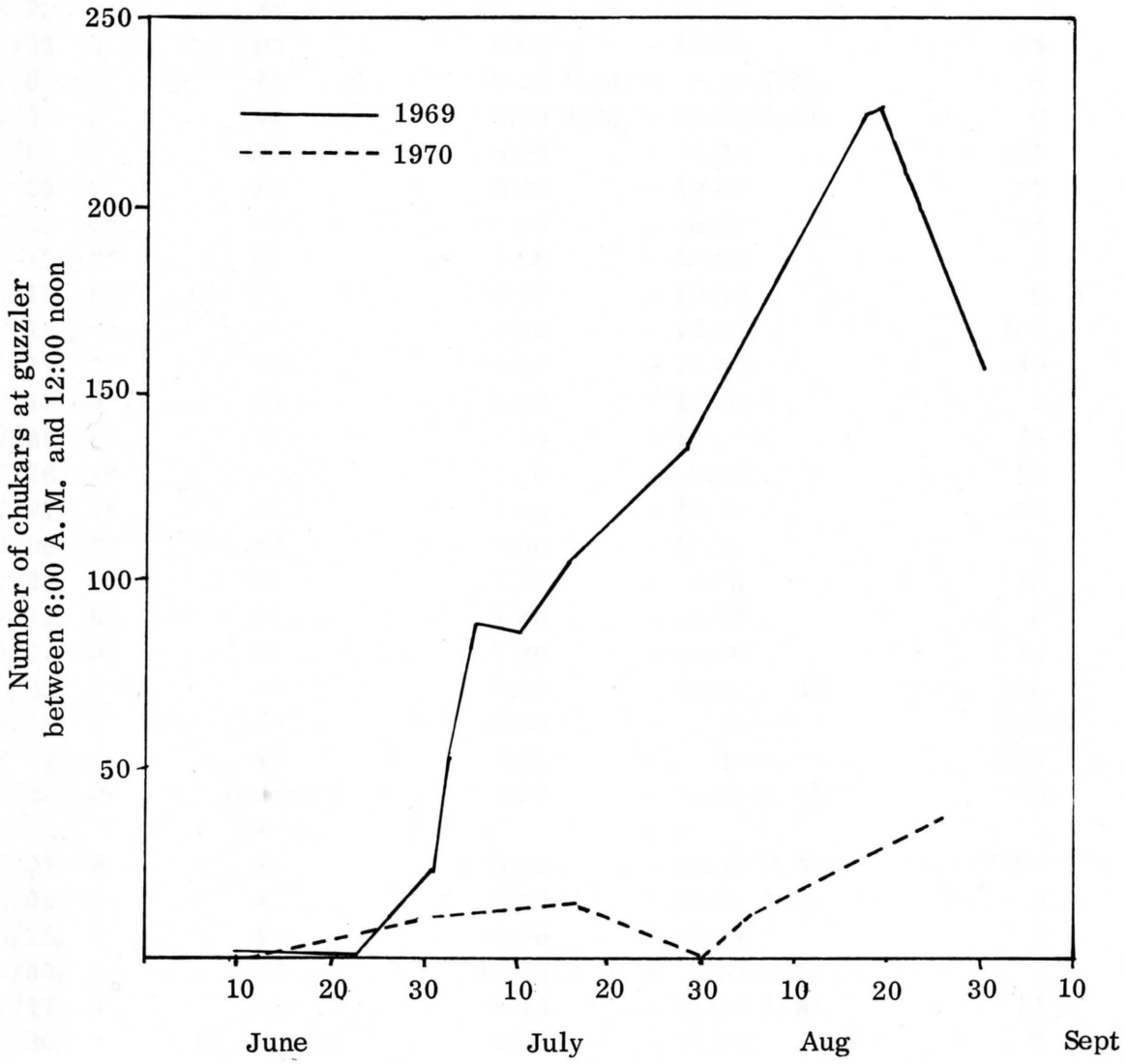



Figure 13. Seasonal trend of guzzler use by chukars in 1969 and 1970, for guzzler #6, Thomas Mountains

Table 5. Results of waterhole counts during 1969 and 1970.

