ECOLOGICAL ASPECTS OF THE VALLEY QUAIL IN THE MADRAS AREA OF CENTRAL OREGON

by

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INTRODUCTION

This report presents the results of an ecological study of the valley quail, Lophortyx californica californica (Shaw), in the Madras area of Central Oregon, from July 17, 1952, to September 10, 1953. The study was conducted under the auspices of the Oregon Cooperative Wildlife Research Unit[1], directed by Mr. Arthur S. Einarsen, biologist of the United States Fish and Wildlife Service. The research unit has thus far conducted five studies on wildlife species at the Madras station; three have been on ringnecked pheasants, and this report is the second on valley quail.

The Madras area has been closed to the hunting of ringnecked pheasants, Hungarian partridges, and valley quail since 1948, mainly to protect the pheasant population from illegal hunting. The area was open to the shooting of valley quail and Hungarian partridge in October, 1953. The closure gave the Wildlife Research Unit an excellent opportunity to study upland game forms without hunter interference. Especially has it been valuable in the study of valley quail populations.

The severe winter of 1949-1950 marked a very sharp

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1. Oregon State Game Commission, United States Fish and Wildlife Service, Wildlife Management Institute, Agricultural Research Foundation, and Oregon State College cooperating.

decrease in the population of valley quail on the Madras area. The die-off, believed to be due to starvation and intolerance of cold temperatures, was so intense that a comparatively small breeding population was left in the spring of 1950, and personnel of the research unit began a study on the valley quail. James A. Mohr, graduate research assistant, conducted a roosting study on the quail for the period of 1951-1952. His report is in the process of preparation. The investigation which this thesis represents was begun in the summer of 1952 and ended in the fall of 1953. The purpose of this particular study was to conduct an ecological study and to record observations which might later be an aid in management of the valley quail.

Unfortunately, the short period of fifteen months alloted for the investigation was not sufficient time to carry out the proceedings in detail, and data on certain phases of the life history lack sufficient replications. Some very interesting results were obtained that seemed to have direct bearing on the management of valley quail in the Madras area and in similar ecological locations.

Description of the Bird

The valley quail, *Lophortyx californica californica* (Shaw), is one of Oregon's finest game birds, and to many

hunters is second to none as a sporting species. The valley quail may easily be recognized by its curved, black top-knot, general steel-blue coloration, and light brownish back. The male has a black throat patch and a scaled abdomen which proves to be golden in color when the bird is held in the hand. The female is generally less conspicuous than the male. Her top-knot is not so large, and she lacks the black throat patch which makes the male so easy to distinguish. Her scaled abdomen is whitish rather than golden.

The seven subspecies of Lophortyx californica are mainly distinguished by slight color variations and geographical range. Hence it is desirable to consult a qualified ornithologist for proper identification. On the basis of the many skins collected and examined by Dr. Stanley G. Jewett[2] and according to Phillips (43, p.21), it is probable that only the subspecies californica is resident in Central Oregon. Some trapped quail appeared somewhat darker than others, but this may have been only a color-range variation since it is likely that crossbreeding would have eliminated subspecies characteristics by this time.

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2. Regional Biologist of the Biological Survey. Interview October 1, 1953.

Figure 1. A male and female valley quail, Lophortyx californica californica (Shaw). (Birds in glass enclosure.)

Introductions of the Valley Quail in Oregon

Wide-spread introductions, incomplete records, and apparent mislabeling of scientific specimens have made the original distribution and range of the valley quail obscure. Present day authorities do agree, however, that the original Oregon range of the valley quail included at least the non-coastal portions of the Rogue River Valley and the Klamath River drainage.

J. S. Newberry, on the basis of two specimens in 1857, listed Lophortyx californica as being indigenous to the Willamette Valley of Oregon. Contemporary ornithologists had no basis for doubting the validity of the range as listed by Dr. Newberry and therefore included that area when writing of the distribution of the quail. Thus the situation became quite confused (38, p.93).

Gabrielson and Jewett (16, p.222), however, examined the one remaining specimen from Newberry's collection in the National Museum and found it to be the California subspecies Lophortyx californica brunnescens Ridgway. It is therefore their opinion that the specimen was actually a mislabeled skin from a coastal area of California, especially since no later collections have revealed the subspecies brunnescens from the Willamette Valley. In fact, only one authentic specimen, as far as

is known, has been recorded for Oregon. This was a road-kill found by Dr. Jewett (28, p.36) in Coos County.

When the transportation problem is considered along with the adverse conditions and the lack of adequate supplies incurred by those who conducted the early expeditions into Oregon, it seems quite possible that specimens might have been mislabeled or deranged. The situation is unfortunate, but it detracts little from the excellent contributions to science that these men made.

Early Willamette Valley Introductions

Transplanting in the Willamette Valley probably started about 1870 (16, p.222), and was carried on by private individuals, sportsmen's groups, and the Oregon Fish and Game Commission. By 1887, the valley quail had been transplanted to Northern Douglas County (2, p.14), and probably other areas as well.

Private game farms were not at all uncommon at the turn of the century. Birds being sold from these hatcheries remain for the most part unrecorded. This could be a possible source of early wide-spread introductions. At times, out of state shipments of game farm birds were published in the first issues of The Oregon Sportsmen.

By 1912, the Oregon Fish and Game Commission had

become active in the transplanting of the valley quail, and in the latter part of that year and in 1913, a total of 220 valley quail had been liberated in Marion, Yamhill, Benton, and Lane Counties. These were all transplanted from Jackson and Josephine Counties in Southern Oregon. In 1914, a notice was to be found in the January issue of The Oregon Sportsmen which stated that the game department was anxious to get in touch with people who could trap valley quail for introductory purposes (12, pp.10-11). In 1914, the game commission liberated valley quail in Benton, Clackamas, Clatsop, Coos, Lane, Lincoln, Marion, Multnomah, and Tillamook Counties (13, pp.16-17).

Early Eastern Oregon Introductions

The early introduction records of the valley quail in Central and Eastern Oregon are few in number. It therefore seems desirable to list the collection dates of individuals who did not find valley quail. These, when supplemented with actual planting records, will help determine a more accurate time of introduction. Only four skins of Lophortyx californica californica (Shaw), taken from Central Oregon prior to 1914, are to be found in the United States National Museum. These

were all taken at Fort Klamath in 1882 and 1883[3].

The distribution of the valley quail east of the Cascade Mountains, according to Bendire in 1892 (3, p.26) did not to his knowledge extend north of Fort Klamath. He did not list the valley quail as occurring at Camp Harney in South Central Oregon or at Walla Walla, Washington. L. H. Miller (35, pp.100-106) did not include the quail for the John Day area. During May and June of 1889, thirteen days were spent collecting. It seems reasonable to assume that if the valley quail had been present in that area at that time, whistling males would have been seen or heard.

It is apparent that the quail was introduced into North Central Oregon around the turn of the century for the late Dr. William L. Finley of the Oregon Fish and Game Commission made the following observation:

> "While on a trip through Wasco County in 1908, I heard a quail call and recognized the note of the mountain quail. I crept up closer to where I could get a view of the bird and found it was a California or valley quail." (14, p.7)

The initial liberation east of the Cascade range was possibly the efforts of a private individual because no records have been found which would indicate otherwise.

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3. Dr. Waldo L. Schmitt, Head Curator, Department of Zoology, Smithsonian Institution, United States National Museum. Letter November 6, 1953.

In 1911, quail were noted as abundant along the Silvies River near Burns, and throughout that section of the state (41, p.149). According to Jewett, the valley quail was planted in Wallowa County in 1912 (15, p.555). Finley (13, p.17) records the planting of two birds in Umatilla County in 1912 or 1913. Alex Walker (57, pp. 131-140) spent considerable time in 1913, 1914, and 1915, collecting in North Central Oregon. He mentions that the valley quail was common at that time in the canyons and on the slopes near the mouth of the Deschutes River, and at Bakeoven Creek near Maupin[4]. It is important to note that although Walker and Jewett made representative collections at Gateway, Haycreek, and the Warm Springs Agency, they did not see any valley quail at these locations. The above collection sites are noted because they border the area with which this thesis is concerned. Had the quail been present in the Madras area, they would have been expected to occur in these locations where conditions were optimum. It is significant to note, then, that the Oregon Fish and Game Commission on March 7, 1914, liberated 12 valley quail at the Baldwin Sheep Company at Hay Creek in what was then a part of Crook County, but

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4. Curator of the Pioneer Museum, Tillamook, Oregon.

has since become a part of Jefferson County. Other Eastern Oregon plantings listed in 1914 include Hood River, Umatilla, Union, and Wallowa Counties (13, p.16). The quail were from wild stock trapped by the Fish and Game Commission in Jackson County, Oregon (49, p.14). Dr. Jewett has records which mention valley quail at Hay Creek for the years 1916, 1917, and 1918. His notes state that the birds were common in 1917[5]. It is believed that these quail were the initial stock which later spread to adjacent areas and populated the canyons and slopes around the Madras project.

DESCRIPTION OF THE AREA AND THE HABITAT OF VALLEY QUAIL

Description of the Area

The Madras region of Central Oregon, the principal farming area of Jefferson County, is found in a semi-arid section which lies in the rain shadow of the Cascade Mountains. Madras, the county seat, lies in the center of the area approximately 43 miles north of Bend and 100 miles south of The Dalles. The average rainfall of eight and one-half inches, the warm summers, and the cold winters are typical of the high desert. The average summer day is quite warm, characterized by temperatures

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5. Jewett op. cit.

above 90° F, but each afternoon strong breezes may be expected from the north which make the nights cool and comfortable. The average winter day is cold with the wind from the southwest. The winter nights usually are frigid, and temperatures near 0° F are common.

Geologically, the parent material of the soil is derived from The Dalles formation which according to Hodge (25, p.23) is of variable composition and is composed of lava flows and water-spread materials. In geologic time, the lava flows blocked the drainage of the Deschutes and Crooked River Valleys and produced many of the lakes of South Central Oregon. These blocked valleys have an alluvial fill which is now favored as farm land. The principal rivers have cut through the old lava flows and have re-established magnificent canyons. The action of wind and water has acted slowly on the erosion resistant lava thus forming rim rocks. In some cases, sheer cliffs of nearly 1000 feet drop down to the Deschutes River. The less spectacular areas are talus covered below rims of igneous rock material. These areas are useless for any form of agriculture except limited grazing. The U. S. Department of Agriculture has classified the soils of the Madras area into 55 types and phases (45, p.13).

