THE

Chukar Partridge

Its Introduction, Life History, and Management

By
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April, 1970

"First of all let it be understood that I am not one of those sentimental individuals who think that only native species should be used in any restocking program. It matters little to me whether a bird is native to the United States or comes from Asia, Africa, or the islands of the seas."

—August Bade, 1937

FOREWORD

"The Chukar Partridge in Nevada," Biological Bulletin No. 1, was published by the Nevada Fish and Game Commission in 1954. This bulletin has been out of print for over 10 years. Since its publication the chukar has been successfully introduced into a number of Western States and Canada. In addition they have extended their range in states where they were initially successful.

This bulletin is essentially a revision of my original work, with emphasis on Nevada, so that it may once again be available to the many sportsmen, wildlifers and other interested persons who have requested copies. At the same time, I have also taken this opportunity to expand upon its contents by attempting to include and update the pertinent introductions and life history and management studies that have been made since 1954 in the Western World in particular, and the remainder of the world in general.

GLEN C. CHRISTENSEN
27 Feb. 1970

Addendum

This edition is an unabridged publication, with minor corrections by the author, of the work first published in 1970. This reprinting was made possible through the efforts of Shawn Espinosa, Game Div., NDOW. It has been adapted for Reprinting and Internet use by Espinosa and Lisa Paul of Archetype Book Composition and proofed by the author. Funding for the document's recreation and reprinting was provided by Nevada Upland Game Stamp proceeds.

GLEN C. CHRISTENSEN
June 2008
Pahrump, NV

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INTRODUCTION

Nevada opened the gates to a new form of recreation in the United States with a 2-day hunting season on the chukar partridge in 1947. Thus, Nevada was shooting for the first time a bird that nearly every state in the Union had attempted to establish, at one time or another, over a period of 54 years.

The first four hunting seasons were not spectacular. This was due to the hunters' unfamiliarity with the chukar's habits, spotty but expanding populations and the characteristic roughness of its habitat. Then in 1951 conditions changed. Chukars were plentiful and the hunters began to find their mark. This was the first big year for the chukar hunter and almost overnight the bird was elevated to the rank of the state's most popular upland game bird.

In January, 1952 the Nevada Fish and Game Commission, under the Federal Aid to Wildlife Restoration Act, established a chukar partridge study. Data collected during the first two years of the study were combined with the findings I made in 1951, which were sponsored by a grant-in-aid from the Wildlife Management Institute and incorporated into the first bulletin. Most of the emphasis in Nevada after 1954 has been placed upon the development of satisfactory management practices, particularly methods for determining and evaluating production and population trends and in collecting production and harvest data. Assistance has been provided in initiating several special food studies and sexing and aging studies that were performed by both undergraduate and graduate students of various universities.

ACKNOWLEDGMENTS

For many years I have recognized the necessity of revising my bulletin "The Chukar Partridge in Nevada" and also in meeting my commitment, as expressed in the foreword of that bulletin, to follow it with a second publication that would encompass the subsequent research and management findings. As the years passed by, 16 of them to be exact, and the demand for the earlier bulletin still had not diminished, it became apparent that I could not delay any longer. The interest and encouragement that have been expressed toward the publication of the present bulletin has contributed substantially toward sustaining my efforts in writing it.

I owe a great deal of gratitude to many sportsmen, wildlifers and nature lovers whom I have been fortunate enough to associate with in the Western States and in India, Pakistan and Afghanistan. The exchange of ideas that has occurred will undoubtedly leave an impression on this work. The unanimous response of Fish and Game personnel throughout the United States, Canada and New Zealand to my questionnaire concerning introductions and hunting was deeply appreciated.

I am particularly indebted to the present State Board of Fish and Game Commissioners and the former members of the Nevada Fish and Game Commission who have supported and financed Nevada's chukar partridge programs over these many years. To the game biologists of the Nevada Department of Fish and Game, who have gathered and documented a great deal of the survey data used in this publication, I can only say that I hope this is worthy of their efforts.

Specifically, Mr. Joe Greenley, Chief of Game, has continually encouraged the implementation and completion of this project and he backed it up by making sure I had the time to do it. Joe Greenley, Fred Wright, Glen Griffith, Gene McDowell, Nils Nilsson and Bill Rollins reviewed and commented on the manuscript and our secretary, Cecil Clipper, suffered through the preparation. Nick Wilson prepared the illustrations.

Dr. Ira La Rivers, University of Nevada, started all of this 20 years ago when he said "why don't you do graduate work on the chukar partridge"—at that time a little known, and rather recently introduced, exotic. He has to this day continued to offer sound advice and help whenever needed.

In conclusion my wife Georgia has managed to raise a family in spite of an absentee husband and I suspect she might have a few words to say, and no doubt most of them would be complimentary, about that sassy chukar bird.

Background

THE RED-LEGGED PARTRIDGES OF THE WORLD

Peters (1934) lists four species of red-legged partridges in the genus *Alectoris*: the rock partridge, *A. graeca* (Meisner) embracing 22 subspecies that include the various "chukars" that have been introduced into North America and other parts of the world; the French and Spanish redlegs, *A. rufa* (Linne), which includes 5 subspecies; the Barbary partridge, *A. barbara* (Bonnaterre), with 2 subspecies; and the monospecific Arabian red-legged partridge, *A. melanocephala* (Rüppell).

As might be expected when dealing with a genera of birds that has a widespread distribution embracing a variety of habitats, often in remote parts of the world, there have been numerous opinions as to the differentiation of the various species and subspecies. Meinertzhagen (1954), for example, describes two subspecies of the Arabian red-legged partridge. A number of authorities in the past, among whom Gray (1830) and Hume and Marshall (1880) were prominent, felt that the Indian subspecies of the rock partridge (which is probably the subspecies that has been predominantly introduced into the United States) should be considered as a separate species. Sushkin (1927) expanded on this concept and felt that all of the forms of the rock partridge from Turkey eastward (excepting *magna*) should form a separate species called *A. chukar.* Other taxonomists such as Hartert (1917), Baker, E. C. S. (1928) and Hellmayr (1929) felt that all rock partridge should be considered as one species, *A. graeca.*

In evaluating these opinions in light of a more recent study done by Watson (1962 a and b) it would appear that a total of seven species of red-legged partridges should be considered today. Watson has followed Sushkin's lead in separating the rock partridge into two distinct species (Christensen, 1969), the Greek or rock partridge (*A. graeca*) and the chukar partridge, *A. chukar* (Gray), and both have maintained the great red-legged partridge, *A. magna* (Przevalski), as a separate species. In addition Watson indicates that Philbyi's red-legged partridge, *A. philbyi* Lowe, should also be considered a species.

In accepting the above nomenclature the species that is the subject of this publication still is commonly known as the "chukar." However, the scientific name *A. graeca,* which has been applied to it in the past, refers now to the "rock" partridge of Greece and Italy, while *A. chukar* is the proper designation for the Asiatic species that we are primarily concerned with. The general distribution of the red-legged partridge by species as well as the more important subspecies is depicted in Figure 1.

THE CHUKAR PARTRIDGE IN NORTH AMERICA, HAWAIIAN ISLANDS AND NEW ZEALAND

The chukar partridge has been introduced successfully into North America, the Hawaiian Islands and New Zealand.

The first introduction made into North America was in 1893 when W. O. Blaisdell of Illinois brought in five pairs of chukars from Karachi, India (Cottam *et al.,* 1940). Following the initial introduction a majority of the states and Canadian Provinces have made attempts to establish this game bird. True (1937) stated that the Indian subspecies of the chukar was introduced into California, and Cottam *et al.* (1940) believed that this same subspecies predominated in the various importations made into other States of the Union. Ridgway and Friedmann (1946) believed that at least three subspecies were involved in the introductions into the United States, probably hopelessly mixed. Specimens taken in Nevada by the author in 1951 seemed to most closely resemble the Indian variety, *A. c. chukar*[1]; however, since there have been several sources of introduction into Nevada, as well as other states and Canadian Provinces, it is entirely possible that some of the adjacent subspecies were brought into this country. The most likely ones would appear to be *A. c. koroviakovi* and *A. c. pallida,* both probably being exported from the Port of Karachi (see Figure 1). For purposes of simplification, whatever the heritage of these original imports, the subsequent amalgamation of subspecies (if such did occur) that has proven to be so successful in the Western United States shall be referred to as the "Indian Chukar" (*A. c. chukar*).

[1]Identified by Dr. Dean Amadon, American Museum of Natural History.


Atlantic
IRE
SCOT
ENGLAND
SPAIN
FRANCE
BELG
NETH
ALGERIA
SWITZ
ITALY
YUGOSLAVIA
TUNISIA
SIC
ROMANIA
ALB
GREECE
BULGARIA
Mediterranean
Black Sea
LIBYA
TURKEY
KAZAKHSTAN
SYRIA
EGYPT
Caspian Sea
UZBEK
S.S.R.
TURKMEN
KYRGYZ
JORDAN
IRAQ
IRAN
SUDAN
SAUDI ARABIA
AFGHANISTAN
Red Sea
Persian Gulf
PAKISTAN
INDIA
ETHIOPIA
Gulf of Aden
BRITISH SOMALILAND
Arabian Sea

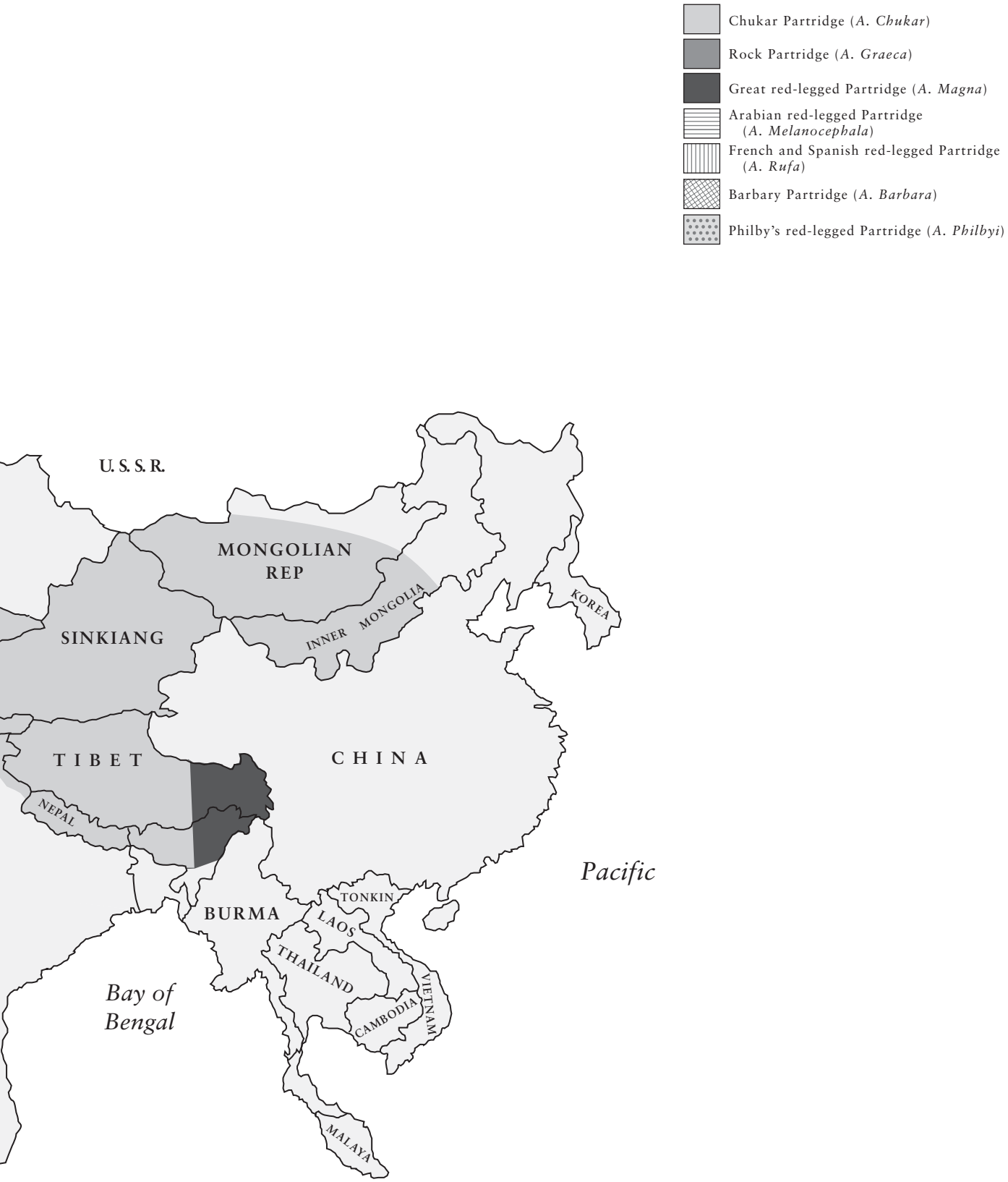


FIGURE 1. Distribution of the red-legged partridge of the world.

As a result of the Foreign Game Introductions Project of the Bureau of Sport Fisheries and Wildlife one other subspecies, the Turkish chukar (*A. c. kleini*), was introduced into several Western States commencing in 1951.

One of the most notable efforts to establish this variety was made in New Mexico, which had previously failed to establish the Indian chukar. It appears, in this case, that the Turkish chukar will meet the same fate. Eight states are known to have released Turkish chukars (Arizona, California, Hawaii, Nebraska, Nevada, New Mexico, Utah and Wyoming) and the individual effort varied from numerous releases totaling 20,000 birds in New Mexico to one trial release of 54 birds in Nevada. In all of the states where the Turkish chukar has been released there has been prior and/or subsequent introductions of the Indian chukar. I know of no instance where it is possible to discern the contribution of the Turkish chukar. An overall evaluation of the Turkish chukar releases in relation to Indian chukar releases indicates that the Turkish bird has had little impact upon the general establishment of the chukar in North America or the Hawaiian Islands, having either failed entirely or become absorbed by the Indian chukar.

In North America, chukar partridges have been released by game departments, sportsmen's clubs or interested individuals in 42 states and 6 Canadian Provinces. Chukars have become established and are being hunted in 10 states (Arizona, California, Colorado, Idaho, Montana, Nevada, Oregon, Utah, Washington and Wyoming) and in one Canadian Province (British Columbia). There is a small area inhabited by chukars, as a result of nearby California releases, in Baja California, Mexico. The status is still uncertain in Nebraska, New Mexico, South Dakota and Texas and it appears possible that through the application of a selective sustained release program based on current knowledge of environmental requirements, this bird can attain establishment in portions of South Dakota and in Southwestern Texas where only limited releases have been made (see Figure 2).

It is interesting and encouraging to note that in 1954 a poll of the states (Christensen, 1954) showed that only California, Idaho, Nevada and Washington considered the chukar as being successfully established and were holding a hunting season on them (Hawaii is not included in this section). At that time eight additional states listed the chukar status as uncertain or hopeful. According to a poll taken in 1968, six of these states (Arizona, Colorado, Montana, Oregon, Utah and Wyoming) now have well established populations and are hunting this magnificent game bird. Since 1954 approximately 471,000 chukars have been released in the Continental United States (more than doubling the total number of chukars released between 1893–1954). The emphasis, and properly so, has been in the west. Most states that were obviously unsuited for the chukar discontinued their release programs. States that were on the verge of success increased their efforts and states that were already successful continued releasing birds to extend their range into suitable unoccupied habitats. As game management came of age, the recent history of chukar partridge releases in the United States (1954–1968) reflected a determination on the part of state biologists to compare, evaluate and plan so that the ultimate goal of establishment could, in the majority, result in success. Table 1 presents a synopsis of chukar releases and establishment in North America and Hawaii.

In the Hawaiian Islands the story of the establishment of the chukar is essentially the same as in North America. The first introductions were with the Indian chukar in 1936 and in recent years some Turkish birds were tried. The chukar has become established in six islands: Oahu, Kauai, Maui, Lanai, Molokai and Hawaii (see Figure 3).

The chukar partridge presently occupies approximately 100,000 square miles of habitat in North America and Hawaii.

According to Williams (1950) the first chukar partridges, presumably the Indian subspecies, arrived in New Zealand in 1920; however, these birds all died. A second importation was made in 1925, but since permission for a release was not granted these birds were placed in a zoo. Two liberations were made in 1926 and both were considered successful. The year 1932 was a banner one during which four importations and six liberations were made. It is known that 192 of the birds came from Quetta, Pakistan and, therefore, belonged to the Persian race (*A. c. koroviakovi*). In all, approximately 500 birds were released through 1949 (17 releases on the South Island and 2 releases on the North Island) using primarily wild imported birds. As a result of population expansion and subsequent movements, the chukar is now thoroughly established on the South Island of New Zealand (see Figure 3). The first hunting season was declared in Ashburton in 1934. Williams (pers. comm., 1970) has stated that the current chukar populations in New Zealand are not as high as they were in 1950 and he

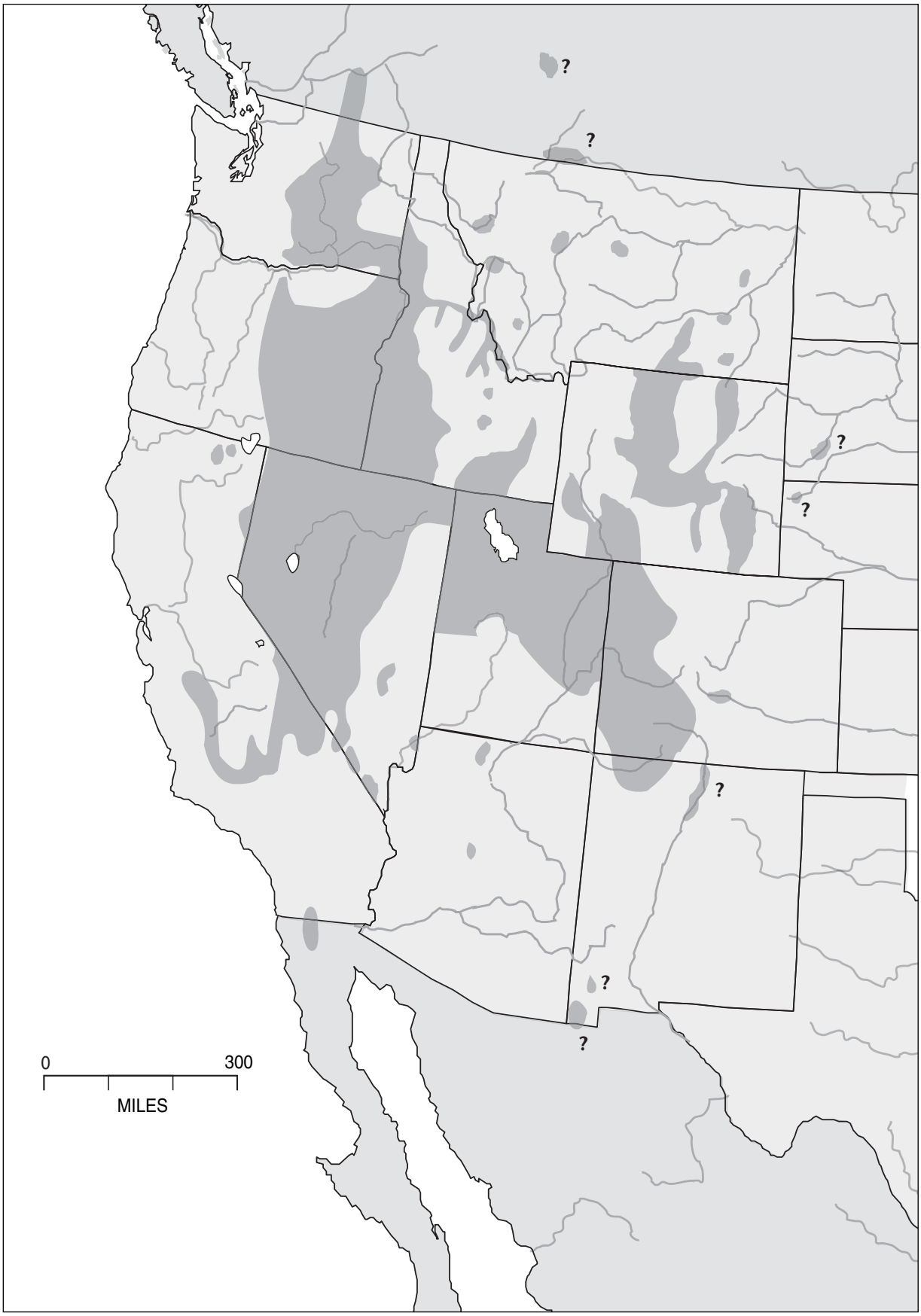


FIGURE 2. Distribution of the chukar partridge in North America.

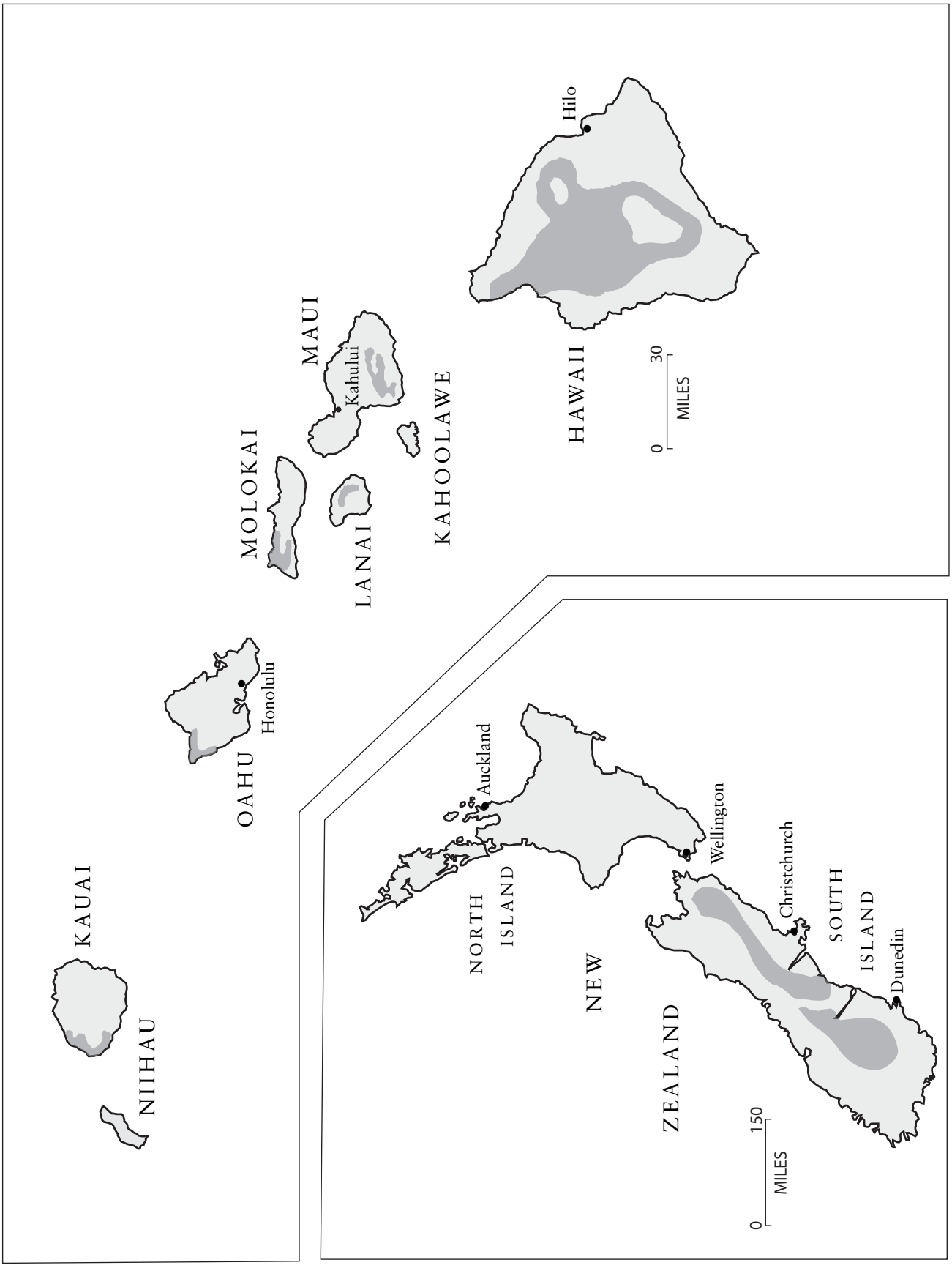


FIGURE 3. Distribution of the chukar partridge in Hawaii and New Zealand.