| Date | Location | Time | Chukars Seen |
|---|---|---|---|
| 6/10/69 | #6 | 6:00 A.M. - 10:00 A.M. | 0 |
| 6/23/69 | #6 | 6:00 - 10:00 | 0 |
| 7/01/69 | #6 | 6:00 - 10:00 | 24 |
| 7/01/69 | #6 | 6:00 P.M. - 8:45 P.M. | 0 |
| 7/02/69 | #4 | 6:00 A.M. - 10:00 A.M. | 0 |
| 7/03/69 | #6 | 6:00 - 11:00 | 51 |
| 7/05/69 | #6 | 6:30 - 10:00 | 89 |
| 7/11/69* | #6 | 6:30 - 10:00 | 88 |
| 7/12/69* | #2 | 7:00 - 11:00 | 0 |
| 7/15/69* | #4 | 6:30 - 10:30 | 0 |
| 7/16/69* | #6 | 6:30 - 10:00 | 105 |
| 7/17/69* | #2 | 6:30 - 11:00 | 50 |
| 7/18/69* | #5 | 6:30 - 11:30 | 0 |
| 7/24/69* | #1 | 8:00 - 11:30 | 94 |
| 7/26/69* | #1 | 7:00 - 10:45 | 50 |
| 7/27/69* | #4 | 7:00 - 10:30 | 36 |
| 7/28/69* | #2 | 7:00 - 10:30 | 0 |
| 7/29/69* | #1 | 7:30 - 9:45 | 22 |
| 7/31/69* | #4 | 7:30 - 11:00 | 0 |
| 8/01/69* | #4 | 7:30 - 10:30 | 12 |
| 8/03/69 | #6 | 6:30 - 12:00 P.M. | 136 |
| 8/18/69 | #6 | 7:00 - 1:30 | 224 |
| 8/19/69 | #6 | 7:00 - 1:30 | 225 |
| 8/26/69 | red rock seep | 8:00 - 10:00 A.M. | 88 |
| 9/01/69 | #6 | 6:30 - 12:00 P.M. | 157 |
| 6/09/70 | #6 | 6:30 - 11:00 A.M. | 0 |
| 6/29/70 | #6 | 6:00 - 11:30 | 9 |
| 6/30/70 | #6 | 11:15 - 2:30 P.M. | 3 |
| 7/17/70 | #6 | 6:30 - 11:00 A.M. | 14 |
| 7/20/70 | N. Dugway spring | 6:15 - 10:30 | 7 |
| 7/31/70 | #6 | 6:30 - 10:30 | 0 |
| 8/05/70 | #6 | 6:45 - 11:30 | 9 |
| 8/26/70 | #6 | 6:30 - 11:00 | 37 |
| 8/27/70 | red rock seep | 7:00 - 11:30 | 35 |

*Conducted simultaneously with trapping.

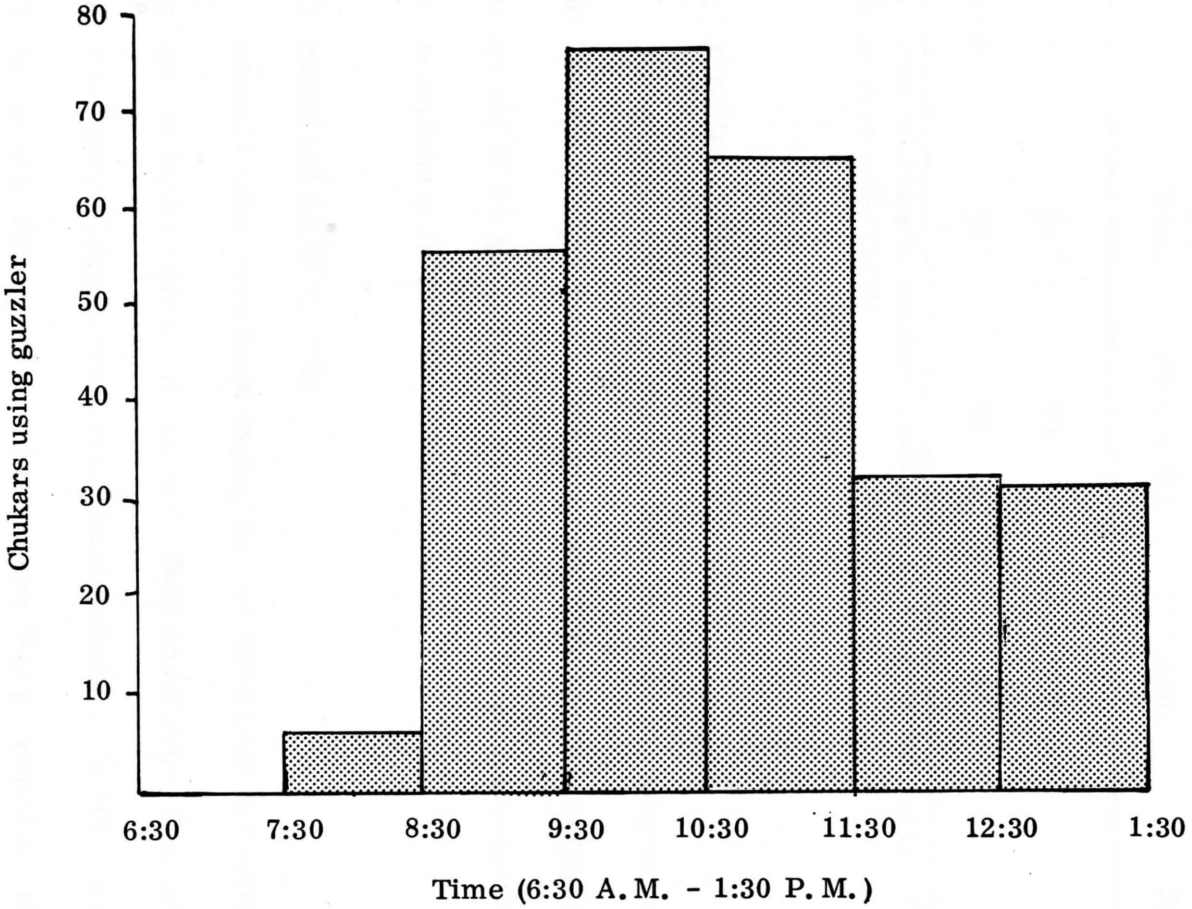



Figure 14. Average daily pattern of use of guzzler #6 by chukars on two consecutive days in August, 1969.