The vegetation of the area is primarily a bunch-grass-shrub association with an occasional western

juniper, Juniperus occidentalis Nuttall. The principal grasses are bluebunch wheatgrass, Agropyron spicatum (Pursh) Scribner and Smith; cheatgrass, Bromus tectorum Linnaeus; and Poa secunda Presl. The principal shrubs are bitterbrush, Purshia tridentata (Pursh) DeCondolle; squaw currant, Ribes cereum Douglas; sagebrush, Artemisia tridentata Nuttall; and rabbitbrush, Chrysothamnus viscidiflorus (Hooker) Nuttall and C. nauseosus (Pallas) Britton. In a few areas, grazing and poor land use has been so severe that inaccessible topography has been the only salvation of the palatable plant species.

The Madras area extends over an area of six townships of cultivated and waste land. Since 1946, approximately 50,000 acres of this land have been placed under irrigation by the U. S. Bureau of Reclamation and is known as the North Unit or Deschutes River Project. Water is taken from the Deschutes River at Bend, and 65 miles of canal are used to deliver water to the irrigation area. The principal agricultural practice has been the growing of potatoes and small seed and grain crops, but the recent unstable markets for such items have caused the farmers to consider other phases of agriculture. Dairy, beef, and sheep production may eventually be the favored farm production for the area.

The lower ends of the main canal and its laterals

invariably spill into canyon tributaries of the Deschutes River which are called wasteways. These side canyons are gradually producing habitat areas which are primarily suitable for wildlife and limited grazing. The Oregon State Game Commission has taken the initiative in many of these wasteways and has instituted a program of planting them with shrubs and trees desirable to wildlife. Some of these waste-water areas support excellent populations of quail and pheasants, but at present, many lack sufficient nesting cover and predation is therefore a problem.

Description of Covey Habitat

The majority of the coveys could be found in combinations of four cover types, namely: sagebrush-rabbitbrush-grass, juniper-sagebrush-grass, weedy areas, and dry or irrigated farmland. Often the habitat could be subdivided according to whether or not it had been overgrazed. For example, two areas might be the same as far as species composition and topography were concerned, but overgrazing in one of these areas might change the plant frequency. Therefore a highly desirable and numerous food plant in one location might be only a remnant in an overgrazed area, or nesting cover might be eaten away by livestock.

At times small numbers of valley quail were observed in areas which were not commonly regarded as quail habitat, such as wheat stubble where no trees or brush were available for roosting or dry-land situations where water was not present. Normally, valley quail range has been considered to be the brushy edge areas of cultivated fields or open perimeters of swales which were well vegetated with shrubs. In most cases where habitat was found described in literature, roosting cover and water availability seemed to be regarded as the two items of primary importance in defining valley quail range (53, p.226 and 9, pp.7-8).

Overgrazing appeared to be a problem only where sagebrush and rabbitbrush were not present. In these areas, such poor land use caused complete denudation of the slopes and waste areas, and usually only rodents found such places to their liking. In the majority of covey areas, unpalatable brushy species were sufficiently numerous to harbor grasses and weeds under their compact canopies. Valley quail found these overgrazed sections acceptable because, in effect, a large amount of edge was provided. Severe winter conditions such as prolonged snow cover would probably result in a lack of food which might cause starvation in this habitat.

The effects of grazing and farming practices on valley quail became so interesting that their influences

on five quail coveys was rather intensively studied. It was fortunate that the flocks involved were in somewhat compact groups; so that covey interaction could also be observed. Each covey was in a somewhat different situation according to the degree of grazing or the proximity of farmed land. Certain of these habitat types appeared to be more advantageous to the well being of quail from a nutritional point of view and for carrying capacity. The habitat of each of the five coveys is as follows:

Covey 1 was to be found in an extensive depression locally known as Dry Canyon. The native vegetation had been heavily grazed in past years, but recent improvements were allowing weedy species and newly planted grasses and legumes to come into the area. The original vegetation was still well represented and western juniper furnished roosting cover. Waste water was continually available, while irrigated wheat and pasture lands were to be found at the top of the rim-rock slopes well within reach of the covey.

Covey 2 was located in Dry Canyon about one-fourth mile above covey one in a heavily grazed area that had waste water available. The more palatable range grasses such as bluebunch wheatgrass were present only under sage and rabbitbrush. A large pond had been fenced from grazing, and the many weed and grass species which grew

up around it furnished food for the quail. Roosting cover was available in the form of western juniper trees, but the covey range did not include tilled soil.

Covey 3 was also in Dry Canyon one mile above covey 2 and one and one-fourth miles above covey 1. The habitat of the area consisted of native and introduced vegetation which had not been grazed for a number of years, except for one corner which was heavily overgrazed. Abandoned farm land provided volunteer wheat for additional food. A potato field was near by, and waste-water was continually available. Juniper trees furnished roosting cover.

Covey 4 was located in an elevated situation locally known as the Juniper Butte area. The habitat was in a completely dry-land condition where no free water was available. The original vegetation had been grazed rather heavily, but sage and rabbitbrush provided a concealment for the more palatable grasses and forbs. Western juniper was available for roosting, and a dry-land wheat field furnished additional food for the covey.

Covey 5 was located in a heavily overgrazed section one mile from covey 4. No farming practice provided food for these quail, and no free water was available. Western juniper was present for roosting. Evidence indicated that heavy rodent and rabbit competition was present.

A general survey of the five covey environments would conceivably lead one to expect certain things to be true about the populations and health of the birds contained within them. For example, a nutritional deficiency might be expected for covey 5 which appeared to have a food competition problem, while covey 1 would be expected to have a nutritional advantage over the other coveys because in addition to having an adequate supply of seed material, legumes furnished a continual source of nutritious green vegetation. Coveys 2 and 3 were expected to be about equal since each had similar types and quantities of food available. Covey 4 was expected to be somewhat lower in health than 2 and 3 because of its dry habitat which did not permit the growth of ample green vegetation. Differences might be expected in coveys 4 and 5 because no water was available as compared with coveys 1, 2, and 3 which had water present at all times. The covey habitats were listed in order of their expected potentialities. Number 1 was expected to be excellent, while number 5 was expected to be poor. (See page 59)

METHODS AND PROCEDURES

In making this study, several methods and procedures were used in order to gather data on the ecology of the

valley quail in the Madras area. Perhaps the most necessary and time consuming activity was that of making detailed visual observations so that social behavior and habits of quail could be recorded. A small number of valley quail were kept in an enclosure at the living quarters for additional study. Artificial roosts were built, a valley quail census was made for the entire Madras project, and an intensive trapping and banding program was carried out. The latter operation provided data regarding bird weights, parasites, and distribution. From time to time when valley quail road kills were found, their crops were saved for food habit studies, and when possible, the skins were preserved. A number of the methods used are described below, but in order to preclude repetition and maintain brevity, some of the procedures are described under separate sections.

Trapping and Banding Operations

When cold weather arrived in late October 1952, and the fall coveys were fully assembled, trapping operations were begun in order to obtain data on sex ratios, age compositions, weights, blood parasites, and quail movements. Five coveys were selected in which an attempt was made to trap all birds present. It was believed that sex and age ratio data secured in this way would contain

a lesser amount of bias and error than might occur if sight records and random sampling techniques were used. When blood samples were taken, however, sixteen coveys from diversified regions of the Madras project were sampled because it was believed that if a blood parasite occurred, it might be present only in certain coveys or regions of the study area. If all of the investigations were carried out on only five groups, parasites might easily be missed.

The traps used were constructed in a manner similar to the standard quail trap described by H. L. Stoddard (52, pp.442-443) with minor modifications which were necessary in order to employ wire and materials that were at hand. Clover screenings, which were furnished by the local seed companies, were used for bait to attract quail to the traps. The screenings were mainly composed of ladino clover, wheat, rye, cheatgrass, old witch grass, and small quantities of various weed seeds. Each trapped valley quail was weighed in the field to the nearest gram on a double-beam balance. Each quail was then identified by means of an aluminum leg band obtained from the Oregon State Game Commission. Colored, triangular, plastic tags were fastened between the wings of the birds with the use of nickle-plated safety pins in a manner devised by James A. Mohr, the previous graduate research assistant. Birds which were randomly trapped for blood samples were banded

but were not tagged because tag color combinations were limited. Indiscriminate tagging might have resulted only in confusion. Slides were made from blood obtained by pricking one of the wing veins with a sharp knife. The slides were then recorded and placed in slide boxes for storage. Later they were stained with Giesma stain and were examined by poultry pathologists of the Oregon State College Veterinary Medicine Department.

In order to facilitate easy handling, a wool sock with a small hole in the instep was used to hold each bird while it was being tagged and while data on sex and age were being recorded. The plastic tag was fastened to the back of the quail through the small hole in the sock's instep. The wing of the bird was brought out through the same hole when a blood smear was made. After data were recorded, the bird was released through the opening. Occasionally, while being weighed, one of the birds would attempt to free itself from the cloth envelopment and would thoroughly derange its feathers. Ordinarily, however, the bird was released appearing as if it had never been handled, except for the colored tag on its back. A small number of trapped birds were injured when predators tried to get into the traps. Bobcats were believed to be most harmful in this respect; however, no serious losses occurred.

Tagging

As was mentioned, each trapped quail was tagged with a plastic triangular marker which was placed between the wings and was fastened to the skin in the thoracic region by means of a number 0, nickle-plated safety pin. The tags were three-fourths of an inch across the top and two inches in length.

Three colors of plastic pennants were used, namely: white, yellow, and red. These were attached to the safety pins merely by perforating each side of the base of the plastic triangle and passing the point and coil of an unfastened safety pin through the two openings. The colored tag was in this way securely fastened between the coil and the head of the pin, and thus could be fastened with little effort.