TABLE 1. Synopsis of Chukar Releases and Establishment

UNITED STATES

State	Date of first release	Total birds released	Status of release
ALABAMA	1939	720	Failure
ALASKA	1938	?	Failure
ARIZONA	1936	11,737	Limited success
ARKANSAS	None	0	...
CALIFORNIA	1932	55,000+	Success
COLORADO	1939	24,080	Success
CONNECTICUT	1940	1,500	Failure
DELAWARE	None	0	...
FLORIDA	?	Few	Failure
GEORGIA	None	0	...
HAWAII	1936	538	Success
IDAHO	1933	25,710	Success
ILLINOIS	1938	9,000	Failure
INDIANA	1937	7,500	Failure
IOWA	1938	1,847	Failure
KANSAS	1937	7,879	Failure
KENTUCKY	1951	5,480	Failure
LOUISIANA	?	Few	Failure
MAINE	None	0	...
MARYLAND	None	0	...
MASSACHUSETTS	?	500	Failure
MICHIGAN	?	Few	Failure
MINNESOTA	1937	85,000	Failure
MISSISSIPPI	?	Few	Failure
MISSOURI	1937	1,838	Failure
MONTANA	1933	7,854	Success
NEBRASKA	1938	28,142	Uncertain
NEVADA	1935	13,655	Success
NEW HAMPSHIRE	1938	130	Failure
NEW JERSEY	1938	0	...
NEW MEXICO	1931	31,000	Uncertain
NEW YORK	None	0	...
NORTH CAROLINA	1938	449	Failure
NORTH DAKOTA	1938	5,600	Failure
OHIO	1935	20	Failure
OKLAHOMA	1940	Several thousand	Failure
OREGON	1951	113,675	Success
PENNSYLVANIA	1935	2,377	Failure
RHODE ISLAND	?	Few	Failure
SOUTH CAROLINA	1940	200+	Failure
SOUTH DAKOTA	1937	1,831	Uncertain
TENNESSEE	1938	5,824	Failure
TEXAS	1938	703	Uncertain
UTAH	1936	185,911	Success
VERMONT	None	0	...
VIRGINIA	1938	100	Failure
WASHINGTON	1931	50,920	Success
WEST VIRGINIA	1949	4,429	Failure
WISCONSIN	1936	43,013	Failure
WYOMING	1939	60,000	Success
Total United States		**795,000**	

TABLE 1. *continued*

CANADA

Province	Date of first release	Total birds released	Status of release
ALBERTA	1937	3,026	Probable failure
BRITISH COLUMBIA	1950	2,606	Success
MANITOBA	1938	500	Failure
NEW BRUNSWICK	1957 (?)	?	Failure
NEWFOUNDLAND	None	0	...
NOVA SCOTIA	None	0	...
ONTARIO	1939 (or prior)	?	Failure
PRINCE EDWARD ISLAND	?	?	...
QUEBEC	None	0	...
SASKATCHEWAN	1938	4,500	Failure
Total Canada		**10,632**	
Total North America and Hawaii		**806,000**	

attributes this to changes in land use (more intensive cultivation and the removal of rough cover).

It is interesting to note the great difficulties experienced in importing chukars into New Zealand where in 1932 a shipment of 685 birds had but 22 survivors and another consignment of 730 birds left India with only 66 reaching New Zealand alive. These shipments, of course, were made prior to the days of fast air freight, but even now the bird importer is faced with many problems that, to the New Zealander of 1932, may have seemed minor indeed!

It is known that the establishment of the chukar in Western North America, the Hawaiian Islands and in New Zealand resulted from the release of approximately 806,500 chukars. The total expenditure needed to accomplish this establishment, if based on $6.00 per bird released, would have been approximately $5,000,000. This is an insignificant figure by today's economy when it is considered that the chukar is still extending its range in many of the Western States, is ranked as being at or near the top of the sportsmen's "favorite" bird list in the areas where it is found, and has in just the past few years provided a return of nearly 6,000,000 birds to the hunters of North America and Hawaii with the major rewards still to come.

THE CHUKAR PARTRIDGE IN NEVADA

The first known introduction of chukars into Nevada appears to have been made in 1935. During this year

the Nevada Fish and Game Commission awarded contracts to Mrs. Minnie Blair and Mr. Ira Hamlin Kent of Fallon, Nevada to rear 200 chukar partridges at $5.00 each for November delivery. Mrs. Blair obtained her birds from Minnesota and Kent's stock was imported from Calcutta in 1933. During the fall of 1935, a total of 289 chukars were distributed for release in Churchill, Douglas, Esmeralda, Humboldt, Lander, Lyon, Nye, Ormsby and Washoe Counties. There are no official release records prior to this date, although Alcorn and Richardson (1951) state that 50 birds were liberated on the Douglas Ranch, Fallon in 1934.

Between the years 1935 and 1954 a total of 6,399 chukars had been released in Nevada (Christensen, 1954) and these releases resulted in the successful establishment of this bird in 14 of Nevada's 17 counties. At this time there were still many areas of suitable unoccupied habitat in the state. During the period of 1955 through 1966 a total of 7,256 chukars were released in the state to establish them in areas of unoccupied habitat and, in one instance, to try and determine if "shot-in-the-arm" releases in areas of occupied habitat, where the chukar populations were in decline, would result in accelerating population recovery. A total of 13,655 chukars have now been released in Nevada and they are established in all 17 counties (see Figure 4). It is felt that the majority of suitable habitat (approximately 25,000 square miles) is now occupied. With the exception of 54 game farm Turkish chukars that were released in Lincoln County all of the birds have been of the Indian variety.

In addition to the liberations of game farm stock made by the Nevada Fish and Game Commission, sportsmen's clubs and private individuals, the Nevada Fish and Game Commission has carried out a limited program of transplanting wild-trapped birds. Table 2 is a yearly record of chukars released in Nevada and a detailed accounting of release site records by county is presented in Appendix A.

Developments following the initial introductions were not systematically followed. However, according to Coleman (1949), the number of failures was greater than the number of successes. Repeated plantings in some areas failed, while the initial liberation in other areas were successful. It is now apparent that although it seemed that some of the original releases failed, suitable chukar populations are now found (years later) to be inhabiting many of these same release sites. Also, in viewing the current distribution of the chukar and evaluating its habitat requirements there were not many releases made (other than those in Clark and Lincoln Counties) that were undesirable, and if so they were usually within the close proximity of desirable habitat. Obviously it is not possible to evaluate the success of each individual release; however, it is apparent that the bulk of Nevada's present chukar population is the result of many small successful releases made between 1935 and 1954. By this time the die was cast, chukars had become established in key areas throughout the state, and when conditions favored good production the local populations overflowed into adjacent unoccupied areas.

TABLE 2. Yearly Record of Chukars Released in Nevada

Year	Game farm birds	Wild-trapped birds	Total
1935	289	0	289
1936	12	0	12
1937	74	0	74
1938	72	0	72
1939	124	0	124
1940	1,145	0	1,145
1941	731	0	731
1942	632	0	632
1943	0	0	0
1944	47	0	47
1945	147	21	168
1946	0	0	0
1947	0	893	893
1948	0	59	59
1949	0	497	497
1950	837	0	837
1951	36	0	36
1952	573	60	633
1953	25	125	150
1954	0	0	0
1955	[1]54	0	54
1956	630	0	630
1957	2,033	0	2,033
1958	1,854	0	1,854
1959	1,771	0	1,771
1960	782	0	782
1961	0	0	0
1962	0	0	0
1963	0	49	49
1964	0	71	71
1965	0	0	0
1966	12	0	12
1967	0	0	0
1968	0	0	0
1969	0	0	0
Totals	**11,880**	**1,775**	**13,655**

[1]Turkish

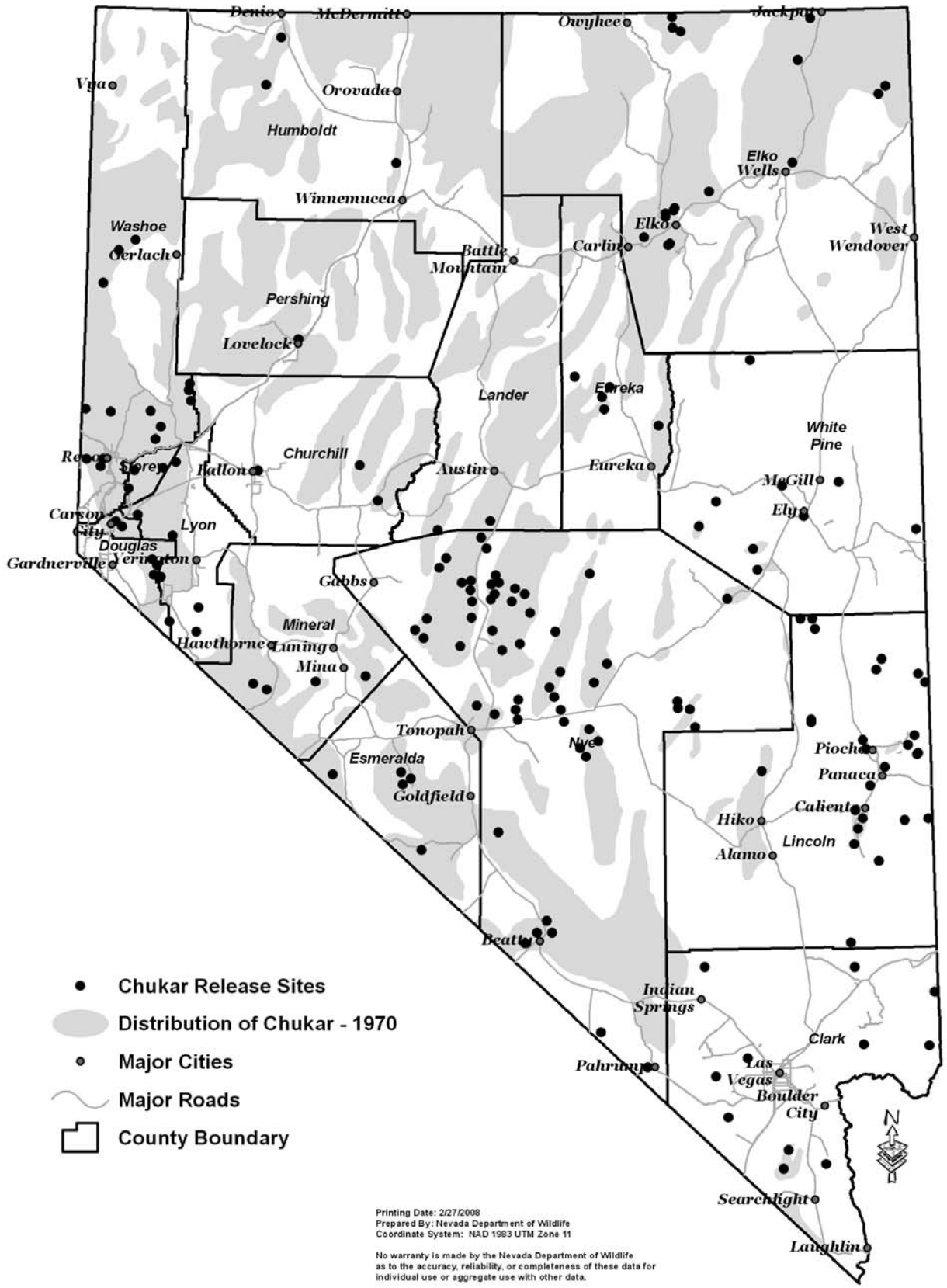


FIGURE 4. Release sites and distribution of the chukar partridge in Nevada.

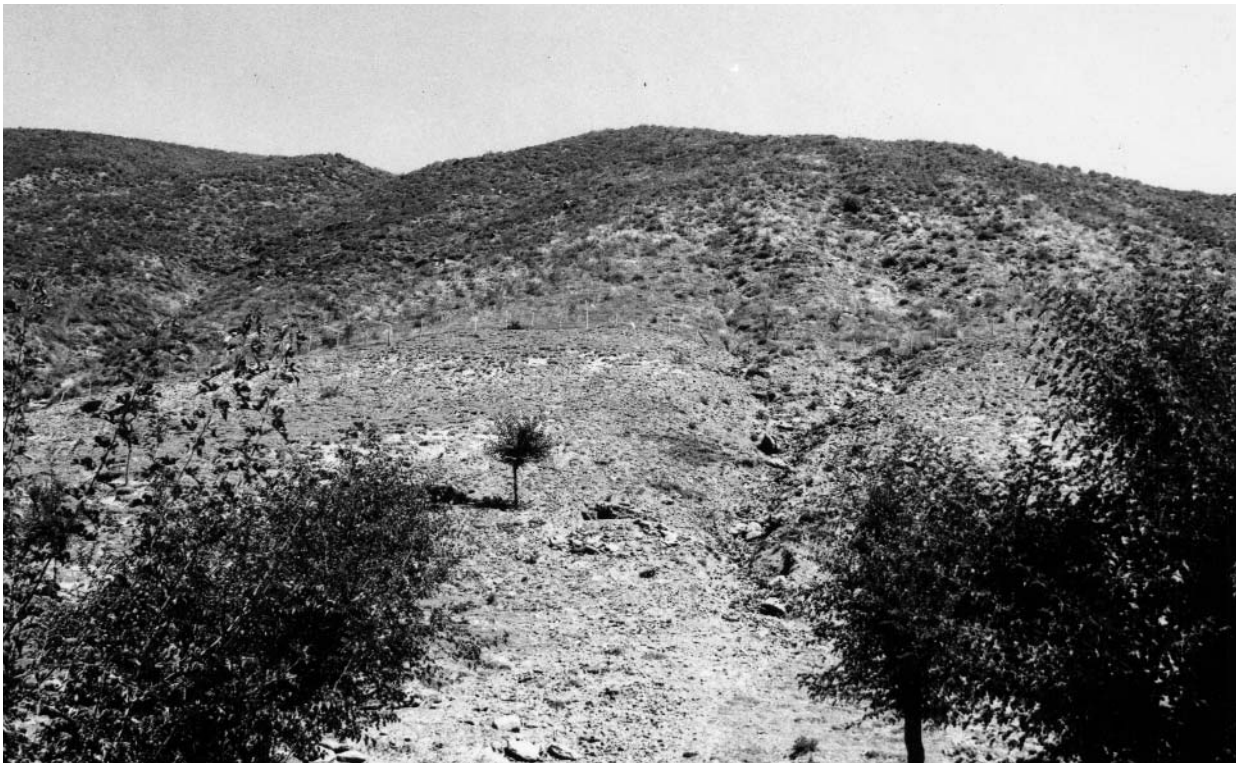


FIGURE 5. Excellent chukar partridge habitat near Srinagar, Kashmir, India. Elevation approximately 5,000 feet at valley floor. (Photo by Gardiner Bump.)

FIGURE 6. Chukar partridge habitat in the vicinity of Doshi, Afghanistan. This scene can be duplicated in many areas of the Great Basin in North America. (Photo by author.)

The chukar habitat in Nevada was occupied through this "spreading" or "overspill" from the release areas. However, this method takes time, particularly if there are any extensive natural barriers or great distances between release sites; therefore, the efforts made by the Commission between 1956–60 to fill in some of the major unoccupied areas paid off handsomely in establishing populations in a short time in Elko, Northern Humboldt and Washoe Counties.

It is possible to arrive at some conclusions as to how long it takes to establish a chukar population by reviewing initial release records in relation to the time the first hunting season was held. There is a record of 25 birds being sent to Nye County in 1935 and 40 in 1939; however, the fate of these birds is unknown. The first documented releases were made in 1940, which included two at Peavine Canyon, and accurate records were kept on all subsequent releases.[2] From the period of 1940 through 1947 numerous releases were made, and although each release generally consisted of only a small number of birds, several follow-up releases were made in some areas. As a consequence, the populations grew to the extent that it was possible to wild-trap 907 chukars in Peavine Canyon in 1947 and to open the hunting season in 1948. Thus a population was established in Peavine Canyon, among other areas, within a 7-year period. The history of the Nye County liberations (Appendix A) is a good example showing that many small releases, more or less systematically made without the benefit of knowing the exact habitat requirements of the chukar, resulted in establishment in a relatively short time (under 10 years). This also led to the later conclusion (as subsequently practiced on a grand scale by the States of Oregon and Utah) that numerous large "saturation" releases, with the benefit of knowing the general habitat requirements, could result in establishment in an even shorter time (within 5 years). Table 3 summarizes initial release data in relation to the first hunting season for Nevada's 17 counties and provides a general idea as to the length of time it took for various populations to develop, but not necessarily fully occupy, all suitable habitats.

Table 3. Time Between Initial Chukar Release and First Hunting Season by Counties

County	Initial release	First hunting	Number of years elapsed	Probable number of years to become established
Churchill	1935	1947	12	12
Clark	1939	[1]1960	21	7
Douglas	1935	1952	17	12
Elko	1938	1955	17	6
Esmeralda	1935	1950	15	15
Eureka	1941	[1]1951	10	10
Humboldt	1935	[2]1948	13	13
Lander	1935	[2]1949	14	14
Lincoln	1938	[1]1964	26	26
Lyon	1935	1951	16	16
Mineral	1945	[1]1949	4	4
Nye	1935	1948	13	7
Ormsby	1935	1951	16	16
Pershing	1937	[2]1947	10	10
Storey	1935	1948	13	13
Washoe	1935	1947	12	12
White Pine	1937	[1]1951	14	14

[1]At opening of hunting season the county contained only small, isolated populations.

[2]Very probable that movement of birds from adjacent counties account for initial population establishment.

This table cannot be interpreted literally, and it should be understood that at least two other factors besides the release site played an important part in establishment. These were (1) current habitat conditions that affect productivity and (2) the influence of birds spreading into an area from previously established populations. In arriving at the probable number of years it took for establishment used in Table 3 an evaluation was made of the early releases in relation to release site location and present distribution and the obvious ineffective releases were discounted. In Mineral County, where the chukar populations were relatively isolated from the influence of other established populations, it appears that the lucky combination of selecting the proper release sites during a series of years that were favorable to high production resulted in establishment in four years. In other counties, which now harbor good chukar populations, the more typical pattern was for establishment to take longer, and Washoe County, which required 12 years, can be considered as representative.

[2]I wish to recognize the late Mr. Walter Bowler (former Nye County Game Board Member) and Mr. Tom McCulloch (a long time Nevada Fish and Game Commissioner from Nye County) for their long sustaining interest and drive in promoting a statewide chukar release program and in maintaining the excellent Nye County records. These gentlemen are only two of many outstanding individuals throughout the State of Nevada whose persistent efforts resulted in the establishment of the chukar partridge.

FIGURE 7. **The chukar has been successfully introduced into Central Otago, South Island, New Zealand. The mountain peaks are approximately 2,500 feet elevation. Hassock grasses are prominent and the scrub is *Discaria toumatou*. Elderberry, lupine and willows are found on riverbanks.** (Photo courtesy of New Zealand Wildlife Service.)

FIGURE 8. **Chukars inhabit Mauna Kea, Hawaii (10,500 feet elevation), where an assortment of native and introduced grasses and forbs are present. Gosmore *(Hypochaeris uadicata)* is the key food plant.** (Photo courtesy of Hawaii Fish and Game.)

General Nature of the Environment

TOPOGRAPHY

Chukar habitat in India, Pakistan and Afghanistan (the countries that were probably the primary source of the birds that were introduced into North America) is characterized geographically by a series of massive mountain chains such as the Himalayas, the Hindu Kush, and the Karakorums, which harbor the highest peaks in the world and undoubtedly present, from a topographical standpoint, some of the most rugged mountain terrain to be found anywhere. Numerous valleys, many with beautiful streams and rivers, weave a pattern through the mountains and, where conditions are suitable, the land is cultivated. The climate is arid to semi-arid depending upon the locality and the vegetation is primarily a grass-forb understory with short brush and, in some instances, a scattered overstory of small conifers. The chukar partridge commonly inhabits the areas from the canyon or valley floor (usually from 4,000 to 6,000 feet elevation although it is found at sea level in Sind and Baluchistan) to mountain slopes and peaks as high as 16,000 feet (Hume and Marshall, 1880).

In North America the major characteristics of the habitat occupied by the chukar are much the same throughout the extent of the birds' range from British Columbia to Baja California and California to Wyoming, and to all outward appearances duplicates the gross topographical and vegetational features found in their native habitat. The major difference in habitats in North America appears to be the change from a primary sagebrush-grass vegetation, which is found throughout the majority of the range, to the more arid saltbush-grass type at the southern extension of its habitat in California and Mexico.

Nevada embraces a large block of chukar habitat in the southwestern portion of its North American range between 37° and 42° north latitude. Here the geography is typical of the Great Basin, which is bounded on the west by the Sierra Nevada Mountains, on the east by the Wasatch Range, the Columbia-Snake watershed in Southeastern Oregon on the north and by the Colorado River drainage to the south. All of the chukar habitat in Nevada, most of it in California, a substantial portion of that in Utah and Oregon, and parts of it in Idaho are found in the Great Basin.

As described by Billings (1951) "The chief physiographic characteristic of the Great Basin is its basin-and-range topography. It is not just a single large basin but more than a hundred relatively small basins separated from each other by fault-block mountain ranges." The mountains and valleys trend in a north-south direction and the valleys lie at about 4,000 to 5,000 feet with the crests of the mountains ranging from 5,000 to over 14,000 feet. The elevations diminish as you go south. The mountains are broken up by steep rugged canyons with talus slopes and rocky outcrops being characteristic. Water is usually found in the form of small, widely scattered springs that are supplemented by occasional streams that may be of an intermittent nature, and a few rivers. The chukar partridge has found its niche in this rugged Great Basin terrain, living from the valley floor below sea level in Death Valley (Harper, 1958) to as high as 12,000 feet in the White Mountains of California and Nevada. In Nevada they generally occupy the elevational range between 4,000 and 9,000 feet.