Table 6. Numbers and percentages of group-marked and individually marked chukars observed at guzzler #6 on two consecutive days in August, 1969, between 6:00 A.M. and 1:00 P.M.

| Date | Group-Marked Chukars | | Individually Marked Chukars | |
|---|---|---|---|---|
| | Number Seen | Percentage | Number Seen | Percentage |
| 8/18/69 | 34 | 63 | 2* | 33 |
| 8/19/69 | 31 | 57 | 3* | 50 |

*The three individually marked birds seen on 8/19/69 did not include either of those seen on 8/18/69.

Use of guzzlers by other species

Nine species other than chukars were observed drinking at the guzzlers (Table 7). Another game bird, the mourning dove (Zenaidura macroura), made extensive use of the guzzlers with as many as 75 doves concentrating around one rain-catchment device.

Other sources of surface water

Natural basins were found throughout the study area in rhyolite outcroppings and in the bottoms of canyons. Such formations often held puddles of water for several days after a brief thundershower. In 1970, a series of heavy rain storms formed large pools of water that persisted as long as two weeks before drying out (Figure 15). Chukar tracks and droppings indicated use of these water sources.

Table 7. Vertebrates observed drinking at guzzlers.

| | |
|---|---|
| **Mammals:** | |
| White-tailed Antelope Squirrel | *Citellus leucurus* |
| Mule Deer | *Odocoileus hemionus* |
| **Birds:** | |
| Brown-headed Cowbird | *Molothrus ater* |
| Bullock's Oriole | *Icterus bullockii* |
| Chukar Partridge | *Alectoris graeca* |
| Lark Sparrow | *Chondestes grammacus* |
| Loggerhead Shrike | *Lanus ludovicianus* |
| Mockingbird | *Mimus polyglottos* |
| Mourning Dove | *Zenaidura macroura* |
| Sage Thrasher | *Oreoscoptes montanus* |

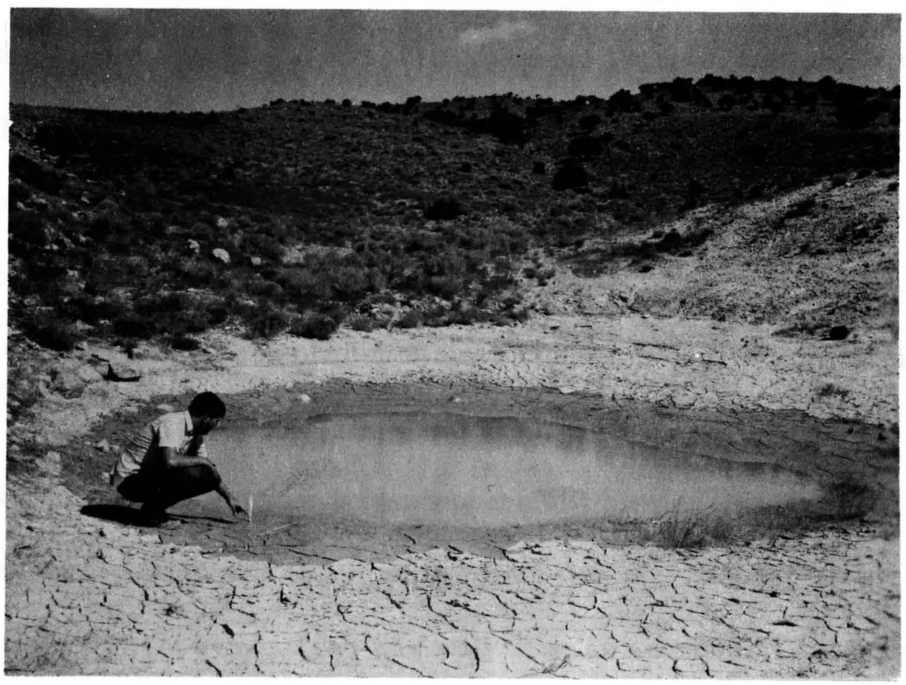


Figure 15. Natural reservoir filled by rain-water, Thomas Mountains, Utah.

## Food Habits

The food habits of the chukars exhibited a chronological sequence of changes. Table 8 shows the results of a volumetric analysis of the contents of 103 crops. The data were separated into four seasons in which the birds appeared to select different food types.

From November - April, green grass blades accounted for nearly all food taken. Crop-content data were supplemented by examination of many droppings during this period and green plant matter invariably accounted for most of the diet.

In May and June, the chukars shifted from grass blades to grass seeds. Seeds of Oryzopsis hymenoides accounted for over 50 percent of the total food taken with other seeds comprising almost another 25 percent of the diet.

In the following months, July and August, seeds still accounted for most of the diet, but invertebrates (grasshoppers and beetles) made up one-third of the diet. In these months, Bromus tectorum was the most important seed type taken but Oryzopsis hymenoides was still taken in substantial quantities.

Late in the summer, invertebrates became equally important with seeds as a food source. During September and October, ants and grasshoppers comprised nearly one-third of the diet. Oryzopsis hymenoides was no longer an important food, but Bromus tectorum seeds accounted for 30 percent of the total volume.

The seeds of domestic rye (Secale cereale) were probably horse feed left by sheep herders. There is no agriculture in the area.