The bird was placed into the holding sock in such a way that its back was exposed through the "instep" opening. The feathers on the back were then lifted and the point of the safety pin was passed under approximately one-half inch of skin and was fastened. Care was taken not to pierce any of the back muscles. When the bird was released, the colored pennant was readily discernible. Later when birds were flushed in the field, it was often possible to recognize a tagged bird that was over fifty yards away, depending upon the amount of light

and the tag color. From these tagging operations, it was hoped that winter and spring movement could be determined by observing the birds as they moved to new areas.

Several complications developed that influenced the effectiveness of this tagging method. The first noticeable weakness in the tagging system was that the red tags could not always be seen on dark days, and even on sunny days their visibility was much less than the lighter colors of yellow and white. The second defect was that from a distance, a yellow tag might be confused with a white tag or the converse might be true. The third and most discouraging fault of the program was that many tags failed to remain on the birds. Of the 76 birds retrapped, 18.42 per cent lost their tags at variable times. Some birds lost their markers in less than one week, possibly because they were improperly applied, while a small number of others retained their pennants over a year.

When quail were re-trapped, it was noticed that many of the back markers had become loosened. This was probably caused by the action of the wings. The rapid wing beat of the quail seemed to create tension where the pin had pierced the skin; thus a larger wound was produced. As the wound healed, the loose skin dried out and sluffed away releasing the pin.

The loosened tags were not always detectable in the field even though they remained on the birds. Often,

the tags tended to slide to one side and became obscured by the quail's feathers. It seems likely that the tagging method would have been more satisfactory if the marker had been applied to the base of the cervical region of the body rather than to the thoracic region because there is less muscular movement there. An even better method might be the use of the wing band as used in Oklahoma on bobwhite quail by Wint (60, p.7).

No undesirable effects to the birds could be attributed to this tagging method. However, one retrapped female quail, which had lost her tag, had developed white feathers at the site of the attachment. It was believed that injury had caused the color change though possibly dissolved metal from the safety pin may have been responsible. When this quail was again released, the white feathers resembled a white plastic tag and conceivably could have been mistaken for one in the field. Even though the tagging method was not entirely satisfactory, some of the pennants remained on the birds long enough to provide information on movement, which is included further on in this paper.

At the close of the trapping and banding operations in late February 1953, 186 valley quail from five separate coveys had been banded, weighed, and tagged. From these, a total of 18 blood slides were taken. In

addition, blood slides were taken from 99 valley quail which were trapped from diversified covey groups. These latter birds were banded but were not tagged with plastic markers.

Artificial Roosts

A program of artificial roost building in the Madras area was first initiated by James Mohr, graduate research assistant, during the 1951-1952 season. The device showed such promise as a management tool that additional ones were built in the 1952-1953 season until a total of six were constructed. These structures were first conceived by Ian McMillan in California in 1947. Since that time, they have been used in some parts of California to provide roosting cover for quail. A detailed description of the shelter was published in California by W. G. Macgregor in 1950 (31, pp.316-319).

On the Madras area, the roosts were first constructed to see if they would aid the survival of valley quail during periods of extremely cold weather. Investigations during the 1952-1953 season with the artificial roost consisted of evaluating its influence on population distribution and its use as an aid in census work.

On the study area, the roosts were constructed in covey territories where juniper trees were present.

Superficially, the roosting trees seemed to be in sufficient quantity, and a shortage of this type of cover was not believed to exist; however, the artificial roosts received use wherever they were constructed. Trees in these areas received little use except when the birds were disturbed at the elevated brushpiles. It appeared that almost every bird within the covey range was attracted to these roosts with the exception of a very few which continued to use abandoned magpie nests as roosting sites.

It was definitely believed that the roosts influenced valley quail distribution mainly because they all but eliminated opportunity for night predation and acted as a shelter against moisture. Temperature did not seem to be an influence in the usage of the artificial roosts because valley quail continued to utilize them even though the roosts were occasionally located in the coldest parts of the covey range. For example, the artificial roosts were for the most part located in canyons which were normal cold-air drainages. Often the minimum temperatures at the site of the artificial roosts were 10° F less than the minimum temperatures at the top of the canyon rims. If temperature was a limiting factor, the birds would be expected to roost in the warmer areas of the range.

One area under observation had a sizeable fall covey

of quail in 1952, but the territory was deserted during that winter. It was noted that birds returned to the area the following spring and again built up a large covey. An artificial roost was then placed in the area, and a check during the winter of 1953-1954 disclosed that the birds had not left the location. The artificial roost was receiving heavy usage at that time. Apparently, the man-made structure was the deciding factor in holding the birds in the otherwise unsuitable winter range.

As a protective device, the artificial roost seemed to be excellent. The metal legs acted as a barrier to all ground predators, and the heavy brushpile afforded efficient concealment from horned owls. Conceivably, a sharp-shin or Cooper's hawk could enter the roosts, but these raptors hunt during the daylight hours, at which time the artificial roosts are ordinarily not used.

When the artificial roosts were built, the principle was followed that to be effective, they must be more attractive than the existing nocturnal cover; and to be so, the more brush piled on them, the better. In order to obtain high usage of the shelters, they must be maintained each year by adding more brush or some other medium which the birds can get under and thus be sheltered. To keep from destroying too much diurnal cover by continuing to cut the lower limbs of juniper trees, such materials as straw and wood paneling were

Figure 2. A heavily used artificial roost blanketed with winter snow.

placed on some of the roosts that were receiving usage. The added meterial did not frighten or cause the birds any confusion that could be observed, and the additional cover in most cases made the entire roost acceptable. The structures which did not have paneling or straw in the brush pile became somewhat useless after one winter, when weathering caused the scale-like leaves to fall from the juniper branches and brush to settle into a smaller mass. The natural vegetation was then more attractive to the birds than the artificial roosts.

One case seemed to illustrate the above point. An artificial roost was left for a period during its second winter without being rebuilt. In the early winter the scale-like leaves began to fall from the juniper brush-pile, and by late January, 1952, the branches were virtually barren of foliage, and thus formed a poor rain shield. Any bird which used the roost was exposed to moisture and subject to limited predation. A December count at the roost showed 35 birds to be using the roost nightly, while a February count at the same roost indicated that only 9 birds found the structure acceptable. It was obvious that insufficient cover was the causative factor because all other elevated brushpiles continued to hold good populations of quail. An effort was therefore made to improve the structure. Paneling from discarded pheasant-rearing coops was scattered over

the roost, and this in turn was anchored with a moderate amount of additional juniper limbs. Within two weeks, the number of birds using the roost had increased from 9 to 34. In the winter of 1953-1954, this same artificial roost was heavily packed with wheat straw to take the place of foliage. A large covey of birds was using this shelter when it was checked in January, 1954.

Census Methods

A census was performed in order to arrive at a figure of quail abundance and, most important of all, to locate coveys which could be studied and compared. Flush counts were used to obtain an estimate of valley quail populations for the entire Madras Project. When quail were flushed, the birds were counted and the numbers were recorded. Often, the figure placed in the notation amounted to nothing more than a rough estimate. It was believed that a covey of over fifteen birds could not be counted accurately except under exceptional conditions. Often flocks of fifty to sixty quail were flushed at single instances. Errington mentions that coveys of bob-white quail numbering up to twenty birds could be counted accurately only if the birds were spread out (10, p.6). The high degree of human error made the final estimate of quail abundance on the project area too inaccurate to be used in anything but a trend in the population. If the

flush method is contemplated for future counts, a study should be made in order to find an acceptable correction factor so that more accurate estimates might be made for current populations.

An attempt was made to count birds after the fall coveys had been formed but before the very large winter concentrations occurred. This was the period between mid October and late December, 1952. At all times, a dog was used to aid the finding of quail, but even this often did not produce any birds to count. Tracks along dusty roads or trails were usual evidence of quail presence, and at times they were the only indications that valley quail were in particular areas. Dusting sites and an occasional moulted feather gave further indications of quail activity. The two latter signs were noted mainly at the first of the census period. Almost always, if quail sign was to be found, it was under the large, outsized sagebrush plants which seemed to occur near or at the edges of the plant association.

At the end of the census, 189 coveys of valley quail had been counted with a total estimate of 4,239 birds, which made an approximate average of 22 birds per covey for the entire project area. Any group of birds, regardless of number, was considered to be a covey, provided that it was flushed in an area where no other