CLIMATE

Most of the Great Basin is arid or semi-arid with the cooler, moister climate being found from Central Nevada northward and the hot desert climate in Southern Nevada, California and Baja California. In Nevada's chukar habitat the extreme in precipitation will vary from an average of 3.50 inches per year at Mina to an average of 12 inches per year at Austin. Average annual precipitation (rounded off) at representative stations in the state are: Reno 7.5 inches; Yerington 5 inches; Lovelock 5 inches; Winnemucca 8.5 inches; Battle Mountain 6.5 inches; Elko 9.5 inches; and Tonopah 5 inches.

The temperature in Nevada in particular, and throughout the remainder of the chukar range in North America generally, is characterized by short, hot summers and long, moderately cold winters. Daily temperature extremes are typical and during the summer months it is not unusual for there to be a 40° F or even 50° F differential in temperature within 24 hours.

Gohain (1959) made climatic comparisons of chukar habitats in India and the Western United States. His use of Leh, which has an average annual precipitation of 3.26 inches, and of Srinagar, with an average annual precipitation of 26 inches, probably represents the extremes found in India. Although Gohain found some correlation in average precipitation and temperatures he did not generally get a good correlation, particularly with Srinagar. It would seem that the use of other stations covering a wider geographic range would have

been more representative of the average climatic conditions that occur in the native habitat of the chukar—the principal difficulty here being the lack of climatic data for suitable areas. Quetta, Pakistan (a very good chukar area), Kabul, Afghanistan (which is considered as representative of medium elevations) and Leh, India (for high elevations) would seem to give an adequate cross section of the climatic conditions that occur, and it is believed that Quetta is the most typical. Table 4 depicts climatic data for these stations and for representative stations in chukar habitat in North America. For the most part, other than the rather high temperatures in the Temblor Range (Maricopa) in California, which is typical of the southern extension of the Great Basin, there seems to be a general climatic agreement.

VEGETATION

In Nevada the sagebrush-grass vegetation is dominant over most of the chukar habitat. Sagebrush (*Artemisia tridentata*) is the commanding plant, often forming pure stands. Other important brush species are Indian tea (*Ephedra viridis*), bitterbrush (*Purshia tridentata*), currant (*Ribes* sp.), horsebrush (*Tetradymia glabrata*) and various species of rabbitbrush (*Chrysothamnus*). Scattered pinyon (*Pinus monophylla*) and juniper (*Juniperus utahensis*) may be present, but the chukar usually avoids areas where the pinyon-juniper climax occurs. The forbs and grasses that are found in this vegetation zone are described by Billings (1951) as follows: "Common perennial forbs include *Castilleja angustifolia, Viola beckwithii, Lomatium nevadense, Delphinium andersonii,* and species of *Wyethia, Balsamorrhiza, Lupinus, Astragalus,* and *Phlox*. Important perennial grass genera are *Poa, Sitanion, Stipa, Elymus, Agropyron, Oryzopsis, Sporobolus,* and in the eastern part of the zone, *Aristida;* all are bunchgrasses. Among the more numerous native annuals are species of *Mimulus, Collinsia, Phacelia, Eriogonum* and *Mentzelia*. The relatively abundant herbaceous vegetation, especially grasses, gives the sagebrush-grass zone many of the characteristics of a steppe rather than a desert." Exotic plants such as red-stem filaree (*Erodium cicutarium*) and cheatgrass (*Bromus tectorum*) play a very important part in providing favored foods for the chukar and cheatgrass is considered by me to be a major factor in influencing habitat desirability in the life cycle of the chukar. It would seem that the early introduction of cheatgrass into the Western United States may well have paved the way for the subsequent introductions

Table 4. Climatic Data from Representative Stations in India, Pakistan, Afghanistan and the United States[1]

Station	Latitude	Elevation	Temperature of means		Temperature of extremes		Average precipitation												
			Jan.	July	Max.	Min.	J	F	M	A	M	J	J	A	S	O	N	D	Year
Afghanistan—																			
Kabul	34 41 N	7,280	31.8	76.9	112	–7	1.21	1.43	4.05	3.67	0.78	0.21	0.13	0.14	0.03	0.56	0.82	0.43	13.46
Pakistan—																			
Quetta	30 13 N	5,502	39.8	79.0	104	3	1.88	1.81	1.88	1.01	0.37	0.15	0.36	0.42	0.07	0.13	0.32	0.93	9.33
India—																			
Leh	34 10 N	11,530	19.2	63.5	93	–19	0.37	0.34	0.30	0.22	0.21	0.17	0.47	0.52	0.28	0.17	0.04	0.17	3.26
Nevada[2]—																			
Winnemucca	40 54 N	4,299	28.0	71.9	108	–36	1.02	0.93	0.88	0.85	0.73	0.66	0.26	0.23	0.41	0.63	0.69	0.91	8.20
Austin	39 30 N	6,605	28.5	70.2	105	–25	1.15	1.29	1.42	1.74	1.58	0.64	0.60	0.62	0.56	0.79	0.80	1.03	12.22
Mina	38 23 N	4,552	32.4	78.0	110	–22	0.42	0.33	0.28	0.36	0.48	0.26	0.22	0.30	0.19	0.21	0.15	0.25	3.45
California—																			
Maricopa	35 – N	680	46.7	85.5	117	17	1.01	1.00	0.97	0.51	0.38	0.13	0.01	0.02	0.11	0.29	0.35	0.91	5.69
Bishop	37 50 N	4,108	37.6	73.1	109	–15	2.45	1.07	1.12	0.30	0.26	0.12	0.09	0.17	0.30	0.33	0.41	0.87	7.49
Idaho—																			
Payette	44 – N	2,152	27.1	73.9	113	–33	1.55	1.18	1.08	0.76	0.91	0.75	0.29	0.15	0.38	0.89	1.08	1.41	10.43
Washington—																			
Yakima	46 50 N	1,067	27.4	71.4	111	–24	0.98	0.69	0.41	0.36	0.47	0.51	0.20	0.16	0.48	0.49	0.96	1.08	6.79
Wyoming—																			
Cody	44 50 N	4,980	23.6	68.5	105	–46	0.25	0.31	0.48	0.99	1.35	1.35	1.01	0.79	0.93	0.77	0.45	0.29	8.87

[1]From *Climate and Man,* 1941.

[2]The Austin and Winnemucca stations in Nevada are representative of the climate found in our more stable chukar habitat. Populations are more erratic in the Mina area.

and successful establishment of the chukar. There is no question that cheatgrass has had a great impact upon changing the vegetational makeup in the Western United States, and concerning this point it is interesting to evaluate the following comments by Billings (1951) concerning the Great Basin vegetation: "Another and more complex ecologic result of overgrazing has been the invasion of annual Mediterranean grasses under the shrubs as replacements for the weakened native perennials. The principal invader has been *Bromus tectorum,* but *B. rubens* and *B. rigidus* have become common in certain types of habitats. *Bromus tectorum* acts as a winter annual in much of the sagebrush zone, germinating after the first autumn cyclonic storms and going through the winter in the seedling stage. In April and May it grows rapidly to a height of about 6 to 8 inches, flowers, sets fruit and dries up by the middle of June. From then on to October it constitutes a critical fire hazard. Fires were apparently rare in undisturbed sagebrush-grass vegetation. Now, as a result of the *Bromus* invasion, they are very common and hundreds of thousands of acres of sagebrush-grass range have been burned at least once. Since, by the time of the fire, the seeds of *Bromus* are on the ground while the seeds of the perennial herbs and shrubs are still attached to the plants, the survival of *Bromus* seed during the fire is far higher than that of most perennial species. The result, within a year or two after the fire, is extensive stands of annual *Bromus* marking the fire scar and providing

FIGURE 9. The northernmost range of established chukar populations in North America, in the vicinity of Keremeos, B.C., Canada, has the typical sagebrush-grass vegetation. (Photo by author.)

FIGURE 10. The Argus Mountains of California depict the arid saltbush-grass vegetation type found in the southern extension of the chukar's range. (Photo by Wayne H. Bohl.)

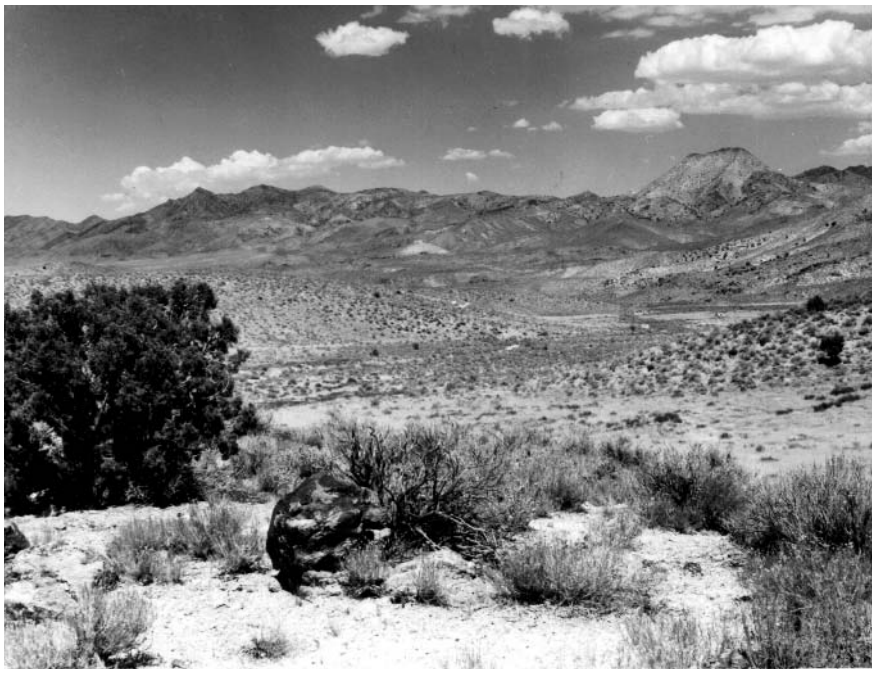


FIGURE 11. **The Dugway Range of Northwestern Utah is representative of many of the Great Basin Ranges. Sagebrush-grass vegetation with an overstory of scattered pinyon-juniper provides excellent chukar partridge habitat.** (Photo by Wayne H. Bohl.)

FIGURE 12. **Cheatgrass, a primary chukar food plant, is found in abundance in this excellent chukar habitat in the Virginia Range near Reno, Nevada.** (Photo by author.)

ready tinder for additional fires." Some of Nevada's best chukar populations are found occupying these extensive cheatgrass stands.

In some of the low foothill areas frequented by chukar the little greasewood-shadscale and big greasewood-shadscale associations replace the sagebrush-grass zone. These associations, which are described in detail by Billings (1945), are characterized by the following shrubs: little greasewood (*Sarcobatus baileyi*), shadscale (*Atriplex confertifolia*), bud sage (*Artemisia spinescens*), big greasewood (*Sarcobatus vermiculatus*), quail brush (*Atriplex lentiformis*) and hop sage (*Grayia spinosa*). The most conspicuous grasses in these areas are cheatgrass, salt grass (*Distichlis stricta*) and Indian rice grass (*Oryzopsis hymenoides*).

The vegetational types that I have described for the Great Basin of Nevada certainly seem to be the counterparts of types I have seen in chukar habitat in India, Pakistan and Afghanistan, where many of the plant species are of the same genera.

Life History

DESCRIPTION

Due to the accuracy of Baker's description of the Indian chukar (Baker, E. C. S., 1922: 307), it is reproduced here in its entirety.

"*Adult Male and Female*—(In *Alectoris* the sexes are alike)—Forehead and lines through the eye, down the neck and meeting as a gorget between the throat and upper breast, black; next the forehead pure grey, this colour running back as an indistinct supercilium, often albescent posteriorly; crown vinous red changing to ashy on hind neck and again to vinous red on back and scapulars, and then once more to ashy on lower back, rump and upper tail coverts; ear-coverts dull chestnut; middle tail feathers ashy drab, outer feathers the same but pale chestnut on the terminal half; outer scapulars with pure pale grey centres; smaller and median coverts and innermost secondaries like the back; outer wing-coverts ashy; primaries and secondaries brown with a yellowish buff patch on the centre of the outer webs; point of chin and below gape black; lores, cheeks, chin and throat white-tinged with buff to a varying extent; below the black gorget the breast is ashy-tinged more or less with brown and vinous at the sides, the lower breast being generally a pure French grey; abdomen, vent, thighs and lower tail coverts chestnut-buff or buff; feathers of the flanks grey at the base, with two black bars divided by pale buff and with chestnut tips.

"*Colours of Soft Parts*—'The irides are brown, yellowish, orange, or even reddish brown; the margins of the eyelids crimson or coral to brick red; the eyelids themselves grey; the bills are crimson to deep coral red, often dusky on culmen, and generally so at base and about the nostrils; the legs and feet vary from coral pink to deep-red; claws dusky brown. In young birds the bill is brownish black and the legs and feet orange-red.'

"*Measurements*—This bird varies most extraordinarily in size, but the very great majority of the specimens available for examination have not been sexed, and though there is no doubt that the males average bigger than the females, the extremes of size seem to be much the same in both sexes. The wing runs from 146 to 180 mm., both of these extremes being specimens from the Simla Hills, the average of 80 birds is 157 mm. Tarsus 41 to 52 mm.; culmen 19 to 21 mm.; tail 78 to 105 mm.

" 'Hume gives the weights as male 19 to 27 ozs., females 13 to 19 ozs.' "

(In this country Nagel [1945] states that well-grown Missouri birds averaged 24 ounces, and Galbreath and Moreland [1953] give the average weight of 50 adults from Washington as 21.24 ounces. Game farm birds were weighed in New Mexico and 24 adult females averaged 18.89 ounces while 22 adult males averaged 21.82 ounces [Bohl, 1957]. In Nevada, 20 wild adult chukars collected from different localities throughout the state were weighed by the author. The male birds varied from 18.75 to 25.50 ounces, averaging 21.70 ounces. The female birds varied from 16.18 to 19.25 ounces, averaging 17.70 ounces.)

"*Young Birds* of the year, otherwise adult in plumage, often retain some of the barred wing quills of the first plumage bird.

"*Young Bird in First Plumage* dull brownish grey, each feather above with white tip and two black spots next it; head a little more rufescent; tail grey with mottley bars of black and white, the outer feather tinged with rufous; below dirty brownish-white with faint brown bars.

"*Chick in Down*—Crown pale bright rufous; above pale fulvous, with four stripes of speckled rufous and black; wings pale fulvous, mottled rufous and black; below pale fulvous, a little deeper on chest."

VERNACULAR NAMES

The vernacular names of the chukar partridge are many and varied. The name "chukar" itself has been spelled in numerous ways, and although not used exclusively as such in scientific journals, the above spelling is the one most commonly applied. The following is a list of local names given to this bird throughout its native range: Chukar, Kabk, Keklik, Chikone, Kaukau, Chukru, Zarkar, chukor, chickore and Nek-pa.

COVER

Regarding the chukar in its native habitat, Scully (1879) states that "The Chukor is common on certain parts of the hills round the valley of Nepal, at elevations of from 5,000 to 6,000 feet, from March to October. It frequents rounded grassy hills, where the small nullahs are fringed with bushes and where there is no forest; in such localities, especially near patches of cultivation, and on bits of stony ground, flocks of Chukor are sure to be found."

The very nature of the habitat in Nevada is conducive to providing more than ample cover for chukars. Tallus slopes, rocky outcrops, scattered brush and clumps of grass over irregular terrain give the chukar sufficient opportunity to hide without difficulty. Chukars prefer an open, unimpeded view and often they are seen perched upon a prominent rock overlooking their domain. When disturbed their first reaction is to run uphill, which has proven to be a sound method of losing many an ardent hunter, and if the pursuer persists they will flush and then lie, utilizing the available cover to perfection.

ROOSTING

Chukars in Nevada have been found roosting on the ground beneath sagebrush, under juniper trees, in the shelter of rock outcrops and in open rocky areas. They do not seek dense cover for roosting.

DUSTING

Dusting plays an important part in the daily life of the chukar. Dusting bowls are frequently seen alongside trails, in the shelter of shrubs and juniper trees, near the base of rocky outcrops, and particularly around watering sites where the birds seem to enjoy the damp soil. They are oblong-oval depressions in the earth and droppings and a few feathers are usually found in and around them.

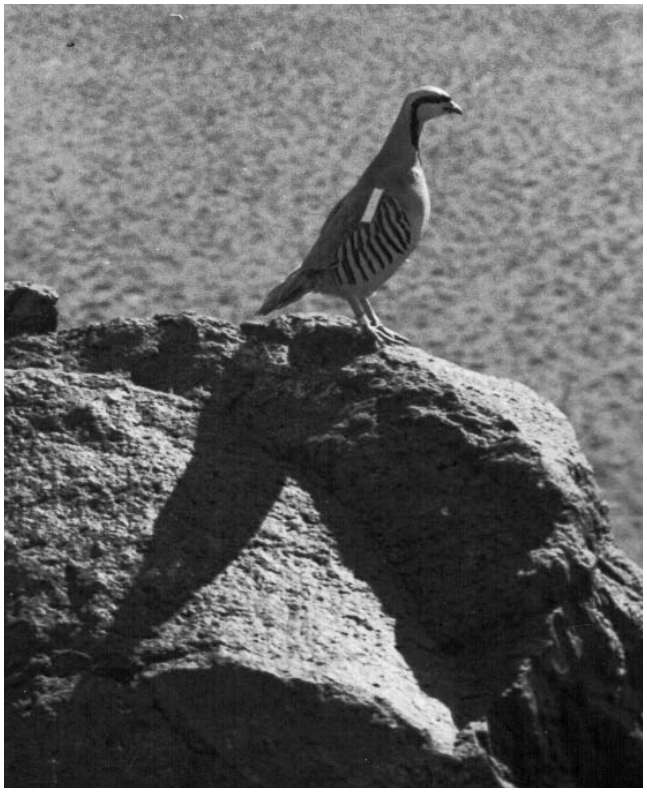


FIGURE 13. **An adult chukar partridge that has been marked with a colored neck tag and a leg band.** (Photo by author.)

CALLS

The chukar has a considerable array of calls and Stokes (1961) describes these in detail. The calls that are most commonly heard in the field are noted here, and for consistency the terminology and the description in quotes (unless otherwise noted) follows that used by Stokes.

The ground alarm call—"A person's first experience with chukars in the wild is likely to be in the fall as a covey of birds flushes wildly a few yards in front of the hunter. The birds separate in long, curving downhill flights. As they burst from the ground the first call is a loud piercing squeal, followed by a series of *whitoo whitoo* calls gradually subsiding as the birds disappear out of range."

Hawk-alarm note—"A large bird or airplane flying overhead generally elicits a short, guttural *kerrr.* It is evenly pitched and given with little mouth movement, but it is audible for perhaps 100 feet. If the disturbance is not too close, the bird will crouch on the spot and turn its head sideways to get the best possible view."

Food call—"Single birds feeding at the hopper or scratching in the litter frequently gave a slow *took*. This is sharp and emphatic with a clear pause between each note. I have heard this call in the wild as a pair of partridges fed slowly across a grassy opening. Among chicks the call is a turkey-like *turk*."

Rally call—"This is the most common call of chukars and the one from which the species derives its common name. At low intensities the call is *chuck, chuck, chuck,* given slowly and with definite breaks between each call. As the intensity of the calling rises, it changes to *per-chuck, per-chuck* with accent on the second syllable, and it is given at faster tempo. This in turn gives way to *chukar-chukar-chukar* with accent on the first syllable. At highest intensity, and usually highest volume, the call becomes a three-syllable *chuckara-chuckara-chuckara.*" Chukars seem to prefer to use this call from the vantage point of a rock where they have a good view of the surroundings. The throaty chucking is very resonant and will carry for great distances. Williams and Stokes (1965)

indicated that the rally call was audible for 300 yards or over under favorable conditions.

The rally call is heard primarily during the early morning and evening hours, although it is used infrequently throughout the day. Both sexes use this call, but during the nesting season it appears to be used more by males. Williams and Stokes (1965) feel that during the breeding season the primary function of the rally call is to space males rather than to attract a mate and that calling at dawn and dusk serves as a deterrent to regulate overall population density. During the summer, fall and winter when the birds travel in coveys, and when a covey is broken up, the rally call is a primary method used for locating one another. When the hunting season is in progress and the birds are scattered this almost constant calling is of decided advantage to the hunter, who is also anxious to locate them, and often leads to the birds' downfall.

One of the most ornate descriptions of the rally call was made by Hume and Marshall (1880) as follows: "The Chukor is a very noisy bird, repeating constantly in a sharp, clear tone, that may be heard for a mile or more through the pure mountain air, his own well-applied trivial name. Like other game birds, they call most in the mornings and evenings; but even when undisturbed, they may be heard calling to each other at all hours of the day; and very soon after a covey has been dispersed, each individual member may be heard proclaiming his own and anxiously enquiring after all his fellows' whereabouts. The tone varies. First he says, 'I'm here, I'm here'; then he asks 'Who's dead? Who's dead?' and when he is informed of the untimely decease of his pet brother and favourite sister, or perhaps his eldest son and heir, he responds, 'Oh lor! Oh lor!' in quite a mournful tone."

Steam-engine call—"A male in breeding season may give a harsh *chak-chak-chak* call, sometimes lasting for five minutes on end; at other times, just a few isolated calls may be given."

Peeping—Studies by the author show that peeping is done by young birds from the first week until they are nearly adult in size. When a brood of chicks is scattered peeping leads to their reunion. Young chicks will usually freeze for 10 to 15 minutes after being scattered and then peeping will begin. It often takes 30 minutes to an hour or more for a brood to reassemble. The reunion of the brood is directed by the adult bird who emits occasional calls that serve to guide the chicks. The chicks will run or make short flights toward the adult after the call. Peeping is almost continuous until the brood is reunited. If the brood is disturbed while in the process of reuniting, the chicks will again freeze, and the adult bird will give the alarm call if the intruder approaches closely.

FLUSHING AND FLIGHT

Chukars literally explode into the air when a covey is flushed. They rise with a flight that changes only under exceptional conditions, beating their wings rapidly a few times and then soaring downhill. Near the termination of the glide they swing uphill, just clearing the tops of the shrubs, and land. The described pattern is generally a semicircular one. The usual flight seems to vary in length from 50 to 400 yards; however, it is not uncommon to see a bird soar across a canyon and land on a mountain slope one-half mile away. When greatly excited, they may go farther. At the termination of a flight chukars often "hold tight" and, as discussed under COVER, they are difficult to see even though the observer may approach within a few feet of them. Short flights of only a few feet occur in cliff-like areas where it is necessary for them to use their wings while going from pinnacle to pinnacle.

When a covey of birds is flushed the entire covey does not always rise at once. Stragglers fly in different directions and as a result the covey becomes widely dispersed. Shortly after landing they commence calling and the covey begins to gradually reassemble.