Table 8. Analysis of food habits of 103 chukars collected on the Thomas and Dugway Mountain Ranges, Utah.

| Season | Nov-Apr | | May-June | | July-Aug | | Sept-Oct | |
|---|---|---|---|---|---|---|---|---|
| Number of Crops | 3 | | 7 | | 17 | | 76 | |
| | Percent Volume | Percent Occurrence | Percent Volume | Percent Occurrence | Percent Volume | Percent Occurrence | Percent Volume | Percent Occurrence |
| **Plant seeds** | | | | | | | | |
| Agropyron spicatum | tr. | 33 | 1.7 | 14 | 8.7 | 47 | 3.2 | 14 |
| Amaranthus blitoides | - | - | - | - | - | - | tr. | 3 |
| Bromus tectorum | - | - | 10.7 | 43 | 20.3 | 71 | 29.8 | 70 |
| Cercocarpus ledifolius | - | - | - | - | 9.5 | 6 | 1.1 | 7 |
| Cleome serrulata | - | - | - | - | - | - | 4.7 | 8 |
| Erodium cicutarium | - | - | tr. | 14 | 4.3 | 12 | .2 | 3 |
| Euphorbia glyptosperma | - | - | - | - | .3 | 6 | - | - |
| Halogeton glomeratus | 1.0 | 33 | - | - | - | - | - | - |
| Helianthus annuus | - | - | - | - | tr. | 6 | - | - |
| Lappula redowskii | - | - | .8 | 14 | .7 | 12 | - | - |
| Lithospermum incisum | - | - | - | - | .1 | 6 | - | - |
| Lycium pallidum | - | - | 12.4 | 14 | - | - | - | - |
| Oryzopsis hymenoides | - | - | 53.7 | 43 | 16.7 | 82 | 2.2 | 33 |
| Secale cereale | - | - | - | - | - | - | 1.2 | 7 |
| Stipa comata | - | - | - | - | 1.0 | 18 | - | - |
| **Leaves and flower parts** | | | | | | | | |
| Artemisia tridentata* | 1.0 | 33 | - | - | - | - | .7 | 10 |
| Astragalus spp. | 3.0 | 33 | - | - | - | - | - | - |
| Chorispora tennella | - | - | 8.3 | 14 | - | - | - | - |
| Elymus cinereus | - | - | - | - | .1 | 6 | 1.7 | 13 |
| Gramineae family | 95.0 | 100 | 3.3 | 14 | 1.4 | 12 | 11.8 | 59 |
| Halogeton glomeratus | - | - | 2.5 | 29 | tr. | 6 | - | - |
| Helianthus annuus | - | - | - | - | - | - | .3 | 3 |
| Juniperus osteosperma | - | - | - | - | tr. | 6 | - | - |
| Unident. dicot. | | | tr. | 14 | 2.9 | 24 | .3 | 14 |
| **Invertebrates** | | | | | | | | |
| Coleoptera order | | | | | | | | |
| cerambycidae family | - | - | - | - | .3 | 6 | 2.2 | 14 |
| scarabaridae family | - | - | - | - | - | - | .1 | 1 |
| tenebrionidae family | - | - | - | - | 10.7 | 12 | .4 | 1 |
| Hemiptera order | | | | | | | | |
| coreidae family | - | - | - | - | 4.2 | 12 | 6.4 | 20 |
| miridae family | - | - | - | - | - | - | .1 | 1 |
| pentatomidae family | - | - | - | - | - | - | .1 | 1 |
| scutelleridae family | - | - | - | - | - | - | .1 | 1 |
| Homoptera order | | | | | | | | |
| cicadellidae family | - | - | - | - | - | - | tr. | 1 |
| fulgoridae family | - | - | - | - | - | - | tr. | 1 |
| Hymenoptera order | | | | | | | | |
| formicidae family | - | - | - | - | - | - | 21.0 | 67 |
| Orthoptera order | | | | | | | | |
| acrididae family | - | - | 6.6 | 43 | 18.8 | 53 | 11.7 | 34 |
| **Other** | | | | | | | | |
| rodent droppings | - | - | - | - | - | - | .2 | 4 |
| dirt | - | - | tr. | 14 | | | .5 | 1 |
| Seasonal % volume seeds | 1.0 | | 79.3 | | 61.6 | | 42.4 | |
| Seasonal % volume leaves and flowers | 99.0 | | 14.1 | | 4.4 | | 14.8 | |
| Seasonal % volume invertebrates | 0.0 | | 6.6 | | 34.0 | | 42.1 | |
| Seasonal % other | 0.0 | | 0.0 | | 0.0 | | .7 | |

*Mostly insect galls.

Selection of succulent foods

The availability of water did not appear to influence the selection of foods by chukars. The average proportion of succulent foods per crop for 76 birds collected in late September was 64 percent for both ranges. The magnitude of the 95 percent confidence limits on these population means, shows that on both ranges, there was substantial variation among individual chukars (Table 9).

Table 9. Confidence limits on the average percentage of succulent foods per crop in the last week of September, 1969.

| Location | Sample Size | Average Percent Succulent Foods | 95% Confidence Limits on Population Means |
|---|---|---|---|
| Dugway | 34 | 64.00 | $50.76 < \bar{X} < 77.24$ |
| Thomas | 42 | 63.79 | $51.21 < \bar{X} < 76.37$ |

## Hunter Success

The study area was heavily used by hunters during the opening weekends of both hunting seasons (late September and early October). Thereafter, hunting pressure was sporadic and much lower. By November, most birds had moved to high slopes and hunter success had diminished.

During the first weekend of the hunting season each year, approximately 75 percent of the hunters on the area were questioned. The unmanned checking station on the Delta access road failed to provide any usable data.