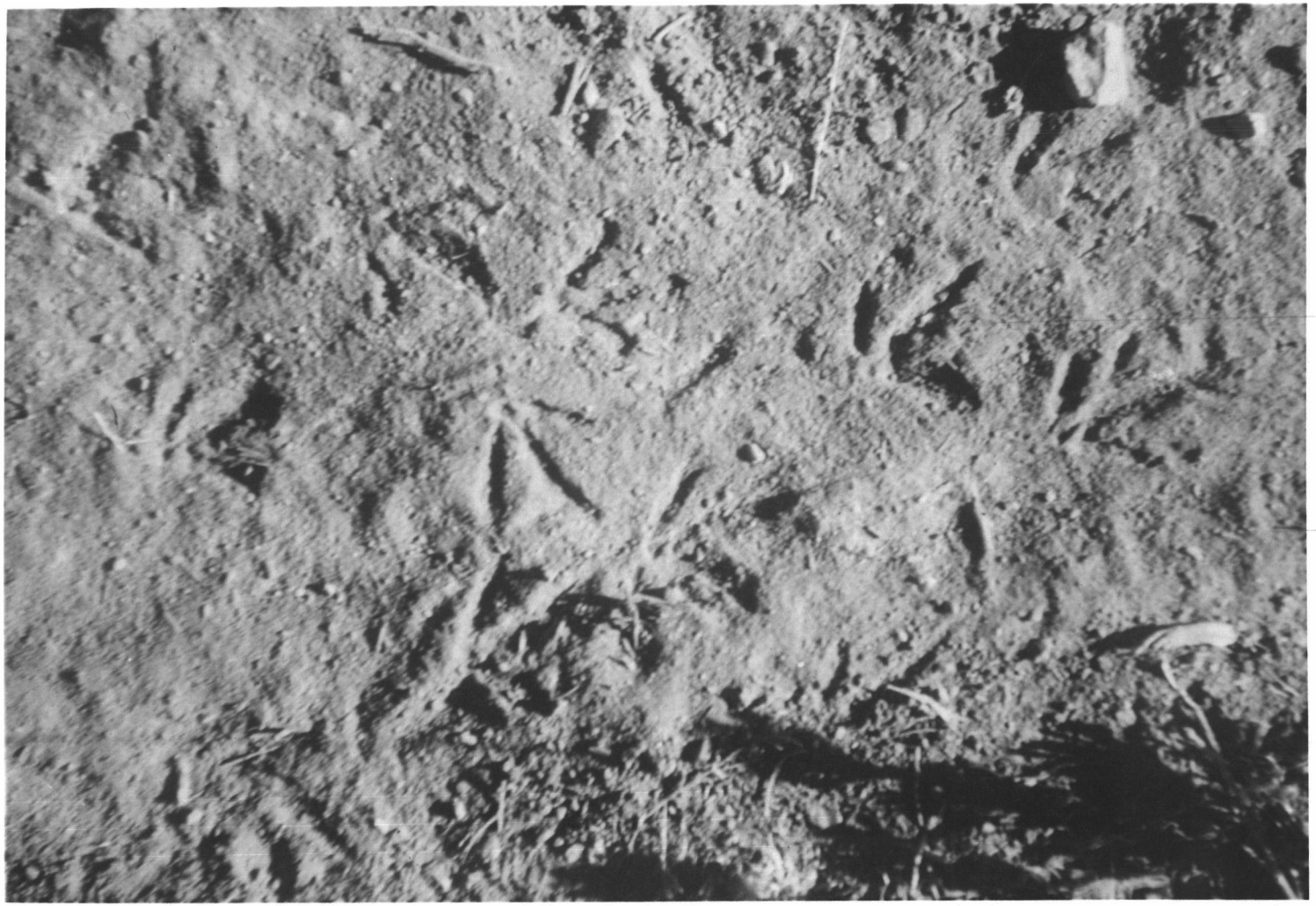

Figure 3. Tracks along a dusty road are often the only indication that valley quail are present in an area.

birds had been seen. The smallest number of birds considered to be a covey was 2; the largest was 65. Small groups of birds flushed in the same locations were counted as one covey. In the area where only 2 birds were seen, it was definitely believed that more birds were actually present, though no more were found. The covey that was designated as having 65 birds might well have been larger, but it was not believed to have been smaller. In all cases where coveys were flushed in the general census of the area, an endeavor was made to underestimate the number of birds in order to counteract the possibility of overestimating. The obvious inaccuracies involved in such a census as described above may include such items as failure to find a covey; failure to flush all birds in a covey, or failure to count accurately all birds flushed. In order to check on the error involved in such a census, certain areas were counted a second time on successive days, and in a few cases surprising differences in bird numbers resulted. In one area, where no birds were found on the first count, 21 were found, when it was recounted. In another case, a covey of 5 birds had increased to 10.

Areas around artificial roosts were counted using the flushing method. The figures obtained were compared to the number of birds using the roosts. In some cases,

phenomenal differences occurred. A covey of 15 birds proved to be 35 when a count was made at an artificial roost. At one time, only 13 birds were flushed after an area was intensively searched. A check at a natural roosting tree that evening proved that 29 birds were present. Not all roosting checks indicated that much larger populations were present, however. For example, 37 birds were counted at a roost while 32 had been counted during the day. No checks at artificial roosts indicated that any of the covey populations were over-estimated.

The evidence seemed to support the belief that many more birds were present than were actually counted, and it was believed that less than fifty per cent of the authentic number of valley quail were actually recorded. A total of 8,500 may be a better estimate of the number of valley quail that were present in the Madras area during the fall and winter seasons of 1952-1953.

Observations of usage of artificial roosts prompted the idea of using these structures for censusing. Brush blinds were used for concealment of the observer, and birds were counted as they flew to the roosts. It was believed that counts made at these structures were between 95 and 98 per cent accurate because subsequent counts at the same roost varied only slightly. The birds often flew to the roosts in groups of less than ten, and

many chose to walk to the elevated brush piles and then fly up in groups of two or three; thus every bird in a covey of fifty or sixty could be easily counted with accuracy. However, if the quail were molested prior to roosting time, either by man or predator, the entire covey often flew into the roost at one time. Then one-half of these birds might on occasion decide to drop to the ground and then fly back to the roost when they were satisfied that no predator was about. When this happened, the count had to be discarded.

Ordinarily, evening counts were more satisfactory than those made in the morning because the birds did not all arrive at the shelter at the same time in the evening. In the morning the birds usually congregated at the top of the artificial roost. The quail chattered, scolded, and called until one of the birds, either male or female, made a venture to the ground. According to the particular whim of the other quail, they might fly from the roost in small groups, or they might flush all at once. When they did the latter, an accurate count was impossible. In all cases observed, they invariably flew to the same ground location where the first bird had flown. Apparently they were confident that the unmolested presence of the first bird indicated safety from predators.

The birds seemed always to fly to the roost just after the sun had gone down. Usually all birds were settled in the roost within fifteen to twenty minutes after the first bird had entered. During the fall of 1953, concentrations of over 200 valley quail were using individual artificial roosts, and small numbers of birds often arrived at the structure before sunset. Weather conditions had little effect upon the artificial roost census, but very wet weather occasionally caused the quail to fly into the roosts in compact groups that were at times difficult to count.

The use of the artificial roost as a census tool permits very accurate enumerations of valley quail to be made with a tremendous saving of time. If a number of these shelters were available to coveys of quail in diversified areas, a few observers could accurately count each covey of birds. The covey range normally used by quail could be estimated and the number of birds per acre might be established. Over a period of years, excellent trends in population might be created, and the covey could be better managed. Since this type of census may be made only in the evening or the early morning, a wildlife manager would be free to spend most of the day gathering valuable data on valley quail or other game forms.

MOVEMENT AND RANGE OF THE VALLEY QUAIL

Periodic counts at three artificial roosts and the program of marking valley quail with plastic markers, provided a certain amount of interesting data on the movement of valley quail from area to area. In addition to the movement associated with covey formation and dispersal, as observed in California by Sumner (53, p.211) and Emlen (7, p.123), a marked tendency for the fall coveys to band into larger winter concentrations was observed in Central Oregon. This latter movement was believed to be in response to inadequate food conditions and possibly in a few instances to predation.

About three weeks after the young valley quail hatched, the first signs of travel from the nesting territory appeared to occur. Up to this time, good ground cover had been sufficient for roosting, but when the young birds began to fly, a search for an off-the-ground roosting site was made. Quail which had nested in cultivated fields no longer found such areas acceptable, and movement to the tree-covered rim-rock areas and side canyons that surrounded the tilled land took place. The inherent gregariousness of this species seemed to require that the birds band together after the broods were hatched; for in early summer, the roosting coveys appeared to grow periodically until fall,

when the last birds in the immediate area had joined the roosting groups. At first the early summer coveys appeared to break up quite rapidly in the early morning into one or two family groups which would feed together. The next evening, one of the broods might roost with another newly-formed covey. However, as the young birds began to grow larger, a definite association at feeding time became increasingly apparent until the entire group of birds began to feed together in the early morning. The concentration usually broke up by mid morning and ordinarily did not re-assemble until roosting time.

Once the quail had banded into fall flocks, the birds appeared to be quite sedentary, and were not observed to venture further than 300 or 400 yards from the evening roost. No exchange of birds between closely associated flocks was observed in the fall. The latter observation compared favorably with data recorded by Emlen and Price in California, but the fall valley quail coveys on the study area seemed to utilize a larger range area than the 120,000 square yards recorded by Price (46, p.5 and 7, p.121). The covey limits were not observed to extend further than one-fourth mile from the evening roost. For that reason, the ranges compare more favorably with those set up for the bobwhite quail in Iowa by Errington and Hamerstrom (11, p.112).

Definite movement was noted in the months of January and February, 1953, when observations of tagged birds were recorded in different covey territories. A total of four positive movements of one mile each was recorded at this season, and three birds were observed to become associated with nearby coveys. Either by coincidence or otherwise, only male birds were observed to make this movement. In January and February, 1953, the populations using the artificial roosts were observed to increase greatly. Valley quail concentrations were seen at this season in areas near sources of food which had previously held few birds, and a small number of farmers reported small coveys feeding in corrals and around hay and straw stacks.

Wandering from the home covey range that was observed in the winter of 1953 took place before sexual stimulation occurred, and it was believed that a food shortage was primarily responsible for this movement. Birds which had been recorded in heavily grazed sections in the fall, 1952, were no longer to be found in those areas, but coveys near sources of good food increased in number in January and February, 1953, when food was limited.

During the winter one covey of birds moved from an area where food was believed to have been sufficient.

The primary cause of movement in this case was believed to have been the presence of three horned owls which took over the quail roosting trees for their own purposes. Harassment of this covey probably continued until the quail sought a new roosting area.

In late April, 1953, the first enlargement of reproductive tissue was noted, and paired birds rapidly began to leave the winter concentrations. Only two accurate recordings of movement by valley quail were obtained for this season. The birds involved were mated at the time they were observed, but it was not known if they moved before or after mating. One bird had moved a distance of one mile and another had moved three-fourths of a mile. In the same month, quail began to be seen in areas quite apart from their winter habitat, and movement of pairs to cultivated, treeless areas was not uncommon. In the early summer paired birds were seen in many areas which were believed to have been vacant in winter. Some of the paired birds were seen in waterless areas over two miles from any known winter population. It was entirely possible that these birds may not have joined a large winter concentration, and therefore, were not previously noted. For that reason, the birds may not have moved very far. A possibility also exists that these birds may have been from an unrecorded winter covey.

During the period from April to June, 1953, unmated male quail were believed to have moved widely into many diversified areas because they were frequently seen calling from conspicuous places at considerable distances from where the winter flocks had occurred. A tagged, unmated male was observed on May 25, 1953, calling in an area approximately one and one-fourth miles from the area where it had been trapped the previous winter. The seasonal movements compare quite closely with those noted by Emlen in California. However, he recorded natural movements of up to four miles and also noted that some unmated males wandered as much as one mile in a single day (7, pp.123,126).