During the winter the birds are extremely wary and it is rarely possible to get closer than 50 to 75 yards without flushing the covey. Close approach is possible only when one crosses over the crest of a hill and surprises a covey on the opposite slope. In contrast, when in pairs, the birds are very difficult to flush and do so only when they are closely approached. This is especially noticeable toward the middle of April when it is often necessary to walk within 10 yards of them. Occasionally the birds do not flush until one has walked a few feet past them, and sometimes it is necessary to practically step on them before they rise. Their desire to "hold" becomes increasingly apparent during the first week of May, when incubation is in progress, and it is with only the most thorough coverage of an area that flushing is possible. More times than not attempts to raise the birds from known sites are unsuccessful because birds

that are located and approached during this season usually run for considerable distances through the brush or other cover and rapidly become lost from sight. Despite the fact that chukars are strong flyers they appear to be ground-loving birds and usually run in preference to flying. In nearly all cases they will run uphill and can effectively outdistance a man. Birds less than four weeks of age generally depend upon "freezing" to avoid detection, although by the second week they are capable of short flights.

The following account by Henderson and Hume (1873) provides a rather vivid illustration of the flushing habits of chukars in their native land: "The Yarkandis disdain the use of firearms for the chase of these birds. A party of men mounted on ponies and armed with whips pursue a covey and in a very short time succeed in capturing the whole flock. The Chikone will never rise more than twice, and after that as they run, they are easily overtaken and knocked over with whips. This sport is carried on over the most terribly rough ground in the rocky valleys, but the Yarkand ponies traverse at the top of their speed, country that most men would only crawl over with the utmost caution and deliberation."

SEASONAL AND ALTITUDINAL MOVEMENTS

During the spring, summer and early fall, water appears to be the determining factor in chukar distribution and movements. Birds have been seen from the valley floor (4,000 ft.) to high mountain basins (between 10,000 and 11,000 ft.) in areas where water is available. After the first fall rains, when grasses begin germinating and succulent food is present, the birds, in coveys, move freely throughout their range and inhabit waterless sites that were previously unoccupied.

Heavy snow will cause the chukars to move to lower elevations where feed is available and they return to higher elevations as the snow recedes. In March, when the birds pair, there is a general movement both altitudinally and latitudinally throughout their range. Phelps (1955) found that the chukar normally travels over a mile radius in the course of feeding, watering and roosting during a day.

MOBILITY

On August 5, 1952, an adult chukar that was wild-trapped at Horse Spring, Lyon County, Nevada escaped

FIGURE 14. Steep, rugged terrain is characteristic of the chukar habitat found in Nevada. Areas such as this often make it easy for the birds to evade their pursuer. (Photo by author.)

(after being banded) from a holding pen at Wilcox Canyon, Washoe County. On October 26, 82 days following the bird's escape, it was killed at Horse Spring, the trapping site. The airline distance from Wilcox Canyon to Horse Spring is 17 miles, and this record suggests a homing instinct. On October 1, 1953, an adult chukar was trapped, marked and released at Hungry Spring, Washoe County. Ten days later the bird was killed at the Bella Vista Ranch south of Reno, a distance of 21 miles from the trap and release site.

In California (Harper *et al.,* 1958) there are records of chukars moving 20 miles in three months and 33 miles in two years and three months.

The ability of the chukar to move long distances in a relatively short time has been a primary factor in establishing this bird throughout suitable habitat in North America.

WATER

In May, as the weather begins to warm up, chukars have been observed at water in the early morning and evening hours. At this time *clockers* (abnormally large droppings of incubating females) are commonly found at watering sites. Following the hatch, and as the weather becomes progressively warmer, the birds are noticed more frequently at water. During the hot summer months it is often possible to flush a covey of birds, usually one or more family groups, near water at any time of day. Despite the tendency of the birds to be near water during most of the day in hot weather, occasional broods of chicks and accompanying adults have been found during the early morning hours on hillsides over a mile from the closest known surface water. As mentioned previously, the summer distribution of the birds seems to depend a great deal upon the distribution and availability of water present in their habitat. Chukars take advantage of all water, from rivers to small creeks and springs to nearly stagnant seeps that hardly more than moisten the ground. I have even found chukars watering in mine shafts where the water was over ten feet below the surface of the ground and, on other occasions, going well back into mine tunnels to where only a faint light revealed the water.

FOOD

Feeding activity seems to be greatest during midmorning and through the afternoon. The birds move continuously while feeding and range widely. In the hot summer months they are often found feeding close to water. During the nesting period their movements are cautious, and when it is necessary for them to cross an exposed patch of land they invariably skulk across, lowering their heads and running. They frequently "freeze" in position with their heads erect in order to survey the surroundings. In the summer and fall, large numbers of birds are often found feeding together on favorite slopes or benches. Small patches of cultivation in canyon or valley areas are often heavily utilized, although these are infrequently found in most of Nevada.

During the period from March 1951 through February 1952, the author collected 29 chukars in the Pyramid Lake area, Washoe County, Nevada and analyzed the crop contents. Each month of the year was represented, and even though the sample was small, it does provide a pattern as to the general food requirements.

Following the fall rains grasses begin germinating. In crops collected during the late fall and winter months (November through March) grass blades made up the bulk of the contents. In addition the birds were found to have eaten small amounts of cheatgrass and red-stem filaree seeds as well as the leaves from unidentified germinating plants. In the spring, as the plants began to bear buds, and insects started to appear, the chukars turned to these sources of food. Crops examined during April and May contained rough fiddleneck (*Amsinckia tessellata*) leaves, stems and buds; lesser gilia (*Gilia inconspicua*) capsules and bracts; wild onion (*Allium* sp.) seeds; grasshoppers and caterpillars. General observations indicated that grass blades and green leaves were also utilized. During the summer months (June through August) seeds became the primary food, the most important being cheatgrass, rough fiddleneck and red-stem filaree. The seeds of other plants such as Indian ricegrass (*Oryzopsis hymenoides*), curly dock (*Rumex crispus*) and mustard (*Descurania* sp.) were taken to a lesser extent. Grasshoppers were still utilized, when available, and constituted the main item of animal food. In the fall months of September and October the seeds of cheatgrass, rough fiddleneck and filaree comprised the major portion of the chukars' diet. The fruits of black nightshade (*Solanum nigrum*) and rootstocks and shoots of Sandberg bluegrass (*Poa secunda*) were found in several crops.

The chukars' utilization of cheatgrass in the form of seeds and/or leaves during every month of the year

FIGURE 15. **An abundance of food is available on these sagebrush-grass covered mountains in Southeastern Washington.** (Photo by Wayne H. Bohl.)

indicates the importance of this particular species. It is also important to note that this utilization occurred during a good range year when an abundance of other plants were also available. The birds' heavy dependence upon green grass leaves during November through March (which varied from 73% to 99% of the total crop contents in my 1952 study) again illustrates the impact the grass family has on the chukars' diet, and very possibly, in influencing the birds' success or failure in various habitats.

Tables 5, 6 and 7 present the food habits data collected in Nevada by Alcorn and Richardson (1951), Christensen (1952 a) and Weaver and Haskell (1967).

Food studies in Washington (Galbreath and Moreland, 1953) indicated that the chukars' main diet consists of cheatgrass seeds, grass leaves and wheat. Many other food species were also listed, and cheatgrass seeds were found to have been eaten by 10-day-old chicks. In California, Harper *et al.* (1958) found that insects apparently formed the bulk of the chicks' diet during the first few weeks of life, as is common with most young gallinaceous birds. Red-stem filaree seeds, fiddleneck seeds and green grass leafage were the three highest ranking foods found in adult birds in the Temblor Area (the southern portion of the Great Basin). Grass leafage (believed to be mainly cheatgrass) was taken, as in Nevada and Washington, during the winter and spring months and was a primary food during this period. In the Inyo-Mono Area Russian thistle (*Salsola kali*) seeds and grass seeds and leafage ranked highest in use. Studies by Sandfort (1954) in Colorado show that cheatgrass seeds, ricegrass seeds and green shoots of cheatgrass, ricegrass, wheatgrass (*Agropyron* sp.) and horsetail (*Equisetum* sp.) are utilized.

In evaluating all of the food studies that have been conducted in the areas where chukars are successfully established in North America it is obvious that exotic plants such as cheatgrass, red-stem filaree and Russian thistle, in seed and in leafage form, play an important part in the food requirements of the chukar partridge. The widespread and year-around use of cheatgrass by the chukar in North America unquestionably makes this plant the priority food species.

When chukars are in the vicinity of agriculture it has been found from the above mentioned studies and other investigations by Sandfort (1954), Johnson (1957) and Ferkovich (1965) that they utilize the grains of barley, oats, wheat and corn; the seeds of sweet clover (*Melilotus* sp.) and bluegrass; and the green shoots of alfalfa (*Medicago sativa*). There are occasional instances where

TABLE 5. Analysis of Contents of Crops of 41 Chukar Partridge, from Wild Habitat in Central and West-Central Nevada, Collected in Late Summer and Early Autumn of 1941, 1948 and 1948 (from Alcorn and Richardson, 1951)

PLANT FOODS (MORE THAN 98% OF ALL CROP-CONTENTS)

	Number of crops containing	Comments
Seeds—		
Bromus tectorum (Downy Brome)	23	Over 80% of contents of 12. (Over 900 seeds in 1.)
Erodium cicutarium (Filaree)	11	95, 60, 45, 20, 15 and 5% of contents in 6. (Over 2,000 seeds in 1.)
Pinus monophylla (Pinon Pine)	5	Almost entire contents of the 5. (32 pine nuts in 1.)
Helianthus sp. (Sunflower)	6	A few in each.
Lomatium sp. (Desert Parsley)	3	35, 20 and 5% of contents.
Polygonum sp. (Smartweed)	3	40% of contents of 3.
Arabis sp. (Rock-cress)	3	30 and 20% of contents of 2.
Descurainia pinnata (Tansy-mustard)	3	80 and 5% of contents of 2.
Grayia spinosa (Spiny Hopsage)	3	5% of contents of 2.
Astragalus sp. (Loco-weed)	3	A few in each.
Amsinckia sp. (Fiddleneck)	3	A few in each.
Argemone hispida (Prickly Poppy)	2	5 and 4% of contents.
Lupinus sp. (Lupine)	2	A few in each.
Oryzopsis hymenoides (Sand Bunch-grass)	1	4 seeds.
Leaves—		
Poa secunda (a Blue-grass)	14	Over 98% of contents of 3. Over 40% of 5 others.
Green grass blades	22	Over 95% of contents of 3. Fair amounts in 7 others.
Green dicot leaves	9	40% of contents of 3.
Fruits, etc.—		
Rosa sp. (Wild Rose)	1	5 "rose apples."
Allium sp. (Wild Onion)	1	95% of contents. 19 onions.
Artemisia galls (Sagebrush)	4	20 and 15% of contents of 2. (19 galls, ave. 8 mm. long, in 1.)
Unidentified composite buds		
Unidentified flowers	1	10 flowers.

ANIMAL FOODS (NONE IN 31 CROPS)

	Number of crops containing	Comments
Locustidae (Grasshoppers) (*Metanoplus*)	9	15 grasshoppers in all, 7 in one crop.
Lygaedae (Chinch Bugs and Allies)	1	3 common milkweed bugs.
Formicidae (Ants)	3	8 ants in all.
Stenopelmatidae (Jerusalem Cricket)	1	1 Jerusalem cricket.
Centipede	1	1 large leg.
Small rodent feces	4	207 in all, 50% of contents of 1. (175 feces 4–6 mm. long.)

TABLE 6. Food Items Found in 29 Chukar Crops Collected Monthly from March 1951 through February 1952 in the Pyramid Lake Area, Nevada (Christensen, 1952); (all items are seeds unless otherwise indicated)

Scientific name	Common name	Number of crops occurring	Comments
Plant—			
Bromus tectorum	Cheatgrass	17	Represented in 8 months
Gramineae	Grass leaves	14	(87% Nov., 99.50% Dec.,
Oryzopsis hymenoides	Indian ricegrass	6	73% Jan., 99% Feb.,
Poa secunda	Bluegrass rootstocks and shoots	2	82% March)
Sitanion hystrix	Squirrel tail	3	
Stipa sp.	Needle grass	1	
Amaranthus retroflexus	Amaranth	2	
Amsinckia tessellata	Fiddleneck leaves, stems, buds and seeds	16	Represented in 9 months
Agoseria sp.	Mountain dandelion flowers	1	
Balsamorhiza hookeri	Balsam root	1	
Chrysothamnus sp.	Rabbitbrush flowers	1	
Descurania sp.	Tansy-mustard pods	2	
Sisymbrium sp.	Mustard pods	2	
Erodium cicutarium	Red-stem filaree leaves and seeds	11	Represented in 7 months
Juncus sp.		1	
Allium sp.	Wild onion	3	
Gilia inconspicua	Gilia capsules and bracts	2	
Rumex crispus	Curly dock	1	
Salicaceae	Willow buds	1	
Solanum nigrum	Black nightshade fruits	2	
Lomatium sp.	Lomatium leaves	1	
Animal—			
Archnida	Spider	1	
Blapstinus sp.	Beetle	1	
Tipulidae	Crane fly	1	
Corixidae	Water boatmen	1	
Pentatomidae	Stink bugs	1	
Homaemus proteus	Shield bug	1	
Aphididae	Aphids	1	
Crematogaster sp.	Ants	1	
Lepidoptera	Moth or butterfly larvae	3	
Heterocera sp.	Beetle cocoon	2	
Melanoplus sp.	Grasshoppers	3	
Bradynotes pinguis	Grasshoppers	1	
Other—			
Grit		16	
Mice droppings		4	
Wood		3	
Feathers		1	

TABLE 7. Fall Food Items in 105 Nevada Chukar Partridge Crops, 1961–1965
(from Weaver and Haskell, 1967; plant names from Munz and Keck, 1959)

	Western Nevada (45 crops)		Northcentral Nevada (60 crops)		Both Areas (105 crops)	
Food Item	**Percent by occurrence**	**Percent by volume**	**Percent by occurrence**	**Percent by volume**	**Percent by occurrence**	**Percent by volume**
Plants (Seeds unless specified otherwise)—						
Bromus tectorum (leaves and stems)	40.0	45.7	21.7	5.1	29.5	25.0
Bromus tectorum	44.4	8.9	80.0	40.4	64.8	24.9
Amsinckia tessellata	26.7	7.1	8.3	7.9	16.2	7.7
Amsinckia tessellata (leaves and stems)	13.3	5.6	...	...	5.7	2.7
Lithophragma sp. (roots)	...	...	35.0	8.3	20.0	4.2
Rumex sp.	...	...	13.3	8.1	7.6	4.2
Helianthus sp.	...	...	11.7	7.5	6.7	3.8
Bromus secalinus	11.1	7.2	...	...	4.8	3.5
Erodium cicutarium	4.4	1.2	13.3	1.9	9.5	1.6
Ephedra sp.	...	...	10.0	1.2	5.7	0.5
Compositae (leaves, stems and buds)	4.4	0.1	1.7	0.7	2.9	0.4
Nicotiana attenuata	2.2	0.8	...	...	1.0	0.4
Artemisia tridentata (leaves)	8.9	0.7	...	...	3.8	0.3
Lupinus sp.	2.2	Tr	5.0	0.5	3.8	0.3
Oryzopsis hymenoides	15.6	0.4	1.7	Tr	7.6	0.2
Aster sp.	6.7	0.5	...	...	2.9	0.2
Festuca sp.	2.2	0.4	...	...	1.0	0.2
Allium sp.	...	...	5.0	0.2	2.9	0.1
Rosa sp.	...	...	1.7	0.3	1.0	0.1
Ribes sp.	...	...	1.7	0.2	1.0	0.1
Madia sp.	...	...	3.3	0.1	1.9	Tr
Agrimonia sp.	...	...	1.7	Tr	1.0	Tr
Brassica sp.	2.2	Tr	...	...	1.0	Tr
Plantago sp.	...	...	1.7	Tr	1.0	Tr
Chaff and unidentified	35.6	10.2	53.3	5.1	45.7	7.6
All plants	100.0	88.9	100.0	87.7	100.0	88.3
Animals—						
Locustidae	24.4	3.2	33.3	9.5	29.5	6.4
Margarodidae	15.6	4.7	...	...	6.7	2.3
Rodent feces	20.0	2.1	3.3	0.6	10.5	1.3
Formicidae	6.7	Tr	16.7	1.9	12.4	1.0
Coleoptera and Hemiptera	11.1	1.1	1.7	0.1	5.7	0.6
Unidentified	...	...	10.0	0.2	5.7	0.1
All animals	77.8	11.1	55.0	12.3	64.8	11.7
Total		**100.0**		**100.0**		**100.0**
Total cc		**205.0**		**212.9**		**417.9**
Average crop content, cc		**4.4**		**3.6**		**4.0**

chukars have been known to cause damage to specific agricultural crops (apples and potatoes in Nevada, and potatoes in Washington and California). However, these incidents have been unusual and so infrequent that for all practical purposes it can be said that there is no conflict between chukars and agriculture.

One very interesting food record was uncovered recently when David Savage and Laun Buoy found several hundred live bugs *Margarodes chukar* (La Rivers, 1967) in the crop of a chukar killed 20 miles northwest of Reno in 1964. Cheatgrass, particularly the roots, appears to be the host plant.

A controlled food study by Savage *et al.* (1969) using game farm birds, showed that the caryopses of medusahead (*Taeniatherum asperum*)—another exotic grass that is becoming established, often at the expense of cheatgrass, in California, Idaho, Oregon and Washington—are not as digestible as those of cheatgrass. If medusahead were to displace large areas of cheatgrass in chukar habitat in the future it could possibly have an undesirable effect.

Although only limited data is available it is interesting to note some of the food habits in India. Thirty chukar crops, collected by Wayne Bohl in the vicinity of Srinagar, India, were examined on a cursory basis by Dr. Joseph Robertson, University of Nevada, and myself. All of the crops were collected in the first week of October, 1961. The most common items found in the crops were the spikelets of *Eragrostis* sp., florets of *Bromus* sp., the seeds of *Cenchrus* sp., *Panicum* sp., *Stipa* sp., wheat, barley and a borage. Compositae achenes and green grass blades completed the list of the major plant foods. Ants were rather abundant and the most conspicuous animal food. Here again, the importance of the grass family as a chukar food is apparent, and the similarity of the food preferences of the chukar in its native and introduced habitats (for the fall at least) are obvious.

REPRODUCTION

Pairing—The chukar, a monogamous bird, usually leaves the covey and begins pairing in mid-March in Nevada. Photoperiod, temperature and food conditions appear to play a part in determining whether pairing will occur earlier (February in some areas) or not at all. When chukars do not pair, or do so only briefly and regroup into coveys, it is indicative of a poor nesting season.

A great deal of dispersion accompanies pairing. This was well illustrated at a study area the author had under observation in 1951 at Pah Rah Mountain near Pyramid Lake. The study area was approximately one square mile in extent and a small spring (5,500 ft. elev.) served as a center of operations. During the winter it was noted that there was a rather constant population of approximately 100 birds in this area. Following pairing the greatest number of birds flushed during any single day was seven pairs and one single. This indicated that about 85 percent of the population had dispersed to areas outside the immediate study limits. Pairs of chukars were found at elevations from 4,100 to 7,000 feet. The dispersal that accompanies pairing obviously was a basic stepping stone in accelerating the chukars' spread and subsequent establishment into unoccupied habitat following releases.

Mackie and Buechner (1963) found that pairing occurred in Washington from early February to late March and that birds over one year in age were the first to pair. They also found that testicular recrudescence began during late January with the full breeding condition being reached in late March and persisting for about three months. In the ovarian cycle recrudescence began about the first of February and culminated in egg laying between mid-March and mid-April.

Once the birds are paired a form of territoriality becomes noticeable in that the male does become aggressive and fights with other males that enter the general nesting area. The extent of this territorial defense is questionable and Moreland (1960) and Mackie and Buechner (1963) feel that rather than a strict defense of a definite nesting area the male bird simply repels other males from the vicinity of the female.

Courtship—During the pairing process calling is very commonplace and several specific calls, which occur only during the breeding season, are used by both sexes. The cock will also display before the hen, running at her with his head down, neck extended and appearing swollen and one wing extended downward until the tip scrapes the ground. The culmination of this courtship activity is the actual mating of the pair. Detailed descriptions of the sexual calls and courtship displays are given by Stokes (1961).

Role of the sexes in nesting—There is some question as to how long the integrity of the pair lasts and what the actual nesting duties of the individual sexes are. Concerning the red-legged partridges in general,

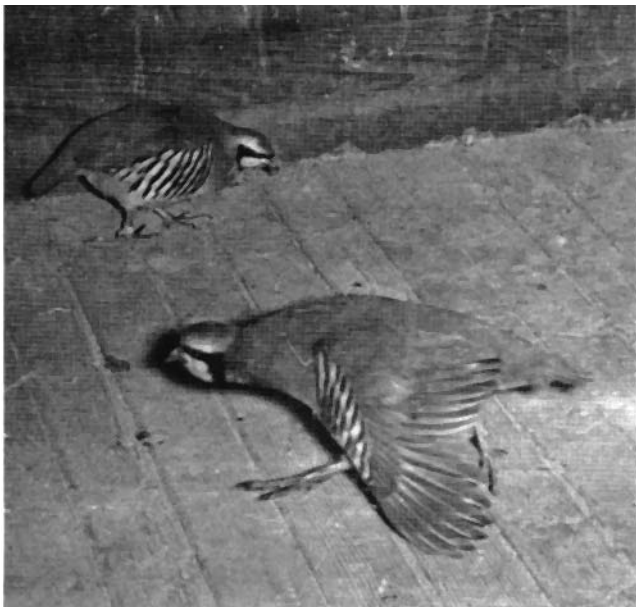


FIGURE 16. **A male chukar's "waltzing" display during courtship.** (Photo courtesy of Allen Stokes.)

Goodwin (1953) brings out that most writers believe that only the female incubates and that the male does not stay near the nest, but sometimes rejoins the family when the young are half-grown. In accounting for the other side of the story, which he does in detail, numerous instances of male participation are mentioned such as "Col. R. Meinertzhagen informs me (*in litt.*) that the first bird he ever killed was an incubating male Red-legged Partridge which he shot with a bow and arrow in 1890, transfixing it on its nest. The nest was on a rick and a female was sitting on another nest some 200 yards away." "In 1920 Col. Meinertzhagen shot a male Rock Partridge *Alectoris graeca* on its nest in Crete . . . ." "Wettstein (1938) killed an injury-feigning Rock Partridge in the Aegean Islands, which had a large brood-patch and proved on dissection to be a male." From his own personal observations Goodwin found that a captive pair of birds both incubated, with the male sitting on the first nest some twenty hours or so after the female had commenced setting on the second. In conclusion he believed that it was probably normal for two clutches to be laid and for the male to incubate the first. Watson (1962 a) believes it is possible for the male to raise a brood when populations are low and cites a case where of twelve partridges collected in Greece and Turkey during the breeding season one male, with a brood of week-old chicks, had an active brood patch.