The hunter success as measured by birds/hunter as well as by birds/hunter-hour was slightly higher on the Dugway Range than on the Thomas Range both years. However, a chi-square test of birds/hunter-hour for the two ranges indicates no statistically significant differences at the 90 percent confidence level. Messerli (1970) reported in 1968, 59 hunters were questioned and had bagged 4.6 birds/hunter. In subsequent years, numbers of hunters increased while hunter success decreased. In 1969, 110 hunters bagged 281 chukars, averaging .348 birds/hunter-hour on the Dugway Range and .287 birds/hunter-hour on the Thomas Range. In 1970, 141 hunters bagged 157 birds averaging .171 birds/hunter-hour on the Dugway Mountains and .147 birds/hunter-hour on the Thomas Mountains (Tables 10 and 11).

Table 10. Hunter success during the first weekend of chukar season, 1969.

| Location | Hunters | Hunter-Hours | Birds | Birds/Hunter | Birds/ Hunter-Hour |
|---|---|---|---|---|---|
| Dugway | 71 | 549.0 | 191 | 2.65 | .348 |
| Thomas | 39 | 313.5 | 90 | 2.30 | .287 |
| Totals | 110 | 862.5 | 281 | 2.55 | .326 |

Table 11. Hunter success during the first weekend of chukar season, 1970.

| Location | Hunters | Hunter-Hours | Birds | Birds/Hunter | Birds/ Hunter-Hour |
|---|---|---|---|---|---|
| Dugway | 96 | 661.0 | 113 | 1.18 | .171 |
| Thomas | 45 | 299.5 | 44 | .98 | .147 |
| Totals | 141 | 960.5 | 157 | 1.11 | .163 |

## Life History Information

### Habitat utilization

Chukars were always closely associated with steep, rocky slopes. The greatest distance from the base of the mountains that chukars were seen was about one mile in a large wash with steep sides. Seventy-four percent of the 1,624 birds for which detailed information was recorded during late spring and summer seasons, were within 20 yards of steep, rocky slopes.

A second important habitat type appeared to be the grassy flats at the bottoms of canyons. Here the soil and herbaceous growth were thickest. Eighty-three percent of the same 1,624 observations of chukars for which detailed data were recorded were within 20 yards of such a habitat type.

Shade was a factor of habitat that was frequently exploited by the birds during the hottest hours of summer days. At such times, chukars became inactive and were most commonly found under juniper trees, in the shade of rock outcroppings, or in the mouths of abandoned mines.

By mid-November, the birds appeared to make an abrupt change in the habitats utilized. Throughout the winter, chukars spent much time on high, rocky slopes, seldom concentrating in the grassy flats of canyon bottoms and mouths. Large piles of droppings were frequently found on ledges of steep, sunny slopes. During the winter months, the green grasses that comprised most of their diet were abundant at the bases of cliffs and the lower edges of rock outcroppings.

Emigration

Several observations indicated the possibility of chukar emigration from the study area. The 200 birds released in the Black Rock Hills control area in 1967 were never positively relocated and it is clear that they did not remain in the release area. A movement of five miles east would put them in the main part of the Thomas Range in the vicinity of guzzlers number 7 and 8, where one uncertain observation of a bird wearing a red tag used on the control birds was made in 1969. A movement of five miles to the west would put them on the Fish Springs Mountains, where a population was regularly observed in the summers of 1969 and 1970.

Another possible emigration was indicated by reports of Army biologists that a population of chukars inhabits Granite Mountain, five miles north of the Dugway Range. This mountain is located on restricted land in Dugway Proving Grounds and the possibility of deliberate release is remote.

In all three of these examples, the intervening habitat over which emigration would have had to occur is alkaline flats with scrub vegetation.

## Productivity

Productivity was assessed from the age ratios of birds killed by hunters. Table 12 summarizes this information for both years and each mountain range. In 1969 the Dugway Range appeared to be significantly more productive. However, in 1970, there was virtually no difference between the two ranges.

Table 12. Age ratios of birds killed during the opening weekends of hunting season in 1969 and 1970 on the Thomas and Dugway Mountain Ranges.

| 1969 | | 1970 | |
|---|---|---|---|
| Dugway | Thomas | Dugway | Thomas |
| 666J:100A<br>92 Birds | 353J:100A<br>68 Birds | 56J:100A<br>86 Birds | 61J:100A<br>29 Birds |

## Predation and mortality

Direct evidence of predation was found only once. A freshly killed chukar with a large part of its head and breast missing was found in an area where a prairie falcon (Falco mexicanus) had been seen the preceding day.

Although numerous incidences of raptors frightening chukars by their presence were observed, no interest in the chukars was demonstrated by the hawks.

In the same area, Messerli (1970) reported evidence of predation by raptors, snakes, and bobcats as well as one nest predation by a woodrat (Neotoma lepida). The same investigator also found 14 juvenile chukars

drowned in drinking basins. A large rock was placed in one corner of each basin during this study and no drownings occurred.

# DISCUSSION AND CONCLUSIONS

The effects of sources of surface water upon the chukars in this study were complex. Only after weighing and interpreting the various results can conclusions about the chukars' need for water and the feasibility of rain-catchment devices as a management technique be drawn.

A number of results obtained in this study indicated that drinking water may not actually be essential to the welfare of these birds.

1. Distribution of chukars during the nesting season did not appear to be correlated with water availability. The difference in density between the area within one-half mile from the water is too small to be statistically or biologically significant (Figure 10).