When the broods were hatched, valley quail movement was started on another cycle. Whether nesting birds retained a homing instinct for their former wintering areas was a matter for conjecture. It appeared, on the study area, that the annual treks to certain wintering areas were a matter of chance. The quail were believed to move to the closest areas of quail cover. Had several areas of equal habitat been available, coveys undoubtedly would have populated all of them.

Periodic counts from December, 1952, to April, 1953, at three artificial roosts in Dry Canyon appeared to present the pattern of quail movement as it was observed

on the Madras project. The counts which were obtained near the first of each month, except for the month of April when two counts were taken, are listed in table I. Other observations of activity at these man-made roosts were not included here because some roosts were not in operation long enough for good comparisons. In December, 1952, each roost showed a good population of valley quail in residence. The numbers counted were 45, 40, and 34. Early February, 1953, counts indicated that movement was taking place because numbers at two artificial roosts increased. It was noted in this month that an old artificial roost was all but vacated because it no longer furnished adequate shelter. When the old roost was improved, birds using it increased from 9 to 34 in less than one month. Early March counts indicated that a great deal of movement was taking place because the roosting coveys greatly enlarged. Where a total of 119 birds had been recorded in December, 1952, for the three artificial roosts, the March, 1953, counts indicated 199 birds. Early April recordings showed some inter-covey exchange as well as the start of covey breakup. By late April, 1953, nearly all of the birds had left the roost in order to establish nesting territories. By June, 1953, only an occasional bird was observed at the elevated brush piles. In August, family groups again began to use

TABLE I.

REPRESENTATIVE OBSERVATIONS OF QUAIL AT ARTIFICIAL ROOSTS DURING THE WINTER OF 1952-1953 AND THE FALL OF 1953.

Roost No.	December	February	March	April 1st	Late April	September
1	45*	9	34	59	**	over200*
2	40*	94	90	80	**	over200*
3	34*	35	75	60	**	over200*

* Birds in nearby trees also counted.
** Warm weather, sharp dispersal of birds.

the artificial roosts, and by early September, greatly increased numbers of valley quail were counted. The latter observation appeared to be proof of an extremely successful nesting season.

THE PHYSIOLOGICAL REQUIREMENTS OF THE VALLEY QUAIL

The Food Habits of Valley Quail

During the fifteen month study period between July, 1952, and September, 1953, an extensive collection of plant specimens was made on the Madras project for the Oregon State College Herbarium. This collection was later used as an aid in determining the species of a number of quail foods. All seed determinations were checked by personnel of the college seed laboratory. Vegetative parts were compared with available material

from the college herbarium; and when questions arose in identification, the herbarium staff was consulted. Scientific names used in this respect were obtained from Peck's Manual of the Flowering Plants of Oregon (42, pp.1-866) and from lists used at the college seed laboratory.

The quail hunting season from October 24 to November 15, 1953, furnished an opportunity for food analysis of a limited number of valley quail crops. The food samples were also supplemented by road-kill specimens taken in the winter months. With the exception of three birds which were collected in January, 1954, no specific collecting program was initiated. Thus the number of crops examined was necessarily small, which made the food analysis only an indication of valley quail preferences.

After the quail foods had been separated and identified, they were room dried and then placed in a drying oven for 24 hours at a temperature of 65° C. The crop contents were then weighed to the nearest milligram on a torsion balance and percentage by weight was determined. Weight percentages of less than one-tenth of a per cent were considered as traces. Seeds and green vegetation were treated separately, even though the same plant was involved. Grit was found in very minute quantities in every crop examined, but no attempt was

made to accumulate it for weight determination.

The food items taken by quail were naturally influenced by the availability of plant species, and for that reason, a large number of crops would have had to be collected for all seasons in different covey areas if anything but a cursory analysis were to be presented. For this study, 25 quail crops were obtained during the open hunting season. Three quail, one of which had an empty crop, were collected in January, 1954, and two road-kills were found in late March, 1953. Since the character of the foods for the three periods mentioned varied so markedly, the results of the latter crop examinations were listed even though the number of samples obtained was very small. Other crops from road-kills were not used because they contained grain which had been spilled from transport trucks, or the birds had fed from piles of clover screenings which tended to concentrate various types of seeds.

On the Madras area, it was quite interesting to note the high percentage of introduced plant species in the diet of the valley quail. With the exception of lupine seeds and bluegrass leaves in the fall and winter, and the presence of annuals in the spring, native plants made up less than one per cent of the diet. The grass family, Gramineae, showed considerably more importance than other plant families. The pea family, Leguminosae, ranked

second, and the sunflower family, Compositae, ranked third in importance.

It would be expected that available food on any given area of quail habitat would be plentiful throughout the summer and into the fall, provided that severe drought did not become too much of a factor. For this reason, only fall, winter, and spring foods were considered. In the fall, food was probably maximum in quantity and nutritive value. It was believed, however, that the vitamin content of the quail food became progressively less as the season wore on, until the successive spring stimulated the growth of new food in the form of early spring annuals and perennials. The importance of the early spring plants probably cannot be overestimated because they unquestionably play a very important role in supplying the necessary vitamin A and protein for reproduction and health.

The necessity of vitamin A was demonstrated in a laboratory experiment on bobwhite quail by Nestler et al. in California (36, pp.13-18). The observers found that lack of vitamin A could be a direct cause of mortality, especially when a sufficient storage supply had not been built up in the bird's liver. Death struck from six days to four weeks after the vitamin was removed from the diet. Low intake of the vitamin in the diet of the spring

population of adult bobwhite quail caused mortality in the offspring of the subsequent breeding season regardless of the growth diet of the chicks. Nestler found that deficiencies of vitamin A in the diet could be traced through the third generation of bobwhite quail.

Observations on gambel quail and chukar partridges in California and Nevada respectively have indicated that breeding activity would not occur unless a sufficient quantity of vitamin A was included in the diet (32, pp.218-219 and 37, pp.3-5). Apparently the lack of vitamin A arrests the development of the sex organs and in turn depresses sexual activity. The usual source of the vitamin in the spring is green vegetation. If severe drought occurs, this source may be eliminated.

Fall Foods

During the fall season, wheat with a weight percentage of 42.6 per cent led all other food items by a considerable margin. The general wide-spread planting of this crop by practically every landowner on the Madras project undoubtedly contributed to the large amount of this item in the diet. Cheatgrass seed was second in importance under the grass family with a percentage of 7.7.

Legumes were second in family importance. White

clover made up 8.1 per cent of the fall seed items, but contributed 15.1 per cent in green vegetation. Leiberg's lupine and silky lupine were next in importance in this family with percentages of 3.0 and 2.5 respectively. White and yellow sweetclover contributed 1.1 per cent by weight.

The sunflower family was prominent because bull thistle and prickly lettuce made up 7.0 and 6.1 per cent of the diet, in that order. It was surprising to find the flowers of rabbitbrush as a constituent of the crop contents.

Animal foods were present in a haphazard manner, and no particular feeding pattern was established. Ants were present in the largest numbers, while most of the other insects found occurred as single individuals. Apparently, animal foods were not of any importance, unless an occasional insect or arachnid provided some unknown food element or unless they were eaten in large numbers by young quail.

Winter Foods

In the winter, the grasses again led all other family groups in importance. Green vegetation in the form of Sandberg's bluegrass surpassed the other crop contents in importance by 10 per cent. Bluegrass made up 27.7 per cent of the crop contents by weight for this season.

Cheatgrass was second with 17.6 per cent, and wheat was third with 14.0 per cent.

The legumes were again second in importance as a family. Leiberg's lupine made up 18.2 per cent by weight, while yellow sweetclover increased in importance to 11.5 per cent of the crop contents. White clover was present as a trace.

The geranium family, Geraniaceae, became more important than the Compositae when alfilerilla increased in quantity from .4 per cent to 4.5 per cent. Bull thistle had dropped from 7.0 to 2.5 per cent by weight.

Spring Foods

From the limited number of crops examined, the indications were that spring foods were very different from those of the fall and winter because the diet was almost entirely of green vegetation. The seed pods of early spring annuals made up the bulk of the diet, while Sandberg's bluegrass contributed only a trace. Ants were scarcely indicated in the food habits for this season.

The Water Requirement of Valley Quail

The larger populations of valley quail on the study area were found in areas where water or irrigated land was available at all times. Similar observations in other

TABLE II.

FOOD ITEMS OF VALLEY QUAIL BY SEASON

Fall (25 crops)

Family	Scientific Name	Common Name	Per Cent by Weight
Seed Items			
Gramineae	*Triticum vulgare Villars	Wheat	42.6
	*Bromus tectorum Linnaeus	Cheatgrass	7.7
	*Echinochloa crusgalli (Linnaeus) de Beauvais	Barnyard Grass	.8
	*Secale cereale Linnaeus	Rye	.2
	*Panicum capillare Linnaeus	Witchgrass	.2
	*Lolium multiflorum Lamarck	Italian Rye-Grass	T
	*Hordeum vulgare Linnaeus	Barley	T
	Festuca octoflora Walter	Sixweeks Fescue	T
	Oryzopsis hymenoides (Roemer and Schultiz) Ricker	Indian Ricegrass	T
Polygonaceae	*Polygonum persicaria Linnaeus	Ladysthumb	1.8
Chenopodiaceae	Chenopodium leptophyllum Nuttall	Narrowleaf Goosefoot	T
Amaranthaceae	*Amaranthus albus Linnaeus	Rough Pigweed	.3
	*Amaranthus graecizans Linnaeus	Spreading Pigweed	.2
Cruciferae	*Sisymbrium altissimum Linnaeus	Tumblemustard	1.2
	*Sisymbrium officinale (Linnaeus) Scopoli	Hedgemustard	T
Leguminosae	*Trifolium repens Linnaeus	White Clover	8.1
	Lupinus subvexus var. leibergii Smith, C.P.	Leiberg's Lupine	3.0
	Lupinus sericeus Pursh	Silky Lupine	2.5
	*Melilotus alba Desrousseaux	White Sweetclover	
	*Melilotus officinalis (Linnaeus) Lamarck	Yellow Sweetclover	1.1

*Introduced species.