In North America it is generally felt that some of the males remain with the hens until all of the incubating, hatching and rearing duties are completed; however, on the basis of limited studies in Washington, this may be the exception. Galbreath and Moreland (1953) feel that, though not always, the pairing bond may break after completion of the clutch and that there is a regrouping of males following this desertion of the females. Mackie and Buechner (1963) found that adult male chukars were present in about 10 percent of 103 brood observations in Washington. This led to the conclusion that generally when two adults accompanied a brood "both appeared to be females." On several occasions in Nevada, specimens collected from coveys of adult chukars during the nesting season have revealed that the covey comprised both sexes and does not necessarily consist of males alone. This agrees with Moreland's (1960) observation that unsuccessful females may join groups of deserted males after mid-June. It is my feeling that reliance upon visual observation to sex the adults accompanying a brood can involve speculation and unfortunately there is a dearth of factual information on this subject. Other than under captive conditions, I know of no authenticated record of a male chukar incubating in the wild. The exact role of the male chukar during the nesting season still requires additional research.

Nesting—On the basis of adult behavior patterns in conjunction with aging broods and backdating the time of hatch in Nevada it appears that the building of a nest and egg laying usually commences in April. In May incubation is in progress and the hatch occurs in late May and June. In Washington, Galbreath and Moreland (1953) calculated that the earliest laying date was April 3 with the average being April 20. The earliest incubation date was April 20 and the bulk of incubation took place about May 10. This would put the hatch off toward the first of June. Mackie and Buechner (1963) using captive females, wild females that were collected and examined and nest observations, reached the conclusion that laying began during early March with a peak in the number of females laying their initial egg occurring during the last week of March and most of the hens beginning to lay by mid-April. They found that all hens collected after March 30 were laying, and those collected after mid-April had ovulated at least seven times. Their data indicated that with the earliest egg laying beginning in March and the late nests not being

FIGURE 17. **One of the few chukar nests found in the United States. This nest was under an *Atriplex* sp. bush and contained 16 eggs.** (Photo courtesy of California Fish and Game Department.)

hatched until mid-August that the nesting period extended over approximately 5 months in Washington.

In the more southern range of the chukar (Temblor Area of California) Harper *et al.* (1958) found a chukar brood as early as April 28, 1955 and in 1954 and 1955 the peak of the hatch was between May 15 and May 29. The hatching dates in the more northern areas of California correlate closely with those in Nevada.

Observations in Gilgit, Pakistan by Biddulph (1881) are in general agreement with those found in North America and he found that the chukars breed between 5,000 and 10,000 ft. elevation with the nests at the highest elevations being hatched last. At 5,000 ft. elevation some of the young birds were able to fly by the first week in June, and he commented on taking a single fresh egg out of a new nest on the 5th of May.

If a nest is destroyed the hen will usually renest. There is no question that chukars are persistent nesters and the presence of downy young in late August indicates that they will keep trying for a successful hatch as long as conditions permit. If the brood is lost at an early date there is also a possibility of renesting. This subject has not been thoroughly studied but is of importance when the peak of the hatch occurs during prolonged periods of inclement weather, which may result in severe chick loss. Field survey data in Nevada during such years reveal a preponderance of late hatched chicks showing that renesting activities do occur, and indicating that there was a substantial chick loss during the peak hatching period. In order to renest at this time the physiological condition of the hen is important since ovary regression is occurring, and based on limited data Mackie and Buechner (1963) feel renesting would seem unlikely after the final stages of incubation or a few days after hatching. Nevertheless, no convincing data is currently available to deny this possibility.

The nest itself is merely a depression scratched in the ground and greatly resembles a dusting bowl that has been lined with dry grasses, stems and feathers. Active nests in rangelands have been very difficult to find in Nevada and other states even though concerted efforts have been made. I found two destroyed nests in Nevada of which one contained 19 eggs and was located under a sagebrush near the base of a hill. The second was situated in a very rocky area on a mountain slope and was well hidden by rocks and brush on each side as well as a flat rock on top. A third nest, where chicks had hatched, was found in a similar site.

In Nevada, randomly laid or "dropped" eggs were found on the open slopes of a nesting area in May. Dump nests, where eggs are collectively deposited, have been noted in other states.

In Washington, Galbreath and Moreland's (1953) study revealed that the nests were all placed under scabland sagebrush and were usually well above the creek bottoms on the mountain slopes. Here again only destroyed nests or nests where the chicks had hatched were found. Mackie and Buechner (1963) found only 4 active nests in their Washington study, Bossenmaier (1957 a) found one in Wyoming, and Phelps (1955) did not find any in Utah.

In California (Harper *et al.,* 1958), a few nests were found in the Temblor Area on slopes of rolling hills with outcroppings of shale, sandstone or granite. Most of the nests were completely obscured from view on three sides and the top. There did not appear to be any specific preference for nesting cover as long as the nest could be well concealed and saltbush (*Atriplex* sp.), golden bush (*Haplopappus* sp.) and desert tea (*Ephedra californica*) with mixed annual and short grasses seemed to serve the purpose. It appears that once the hen is incubating she holds very close to the nest and Harper *et al.* (1958) report an incident where one observer lifted a hen off the nest to count the eggs without causing her to leave or desert.

Eggs—Hume's (1890) accurate description of the eggs is as follows: "The eggs vary a good deal in size and shape, as well as in type of colouring, but typically they are somewhat elongated ovals, a good deal pointed towards the small end. Pegtop and spheroconoidal varieties occur, but these forms are the exceptions in this species, while they are the rule in those of the three species of Francolin. The type of colouring, too, varies; in one type the ground colour is pale cafe-au-lait, thickly speckled and spotted with purplish, reddish, or yellowish brown; in an other the ground colour is a pale creamy white or pale isabelline, and the eggs are pretty thickly blotched, streaked, and spotted with pale purplish pink, the spots and blotches being occasionally slightly in relief, as if drops of white paint tinged with purple had been dropped on the egg. The eggs are moderately glossy—more so perhaps than in the Common Francolin, less so than in the Grey Partridge. The common type is that first described, and in some eggs the specklings are so excessively minute, that the eggs, looked at from a little distance, appear a uniform somewhat brownish cafe-au-lait."

Mackie and Buechner (1963) using captive females found that the mean rate of laying was 1.3 eggs per day and Moreland (1960) stated that the mean weight of thirty eggs was 22 gr. and the mean length and width of fifty-one eggs was 40 mm. and 30 mm. respectively. The number of eggs found in the four active nests discovered by Mackie and Buechner (1963) varied from 10 to 21 and averaged 15.5 eggs. The incubation period is 24 days.

Broods—After hatching the brood is cared for by one or both of the adults. The young are precocious and leave the nest immediately after drying. If, during the early days of life, the chicks are threatened by danger the adult will often feign injury in an effort to distract the intruder. By the time the chicks are 3 weeks of age brood integrity is questionable and during a normal production year it is not uncommon to see 30 to 50 chicks with from 1 to 3 adults. On exceptional years I have seen coveys of over 100 chicks of various age classes with as many as 10 adults. The loss of brood integrity seems to be most commonplace at watering sites, particularly small springs or seeps that are utilized by a large number of birds. In these instances the young birds become hopelessly mixed and the shifting of chicks from one brood to another, and even the complete loss of individual broods, occurs and eventually results in a breakdown of the family group. When chick adoption happens it is interesting to speculate once more on the possibilities of the hen nesting a second time (see *Nesting*), although it would appear that complete brood loss would have to occur shortly after the hatch.

When the birds water in the morning I have noticed that adults without broods are often the first to visit the watering sites and are followed later by the birds with broods. The exact time of watering appears to vary according to weather conditions, and during the early part of the summer the broods may not be brought to water until two or three hours after sunup.

The brood size varies from year to year depending upon the prevailing conditions that affect reproduction. Because of the early loss of brood integrity it has been difficult to be sure that all observations represent single broods and discretion has been used in recording this data. Long term studies in Nevada between 1960 and 1969 show that the average brood size, on a statewide basis, has varied from 8.5 chicks in 1964 to 12.4 chicks per brood in 1968. During this period there has been a variation within the state from a low average of 3.5 chicks per brood in 1960 in Clark County to a high average of 13.3 chicks per brood in West-Central Nevada in 1965. On many occasions individual broods containing as many as 19, 20 or more chicks have been observed and it is felt that 20 chicks would probably represent the upper limit of a single hatch.

Since brood size has obvious deficiencies when used as a measure of production it is felt that the most accurate measure of yearly production is through the use of the adult:young ratio. These counts are made in July and August when it is still possible to distinguish the young from the adults. In Nevada the broods are classified as follows during the summer field surveys:

Age Class

I—downy young to 1/4 grown (0–4 weeks)
II—1/4 to 1/2 grown (4–8 weeks)
III—1/2 to 3/4 grown (8–12 weeks)
IV—3/4 grown to adult size (12–16 weeks)

This simplified method of age classification is quite easy to use and was designed to obtain consistent yearly data with the consideration that many field personnel, often involving people who had not previously worked with upland game, will be using the method from year to year. A more exacting method for determining the

age of chukar chicks, which can be particularly helpful on specific studies, has been formulated in California and is presented in Table 8.

Long term data on adult : young ratios is instrumental not only in determining the yearly production, but also in helping to determine the population trend. This subject will be dealt with in detail under MANAGEMENT. It has been found both in Nevada and in California (Harper *et al.,* 1958) that the use of adult : young ratios from wild trapped chukars is not reliable due to the selective trapping vulnerability of the young chukar. Therefore, the classification of an adequate field sample is necessary.

TABLE 8. **Criterion for Estimating Age of Broods in Field (taken from known ages of game farm chicks);** (from Harper *et al.,* 1958)

Age	Markings and characteristics
5 days—	Flight: not capable, hen feigns injury Height: approximately 2 1/2 inches (standing) Body coloration: striped buff-brown, mottled appearance Head: line through eye Tail feathers: 0–1 mm.
10 days—	Flight: capable, usually within two weeks or less Height: approximately 5 inches Body coloration: light buff under parts, spotted black Head: black-brown spot for ear tuft; bill has black-brown upper mandible Tail feathers: 2–3 mm.
33 days—	Flight: strong Height: approximately 6–7 inches Body coloration: mottled-striped brown, no barring on flank Head: eye-ring turning red; line of down along each side of head, yellow brown Tail feathers: 5–6 mm.
47 day—	Height: approximately 7–8 inches Body coloration: barring distinctive on flanks Head: gray crown, line of down gone, throat patch dull and gray-white, black "V" incomplete Tail feathers: 8–9 mm., reddish tips, gray base 3/4 length
61 days—	Height: approximately 9–10 inches Body coloration: barring distinct, uniform gray-black, slightly spotted Head: bill dominantly red-black, throat patch distinct, dull brown-white, black "V" complete, rufous ear tuft distinct Tail feathers: 9–10 mm., reddish tips

Factors affecting reproduction—Since many environmental factors exert an influence upon a chukar population it is not always correct to say that a decline in production was due to bad weather when the chicks were hatching or that an increase was due solely to good range conditions, because there are often interrelationships of several factors that may, during any one year, determine the fate of the population. Since the basic habitat of the chukar is found in arid or semi-arid regions the amount of precipitation that is received during key periods of the year appears to be the primary factor in determining reproductive success. The effective precipitation in any given range largely determines the composition, abundance and condition of essential food plants that in turn play a major role in influencing the yearly chukar production. Precipitation totals alone do not tell the entire story. It is essential that the precipitation occurs at the proper times of the year to initiate the germination of the essential winter food plants (grasses) and to carry this food crop through the winter in a palatable form and then to provide for the growth of the necessary annuals, perennials and forbs and culminate in the maturing of a seed crop. Local thundershowers, which are not recorded, can have a considerable influence in some areas with the result that there may be pockets of good chukar production scattered through a general area of poor productivity. Temperatures and winds and prevailing soil conditions (frozen or not) also play an important role in determining the effectiveness of the precipitation. It has not been possible to obtain consistent direct correlations between total precipitation (based on a food year from November through June) and chukar production *per se,* and there always seems to be the odd year where some interpretation involving other factors is necessary.

Long term data concerning yearly production and population trends in Nevada show that our chukar populations exhibit the typical "boom or bust" pattern and that this largely correlates with drought conditions and the subsequent lack of proper feed. During the severe drought years of 1953 and 1954 the adult : young ratios in Washoe County were 100/63 and 100/11 respectively, showing the production had almost reached a standstill. At this time food conditions were so poor that adult birds collected during the nesting season were found to be subsisting on the dry rootstocks and stems of grasses. Needless to say, few birds nested

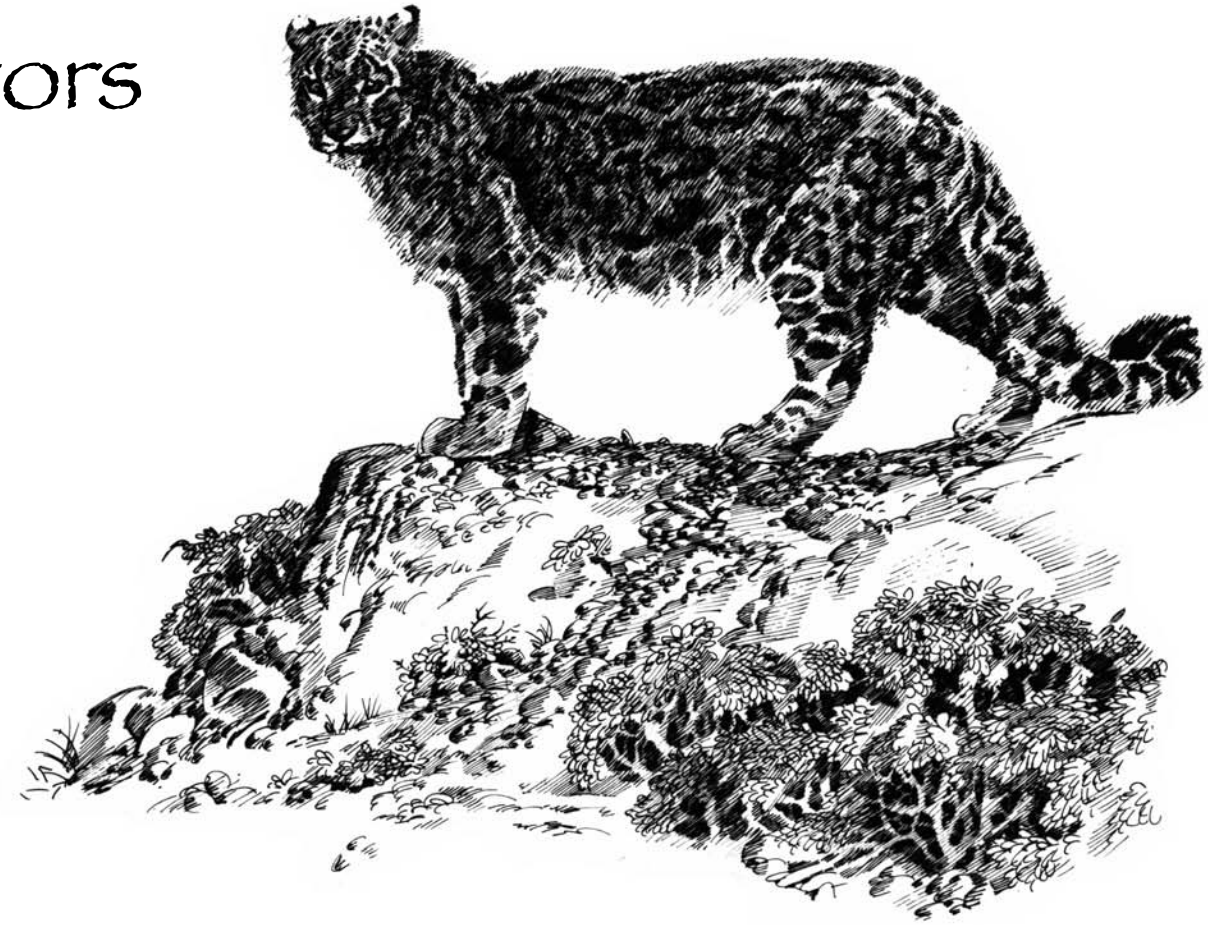
successfully and although pairing occurred in some instances coveys of adults, consisting of both sexes, were observed throughout the nesting season. In the 19 years since production records have been kept in Nevada (1951–1969) our chukar populations (on a statewide basis) have bottomed out three times (1954, 1959 and 1966) and reached population peaks four times (1952, 1958, 1964 and 1969). When a population bottoms out (as in 1954) it seems to require a minimum of three good production years, back to back, to bring the population to a peak again. Such a sequence does not usually occur and the population may drift along at a mediocre level for several years.

In addition to affecting chukar production indirectly through the food chain, climatic conditions can also directly affect the success of the hatch. Abnormally heavy precipitation in May and early June can cause chick mortality and in some instances adverse climate may result in nest loss.

COMPETITION WITH OTHER UPLAND GAME SPECIES

The game birds that have been seen in areas with the chukars are the mourning dove (*Zenaidura macroura*), California quail (*Lophortyx californica*), mountain quail (*Oreortyx picta*), Gambel's quail (*Lophortyx gambeli*) and the sage grouse (*Centrocercus urophasianus*). Chukar and California quail are frequently observed in the same canyon areas, and chukar, California quail and mountain quail have been captured together in the same trap. In many areas of Central and Northern Nevada where former sage grouse habitat has deteriorated through range misuse to the point where it is no longer suitable for sage grouse, the chukar has moved in and is filling what would have been a serious void. Harper *et al.* (1958) reports that an adult chukar was observed killing a Gambel's quail chick at a waterhole in California. This seems to have been a rather singular case of incompatibility. I do not know of any instance where there is serious competition between the chukar partridge and a native game species.

Inimical Factors



NEST DESTRUCTION

Magpies, ravens and various ground predators, particularly snakes, have been reported as being instrumental in destroying the eggs in chukar nests. In Nevada, Alcorn and Richardson (1951) reported an instance of a gopher snake swallowing six eggs. It seems reasonable to believe that such a loss does occur, however, due to the difficulty in locating nests. Only limited data is available.

Range fires commonly occur over large areas of chukar habitat being spread primarily by cheatgrass. Since cheatgrass usually becomes tinder dry by early June it is conceivable that some nest loss as well as the loss of newly hatched chicks can result from an early fire.

PREDATION

Known predators of the chukar partridge in California (Harper *et al.*, 1958), Washington (Galbreath and Moreland, 1953 and Moreland, 1960) and Nevada are the coyote, bobcat, great horned owl, prairie falcon, sharp-shinned hawk, Cooper's hawk, red-tailed hawk and golden eagle. When the birds are in a healthy condition it is felt that predation is minimal. The chukar is a very alert bird and a sentinal bird usually sounds the alarm well ahead of the predator. Hundreds of man hours of observation in Nevada during the past 20 years have revealed surprisingly few actual kill records.

In contrast to our North American predators Williams (1950) states that in New Zealand the chukars' enemies include "stoats, cats, hedgehogs, rats and harriers, all of which wreak most of their damage during the nesting season or in the period after hatching when the young are unable to fly." Biddulph (1881) reports that he commonly saw eagles stoop at chukars in Gilgit, Pakistan.

ACCIDENTAL DEATHS

Road kills, where paved highways transect good chukar habitat, do occur but are exceptional. In some areas (Galbreath and Moreland, 1953) birds have been known to fly into wires, but this is again an insignificant factor. Perhaps the greatest cause of accidental mortality is the drowning of both adults and young in stock watering troughs, large open top water storage tanks and open pits or shafts that the birds cannot climb or fly out of. The greatest losses occur with young birds and they are particularly vulnerable to the stock watering trough, which is often the only water supply available.

CLIMATE

The effects of snow—During December 1951, an 8-inch snow in the Virginia Range (Pyramid Lake Area) forced the birds down to the lower foothills. As the snow melted or was blown off the higher slopes the birds returned to these areas. By the first week of January, 1952, no birds were seen lower than 4,800 ft. elevation. During the second week of January, much of Nevada received the heaviest snowfall experienced since 1937. The Virginia Range was covered by a minimum depth of two feet of snow, excepting areas below 4,500 feet elevation and some of the lower south-facing slopes. This snow remained on the ground throughout the month. Available food was completely covered in the higher areas so a downward movement of chukars occurred. The birds congregated on the valley floor (4,000–4,100 ft. elev.) where grasses and red-stem filaree were available for food. On some of the lower slopes, where snow was only an inch or two in depth, they were able to scratch beneath the brush and reach the green vegetation. In a one and a half mile walk along the foothills west of Pyramid Lake 800 to 1,000 chukars were seen. They were in coveys of from 11 to 150 birds. This area was kept under close observation during what was deemed the critical period and occasional specimens were collected. All birds collected were in excellent condition and had good fat reserves. There was no evidence to indicate that the birds in this area suffered due to the snow, and by the first week of February they had returned to higher elevations (up to 7,000 ft. elev.) staying close to the snowline.

The Peavine Mountain Area (Northwest of Reno) was probably the hardest hit of any of the chukar habitat in West-Central Nevada. Many birds were forced down to the highways in the vicinity of Reno and even into the city itself (4,500 ft. elev.), where they took advantage of the food that was uncovered by plows along the roads and that handed out by sympathetic citizens. One specimen taken four miles west of Reno showed near depletion of the fat reserves. The birds observed in the same covey were fairly active and apparently not in severe distress.

FIGURE 18. **Deep, long lasting snow can result in periodic winter kill of chukars. Peavine Mountain, Washoe County, Nevada.** (Photo by author.)

In Central Nevada losses of chukars, as a result of the heavy snowfall, were observed at Birch Creek and probably occurred throughout a large portion of this area (Christensen, 1952 b). Deep snow, which made the winter food supply unavailable, had been present in this area for a number of weeks. The high elevation of the valley floor east of the Toiyabe Range (6,000 feet and above) made it impossible for the chukars to go to lower snow-free areas without moving long distances. Twelve dead birds were found and one adult female was collected at Birch Creek. The specimen that was taken weighed only 11.85 ounces, as compared to an average weight of nearly 18 ounces for a healthy mature female. There was a pronounced lack of vigor in all of the birds seen in the area. The majority of the birds that were observed were congregated on cattle feeding grounds where they attempted to glean a living from barley hay and cottonseed cake.

During the winter of 1967–68, by which time good chukar populations had become established in Northeastern Nevada, another severe snow storm (comparable to that of 1951–52) beset the state. Chukar losses were observed in Elko County under circumstances similar to those found at Birch Creek in 1952. It is apparent that in areas of chukar habitat in Nevada, where the lower valley elevations are in the vicinity of 6,000 feet, that there can be severe losses to local chukar populations as a result of heavy snows. Prolonged cold temperatures following heavy snows (as observed in Birch Creek) will compound the problem.

Galbreath and Moreland (1953) reported that a similar, and apparently even more massive, winter kill

FIGURE 19. **Chukars in the high mountainous areas of Wyoming are subjected to stern winter conditions. Wind blown, snow free slopes in the Big Horn Basin provide feed.** (Photo courtesy of Wyoming Game and Fish Department.)

occurred in Washington in 1950 when the birds were subjected to one of the worst blizzards ever experienced.