2. Although some broods were raised in areas devoid of all surface water, the age ratio of chukars on the Dugway Range in 1969 indicated successful reproduction. After most water sources had been removed from that range for more than a year, the 1970 age ratio indicated that productivity was equivalent to that of the Thomas Range where guzzlers remained functional (Table 12).

3. In August and September, chukars were repeatedly found two or three miles from the nearest source of water and were undoubtedly subsisting without surface water other than that provided by rain.

4. In some cases, chukars marked at guzzlers that were subsequently turned off were found in the same vicinity as long as 28 months after water availability was removed (Figure 12).

5. Although June and July weather was typically hot and dry, guzzler use was low and sporadic during these months (Figure 13).

6. Observations of marked chukars at guzzlers indicated that many birds did not drink at a regular hour each day or on a daily basis (Table 6).

7. Although moist foods made up a substantial proportion of the food taken by chukars, there appeared to be no compensation for lack of drinking water by selecting more succulent foods. In fact, even in waterless areas some crops were found to contain only dry seeds (Table 9).

8. Hunter success in waterless areas was equivalent to that in areas with water (Tables 10 and 11). The removal of water from one of the ranges did not appear to effect the density of the chukars. Birds concentrated around water sources were quickly scattered when heavily hunted and offered little advantage to the hunter.

9. Chukars may have emigrated from the study area to Fish Springs Mountains where they have increased in numbers. Some of these birds seem to be living without the use of permanent sources of water.

There were also a number of results that may indicate surface water was important to the chukars and that rain-catchment devices are effective management tools.

1. By August, there was a definite concentration of chukars around sources of water. Although smaller numbers of birds could still be found farther from water, the density within one-half mile of the water was twice that of other areas (Figure 11). When compared with spring distribution, this

evidence indicates a movement of chukars to sources of water during the summer months.

2. None of the 200 chukars released on the waterless Black Rock Hills remained in that area.

3. Birds that were marked at guzzlers that were subsequently turned off, tended to move farther and sooner than those released at guzzlers that remained functional.

4. Chukars used all available sources of drinking water including a saline spring.

Before weighing the negative and positive evidence in regard to the significance of water to chukars, it is important to consider several other factors.

Although both summers in this study had periods of several weeks during which no precipitation occurred, the annual rainfalls for both years were above normal. There is substantial evidence that the chukars could survive without any surface water when range conditions are as they were during this study. However, it is not known what effects a drought year might have on the availability of succulent foods and consequently on the chukars' need for drinking water. Succulent foods comprised about 60 percent of the food in an average crop during the late summer. If this source of water were not available, the birds would have to rely on water produced as a by-product of oxidative metabolism. Although in terms of water conservation, the uricotelic mechanism of excretion used by all birds is very efficient, authorities doubt that any normally active bird can satisfy its water requirements by oxidative water alone (Bartholomew and Cade, 1963).

Working with Gambel's quail in southern Utah, Nish (1964) found that during dry years, the population declined drastically in spite of the availability of water. This decline was thought to be caused by low precipitation and the resultant poor food availability. A shortage of food was believed responsible for poor production of chukars in Nevada during drought years (Christensen, 1970). Since guzzlers have no influence on food production, in dry years, declines in the population of chukars would be expected in spite of water availability.

It is difficult to separate the roles of food availability and deliberate selection in determining the food habits of chukars. However, certain foods did appear to be chosen in preference to others. Although cheatgrass seeds were abundant throughout the summer, Indian ricegrass seeds, readily available only in May and June and much less abundant than cheatgrass seeds, were taken in larger quantities in these months.

Likewise, the birds seemed to switch from seeds to invertebrates when insects became more plentiful in July through September. Green grass blades appeared to be taken in quantity only in winter months when seeds and insects were not available. To some extent these preferences indicate selection of the most nutritious foods available. It is not known if the apparent selection of invertebrates over seeds was influenced by a need for foods containing more water.

Although turning off the guzzlers on the Dugway Range left large areas and many birds without permanent sources of drinking water, two natural springs remained. Consequently, the Dugway Range was not completely devoid of water and contrasts between the two ranges may have been reduced.

In a previous study, the Black Rock Hills were chosen as a waterless control area to determine if a permanent chukar population would be established. Close examination of this area indicated that it may not have been a valid control. At least one factor other than water appeared to be deficient. There was a definite lack of substantial stands of grasses, one habitat type with which chukars seem to be closely associated. Furthermore, the birds would need to emigrate only five miles west or east to find suitable habitat.

Chukars on both ranges had low reproductive success in 1970. Earlier in the spring, nearly all birds were paired indicating that nesting was attempted. The probable cause of the failure to bring off normal clutches was a heavy rainstorm during the second week of June. In 1969, nearly all clutches were hatched during the first week of June. Similar synchrony of nesting in 1970 would have resulted in most juveniles being under 10 days old during this storm and possibly vulnerable to this adverse environment. Christensen (1970, p. 45), reported that adverse weather in May and early June can cause chick mortality.

The fact that concentration of birds around water sources did not improve hunter success may be explained by the high hunting pressure. Most hunting occurred during the opening weekend of the season and was focused in the vicinity of the guzzlers. As a result, the birds quickly dispersed, with few hunters being able to capitalize on these concentrations. Later in the season, while chukars still utilized the guzzlers and when hunting pressure was reduced, a few hunters reported that birds were readily available at water sources. In

1968, Messerli (1970) found substantially higher hunter success and much lower hunting pressure than occurred during 1969 and 1970. The lower pressure probably enabled the hunters to exploit concentrations of chukars at guzzlers.