TABLE II (continued)

Family	Scientific Name	Common Name	Per Cent by Weight
Leguminosae	*Trifolium pratense Linnaeus	Red Clover	T
Geraniaceae	*Erodium circutarium (Linnaeus) L'Heritier	Alfilerilla	.4
Loasaceae	Mentzelia albicaulis Douglas	White Stemmed Mentzelia	.3
Onagraceae	Epilobium paniculatum Nuttall	Tall Annual Willow-Herb	T
Hydrophyllaceae	Phacelia ramosissima Jussieu	Long-Branched Phacelia	T
Boraginaceae	Amsinckia tesselata Gray	Fiddleneck	.2
	Amsinckia intermedia Fernald and Wiegand	Coast Fiddleneck	T
Scrophulariaceae	Collinsia parviflora Douglas	Small-Flowered Collinsia	T
Compositae	*Circium vulgare (Savi) Tenore	Bull Thistle	7.0
	*Lactuca scariola Linnaeus	Prickly Lettuce	6.1
	Chrysothamnus nauseosus (Pallas) Britton	Rabbit-brush (Dry Flowers)	.2
	*Taraxacum officinale Linnaeus	Dandelion	T
	Lagophylla ramosissima Nuttall	Slender Rabbit-leaf	T
Green Vegetation			
Gramineae	*Bromus tectorum Linnaeus	Cheatgrass (Including Other Green Vegetation)	1.2
Leguminosae	*Trifolium repens Linnaeus	White Clover	15.1
Animal Food			
Order	Family		
Araneida	--	Spider	
Homoptera	Cicadellidae	Grasshopper	
Hemiptera	Pentatomidae	Stink bug	
	Miridae	Lygus bug	
Coleoptera	Chrysomelidae	Beetle	

*Introduced species.

TABLE II (continued)

Family	Scientific Name	Common Name	Per Cent by Weight
Lepidoptera	--	Moth (Larvae and Chrysalid)	
Hymenoptera	Formicoidea (Superfamily)	Ants	.2
		Total	100.0
	Winter (2 crops)		
Seed Items			
Gramineae	*Bromus tectorum Linnaeus	Cheatgrass	17.6
	*Triticum vulgare Villars	Wheat	14.0
Cruciferae	*Sisymbrium altissimum Linnaeus	Tumblemustard	3.5
	*Lepidium perfoliatum Linnaeus	Clasping Peppergrass	1.0
Leguminosae	Lupinus subvexus var. leibergii Smith, C.P.	Leiberg's Lupine	18.2
	*Melilotus officinalis (Linnaeus) Lamarck	Yellow Sweetclover	11.5
Geraniaceae	*Erodium circutarium (Linnaeus)	Alfilerilla	4.5
Compositae	*Circium vulgare (Savi) Tenore	Bull Thistle	2.5
Green Vegetation			
Gramineae	Poa secunda Presl	Sandberg's Bluegrass	27.7
Leguminosae	*Trifolium repens Linnaeus	White Clover	T
		Total	100.0

*Introduced species.

TABLE II (continued)

Family	Scientific Name	Common Name	Per Cent by Weight
	Spring (2 crops)		
Green Vegetation			
Gramineae	Poa secunda Presl	Sandberg's Bluegrass	T
Caryophyllaceae	*Holosteum umbellatum Linnaeus	Jagged Chickweed	--
Cruciferae	*Draba verna Linnaeus	Vernal Whitlow Grass	--
Polemoniaceae	Polemonium micranthum Bentham	Annual Polemonium	--
	Microsteris gracilis (Douglas) Greene	Pink Microsteris	--
Animal Food			
Hymenoptera	Formicoidea (Superfamily)	Ant	T
		Total	100.0

*Introduced Plant Species.

areas have probably caused sportsmen and biologists alike to believe that water, in a free state, was an essential factor in quail survival, despite literature to the contrary. Grinnell, in California, (22, p.529), believed that in the rainless and dewless periods water was a critical factor in the survival of young quail, and that it had to be within 400 yards of the nest if the young were to survive. Vorhies, however, in Arizona, (56, pp.447-449), cited several instances of gambel quail, Lophortyx gambelii Gambel and scaled quail, Gallipepla squamata (Vigors), reproducing and thriving in areas which were as much as two miles from water. It was his conclusion that a slight amount of green plant material provided sufficient moisture for health.

In order to settle the question, as far as the California quail, Lophortyx californica brunescens Ridgway, was concerned, Sumner (53, p.193) removed all water from a penned enclosure which held two pair of quail. One brood was hatched, but no distress was observed; however, it was noted that the green material in the enclosure was being heavily used. The brood of the second pair perished within ten days, apparently because all of the green material within their reach had been eaten. It was significant to note that the first brood of quail, observed by Sumner, survived into the

fall even though they had never received free water.

On the study area, two coveys were observed for two successive seasons in dry-land areas which were nearly two miles from any known water. During both years, young were seen in July and August. It did not seem that water was being supplied in the form of dew because none was detected in this very dry area. The birds involved were apparently just as healthy as quail from watered areas, though their winter weights averaged slightly less. This latter observation was believed to have been the result of inferior food conditions rather than unavailable water. Moisture from sagebrush, rabbitbrush, perennial grasses, and various forbs was apparently sufficient for these birds. Insects were available in quantity, but were probably not used to any extent except by young birds. A similar observation was made by Rahm in the San Bernardino National Forest of California when he noted that valley quail were in a waterless area (47, p.151).

The existence of valley quail in dry areas is apparently widespread in Central Oregon, for according to the local residents, valley quail populations were scattered over the study area long before irrigation water was made available by the Deschutes River Project. Several instances of quail existing in non-watered areas were observed, but detailed observations were made only

on the above-mentioned coveys.

The occurrence of valley quail coveys in waterless areas in no way implied that water development would be useless in quail management. Quite to the contrary, the use of the gallinaceous guzzler (18, p.158) and water developments have greatly increased quail populations in California (19, p.155 and 50, pp.110-112). According to the local residents on the Madras area, the population of valley quail greatly increased when irrigation water was supplied.

The birds were observed to take water in the spring, summer, and fall when it was available, and in the winter, quail were observed to eat frost shortly after they left the roost in the early morning. There was, therefore, reason to believe that watered areas were probably correlated with preferred habitat.

THE WEIGHTS OF VALLEY QUAIL

Weight Comparisons Between Sexes

In order to make weight comparisons between sex, age, and covey groups, valley quail weights were taken as part of the winter trapping and banding program. Recordings to the nearest gram were taken in the early morning from November, 1952, through February, 1953, in an effort to include the critical winter months in which marked quail

mortalities were previously observed on the Madras area (5, p.15). A total of 186 birds from five distinct coveys were weighed. When a particular bird was trapped more than once in any one month, the weight recorded for that bird was the mean of these observations. When comparisons were made between populations or coveys, the mean computed for each covey included all observations made during all months sampled.

Weight Comparisons of Adult Quail in All Coveys

A total of 40 adult males were trapped from all coveys combined. The largest weight recorded for adult males was 220 grams; the smallest weight was 170 grams; and the sample mean was 197.80 grams. The number of adult females weighed was 26. The largest female weight recorded was 218 grams; the smallest weight was 184 grams; and the sample mean was 198.00 grams. The sample mean weights of adult males and adult females were very close numerically--the mean for females being 0.20 grams larger. Application of the "t test" revealed that this sample difference was not significant at the 0.05 level of significance (Appendix table A). Therefore, no sex differences in mean weights were considered to exist for adult birds.

Weight Comparisons of Juvenile Quail in All Coveys

A total of 59 juvenile males were weighed. The largest bird taken in this group was 207 grams; the smallest taken was 152 grams; and the sample mean was 188.46 grams. The number of juvenile females weighed was 61. The largest immature female taken weighed 218 grams; the smallest immature female weighed 161 grams; and the sample mean was 184.84 grams. The sample mean weight for juvenile males was 3.62 grams larger than that for juvenile females. The use of the "t test" indicated that this difference was not significant at the 0.05 level of significance (Appendix table B). Therefore, no sex differences in mean weights were considered to exist for juvenile birds.

Weight Comparisons between Coveys

A comparison of weights among the five quail coveys was made because such procedure seemed to be a reasonable test for evaluating the environments of the different coveys as far as food conditions were involved. If no significant differences could be found in covey weights, there would be little reason to believe that food conditions were different for any of the coveys. If the weights in an overgrazed area were significantly lower than those of an ungrazed area, then there might be

reason to suspect that lack of food was a contributing factor to the reduced weight. For this analysis, the sexes were combined for both adults and juveniles since statistical comparison had indicated that there was no difference in the weights of males and females by age groups.

In the five coveys compared, the food conditions were expected to be at extremes in coveys 1 and 5. Covey 1 was thought to have advantageous food conditions, while covey 5 was believed to have inferior food conditions. Coveys 2, 3, and 4 were thought to be using comparable habitats, but their food conditions were considered to decrease in the order listed.

Weight Comparisons of Adult Quail between Coveys

In covey 1, a sample of 15 adults was weighed. The largest bird weighed 220 grams; the smallest weighed 191 grams; and the sample mean was 204.13 grams. In covey 2, the weighed adults were 14 in number. The largest bird weighed 216 grams; the smallest weighed 176 grams; and the mean weight was 197.07 grams. In covey 3, a sample of 13 adult birds was weighed. The largest bird weighed 208 grams while the smallest weighed 176 grams; and the mean was 197.38. In covey 4, a sample of 13 adult quail was weighed. The largest weighed 218 grams, while the

smallest weighed 174 grams; and the mean weight was 196.77 grams. In covey 5, a sample of 15 adults was weighed. The largest bird weighed 204 grams, while the smallest weighed 170 grams; and the mean weight was 192.27 grams.

As was believed would be the case, the sample means of coveys 1 and 5 were at the extreme ends of the weight classification. The sample mean of covey 1 was considerably larger than the sample means of all other coveys, while the sample mean of covey 5 was smaller than those of all the other groups. The sample means of coveys 2, 3, and 4 were close numerically. Analysis of variance indicated at the 0.05 significance level the mean difference in the population approached significance. Use of "least significant differences" indicated at the 0.05 level that only coveys 1 and 5 were significantly different from each other (Appendix table C). There was insufficient evidence to determine whether or not differences existed between the other possible covey comparisons.