In Idaho it was reported that the severe winter of 1963–64 reduced the Upper Snake Region's chukar population to a bare remnant and that the birds were not expected to reach a high population density because of unsuitable climate. Chukars appeared to be able to withstand an 8 inch snowfall for six days in Wyoming (Bossenmaier, 1956) in areas where it was possible to move to cattle feed-lots and ranch yards.

Reports to the Western States Chukar Committee (1956 Vol. 3(1)) from British Columbia stated that it was felt that chukars cannot winter successfully above 1,400 feet, the approximate limit of the sagebrush country, in the central valleys. Snow could be a critical factor in this northernmost portion of the chukar range.

Winter kill is to be periodically expected throughout the northern range of the chukar in North America; however, it appears that in areas where the bird is presently established such losses, even though they may be severe, are of an erratic nature and that the birds can recover from this loss rather quickly through movement into the "disaster" area by birds from adjacent unaffected populations in addition to reproduction of the survivors.

The effects of precipitation—Young chicks that have recently hatched can be killed as a result of exposure to rains. Other discussion on this was presented in the section on *Factors affecting reproduction*.

FIRE

During August 28, 1951, a range fire started near Vista, Nevada (five miles east of Reno) and traveled 25 to 30 miles northeast of the point of origin, burning over approximately 35,000 acres of land. The majority of the burned range was excellent chukar partridge habitat and portions of this same area had been burned in previous years. Eight days after the fire was under control a survey was made over approximately 12 linear miles of the burn where large populations of chukars were known to occur. No dead birds were seen, but approximately 2,000 chukars were observed in the burned area. The majority of the birds were seen at springs and in the vicinity of small creeks. Birds were observed as far as five miles within the burn.

Incidents such as this occur yearly throughout the chukar habitat in Nevada and other Western States, and when the fires occur after the birds are capable of strong flight it seems doubtful that any serious loss is

FIGURE 20. **Burns are prevalent over most of Nevada's rangelands and contribute toward creating good chukar habitat. Note the heavy growth of cheatgrass (the result of previous burns) in the area to the left.** (Photo by author.)

sustained. Cheatgrass fires are usually fast with a low flame and the area of intense heat is restricted along the fire front. Once the front passes, the ground where the fire has been cools rapidly. The fire will often be spotty, depending upon wind conditions. Because of the characteristics of a cheatgrass fire it is entirely possible for chukars to escape the flames easily and to return to the burn area almost immediately following the fire without suffering harm. I have yet to hear of an authenticated case where chukars capable of flight have suffered a loss due to this type of fire.

DISEASE

Wild chukars appear to be relatively disease free. In 1951, two wild birds collected by the author near Pyramid Lake had infections of malaria (*Plasmodium* sp. and *Haemoproteus* sp.). A few years later several birds were killed by Reno hunters that were infected with sarcosporidiosis. Since a great number of chukars often concentrate at a small spring or seep it would appear that these sites would be the primary source of contamination in spreading disease. Literally thousands of wild chukars have been observed in the field during past years, and a great many have been examined by Department personnel and by sportsmen during the hunting seasons. As yet we do not know of any instance where disease or parasitism has caused serious mortality.

Game farm chukars are susceptible to many of the common fowl diseases. Coccidiosis is probably the most common disease. Galbreath and Moreland (1953) report gapeworm (*Syngamus trachea*), tapeworm (*Raillietina* sp.) and infectious coryza as a few of the diseases found on the Washington game farm. Nagel (1945), in addition to some diseases already mentioned, encountered blackhead and caecal worms (*Heterakis* sp.) in Missouri. McNeal, Platt and Hinshaw (1939) found intestinal flagellates (*Hexamita* sp.) and *Trichomonas gallinarum* was found in game farm birds from Salinas Valley by Wichmann and Bankowski (1956). Nematodes (*Ascaridia galli*) have been identified in reared birds by Tibbits and Babero (1969), and eastern viral encephalomyelitis has been reported by Moulthrop and Gordy (1960).

Management

DETERMINING AND MAPPING DISTRIBUTION

In order to effectively manage the chukar resource of Nevada the distribution of the species must be known. Detailed distribution records are maintained on all sight and kill records and these are mapped on a county basis. An attempt is made to update all distribution maps on a 5 to 10 year basis. This data provides us with basic information as to the type and amount of habitat occupied by the chukar and the potential unoccupied habitat that remains in the state.

CENSUS METHODS IN GENERAL

There have been several approaches toward attempting to determine the annual population of chukars and these are described by Nilsson (1956). Survey methods have varied from obtaining general impressions, counting total birds in areas where they concentrate, making brood counts, strip transects, call counts, and obtaining adult:young ratios. In most cases the nature of the terrain makes it extremely difficult to work in chukar habitat, and has been a major factor in handicapping the development of suitable census techniques. The location of birds following initial releases for establishment was so difficult in New Mexico that it led to Bohl's (1956) development of a field method for playing recordings of the rally call in an effort to locate chukars that would respond. Williams (1961) intensified investigations on this technique to determine if the use of this call could lead to a reliable index of chukar abundance. The results of this study showed that calling is influenced by many variable factors and that it is not possible to accurately census chukars through the use of the call count.

It has been found in Nevada that standardized route or strip counts do not work well since the presence of the birds on these areas depends largely upon prevailing feed and climatic conditions that vary from year to year. Therefore field surveys, other than waterhole counts, need flexibility. It has already been mentioned that brood integrity is lost early, so this method has to be carefully applied as a measure of annual production and has its obvious pitfalls.

Since 1952 adult:young ratios, obtained through the classification of as many chukars as possible over selected representative chukar habitat in the state, has been used as the primary measure of annual production in Nevada. The yearly adult:young ratio then forms the basis, when evaluated in light of the annual harvest records and the biologists' judgment as to prevailing food and climatic conditions that affect production, in determining the annual population trend. It is my opinion that when properly implemented on a local or statewide scale this is the quickest, most efficient and most accurate method of determining the population status on a year to year basis, and this approach has allowed us to correctly predict the general chukar population level (low, medium or high) in Nevada for nearly every year since 1952. Recent refinements in evaluation techniques now make this method of determining population trends fully compatible with our ability to harvest the birds and in setting seasons that reflect the general population level.

DETERMINING ANNUAL PRODUCTION

Field surveys are conducted annually during July and August with the objective of classifying an adequate sample of chukars to obtain an accurate adult:young ratio. This ratio is used as the measure of annual production. In conjunction with the classification counts a yearly average brood size is obtained by recording the brood sizes of chicks prior to banding and where it is felt that brood integrity still exists.

Pre-described routes, which are mapped and on permanent file, are surveyed throughout representative chukar habitat in the state. The surveys consist of standardized waterhole counts and of semi-random road and walking surveys. The primary objective of both survey methods is to locate a sufficient number of birds so that an adequate sample can be classified, and the field biologist is encouraged to enlarge upon the survey routes or to modify them according to prevailing conditions. In other words the survey maps show the general areas where chukars will be found and it is up to the biologist to work the area thoroughly enough to feel that he has a representative sample.

Waterhole counts—A vehicle is driven to an advantageous observation point near the waterhole and the observer remains quietly within the vehicle and records the numbers and age classes of birds that come to water. It is usually possible to drive the vehicle as close as 30 to 50 yards from the waterhole without disturbing the birds. The observer should be at the waterhole

at sunrise and should remain there until all of the major watering activity is completed (usually about 9:00 A.M. P.D.S.T.). Waterhole counts usually provide excellent results for time expended and strategically planned waterhole counts can result in large samples of birds. Unfortunately, it is not possible to find suitable waterholes throughout the state, particularly in Northern and Central Nevada where streams are more prevalent, so road and walking surveys must also be used. It has also been found that in some years frequent spring and summer showers limit the concentration of birds at watering sites and during these times the waterhole count is often futile.

Road and walking surveys—Roads that traverse chukar habitat, and particularly those in canyons along watercourses, are driven during the survey period in order to locate and classify as many chukars as possible. In some instances isolated springs away from the road are walked to and streams, which are not accessible by road, are walked. If, as a result of spring and summer rains, the birds are badly dispersed the survey areas are enlarged and the amount of effort expended in that area increased until it is felt that an adequate sample is obtained. The same procedures apply during drought years when production is limited and the population decimated in order to insure confidence in the data collected.

The adult:young ratios and brood size data for Nevada from 1951 through 1969 are given in Table 9.

TABLE 9. Adult : Young Ratios and Average Brood Sizes of the Chukar Partridge in Nevada (statewide figures except 1951)

Year	Number of birds classified	Adult : young ratio (young per 100 adults)	Average brood size
1951	[1]332	876	...
1952	776	743	...
1953	641	42	...
1954	665	106	...
1955	535	207	...
1956	1,553	509	...
1957	3,908	418	...
1958	1,305	549	...
1959	657	71	...
1960	4,804	232	9.0
1961	5,846	245	9.5
1962	3,550	550	11.0
1963	5,007	307	12.0
1964	5,056	108	8.5
1965	4,736	163	11.0
1966	5,543	142	9.0
1967	3,214	493	11.5
1968	7,380	317	12.5
1969	8,495	706	11.0

[1]Washoe County only.

DETERMINING POPULATION TRENDS

Chukar population trends are determined by the evaluation of the current years' annual production (adult:young ratio) in relation to past years adult:young ratios, the yearly harvest and the production years' climatic data and food plant growth pattern (Nov.–June). The yearly adult:young ratios and the annual harvest data are obtained through prescribed procedures and over a period of years they provide the depth that is so necessary to make an accurate analysis of the current status of the population. Climatic data and the phenology of the food crop, which play such an important part in determining the annual production of the chukar, are factors that require periodic year-around observations of the biologist as well as documentation and evaluation of weather record data, and in the final analysis must be tempered by individual judgment based upon field experience.

Once sufficient data is collected and organized on a yearly basis it is fairly simple to read the pattern of annual chukar production, harvest, climatic data and food plant phenology and to arrive at a reliable estimate of the existing population trend. An example, which shows the great fluctuation in population trends, and how to determine these trends so proper hunting season recommendations can be made, is presented using actual field data collected between 1951–1959 in Nevada. In order to simplify this illustration climatic data, food conditions and pertinent field observations are generalized in the text.

Production and Harvest Data for Determining Chukar Population Trends (Example)

Year	Adult : Young Ratio (Young per 100 adults)	Harvest (10% questionnaire)
1951	876	36,184
1952	743	43,742
1953	42	18,090
1954	106	closed
1955	207	1,120
1956	509	12,655
1957	418	55,660
1958	549	118,650
1959	71	19,648

Evaluation of Data for Determining Chukar Population Trends

1951–52—These were both good precipitation years and the precipitation pattern resulted in an excellent food crop. These were the first years for formal surveys and only local areas were sampled. The data indicated high chukar production during both years. In 1952 the chukar population, working off a high 1951 base (good production and a good harvest, keeping in mind that hunters were just beginning to take an interest in chukar hunting) peaked out.

1953—Decided drop in precipitation resulting in a drought year. Food crop not sufficient to condition breeding adults or to sustain a suitable hatch. Severe drop in production. Population level will obviously decline; however, it is known from the 1952 production and harvest that this decline will be from a peak population base and therefore there will be a good carry-over of adult birds into 1953 and even with very poor production the population will not bottom out.

1954—Precipitation about same as 1953. Food plant phenology unfavorable except in isolated areas. The 1953 harvest and production indicates that we entered the 1954 breeding season with a low-medium population base. Coveys of adult birds during the breeding season show that there is limited participation in nesting. Although production is up slightly it is restricted to few birds and it will have an insignificant effect on the population level, which will bottom out.

1955—Slight increase in precipitation results in a food crop. The adult carry-over into 1955 is obviously at rock bottom. There is an increase in production over 1954, working from a very low population base. This is a mediocre year. The population level will be low.

1956—Significant increase in precipitation resulting in a favorable food crop. Dramatic increase in productivity from a low population, as indicated by the 1955 production and harvest. This is the first significant stage of a population recovery with the population base broadening and pulling out of the crash, but the population level is between low and medium.

1957—Slight decline in precipitation but sufficient moisture in the proper pattern to make a food crop. Production drops but is still good. In evaluating the 1956 production and harvest there is obviously a higher population base. The population level should increase and be on a solid broad base. This is a median year.

1958—Good precipitation provides for an excellent food crop. Production increases working off the high 1957 carry-over. This should result in the population nearing or attaining a peak. It has taken four years for the chukar population to build up from a crash (1954) to a peak (1958) and this was done by putting one mediocre production year and three good production years back to back. Obviously there are many variations of what could happen.

1959—A poor precipitation and food year. Very poor production. The population will decline, but as in 1953 there will be a high adult carry-over (which will account for the majority of the 1959 harvest) and the population level will drop between low and medium.

The above example is based on statewide data (except for 1951, which was for Washoe County). The individual county data, which is the management unit in Nevada, will show adult:young ratios above and below that depicted for the state during any one year. It is important to obtain adequate samples from all of the major counties that harbor chukars so the state totals will be representative and consistent.

In using this method of analysis to determine the population status it is essential to point out that there are, and always will be, variables in the data collected that may not always be a true reflection of actual conditions or the end result. Sometimes this data simply will not fit into a pattern. It must also be understood that only the data for primary factors, adult:young ratios, harvest and climate are documented (food plant phenology is generalized), and for the most part this is all that is necessary and all that can be normally programmed during general statewide field surveys. Many other factors that influence a population (nest destruction, disease, predation, etc.) are not usually evaluated. Some of these "secondary" agents may on occasions become "primary" factors in affecting some phase of the reproductive cycle. So again, in the final analysis, the field experience and judgment of the biologist has to be considered in making the final interpretation. Our experience in Nevada has shown that we have been able to keep our finger on the long-term chukar population trend, and on an annual basis we have the means of evaluating the general population status and recommending an appropriate hunting season with confidence.

By using the system described above, with the county as the basic unit, it is possible to manage

chukars in Nevada on a county or a regional (complex of adjacent counties) or a statewide basis.

RECOMMENDATIONS FOR SETTING THE HUNTING SEASON

The recommendations that are made for setting the hunting season should be consistent with the status of the current population. When there is a high population there should be a long season and a liberal bag and possession limit. When the population bottoms out the season should be shortened and the bag and possession limit reduced. Similarly, there should be a moderate season and bag and possession limit for years when the population is between the boom and the bust. Under the prevailing conditions of chukar hunting in Nevada, where there is still a limited number of hunters and hundreds of square miles of chukar habitat is totally inaccessible to the hunter, there should never be a closed season. There has only been one year (1954) when the chukar season was closed statewide in Nevada. On several occasions separate counties have been closed during various years. A study on the effects of a closed season on chukar populations in Western Nevada was made by Christensen (1958) and the conclusion was that the "holding of a hunting season during a period of population low has no important depressive effect. The advisability, and success, of holding such a season depends greatly upon public acceptance. Areas in Nevada that held chukar seasons during the drought period (*population low*) recovered as quickly as those that did not have seasons, and these areas are now providing the bulk of the state harvest." This open season concept has been adhered to and, with the occasional exception, accepted by the public.

The format of having the hunting season reflect the general status of the chukar population level is essential to indicate to the hunters what they may expect in terms of hunting success and to build up long term confidence in the Department's hunting season recommendations. Nothing is more damaging to a management program or to the biologist's image than to recommend a liberal season when the game population is low (even though the biologist is convinced it will do no harm) unless the hunting public has been educated to accept it. Properly informed hunters are an integral part of good game management.

Over the years a format has been developed by the Nevada Department of Fish and Game that serves as a guideline toward recommending consistent seasons on a statewide basis that reflect the chukar population status. It has been found that early and mid-September season opening dates are generally objectionable because of the frequent occurrence of three-quarter grown (and sometimes even smaller) chukar chicks. This is essentially a public relations problem, but it is an important one to recognize. Mid-October to November openings provide for well grown chicks, but often takes the edge off the good initial kill that can be obtained when the weather is hot and the birds are dependent upon water. The approach that is now used by the Department is to work within the following framework when preparing season recommendations for presentation to the County Game Boards and the Commission:

Season Date (Open)	Number of Days	Bag Limit	Possession Limit
Last Saturday of September for	120 (maximum)	10	20
Last Saturday of September for	30 (minimum)	5	10

In using the framework a season can be rather quickly selected according to the current population status. If the chukar population is at or in the vicinity of a peak the maximum season is recommended. If the population has crashed the minimum season is recommended. If the population is somewhere between the two extremes then the number of days and/or the bag and possession limit are adjusted within the framework to reflect the population level. The opening date of the above framework has been permanently adopted as policy by the State Board of Fish and Game Commissioners—with the obvious benefit that the hunters can make long term plans for the initial hunt. The remainder of the framework has not been adopted by the Commissioners. The Department's season recommendations are presented to the 17 County Game Management Boards of the state and then to the State Board of Fish and Game Commissioners, who evaluate the recommendations and set the season. For the most part Nevada has had very liberal hunting seasons, there has been generally good public acceptance and progress is being made toward developing a system whereby the type of hunting season that is adopted from year to year will reflect the prevailing chukar population level.

HUNTING

Hunting is a management tool that is used to safely harvest the annual surplus of a game population. The hunting season is the end result of the year-around field work, data collection, analysis and recommendations of the game biologist. The hunting season is the period of the year when thousands of nimrods will go into the field, arms in hand, and test the expertise of the biologist and perhaps add some of their own. The hunting season is the most controversial phase of any game management program.

The chukar partridge, being a relative newcomer to the hunting scene in the United States, has perhaps been blessed (as far as management is concerned) in that it has been established and hunted for such a short time that there are very few ingrained, long term, radical prejudices that affect management practices. Hunters are well aware of the inaccessibility of much of the chukars' habitat. They are also aware of the strenuous effort they must exert in order to limit out. They know that the best chance of obtaining a limit is when the weather is warm and the birds are close to water, and they also know that once the grasses green-up in the fall and the weather cools down the chukar will range widely and hold his own against the best of hunters.

Nevada hunters and biologists were seriously concerned when the bottom fell out of the chukar population in 1954—and the hunting season was closed. Studies were initiated and the sportsmen informed of the results, and in subsequent years it has been learned by both biologist and hunter alike that range conditions, which have been previously discussed, pretty well determine the annual chukar production and we recognize the "boom and bust" nature of the chukar population. In evaluating these factors most hunters do not now seem to be concerned about closing the season in the event of a drastic population decline; however, they are interested in having a shorter season. Similarly, in years of high populations, when it is not at all possible to adequately harvest the surplus, they are not interested in early September seasons that could result in considerably increasing the initial kill, because they don't want to shoot "quail" sized chukars. Perhaps this is partially the result of a Department recommendation for later "quality" hunts. These patterns have developed to a large extent because for once the hunting public was looking to the managing agency for answers about a game species that was new to both and as these answers became available they were passed on to the sportsmen of the state. In any event, there is perhaps a closer feeling of agreement between sportsmen and biologists concerning chukar management than on any other game species in Nevada. In past years, hunting seasons in Nevada have covered a wide spectrum as can be seen from Table 10.

Perhaps one of the most unusual chukar seasons held in the United States, and one that illustrates the efforts that are being taken in order to try and tempt hunters into relatively inaccessible and unhunted areas, was the 1969 Idaho special chukar hunt near the middle fork of the Salmon River. The only access to this area is by boat and the season was from August 9 to September 19 with a bag and possession limit of 10 and 20 birds respectively. It was legal to hunt or kill chukar with a shotgun, rifle or pistol of any kind, including an air rifle or air pistol. This was followed by a regular season commencing September 20 and lasting to January 25, 1970 with 10 birds daily and in possession. This 169 day season, which was preceded by a good information-education program, is the longest held in the United States to date (not included in the 1968 poll, Table 12).

The ultimate goal of the hunting season is twofold: the harvest of game and recreation. There is ample opportunity for both when hunting during years when there is a fair to good chukar population. The harvest is a reflection of the chukar population level and is also a measure of the skill (and perhaps even endurance) of the nimrod. The chukar harvest in Nevada is presented in Table 11.

TABLE 10. Synopsis of Hunting Season Structure in Nevada, 1947–1969

First hunting season	1947
Earliest season opening	September 14, 1952
Latest season opening	November 18, 1951
Shortest season	2 days in 1947
Longest season	136 days in 1965
Daily Bag Limit	
Smallest	3 birds in 1947
Largest	10 birds in 1965
Possession Limit	
3 birds in 1947	
20 birds in 1965	

There has never been a season limit.

FIGURE 21. This prime chukar habitat along the middle fork of the Salmon River in Idaho illustrates the reason why it is possible to have 4 month hunting seasons without endangering the species. (Photo courtesy of Idaho Fish and Game Department.)

TABLE 11. Chukar Partridge Harvest Data for Nevada 1951–1968[1]

Year	Number of hunters[2]	Hunter days	Birds harvested
1951	4,666	...	36,184
1952	6,889	...	43,742
1953	5,500	...	18,090
1954	Closed season	...	...
1955	487	...	1,120
1956	2,689	6,425 (trips)	12,655
1957	7,207	21,045 (trips)	55,660
1958	10,242	36,244	118,650
1959	5,921	14,809	19,648
1960	7,221	24,806	52,249
1961	6,902	19,023	34,374
1962	7,224	27,272	63,812
1963	11,059	44,513	127,008
1964	12,980	49,071	175,571
1965	16,458	56,563	131,048
1966	6,028	18,997	28,963
1967	8,376	27,792	48,984
1968	10,047	36,665	78,064
Total			**1,045,822**

[1]Data compiled from a 10% hunter questionnaire.

[2]From 1951 through 1967 the format of the questionnaire was such that some hunters could have been counted twice and these figures could be as much as 10% high.

In reviewing the harvest data in Table 11 it becomes quite apparent that there is a direct correlation between the number of participating hunters, hunter effort and the status of the chukar population. In essence the law of diminishing returns, whereby the number of hunters and hunter effort decreases as the chukar population decreases, imposes a self-regulatory mechanism that makes it inconceivable that a broad based chukar population could ever be overharvested. The potential for excess harvesting of a local population of birds, which are restricted to a single water source subjected to heavy hunting pressure, does exist, but only for the limited period of time that hot weather holds them to the vicinity of water. It is doubtful that even under these conditions an overharvest results since many birds still escape to the rimrocks. If overharvest does occur, birds from adjacent inaccessible areas will repopulate these niches when expansion occurs during peak population years.

Chukar hunting is rapidly developing into one of the major upland game pursuits in the western part of North America. The combination of a wily adversary living on public domain where a man can roam freely and test his endurance and skill is resulting in ever increasing hunter participation. Twelve states and one

Canadian Province now have a hunting season on the chukar. Basic season and harvest data for the United States and British Columbia, Canada is presented in Table 12.

The chukar has the reputation of being an exceedingly hard bird to hunt, but this will vary with field conditions. During the opening weeks of the hunting season the birds are generally concentrated around watering sites, are not exceptionally wary (particularly the young birds) and this period is usually very profitable for the nimrod. Driving roads along stream courses and rugged canyon areas as well as sitting by waterholes are favorite hunting methods. As the season progresses, and following the fall rains, the birds begin to range over a larger area and the hunters must spend more and more time on foot traversing the broad mountain slopes and working their way to the peaks of rugged hills and mountains. The advent of 4-wheel drive has opened up much country to vehicle traffic that man formerly had to walk, yet even with these machines there is still a vast amount of habitat that requires "shanks mare," perseverance, and considerable physical stamina in order to gain entry.