The installation costs of guzzlers was estimated by a state official at approximately $500 each. Given the necessary maintenance, they should remain indefinitely functional. However, it was obvious during this study that to insure uninterrupted operation, each drinking basin should be cleaned and adjusted at least once during the summer and preferably twice. The need for periodic maintenance of these guzzlers was also stressed by Messerli (1970).

There is much evidence from this study that permanent sources of water were not essential to the well-being of these birds. Rain-catchment devices did not improve the productivity of chukars or their availability to hunters. All evidence indicating a need for drinking water was subjective, based on the birds' use of water and concentration around it. No detrimental effects to the welfare of the chukars were caused by the removal of water. Unless the importance of guzzlers is greatly increased during drier years, their installation is not a feasible management technique for chukar partridge in habitats comparable to this study area.

# RECOMMENDATIONS

1. In order to evaluate the effectiveness of guzzlers for improving chukar habitat during drought years, the guzzlers on the Dugway Range should remain non-functional until after such conditions have occurred. Then a comparison should be made of the Dugway chukar population with the population of the Thomas Range (with functional guzzlers).

2. In future years, these populations of chukars should be compared using hunter success data and age ratios of hunter kills. These data could be collected at a hunter checking-station during the first weekend of each hunting season.

3. Unless future evidence indicates otherwise, chukar management policies should not include installation of guzzlers in habitats comparable to this study area.

# SUMMARY

Research was conducted during 1969 and 1970 to determine the effects of available water on the populations of chukar partridges and to evaluate rain-catchment devices as a technique for improving chukar habitat in arid regions. The study was done on the Thomas and Dugway Mountain Ranges in Juab and Tooele Counties, Utah.

The basic design of the study was to evaluate the effects of removing most permanent sources of water from one of the two ranges and later to compare the chukar populations on the two ranges. Among the methods used were extensive censusing, trapping and marking of chukars, collecting and analyzing stomach contents, questioning hunters for success data, and aging wings of harvested chukars.

The spring distribution of chukars did not appear to be influenced by the availability of water. Chukars nested throughout the study area. In summer months, most birds concentrated around sources of water and guzzler use increased to a maximum in late August. However, some chukars appeared to be living without use of any permanent water sources. In winter months, the birds inhabited rocky slopes high on the mountains.

Chukars marked at guzzlers that remained functional throughout the study tended to move less than those marked at guzzlers that were subsequently turned off. Most drinking was done during mid-morning. Observations of marked birds indicated that many did not drink at a regular hour on a daily

basis. Several chukars were observed drinking water from a saline spring. The salt content was 20 percent that of sea water.

The food habits of chukars did not appear to be influenced by the availability of water. In September, about 60 percent of the food in an average crop from either mountain range was succulent types.

Hunter success was not affected by removal of sources of surface water. In 1970, success dropped substantially throughout the study area. This was believed to be a result of a severe storm in early June that caused very low nesting success and productivity. In both years, hunter success was equivalent on the two ranges.

It was concluded that in these years, water provided by guzzlers failed to improve chukar productivity, survival or availability to hunters. The results of this study indicated that unless drinking water is far more important to chukars in drier years, installation of rain-catchment devices in comparable habitats is not a feasible management technique.

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# APPENDIX

Table 13. Comparison of ground cover between 6 guzzler sites in Juab County, Utah, 1968. (From Messerli, 1970, p. 19).

| Ground Cover | Percent Ground Cover | | | | | |
|---|---|---|---|---|---|---|
| | Guzzler Number | | | | | |
| | 1 | 3 | 4 | 6 | 9 | 12 |
| Bare Ground | 39.4 | 16.9 | 33.0 | 32.9 | 27.7 | 38.7 |
| Rock | 7.8 | 22.5 | 17.4 | 24.4 | 9.6 | 18.3 |
| Cheatgrass | 19.5 | 33.4 | 17.6 | 26.2 | 19.2 | 1.2 |
| Broom Snakeweed | 8.5 | 5.5 | 6.9 | 2.6 | 8.5 | 9.1 |
| Big Sagebrush | 11.4 | 3.9 | 3.7 | 3.7 | 7.3 | 3.4 |
| Indian Ricegrass | 4.0 | 1.7 | 1.9 | 0.8 | 3.4 | 2.8 |
| Horsebrush | 3.4 | 4.6 | 4.0 | 0.2 | 8.1 | 5.2 |
| Utah Juniper | 1.9 | 2.7 | 2.6 | 2.2 | 1.7 | 4.7 |
| Galleta Grass | 1.2 | 0.8 | 0.4 | 0.0 | 0.0 | 0.2 |
| Winterfat | 0.9 | 0.2 | 0.0 | 0.1 | 0.4 | 0.0 |
| Shadscale | 0.8 | 0.0 | 1.0 | 0.0 | 9.7 | 6.3 |
| Bluebunch Wheatgrass | 0.6 | 4.3 | 6.4 | 2.2 | 1.9 | 3.3 |
| Mormon Tea | 0.4 | 0.2 | 0.9 | 0.1 | 0.1 | 0.7 |
| Squirreltail Grass | 0.3 | 0.0 | 0.0 | 0.1 | 1.9 | 0.0 |
| Rubber Rabbitbrush | 0.2 | 0.0 | 0.9 | 0.7 | 0.0 | 0.0 |
| Cliffrose | 0.1 | 0.5 | 1.9 | 0.0 | 0.0 | 0.4 |
| Bluegrass | 0.1 | 0.0 | 0.0 | 0.3 | 0.0 | 0.0 |
| Curlleaf Mahogany | 0.0 | 0.5 | 0.0 | 2.5 | 0.0 | 0.0 |
| Split-leaf Mallow | 0.0 | 0.3 | 0.0 | 0.0 | 0.0 | 0.0 |
| Tansymustard | 0.0 | 1.6 | 0.0 | 0.0 | 0.0 | 0.0 |
| Fourwing Saltbush | 0.0 | 1.0 | 0.0 | 0.0 | 0.0 | 1.1 |
| Needle and Thread Grass | 0.0 | 0.0 | 0.6 | 0.3 | 0.0 | 3.0 |
| Stemless Goldenweed | 0.0 | 0.0 | 0.5 | 0.5 | 0.0 | 0.3 |
| Phlox | 0.0 | 0.0 | 0.3 | 0.2 | 0.0 | 0.0 |
| Malcomia | 0.0 | 0.0 | 0.2 | 0.3 | 0.0 | 0.0 |
| Spiny Hopsage | 0.0 | 0.0 | 0.0 | 0.2 | 0.0 | 0.0 |
| Halogeton | 0.0 | 0.0 | 0.0 | 0.1 | 0.6 | 0.0 |
| Bud Sagebrush | 0.0 | 0.0 | 0.0 | 0.0 | 0.2 | 0.0 |
| Princes Plume | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 |