Weight Comparisons of Juvenile Quail between Coveys

In covey 1, a sample of 29 immature quail weights was taken. The largest sample weight was 218 grams; the smallest sample weight was 161 grams; and the sample mean was 191.83 grams. The number of juvenile weight

observations in covey 2 was 31. The largest weight was 212, while the smallest weight was 152 grams; and the sample mean for this covey was 186.68 grams. For covey 3, 22 observations were made. The largest weight recorded was 201 grams, while the smallest was 168 grams; and the mean weight was 185.23 grams. A total of 18 birds was weighed in covey 4. The largest bird weighed 198 grams; the smallest weighed 170 grams; and the sample mean was 184.83 grams. Covey 5 was represented by a total of 20 weights. The largest was 207 grams; the smallest was 170 grams; and the sample mean was 182.10 grams.

The juvenile birds when classified by coveys fell into a pattern that was very similar to that of the adult birds. As before, coveys 1 and 5 were at the extreme ends of the weight classification. The sample mean of covey 1 appeared to be greater than the means of other coveys. The sample means of groups 2, 3, and 4 were close numerically, and the mean of covey 5 was again less than those for all other groups. Analysis of the variance indicated that at the 0.05 level of significance, the population mean weights of all the coveys were not the same. "Least significant differences" revealed that coveys 1 and 5 were significantly different at the 0.05 level (Appendix table D). There were insufficient data to determine whether or not differences existed between any of the other coveys.

The belief that environmental differences in food relationships were important factors in the condition of the valley quail on the Madras area seemed to be substantiated. It was probable, however, that unknown factors contributed to the differences in covey weights.

Weight Comparisons between Months

In order to substantiate the theory that food quantity and quality were lowered as the winter season progressed, weight comparisons between months were made for adult and juvenile valley quail. If food quality and availability were a problem, then bird weights presumably would reflect these conditions.

Weight Comparison of Adult Quail by Months

In the month of November, 1952, a sample of 30 adult weights was taken. The largest sample weight for the month was 220 grams; the smallest was 170 grams; and the sample mean was 194.70 grams. In December, 1952, 31 adult birds were weighed. The largest was 218 grams; the smallest was 186 grams; and the sample mean was 202.35 grams. The total number of adult birds weighed for January, 1953, was 18. The largest bird recorded was 216 grams; the smallest weight was 184 grams; and the mean for the month was 200.39 grams. In February, 1953, a

total of 13 adult birds was trapped. The largest weighed 210 grams; the smallest weighed 182 grams; and the mean for the month was 190.69 grams.

Analysis of variance indicated that at the 0.05 level not all of the sample means were equal. "Least significant differences" indicated that the sample difference between the months of November and December, 1952, was significant as was the difference between January and February, 1953 (Appendix table E). There were insufficient data to conclude that there was any difference between the adult weights for December, 1952, and January, 1953.

Weight Comparison of Juvenile Quail by Months

In November, 1952, a total of 53 sample juvenile weights was taken. The largest weight was 219 grams; the smallest weight was 152 grams; and the sample mean weight for the month was 181.70 grams. For December, 1952, a total of 53 sample weights was again taken. The largest bird weighed 218 grams; the smallest weighed 162 grams; and the sample mean for the month was 192.89 grams. In January, 1953, the number of immature birds weighed was 33. The largest bird weighed during this month was 207 grams; the smallest immature quail weighed 173 grams; and the mean was 189.36 grams. The February weights of juvenile quail were obtained from a total of 22 birds.

The largest was 206 grams; the smallest was 168 grams; and the mean sample weight was 181.55 grams.

Analysis of variance indicated that one or more significant differences existed between the sample juvenile weights by month. The greatest differences in the sample mean weights occurred between November and December, 1952, and between January and February, 1953. As with the adult birds, "least significant differences" indicated the difference between the means of November and December was significant at the 0.05 level. The means for January and February were also shown to be significantly different at the same level. The difference in sample mean weights between December and January approached significance at the 0.05 level, but there was insufficient evidence to conclude that they were different (Appendix table F).

Interpretation of Weights by Month

The analysis of the adult and juvenile sample weights seemed to indicate that lack of sufficient food either in quantity or quality was the cause of weight changes. In both adult and immature valley quail, weights increased from November, 1952 to December, 1952. In the case of the adult birds, the weight gain was believed to have been due to an abundant food supply. The increase in the

weight of immature birds during the period was probably the result of the normal processes of growth and the abundant food supply. In the adults, little difference was noted between December and January. Food was believed to be plentiful until the first of the year, at which time quantity and quality probably began declining. Between December, 1952, and January, 1953, the juvenile sample mean weights dropped to a lower level instead of continuing to increase. Had food conditions not been a factor in valley quail weights, the weights of juvenile birds would have been expected to converge slowly with weights of the adults. The mean weights of adult and immature quail both dropped in February, 1953.

The highly significant differences between the sample weights of January and February in both adults and juveniles was believed to have been the result of poor food conditions. Available food supplies were thought to be at their lowest yearly level at this time. The subsequent growth of spring annuals in March and April, 1953, seemed to be the source of necessary food elements which enabled the valley quail to reproduce effectively.

Full adult weight in young quail was not believed to be attained until the birds were about one year old. This observation was in complete accord with that of Sumner in California, who noted that adult weight was not reached

until the beginning of the second year of life (53, p. 249). Williams in New Zealand, however, did not believe that a full year was required for the birds in that location to attain adult weight. He thought that three to four months was a sufficient length of time (58, pp.476-477). A constant nutritious food supply available to quail in New Zealand may have been responsible for Williams' conclusion.

In the winter weight observations on the Madras area, an occasional immature bird appeared to attain adult weight in the three to four month's time observed by Williams, and in a few instances, the weights of juvenile quail actually surpassed those of many adult quail. For example, an immature female trapped on December 2, 1953, weighed 218 grams which was equal to the weight of the largest adult taken during that month, and exceeded the mean of the adult and immature birds by 15.65 and 25.11 grams respectively. When extra heavy immature quail weights occurred, they were believed to be from an obese condition. The young valley quail three to four months of age were not believed to possess the heavy bone and muscle structure of fully mature birds. For that reason, the weights of juvenile birds were not maintained as efficiently as the weights of adult quail when food conditions became critical.

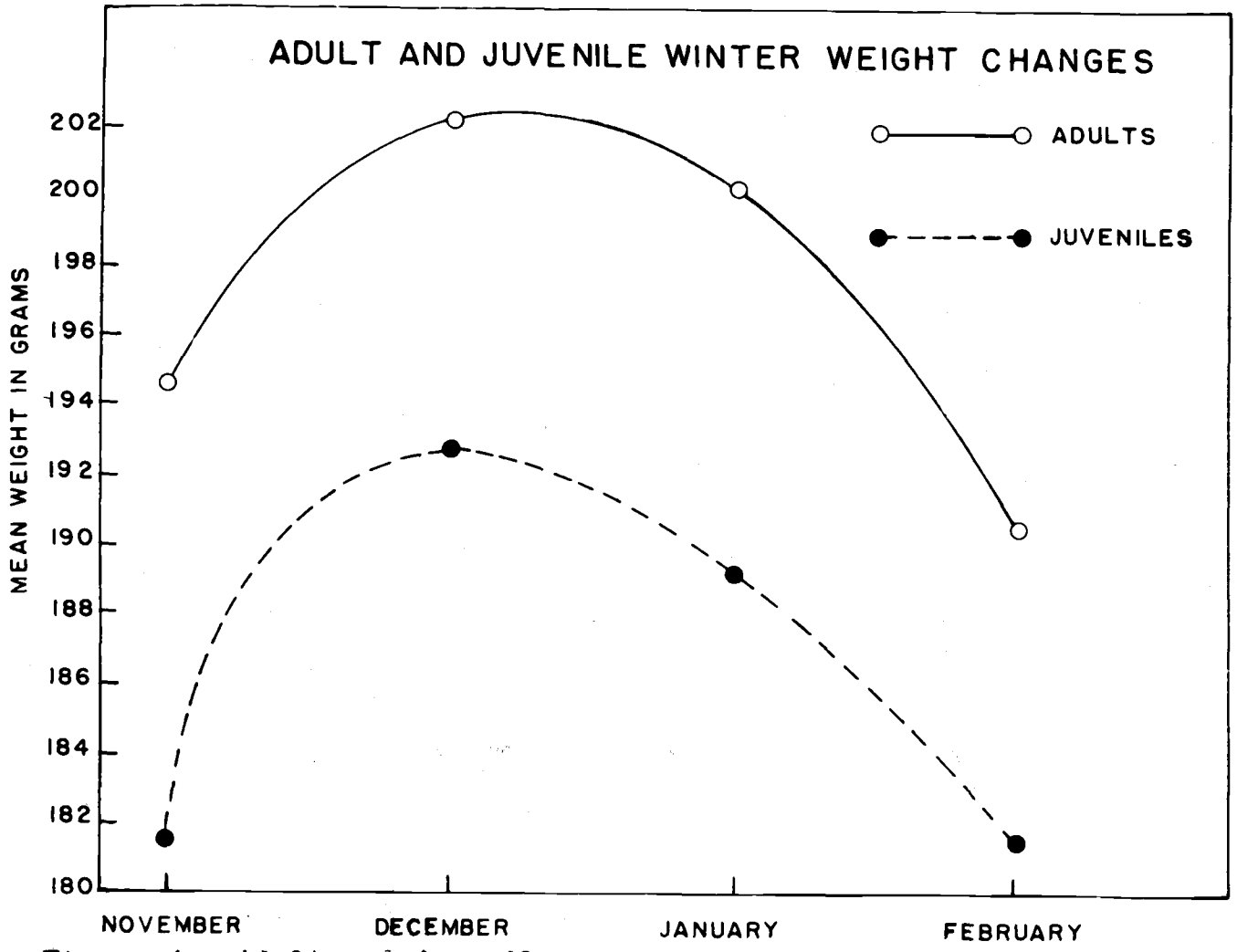

Figure 4. Adult and juvenile weight changes compared as mean weights from November, 1952 through February, 1953.