During the early morning the birds are assembled in coveys. At this time they manifest a strong tendency to run ahead of the hunter and will generally flush only when pressed (as winter progresses and the hunting season wears on this pattern changes and the birds will often jump well ahead of the hunter). Following flushing the covey will break up into small groups or singles when landing. Almost immediately they will then begin to call while working their way toward the highest peak in the area. The hunter will then proceed through the arduous process of working his way up the slope, or circling the peak (a method I prefer) in an effort to meet the birds before they crest the top, spurred on by the occasional call that keeps him informed of his quarry. It is during this period that a dog is an invaluable aid to the hunter. Once the covey is dispersed the birds will hold reasonably well, but more important is the aid a dog provides in finding and retrieving wounded or dead birds. Birds that are shot high on the mountain will (unless cleanly hit) frequently glide for long distances and finally drop in the canyon bottom or even on the opposite hillside and the chore of retrieving these, after finally gaining the advantage of the mountain, can put the best of hunters out of sorts.

Nevada sportsmen are not alone in undergoing considerable toil to obtain a limit of birds and perhaps it is well to present an account of chukar hunting in India as written by Hume and Marshall (1880): "In October, the birds keep in coveys of from ten to fifteen, or even more. A covey marked down, you go to look them up. Sometimes you walk, and walk seeing nothing of them; they have squatted; and the first you see of them is one rising from behind some stone close at your feet. At the first shot they rise with a whir all around, and sweeping away down the hillside in all directions, alight, generally widely separated, on the sides of the hills all around, and

TABLE 12. Hunting Season and Harvest Data for Western States, Hawaii and British Columbia[1]

State	First hunting season	Longest season (days) (through 1968)	Largest limit bag	Largest limit poss.	Largest harvest	Total harvest (through 1967)
Arizona	1962	123	8	8	50	250
California	1954	72	5	5	74,000	438,000
Colorado	1958	64	4	8	9,000	32,000
Hawaii	1952	27	8	8	2,379	23,000
Idaho	1953	127	10	20	167,000	994,000
Montana	1959	71	6	12	4,500	20,000
Nevada	1947	136	10	20	176,000	968,000
Oregon	1956	110	10	20	295,000	1,235,000
South Dakota	1966	14	3	6	3	3
Utah	1956	112	8	16	61,000	346,000
Washington	1949	121	8	24	165,000	1,337,000
Wyoming	1955	120	5	15	16,000	160,000
British Columbia	1958	115	10	30	22,000	107,000
Total						**5,660,253**

[1]Data compiled from a 1968 poll

FIGURE 22. **A shikar near Srinagar, India, resulted in two men harvesting 32 chukars in 2 1/2 hours. Knowledgeable native "beaters," who can direct the birds over the hunter's head, help.** (Photo by Wayne H. Bohl.)

FIGURE 23. **A hunter, even with a lot of help, would meet his match in this rugged chukar habitat north of Gilgit, Pakistan.** (Photo by author.)

immediately commence calling vigorously to each other. You will hardly have got more than one (or two with a foul shot) with the second barrel; but if your men have marked the birds properly, and you do not mind hard trudging, you may, having broken up the covey, proceed to walk up and bag almost every single bird. More commonly, as you approach the spot where the covey has been marked, and long before you are within shot, you see the little red-brown birds (as they look) scuttling along at a tremendous pace in front. You push on, if the ground is decent running smartly, and generally get near enough to some of the hinder ones to flush and get shots at them and raise some of the rest; but in this case probably not above half the covey; the foremost ones, who are over the brow of the hill, not rising at your shots, but only running on all the harder. Those you have flushed, and which have been marked, can then be followed up and accounted for. Birds thus separated, and alighting after a good flight, do not usually run much, and often lie like stones, rising when you are quite close to them from precisely the spot where alighted.

"The remainder of the covey must then be looked for, viz., at the bottom of the hill down which they escaped, and working upwards. And here two or three steady dogs are very useful; for Chukor will run up hill quite as quickly as most sportsmen can toil up; and by setting the dogs on to press them, they rise and come down superb over-head shots, two or three of which, if fairly hit, put one, for that day at any rate, in the best of humours with oneself and the world in general. At all times the Chukor flies strong and fast, but when flushed by dogs a hundred yards or so above you, he sweeps down in a style that leaves nothing (except perhaps a drag) to be desired."

On the other side of the coin, and it appears that sportsmen even disagree among themselves at times, Jerdon (1864) described this interesting hunting passage by Wilson: "From the beginning of October, Chukor-shooting, from the frequency and variety of the shots, and the small amount of fatigue attending it, is, to one partial to such sport, perhaps the most pleasant of anything of the kind in the hills. About some of the higher villages, ten or a dozen brace may be bagged in a few hours. Dogs may be used or not, at the discretion of the sportsman; they are not at all necessary (*keep in mind that this fellow had plenty of native beaters*—ed.) and if at all wild, are more in the way than otherwise." Hume and Marshall (1880) commented on this later by saying "Mr. Wilson perhaps forgot that everybody cannot walk 30 miles in a day over the worst ground, and come in as fresh as a lark, as he could. As a rule, if you want to make a good bag, ten to twenty brace of Chukor, it is very hard work." To this I add "Amen."

To complete this dissertation, the end result of all of the above effort must be put into the pot, and fried, stewed or roasted, and eventually find its way into the digestive tracts of the hunter and his friends. Hume again, who seemed to be an epicure of sorts, had his ideas about the eating qualities of the chukar and his account in 1880, when considered in the light of modern day cooking facilities, is probably as good as any: "October is the best month, I think, for Chukor-shooting on the lower ranges, as there the young are by that time almost as strong on the wing as the old birds, and are then tenderer, fatter and better eating than at any other time. Old Chukor, even cooked gipsy fashion, are at best but poor eating, dry and, even though hung till gamey, still not tender; but the birds of the year killed in October, properly kept and properly cooked, are really excellent."

COLLECTING HARVEST DATA

Three methods of collecting harvest data are used in Nevada. The field data is recorded on standardized forms that are maintained in a permanent file. Summaries of this data are recorded on long term "Data Sheets," which are kept on file in the Division of Game and Regional Offices.

Checking stations—are operated during the opening weekend of the hunt and are placed on main access roads and highways where heavy hunting pressure occurs. An attempt is made to keep the same checking stations in operation at the same locations every year so consistent data can be obtained. Information as to the total number of hunters, unsuccessful hunters, birds killed, days hunted, weather conditions and the area hunted are recorded. Wings are collected for later determination of sex and age of the birds harvested.

The checking station provides an immediate means for determining the general success of the hunt. The total number of hunters, hunter success and the average number of birds killed per hunter (which are recorded on long term data sheets) can be compared on a yearly basis in relation to the predicted current years' chukar population trend. A quick analysis and use of this data

keeps the game manager current with what is happening in the field and makes it possible for him to keep the public properly informed.

Field bag checks—are made at random throughout the duration of the season. The same data is collected as at the checking stations and at the end of the year this information is compiled and submitted on a long term data sheet. Field bag checks make it possible to follow the progress of hunting success through the duration of the season.

Annual hunter questionnaires—are mailed to 10 percent of the licensed hunters of the state and request essentially the same basic information as obtained at the checking station. The important difference here is that hunter data for the entire season is provided, rather than being limited to two days (at a checking station) or random checks throughout the season. The information obtained from the questionnaire is tabulated on a county basis and provides statewide information as to the total number of hunters, total birds harvested, total hunter days and kill per hunter. A great deal of accessory information is also gleaned from the questionnaire such as the distribution of the kill by county of hunter origin, the distribution of hunters by county of hunter origin and the distribution of hunter days by county of origin. The information obtained from the questionnaire provides the best data available for determining the utilization of the game population, and in providing consistent long term data that can be used with other survey data in managing the species.

SEX AND AGE DETERMINATION

Sexing—Many attempts have been made to find satisfactory external sex criteria for chukars. Adams (1858) used the presence of the metatarsal spur to distinguish the male from the female and in subsequent years this feature has probably been one of the main yardsticks for distinction. During studies in Nevada I found that the metatarsal spur was not restricted to the male bird only, with some females having well developed spurs, and that this characteristic could not be used with full confidence (Christensen, 1954).

Cunningham (1959) using game farm birds found that the spur process becomes apparent at about 14 weeks of age and it was his opinion, with which I agree, that "all chukars potentially have a spur process which is developed to a much greater degree on some birds than others. Even the apparently "spurless" birds possessed a slight indication of a spur." He proceeded to show that there was an apparent difference in the spur development of male and female chukars and felt that the relative size of the spur process offered a potential criteria for sexing after the birds reached 17 or 18 weeks of age but that further research is needed.

Many observers have noted the general physical difference between the two sexes with the adult male bird being larger and stockier than the hen, but this is a relative matter that I have never felt was a reliable method for field use (Christensen, 1954). Cunningham (1959) explored this phase of sexing in depth and on the basis of visual observations found that:

1. The males tend to be larger and blockier than the females.
2. The bill and tarsus of the males tend to be a brighter orange than those of the female.
3. The bill and tarsus appeared to be larger and heavier on the males.
4. The metatarsal spur process appeared to be more prominent on the male birds.
5. The throat patch enclosed by the black mask appeared to be more buffy in the males.
6. The gray superciliary line appeared lighter and tended to extend higher up the crown on the males.

Obviously, in every case these criteria depend upon "a matter of degree," and when the accuracy of using these standards for sexing chukars was tested, using dead birds that could be handled (simulating conditions at a checking station), it was concluded by Cunningham that the sexing of chukars by gross external examination by experienced personnel was less than 80 percent accurate. The birds used in this experiment were between 16 and 21 weeks of age—representing birds of the year that would be encountered during the hunting season.

Older age birds are more easily sexed (again in the hand) than younger age groups, and during the spring of the year when the birds are in breeding condition the accuracy of sexing birds in the hand would probably increase. The accuracy of sexing birds visually and at a distance under field conditions during the breeding season has not been systematically tested. When a pair of birds are together, and it is possible to view them close enough, there are apparent differences both physically

and in their actions and at this time it is probable that the greatest accuracy of sexing by visual observation is attained. Attempts to sex single birds, or birds in groups of more than two, visually in the field at any time of the year would be questionable in my opinion. Collection of the bird, or samples from the covey, and internal examination is the most reliable method.

Aging—The presence of mottled secondary feathers is indicative of a juvenile bird. By the time the bird is 16 weeks of age these feathers have been molted and complete adult coloration is attained. Therefore, this feature cannot be used reliably for aging birds during the hunting season. Following the pattern of most Galliformes, juvenile chukars do not moult the outer two primaries during the first year and this feature, in conjunction with the shape, condition and color of the outer two primaries (Smith, 1961), is an aid toward age determination.

Campbell (1963) evaluated various skull characters in an effort to find a practical sexing and aging method but concluded that the differences were not consistent enough to be reliable. The depth of the bursa of Fabricius was used as an aging characteristic by Harper *et al.* (1958). Campbell and Tomlinson (1962 a), using Turkish chukars, concluded that during the fall of the year a bird with a bursa measuring more than 10 mm is a juvenile and any bird with a bursa of 10 mm or less is an adult. Mackie and Buechner (1963) studying Indian chukars in Washington found that the bursal depths of all specimens classified as juveniles fell within a range of 10 to 21 mm during December–February. Another criteria, that of the weight of dried eye lenses, was examined by Campbell and Tomlinson (1962 b) and although there was an overlap in the lens weights between juveniles and adults there was a significant difference in the mean lens weights of juveniles and adults in both sexes. In regard to practical application all of the above methods for aging and for sexing have two things in common: they are generally too time consuming to apply in the field and the techniques would necessarily be limited to field biologists trained in their application.

A key for sexing and aging chukar partridge—A simplified method for sexing and aging chukar partridge has recently been developed by Weaver and Haskell (1968). This approach has the built-in advantage in that the only item needed in the field is a pair of shears so one wing of the chukar can be clipped and saved for future examination. Personnel who are operating hunter checking stations or are making field bag checks can quickly obtain the wings, with a minimum inconvenience to the hunter, and they do not have to be trained in the aging and sexing techniques. The wings are placed in plastic bags and frozen so they can all be examined at a later date at a "wing bee" conducted by experienced personnel. Although our experience in Nevada has been limited to two years (782 wings classified in 1968 and 924 in 1969) it is felt that this method has possibilities for general field use, and it provides for a consistent approach and appraisal. The adult:young ratios that are obtained from the wing classification provides data on the current population composition, which can be compared to the adult:young ratios obtained earlier in the year during the summer surveys.

The key that is used for determining the sex and age of chukars from wings is presented in Table 13. It has been found in using this key that there is a tendency to overlook the vestigial 10th upper primary covert and measure covert 8 rather than 9.

There is some inconsistency in the female:male ratios obtained from the wing analysis method when compared to ratios resulting from internal examination (Table 14) indicating that there may be a possible prejudice in favor of females. Additional investigations should be made into this aspect.

TABLE 13. A Key for Determining Age and Sex of Chukar Partridge from Wings, from Mid-September through December (from Weaver and Haskel, 1968)

1a. Mottled secondaries absent	2
1b. Mottled secondaries present	juvenile 5
2a. Neither primary 9 nor 10 in stage of molt	3
2b. Either 9 or 10 or both in stage of molt	adult 8
3a. Upper primary covert 9 is less than 29 mm long	4
3b. Upper primary covert 9 is 29 mm long or more	adult 8
4a. Outer two primaries pointed at tips, only slightly faded, showing little wear	juvenile 5
4b. Outer two primaries faded, showing wear	adult 8
Sa. Primary 3 is fully grown, is at least 4 mm longer than primary 2	6
Sb. Primary 3 is in stage of molt, not fully grown	7
6a. Primary 3 is less than 135 mm long	juvenile female
6b. Primary 3 is 135 mm long or more	juvenile male
7a. Primary 1 is 119 mm long or less	juvenile female
7b. Primary 1 is longer than 119 mm	juvenile male
8a. Primary 3 is 136 mm long or less	adult female
8b. Primary 3 is longer than 136 mm	adult male

TABLE 14. Female : Male Ratios Obtained from Internal Sexing and from the Wing Analaysis Method

Year	Birds sampled	Female : male	Method	Source
1950	302	100 : 119	Internal exam	Williams (1951) New Zealand
1952	176	100 : 95	Internal exam	Christensen (1954) Nevada
1954	96	100 : 95	Internal exam	Harper et al., (1958) California
1968	792	100 : 65	Wing Key	NevadaWing Bee 1968
1969	924	100 : 52	Wing Key	Nevada Wing Bee 1969

The adult : young ratios obtained from the wing key method are compared with the data collected from the summer classification surveys in Table 15. Again more background data is needed so an in-depth analysis for accuracy can be made.

TABLE 15. Adult : Young Ratios Obtained from Field Classification and Wing Analysis

	1968	1969
Brood surveys (statewide)	100 : 307	100 : 706
Wing analysis	100 : 414	100 : 503

GAME FARM PROPAGATION

Chukars that were originally brought into North America from India or the Pakistan-Afghanistan Area, and Turkey were placed on game farms for propagation. It would probably be safe to say that all of the successful chukar releases, which have resulted in the establishment of the chukar in North America and Hawaii, were the direct result of numerous game farm propagation programs. The largest direct release of wild-trapped native chukars was with the Turkish introductions in New Mexico, which were a failure. Once the Indian chukar became established (as a result of the release of game farm stock) wild-trapped stock was used for expanding their range within the state where they were trapped or they were sent to adjacent states that had not yet established a population. Over 800,000 chukars have been released in North America and Hawaii and of this number approximately 552,000 were released in States and Canadian Provinces where they eventually became established. All of these chukars, excepting about 15,000 birds wild-trapped from established populations primarily in California and Nevada, were game farm reared. In New Zealand the chukar was established from wild trapped imported birds as well as game farm stock.

Many of the releases that have resulted in establishment have been made in the fall. However, early spring releases whereby the birds do not have to face winter losses and can immediately enter the breeding season, though more expensive, provide for the best and most immediate results.

Jonkel (1954) in a Montana study found that the use of pens to hold chukars in the release area (gentle release method) did not influence the birds to stay in the area after the release. Therefore, the common practice of direct releases into the wild appears to be a sound one.

During the years of the first releases the private game bird fancier was responsible for rearing many of the chukars that were subsequently liberated. As the demand for releases increased state operated game farms went into full production. The techniques that were developed to successfully rear chukar partridges in volume so that massive sustained liberations could be made are a tribute to both the private fanciers and the public employees, many of whom found that their hobby, or job, ended up in being a full time devotion to a labor of love.

The chukar has proven to be very adaptable to game farming and when reared under the proper conditions the production records will equal that of the best of game farm birds. A well planned game farm, large or small, where emphasis is placed on a proper facility for the care of the birds and eggs, nutrition, good incubation and hatching equipment, maintenance of records and a continuous program of sanitation, will result in compensating the manager with high returns and a minimum of problems.

Unfortunately there does not seem to be any single source that encompasses all of the techniques for properly rearing chukars, although considerable work has been done by various investigators. Universities that have a Poultry Husbandry Department, such as the excellent facility at the University of California, Davis, can supply much of the basic data for proper planning of a rearing facility, the precautions that should be observed, and information on the latest production techniques. Some of the states that have operated game

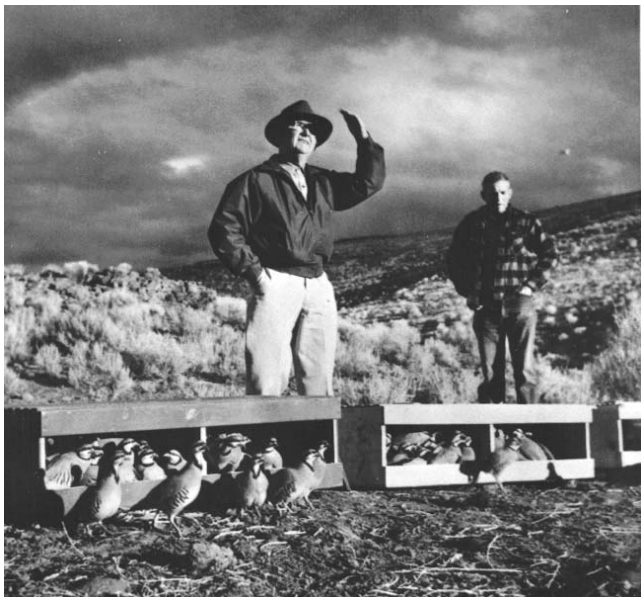


FIGURE 24. **The release of game farm reared chukars has been instrumental in the establishment of this species in North America and Hawaii.** (Photo by author.)

farms for rearing chukars have published their findings in technical papers or in thesis form.

The basic highlights of chukar propagation under artificial conditions is that eggs should not generally be stored more than two weeks and they should be kept between 50° F and 60° F with a relative humidity of approximately 80–90 percent. Nearly all modern day game breeders use forced air incubators and the optimum temperature and humidity requirements may vary slightly with the type of incubator used, where the incubator is housed and the geographical location (elevation) of the game farm. An incubating temperature of 99.5° F is usually standard and the relative humidity should be between 50 and 60 percent (i.e., a wet bulb reading between 82° F and 86° F will generally produce good results). More exacting refinements should be made in accordance with the prevailing operating conditions. After 21 days the eggs are placed in the hatcher where the temperature is dropped to 99° F and the relative humidity increased two to four degrees on the wet bulb. Hatching is complete and the chicks ready for transfer to the brooders on the 24th day. The process of rearing the chicks involves proper feed, water, temperatures, space and sanitation. The use of commercially prepared foods is generally recommended unless the facility is large enough to warrant self-mixing equipment.

Bade (1937 b) reports that two hens at the Yountville farm in California laid 106 and 112 eggs, respectively, during one season. A year later another hen produced 136 eggs and over 95 percent were fertile. Chukars appear to be monogamous in the wild but Funk, Hamilton and Kempster (1941) found that flock matings of chukars produced more satisfactory results than did mating in pairs, and that the best results were obtained when one male was mated to four females. This observation was based on a single trial. They also found that exposure of chukars to artificial lighting stimulated them into earlier egg production and increased the total egg production. Greenhalgh and Hyatt (1956) also found that the use of artificial lighting resulted in earlier and increased egg production with game farm birds in Utah. Intensive artificial lighting experiments now being conducted by Woodard (pers. comm.) at the University of California, Davis indicates that this method may result in controlled year-around production and undoubtedly scientific management under controlled conditions is going to play an important role in obtaining the maximum benefits from future investments.

Heggen (1954) found that mating chukars at a ratio of 3 hens to 1 cock was as satisfactory as using either 1 or 2 hens per cock. He also noted that although egg production was greater for 2 year old brood stock that fertility and hatchability was better in 1 year old breeders and that ground pens were generally more satisfactory than wire-floored pens. The effects of egg production and fertility as affected by vitamin supplements and of hatchability as affected by relative humidity, vitamin supplements, and storage were studied by Sparks (1955). He found that vitamin B complex supplement resulted in a significant increase in egg production but no increase in egg fertility or hatchability. Vitamins A and E used as supplements resulted in an increase in hatchability. He also noted that incubator operation at 55 percent humidity as compared to 45 and 60 percent gave near equal or better hatchability on all groups tested except one, and that hatchability declined after 3 weeks of egg storage. Sound advice as to general precautions and procedures is presented in the book "Fertility and Hatchability of Chicken and Turkey Eggs" by Taylor (1949).

The use of game farm production of chukar partridges as a management tool to rear birds for release for establishment in suitable game deficient habitats is now on the decline. The general habitat requirements of this species are recognized and, with few exceptions (as mentioned on page 6) the current boundaries that now

delineate the range of this species in North America are probably going to represent its optimum distribution. Most of the Western States have reached their goals of establishment and are in the process of terminating their release programs by filling in isolated niches where the chukar has not been previously liberated. Nearly all of the state game farms are considerably reducing or entirely phasing out their chukar propagation programs, and most of the future needs will probably be fulfilled from wild-trapped stock.

The future for the artificial propagation of the chukar partridge is still very bright, for now the chukar ranks high among the list of birds reared for release on private and commercial shooting preserves, which are going to play an ever increasing role for supplying hunting on private lands. Those who are interested in this part of management, under artificial conditions, should refer to the Nilo System of Shooting Preserve Management (1966).