Table 14. Scientific and common names of plants mentioned in the text.

| Scientific Name | Common Name |
|---|---|
| Agropyron spicatum | Bluebunch wheatgrass |
| Amaranthus blitoides | Amaranth |
| Artemisia spinescens | Bud sagebrush |
| Artemisia tridentata | Big sagebrush |
| Astragalus spp. | Locoweed |
| Atriplex spp. | Saltbush |
| Bromus tectorum | Cheatgrass |
| Cercocarpus ledifolius | Mountain mahogany |
| Chorispora tennella | Chorispora |
| Chrysothamnus spp. | Rabbitbrush |
| Cleome serrulata | Bee plant |
| Cowania mexicana | Cliffrose |
| Descurainia pinnata | Tansymustard |
| Elymus cinereus | Wild rye |
| Ephedra spp. | Mormon tea |
| Erodium cicutarium | Storksbill |
| Euphorbia glyptosperma | Spurge |
| Eurotia lanata | Winterfat |
| Grayia spinosa | Spiny hopsage |
| Gutierrezia sarothrae | Broom snakeweed |
| Halogeton glomeratus | Halogeton |
| Haplopappus acaulis | Goldenweed |
| Helianthus annuus | Sunflower |
| Hilaria jamesii | Galleta |
| Juniperus osteosperma | Utah juniper |
| Lappula redowskii | Stickseed |
| Lithospermum incisum | Stoneseed |
| Lycium pallidum | Matrimony vine |
| Malcolmia africana | Malcolmia |
| Oryzopsis hymenoides | Indian ricegrass |
| Phlox spp. | Phlox |
| Poa spp. | Bluegrass |
| Salsola kali | Russian thistle |
| Secale cereale | Domestic rye |
| Sitanion hystrix | Squirreltail |
| Sphaeralcea coccinea | Globemallow |
| Stanleya pinnata | Princesplume |
| Stipa comata | Needle and thread |
| Tetradymia spp. | Horsebrush |

Common names were derived from Holmgren and Reveal's (1966) Checklist of the Vascular Plants of the Intermountain Region.

## Appendix B

## Hunter Questionnaire

THANK YOU FOR STOPPING. The chukar population of this area is being intensively studied by the Division of Fish and Game and the Utah Cooperative Wildlife Research Unit. Results of this research will serve to guide future chukar management in Utah. Your cooperation in filling out this questionnaire is greatly appreciated.

ONE PERSON PER PARTY PLEASE ANSWER THE FOLLOWING:

1. Date of hunt _____ 2. Time at start of hunt _____

3. Time at end of hunt _____ 4. Number of hunters in party _____

5. Total chukars bagged by party _____ 6. If you hunted this area in previous years, how would you compare success? _____

_____

7. How many hunters, other than your party, did you see? _____

8. General area hunted

| Dugway Mountain Range | | Thomas Mountain Range | |
|---|---|---|---|
| Dugway Pass area | _____ | East Face Thomas Range | _____ |
| East Face Dugway Range | _____ | West Face Thomas Range | _____ |
| West Face Dugway Range | _____ | Topaz Mountain | _____ |
| Fandangle Canyon | _____ | Spore Mtn. Mining Area | _____ |
| Other | _____ | | _____ |

9. If you do not object to being contacted for further information, please write your name and address on the reverse side of this questionnaire.

**PLEASE LEAVE ANY BANDS AND TAGS THAT WERE ON YOUR BIRDS AND ONE WING FOR AGING FROM EACH CHUKAR IN THIS ENVELOPE AND PLACE IT IN THE BOX PROVIDED. IF YOU HUNTED IN MORE THAN ONE AREA PLEASE DESCRIBE THE GENERAL LOCATION WHERE ANY TAGGED OR BANDED BIRDS WERE BAGGED.

THANK YOU

UTAH STATE DIVISION OF FISH AND GAME

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