In its native land chukars have long been cherished as pets and as fighting birds and subsequently held in captivity. Game farm propagation as practiced today was not known, but birds were captured from the wild and eggs collected and hatched. Baker, E. C. S. (1922) quoted a passage stating that "They are very easy to take, whether caught adult or reared from the egg, and soon learn to know their masters and to follow them. They are usually kept in small cages, but are daily allowed out, practically without any restraint, and allowed to wander about in search of food much like a farm-yard fowl." The chukars' reputation as a fighter has a lot to do with the demand for holding it in captivity, and Jerdon (1864) stated "The male, says Major Brown, is very bold, and is tamed for the purpose of fighting. In a domesticated state, he makes no hesitation in offering battle to every animal, and pecks very fiercely, always searching for a tender part; the nose of a dog, or the naked feet of the native servants immediately attract his attention, and he soon makes the object of his attack fain to run." In India the chukar is used as a captive fighting bird primarily in Northwest Kashmir (Baker, E. C. S., 1922) "but his cousins over most of the range inhabited by them are very commonly kept for this purpose. His character for pluck and pugnacity has ranked very high from the time of the Romans, and then as now, large sums were won and lost over the victory or defeat of a favourite bird." The practice of "fighting chukars" still prevails and I saw such birds in Afghanistan in 1960.

FIGURE 25. Pet chukars for sale in an Afghanistan bazaar. (Photo by author.)

FIGURE 26. **The use of a modified clover leaf trap surrounding a water source is a successful method for capturing chukars.** (Photo by author.)

TRAPPING

Trapping chukars from established populations can serve a twofold purpose: (1) The birds that are captured can be liberated in areas of suitable unoccupied habitat in an effort to expand their distribution and (2) trapping can be used as a tool to gain specific knowledge concerning important life history problems. The majority of the emphasis to date has been in wild-trapping birds for liberation into areas of unoccupied habitat within the state or in sending them to other western states for the same purpose.

Only a minimum amount of trapping, banding, marking and releasing at the trap site has been done in order to study the general habits and characteristics of a specific population. The lack of emphasis on these studies has largely been due to the priority of achieving widespread establishment, for once a wild bird is in the hand there has always appeared to be a considerable demand for it. As previously mentioned some studies dealing primarily with movements have been done in Nevada (Christensen, 1954) and California (Harper *et al.,* 1958). This is an area where explicit programs designed to obtain specific life history data that can be used in management as well as to answer questions that we now generalize upon (such as the rate of population turnover, the effects of hunting on a local population that is subjected to heavy hunting pressure, more specific information as to daily and seasonal movements) are needed.

Trapping techniques—The success of the trapping program depends upon the number of birds available in a vulnerable situation. The population level determines the number of available birds; range and water conditions determine vulnerability. Hard work and ingenuity of the trapper will determine his success in relation to the prevailing conditions.

In Nevada, waterhole trapping during years of high chukar production has been found to be the most rewarding method. In order to be successful the water should be limited to a small spring, seep, tunnel, mineshaft or livestock watering trough, which can be surrounded by a circular trap of 1″ × 2″ mesh welded wire (modified clover leaf trap) that is three feet high. The top of the trap is covered with 1″ mesh chicken netting. The two ends of the welded wire are brought together to form a funnel entrance the width of the bird's body and about one and a half to two feet long. Dirt is packed around the entire outer edge of the wire to hold it in place and prevent the birds from escaping under the edges. These traps are very portable since the wire can be carried in rolls and there is unlimited

flexibility in that each trap can be designed to fit the specific need. If there is too much water present to enclose with a trap, but not too much to be contained, the exposed portions can be covered by canvas or plastic. In some instances it may be desirable to close off a water supply entirely and substitute a container of water within the trap. This method has been used successfully in both Nevada and California.

Bait trapping, using quail traps, was successful in Peavine Canyon, Nye County, Nevada in 1947–49 but subsequently has never been used with good results. In California, Harper *et al.* (1958) found that bait trapping, using wheat as bait, was most successful in the Inyo-Mono Area and that trapping over water provided the best results in the Temblor Area.

It appears that the use of bumper mounted cannon nets may have good potential since, during the summer months, chukars are found alongside the back trails and roads and will run ahead of a vehicle and could be susceptible to capture by this method.

I have a personal preference for the circular trap previously described for use with bait or over water because of the ease of transport, installation and tremendous flexibility. Nevertheless there will be occasions when a different type of trap may be needed and two good sources for these designs are "Bird-Ringing" by Lockley and Russell (1953) and "Live-trapping North American Upland Game Birds" by Wilbur (1967).

WATER DEVELOPMENT

The summer range of the chukar partridge appears to be limited by the availability of water, and since the chukar inhabits a basically arid or semiarid environment there are suitable portions of habitat within its range that are essentially waterless. It therefore follows that water development can be used to expand the distribution and increase the chukar population.

Guzzlers—The modern guzzler consists of a 750 to 1,000 gallon fiberglass cistern that is placed underground and supplied with water from rainfall collected from a metal apron. The mouth of the guzzler is exposed and a ramp allows the birds to enter to drink. Guzzlers, which were first developed in California, have been used very successfully with quail and at the present time are also of considerable importance to the chukar population found in the Temblor Range of California (Harper *et al.*, 1958).

Thirty-five guzzlers have been installed in waterless areas of otherwise good chukar habitat in Nevada and the utilization has varied from none to fairly good. The overall use of guzzlers for chukars in Nevada has not been outstanding but most of them have resulted in holding a small population of birds and in a few specific instances (particularly where a guzzler has been used to replace an existing poor water supply that had chukar utilization) the use has been very good. In evaluating the guzzler program for Nevada it is felt that:

1. Guzzlers, other than for special purposes described below, should be installed only in waterless areas of otherwise good habitat in regions of heavy hunter use. Guzzlers should be spaced approximately 1 mile apart from each other or from existing watering sources.
2. At the present time one of the major chukar management problems in Nevada is to secure an adequate harvest. Therefore, since there are many accessible chukar populations that are seldom subjected to a hunter's gun, the use of guzzlers to expand chukar distribution should currently have a low priority and be programmed primarily as a future need in relation to hunter utilization.

Water developments and improvements—The development and improvement of existing water supplies is presently a more important management practice than the installation of guzzlers. Huntable chukar populations already exist around these watering sites, and the

FIGURE 27. Fiberglass cisterns and all steel apron construction provide relatively maintenance-free guzzler installations in Nevada. (Photo by author.)

loss of a spring or a seep appears to result in the loss of the population that utilizes it. During drought years key watering sites often are reduced to a trickle of water or go completely dry. In many instances these sites, which are often utilized by livestock, can be reconditioned so as to insure a permanent water supply. Arrangements are now made with the Bureau of Land Management whereby many of the older and all of the new livestock watering troughs or other watering developments will have provisions for supplying water for wildlife where necessary. Escape ramps are essential in stock watering tanks that are used by chukars. Supplemental bird drinking basins can also be provided for, at little cost, away from the stock watering tank. In some instances springs are dug out and boxed in and the water piped to other areas. In these cases it is essential to provide available water near the original source for the chukar population that once depended upon the spring. This can be done by tapping into the pipeline and creating drinking basins. In some cases the installation of a guzzler, which is supplied with water from the pipeline, may be a practical approach. Two bulletins that provide details on some of the more common water improvement and protective devices are "Water Developments for Upland Game Birds" by Donald McLean (1962) and "Water Development—Range Improvements in Nevada for Wildlife, Livestock and Human Use" by the Bureau of Land Management (1964).

THE VALUE OF THE CHUKAR AS A GAME BIRD

The primary value of the chukar partridge as a game bird in North America is that the vast majority of the habitat it now occupies was formerly deficient of resident upland game bird species. The chukar partridge truly filled a void. As previously mentioned other game bird species such as sage grouse, Gambel's, California and mountain quail and the dove, are found to occupy portions of the same habitat complex without serious conflict, but the chukar partridge is the primary species and a welcome addition. It has been stressed that in Nevada in particular, as well as in most of the Western States, the chukar is found primarily upon public lands that historically are the "open range" that has been heavily utilized for livestock grazing. Therefore, the many problems that face the pheasant hunter, for example, in regard to obtaining the right to hunt on private lands is automatically eliminated. The chukar hunter can generally move about freely over a vast domain and feel that he belongs to the land. It is difficult to place a value on this freedom but it is probably one of the greatest benefits chukar hunting has to offer.

The chukar is continuing to expand its range and to occupy isolated niches. Perhaps one of the most important attributes of this species in Nevada is its ability to quickly take advantage of and move into habitats that have generally deteriorated as a result of land misuse, fires and droughts. One of the most important upland game management problems in the west today is to try and find methods to reduce the rapid loss of sage grouse habitat. Years of intense overgrazing, coupled with periods of prolonged drought and land management practices that are detrimental to the sage grouse habitat, have placed this species in a precarious position. Now, in many of these formerly good sage grouse ranges where the habitat changes have been so severe that the sage grouse populations have drastically declined or even been eliminated, the chukar partridge is finding conditions upon which they thrive. The chukar partridge has, therefore, been able to occupy and provide hunting and recreation in habitats that the sage grouse will no longer tolerate, and in doing so has filled what could have been some serious game deficient areas.

From the hunting and recreation standpoint the chukar is without doubt the number one upland game species in Nevada. Nevadans, and an ever increasing number of sportsmen throughout the United States, have a lot of respect for this sassy little import who has taken over some of the most inhospitable country in the west and made a go of it. The challenges, the strategy, the test of endurance and finally the thrills that come following a clean hit of a bird that literally "jetted" its way down a rugged mountain slope, are the primary topics of conversation wherever sportsmen gather.

In this age of economics where it appears that a dollar value has to be placed upon everything, I have waited until the end to try and arrive at this calculation. I believe I have given you the best values, and I never have and never will have any faith in the continually increasing concepts that emanate from bureaus throughout our country that everything has to be boiled down to the "buck."

Hunter participation and success varies from year to year since chukar populations fluctuate widely, therefore the following data will deal with averages. Based on a

FIGURE 28. **A boy and his dog, with a couple of hard-earned chukars, represent the end result of a sportsman's dream.** (Photo by author.)

13-year record in Nevada (1956–1968), sportsmen have hunted 383,225 days for chukars. In using the 1965 National Survey of Fishing and Hunting figure of $4.79 spent by small game hunters per hunter day, a total of $1,835,648.00 has been spent since 1956 on hunting licenses, travel, hunting gear, food and accommodations for chukar hunting. The average annual expenditure made by Nevada chukar hunters is approximately $141,200, and over 1,000,000 chukars have been harvested in the state between 1951–1968. In a state such as Nevada where the total human population is less than 600,000 and there are only two major population centers (Reno and Las Vegas) the above figures indicate that chukar hunting does have a noticeable financial impact, particularly in the many small cities throughout the state.

On a national scale I conservatively estimate the cost of harvesting approximately 6,000,000 chukars (1947–1968) to be about $14,000,000. Since the first introduction of the chukar into North America in 1893 there has been approximately $5,000,000 expended in establishing this species. Obviously there has been a handsome return for this investment strictly from an economic evaluation that does not consider the esthetic and recreational values.

The history of chukar partridge introductions and their subsequent establishment in North America, the Hawaiian Islands and New Zealand attest to the need to keep apace with our ever changing environment. We must continue to explore other possibilities, learn from past mistakes and advance through research. In doing so it becomes apparent, as vividly illustrated by the success of the chukar partridge, that these efforts are resulting in the development of another game management tool, that of beneficial and successful exotic game introductions, which can play an important part in the wildlife management programs of the future.

Appendix

APPENDIX A
Chukar Release Site Records in Nevada

Release Site	No. Birds Liberated	Date	Source
Churchill County			
Eastgate	10	1935	Game Farm
Fallon	50	1935	Game Farm
Horse Creek Ranch	8	1935	Game Farm
Total	68		
Clark County			
Unknown	4	1939	Game Farm
Unknown	40	1941	Game Farm
Potosi Mt.	36	1944	Game Farm
Gold Butte	32	1947	Wild-Trapped
Red Rock Spring	63	1947	Wild-Trapped
Knob Hill	20	1949	Wild-Trapped
Hidden Ranch	36	1951	Game Farm
Virgin Mts.—Key West Mine	25	1953	Game Farm
Virgin Mts.—Key West Mine	149	1956 (Jan.)	Game Farm
Virgin Mts.—Key West Mine	142	1956 (Dec.)	Game Farm
Virgin Mts.—Key West Mine	300	1958 (Feb.)	Game Farm
McCullough Mts.—Big Pine Spring	100	1959 (Mar.)	Game Farm
McCullough Spring	242	1960 (Jan.)	Game Farm
Total	1,189		
Douglas County			
Unknown	15	1935	Game Farm
Unknown	40	1940	Game Farm
Burbank Canyon	20	1948	Wild-Trapped
Heines Canyon	19	1949	Wild-Trapped
Pipeline Canyon	20	1949	Wild-Trapped
Total	114		
Elko County			
Unknown	12	1938	Game Farm
South Fork Humboldt River	44	1949	Wild-Trapped
Coal Mine Canyon	100	1952	Game Farm
Eight Mile Spring	23	1952	Wild-Trapped
Metropolis	100	1952	Game Farm
Carlin Canyon	65	1953	Wild-Trapped
Metropolis	98	1956	Game Farm
Crittenden Res.	89	1957	Game Farm
Contact—Vineyard Dam	119	1957	Game Farm
Bruneau Canyon—Mink Ranch	123	1957	Game Farm
Bruneau Canyon—Meadow Creek	123	1957	Game Farm
Crittenden Res.	166	1958	Game Farm
Contact—Vineyard Dam	204	1958	Game Farm
Bruneau—McDonald Creek	200	1958	Game Farm
Kitteridge	100	1958	Game Farm
Bruneau Canyon—Mink Ranch	160	1959	Game Farm
Eighteen Mile Ranch	120	1959	Game Farm
Riverside	160	1959	Game Farm
Total	2,006		

Release Site	No. Birds Liberated	Date	Source
Esmeralda County			
White Mts.	25	1935	Game Farm
Unknown	6	1938	Game Farm
Unknown	40	1941	Game Farm
Cow Camp	32	1947	Wild-Trapped
Mary Mine	10	1947	Wild-Trapped
Nivloc	10	1947	Wild-Trapped
Tule Canyon	45	1947	Wild-Trapped
Total	168		
Eureka County			
Unknown	40	1941	Game Farm
Cottonwood Canyon	25	1949	Wild-Trapped
Roberts Creek	25	1949	Wild-Trapped
Thomson Ranch	25	1949	Wild-Trapped
Tonkin	25	1949	Wild-Trapped
Twin Peaks	30	1949	Wild-Trapped
Willow Creek Ranch	25	1949	Wild-Trapped
Total	195		
Humboldt County			
Unknown	15	1935	Game Farm
Woodward Ranch	12	1936	Game Farm
Unknown	40	1940	Game Farm
China Gardens	23	1952	Game Farm
Alta Creek	121	1956	Game Farm
Total	211		
Lander County			
Kingston Canyon	15	1935	Game Farm
Unknown	20	1940	Game Farm
Gold Park	40	1941	Game Farm
Total	75		
Lincoln County			
Unknown	50	1938	Game Farm
Conway Ranch	40	1939	Game Farm
Pecks	40	1939	Game Farm
Blake's Ranch	35	1940	Game Farm
Cave Valley	25	1940	Game Farm
Cole Ranch	60	1940	Game Farm
Guyman's Ranch	21	1940	Game Farm
Patterson Pass	25	1940	Game Farm
Ursine	35	1940	Game Farm
White Rock Mt.	26	1940	Game Farm
Valley between Boyd and Panaca	700	1940–41	Game Farm
Barclay	25	1941	Game Farm
Conway Ranch	27	1945	Game Farm
Hamlin Ranch	40	1945	Game Farm
Rox	32	1947	Wild-Trapped
Connor's Spring	25	1949	Wild-Trapped
Hackett Ranch	25	1949	Wild-Trapped
Rose Valley	25	1949	Wild-Trapped
Sawmill Canyon	25	1949	Wild-Trapped
Wilson Mts.	25	1949	Wild-Trapped
Dimick Ranch—Cottonwood Creek	100	1952	Game Farm
Coyote Spring	60	1953	Wild-Trapped

Release Site	No. Birds Liberated	Date	Source
Lincoln County, *continued*			
Buckboard Spring	54	1955	Game Farm (Turkish)
Meadow Valley Wash—Gourd Spring	200	1959	Game Farm
Elgin	300	1959	Game Farm
Gourd Spring	270	1960	Game Farm
Elgin	270	1960	Game Farm
Delamar Mt.—Buckboard Spring	9	1963	Wild-Trapped
Clover Mt.—Quaking Spring	11	1963	Wild-Trapped
Meadow Valley Wash—Elgin	16	1963	Wild-Trapped
Bradshaw Ranch	13	1963	Wild-Trapped
Total	2,609		
Lyon County			
Horse Spring	10	1935	Game Farm
Ramsey	10	1935	Game Farm
Wild Rose	14	1935	Game Farm
Unknown	20	1941	Game Farm
Churchill Canyon	147	1950	Game Farm
Garden Canyon	190	1950	Game Farm
Nye Canyon	200	1950	Game Farm
Scott Canyon	200	1950	Game Farm
Churchill Canyon	120	1956	Game Farm
Total	911		
Mineral County			
China Garden	25	1945	Game Farm
Pilot Mt.	?	1945	Game Farm
Powell Canyon	25	1945	Game Farm
Summit Spring	30	1945	Game Farm
Garfield Spring	34	1947	Wild-Trapped
Total	114		
Nye County			
Unknown	25	1935	Game Farm
Unknown	40	1939	Game Farm
Antelope Spring	24	1940	Game Farm
Baxter Spring	24	1940	Game Farm
Beatty	6	1940	Game Farm
Bellehelen	20	1940	Game Farm
Bill Berg's Ranch	16	1940	Game Farm
Cedar Corral Spring	20	1940	Game Farm
Currant Creek	20	1940	Game Farm
Dan Berg's Ranch	16	1940	Game Farm
Gendron Ranch	8	1940	Game Farm
Haw's	20	1940	Game Farm
Hot Creek	18	1940	Game Farm
Hunt's Canyon	24	1940	Game Farm
Jack Bordoli Ranch	16	1940	Game Farm
Meadow Canyon	16	1940	Game Farm
Millet	16	1940	Game Farm
Moore's Creek	20	1940	Game Farm
Nyala	16	1940	Game Farm
Pablo Canyon	16	1940	Game Farm
Peavine Canyon	46	1940	Game Farm
Peavine Canyon	30	1940	Game Farm
Pine Creek	16	1940	Game Farm
Rye Patch	8	1940	Game Farm

Release Site	No. Birds Liberated	Date	Source
Nye County, *continued*			
Sharp	24	1940	Game Farm
Stone Cabin	12	1940	Game Farm
Twin River	16	1940	Game Farm
Ash Meadows	50	1941	Game Farm
Broad Canyon	30	1941	Game Farm
Farrington Ranch	30	1941	Game Farm
Jefferson Canyon	30	1941	Game Farm
Barker Creek	40	1942	Game Farm
Barley Creek	30	1942	Game Farm
Breen Ranch	30	1942	Game Farm
Broad Canyon	30	1942	Game Farm
Darrough's Hot Spring	30	1942	Game Farm
Eden Creek	30	1942	Game Farm
George's Canyon	30	1942	Game Farm
Hannapah Spring	22	1942	Game Farm
Hot Creek	30	1942	Game Farm
Hunt's Canyon	30	1942	Game Farm
Longstreet Ranch	30	1942	Game Farm
Longstreet Mine	30	1942	Game Farm
Manaposa Canyon	30	1942	Game Farm
Nyala	30	1942	Game Farm
Pahrump Valley	46	1942	Game Farm
Peavine Canyon	92	1942	Game Farm
Pine Creek	30	1942	Game Farm
Shoshone Canyon	30	1942	Game Farm
Stone Cabin	12	1942	Game Farm
Ash Meadows	30	1947	Wild-Trapped
Beatty	34	1947	Wild-Trapped
Breen Ranch	29	1947	Wild-Trapped
Cloverdale	10	1947	Wild-Trapped
Hannapah Spring	30	1947	Wild-Trapped
Hot Springs	20	1947	Wild-Trapped
Hunt's Canyon (upper)	35	1947	Wild-Trapped
Hunt's Canyon (lower)	45	1947	Wild-Trapped
Indian Springs	22	1947	Wild-Trapped
Liberty Mine	56	1947	Wild-Trapped
Mohawk Creek	20	1947	Wild-Trapped
Pahrump Valley	?	1947	Wild-Trapped
Rye Patch	18	1947	Wild-Trapped
Springdale	30	1947	Wild-Trapped
Stewart Creek	23	1947	Wild-Trapped
Stonewall Mt.	24	1947	Wild-Trapped
Wagon Johnnie's Creek	27	1947	Wild-Trapped
Warm Spring	30	1947	Wild-Trapped
Willow Creek	28	1947	Wild-Trapped
Willow Springs	22	1947	Wild-Trapped
Wall Canyon	90	1957	Game Farm
Pablo Canyon	120	1957	Game Farm
Peavine Canyon	190	1957	Game Farm
Hunt's Canyon	201	1957	Game Farm
Hot Creek	200	1957	Game Farm
Tybo	200	1957	Game Farm
Wall Canyon	98	1958	Game Farm
Cottonwood Canyon	120	1958	Game Farm
Tybo	203	1958	Game Farm
Peavine Canyon	263	1958	Game Farm
Haw's Canyon	200	1958	Game Farm
Wall Canyon	100	1959	Game Farm

Release Site	No. Birds Liberated	Date	Source
Nye County, *continued*			
Peavine Canyon	100	1959	Game Farm
Cottonwood Canyon	100	1959	Game Farm
Tybo	100	1959	Game Farm
Haw's Canyon	100	1959	Game Farm
Total	4,223		
Ormsby County			
State Prison	15	1935	Game Farm
Brunswick Canyon	28	1949	Wild-Trapped
Total	43		
Pershing County			
Lovelock	50	1937	Game Farm
Total	50		
Storey County			
Lagomarsino Canyon	7	1935	Game Farm
Total	7		
Washoe County			
Geiger Grade	10	1935	Game Farm
Monte Cristo Ranch	10	1935	Game Farm
Olinghouse	10	1935	Game Farm
Painted Rock	10	1935	Game Farm
Reno (Hunter Lake Drive)	10	1935	Game Farm
Reno (Plumb Lane)	10	1935	Game Farm
Willow Spring	10	1935	Game Farm
Unknown	36	1941	Game Farm
Peterson Mt.	21	1947	Wild-Trapped
Verdi	100	1950	Game Farm
Coyote Spring	50	1952	Game Farm
Kyola	50	1952	Game Farm
Kyola	37	1952	Wild-Trapped
Packard Spring	50	1952	Game Farm
Little Smoke Creek Ranch	210	1957	Game Farm
Buffalo Meadows	250	1957	Game Farm
Parker Ranch	118	1957	Game Farm
Total	992		
White Pine County			
Unknown	24	1937	Game Farm
Unknown	4	1938	Game Farm
Duck Creek	11	1944	Game Farm
Ellison Ranger Station	64	1947	Wild-Trapped
Ely	38	1947	Wild-Trapped
Cathedral Canyon	50	1949	Wild-Trapped
Moorman Ranch	25	1949	Wild-Trapped
White River	50	1949	Wild-Trapped
Silver Creek (Hendry Creek)	100	1952	Game Farm
Twin Springs	231	1959	Game Farm
Bothwick	71	1964	Wild-Trapped
Duck Creek Basin	12	1966	Game Farm
Total	680		
Grand Total—Statewide	**13,655**		

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