Weight of Ingested Food Material

The weight of ingested food material in valley quail was obtained by holding a group of 57 adult and immature birds for a period of 24 hours without food or water. Weights were taken at the beginning and end of the holding period, and the differences between the starting and ending weights, presumably caused by fecal elimination, were considered to be the weights of food matter contained within the bird's body. The birds studied were wild, trapped during the period of February through April, 1953, from various covey areas in conjunction with other studies. The quail were released in their resident covey locations after the 24 hour holding period. The crop contents of these birds at the beginning of the observations varied from being very full to being practically empty. Because weight variations of from 2 to 17 grams were recorded in 4 instances when quail were retrapped on successive days, this particular study was carried out in order to ascertain the probable limits of weight fluctuation which were due to differences in the amount of ingested food.

Food content was believed to be a source of error which should be closely regarded if weight comparisons were to be made of birds taken by different sampling methods or at different times during the day. For

example, the weight of a bird taken in the early morning before it had a chance to feed could hardly be compared with a bird which was taken in the evening after it had completed two feeding periods, unless food weight were taken into consideration. Similarly, it would not appear that the weight of a trapped bird with a full crop should be compared with the weight of a roadkill which had an empty crop.

Of the 57 birds held in this study, the weight of eliminated food material in 24 hours varied from a maximum of 30 grams to a minimum of 4 grams. The sample mean of eliminated material was 18.05 grams; the 95 per cent confidence limits for the population mean were 16.87 and 19.24 grams. The maintenance of uniform sampling both in time and technique therefore appeared to be a necessity.

After the 24 hour holding period had elapsed, the observed quail displayed considerable hunger activity by picking at minute particles of soil and excreta which were not thoroughly cleaned from the holding pen floor. The birds showed extreme fear when they were approached, and they made many attempts to flush from their confined area; but when food was placed before the quail, fear reactions disappeared. The birds concentrated on feeding and apparently disregarded the fact that they were being

watched from a distance of only three feet.

Weight-Loss Observations on Starved Valley Quail

As data was being gathered on the influence of crop contents on the weights of valley quail, it became apparent that the birds continued to lose weight rapidly, even after the crop and intestine contents had been passed off. The foregoing observation stimulated the idea that perhaps this continued rapid weight loss under artificial starvation might give a clue as to what would occur if the food of the valley quail was unavailable under packed snow and ice. The experimental starvation period was therefore prolonged.

In April, 1953, two groups of valley quail, designated as A and B, were wild trapped and held for a 54 hour starvation period during which weight recordings were made every 6 hours. Group A contained five birds which received neither food nor water. Group B contained four birds which received no food but had a continual supply of water. Minimum temperatures during the starvation period varied from 16° to 21° F, and the maximum temperatures ranged from 53° to 64° F.

Mannerisms and distress actions of these birds were recorded. Particular attention was paid to hindering the birds from picking up their own waste by thoroughly scraping and cleaning the holding pens after each series

of weighings. The greater part of the weight lost in the two populations of this study during the first 24 hours was considered to be caused by fecal elimination. Weight lost during the remaining 30 hours of starvation was believed to be mainly from tissue and metabolic water.

Population A, which received no water, lost a mean weight of 18.40 grams during the first 24 hours (mainly ingested food) and a mean of 18.60 grams during the remaining 30 hours (mainly tissue and water). The largest amount of "tissue" lost by a bird of population A was 23 grams. The smallest was 16 grams. The mean weight-loss during the remaining 30 hour period was 3.72 grams for each 6 hours of starvation. Population B, which received a constant water supply, lost a mean weight of 18.75 grams during the first 24 hours (mainly ingested food) and a mean of 17.75 grams during the remaining 30 hours (mainly tissue and metabolic water). The largest amount of "tissue" lost by a bird of population B was 23 grams, and the smallest was 13 grams. The mean weight-loss during the remaining 30 hour period was 3.55 grams for each 6 hours of starvation.

The sample observations of weight lost did not appear to be different even though one population received water and one did not. Application of the "t test" revealed that there was insufficient evidence to declare the populations different at the 0.05 significance level

(Appendix table G).

The birds held for 54 hours became quite weakened. Fecal matter found in the holding pens after 24 hours of starvation consisted mainly of whitish urine and watery discharge. By the time 48 hours had passed, the birds had ceased their usual attempts to flush when they were observed from close range. Movement occurred only when a hand was placed inside the holding pen; however, those birds which had no water appeared to be in a more destitute condition. Both groups of birds spent much time huddled together as if chilled; they fluffed out their feathers, and stood in the sun when it was possible.

When the starvation period was discontinued, water was given to the quail which had been without it. Their thirst was evident for they spent much time drinking. Yellow cracked corn, a food which the birds had never seen, was provided to both groups. The quail showed difficulty in eating the large pieces, but the smaller ones were taken, though not too avidly. Grit, in the form of crushed granite was accepted by the birds as were sweet clover leaves and rye seedlings. Clover screenings, which consisted of ladino clover and numerous weed seeds were then given, and food consumption immediately became rapid. A seed mixture of wheat, rye, and barley was also eaten. Five hours after the valley quail had been given food,

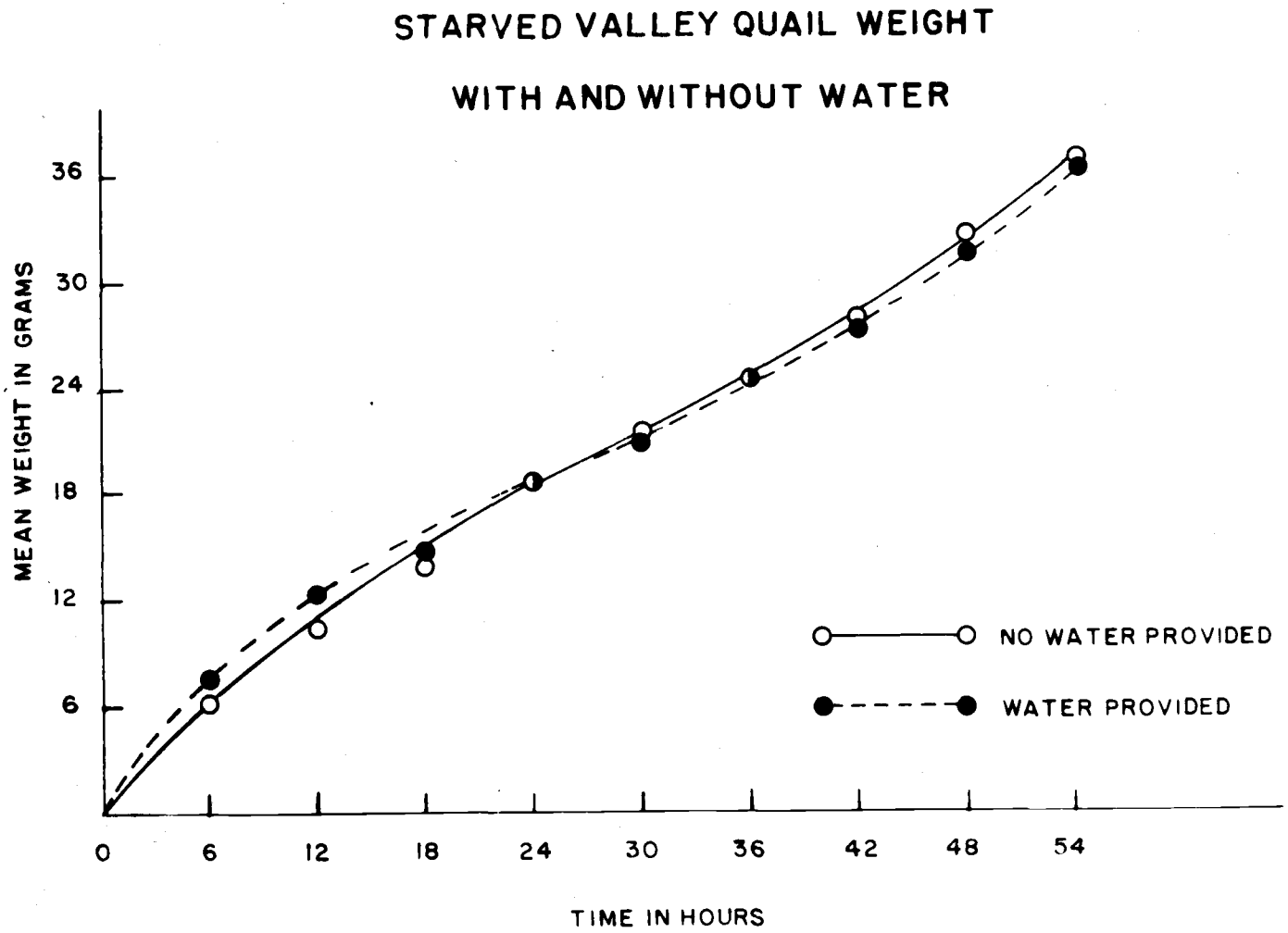

Figure 5. Mean weight-loss comparisons of starved valley quail with and without water during April 1953.

the feces were no longer watery but were of considerable substance.

Both groups of birds were observed from directly above the enclosure when they were fed, but nearly complete disregard was given to this by the quail, for they gave only an occasional upward glance. A similar observation was noted for quail which were fed after 24 hours. Under these circumstances, in winter, when snow remains on the ground for prolonged periods, birds which had lost nearly all of their wariness because of hunger, would be extremely vulnerable to predators. The rapid loss of weight by valley quail in this experiment indicated that starvation would be a very serious problem if the birds were without food for a period of only a few days.

REPRODUCTIVE BEHAVIOR OF THE VALLEY QUAIL

Mating on the study area, in general, took place in the early spring when the weather began to warm and the increased day length and essential food elements stimulated the reproductive organs of the quail. For the most part this activity took place in early April. Gonad enlargement, as evidenced by examination of road kills began to take place in early March, at least in some individuals, and was definitely underway by the latter

part of that month.

Mating behavior was difficult to observe, but it was believed that some birds were paired before light conditions had increased sufficiently to stimulate them sexually. Males were seen giving special attention to certain females at all seasons of the year, but this may have been the habit of these birds and did not necessarily mean that they were mated.

One interesting observation was made on August 28, 1952. An immature male was seen "protecting" an immature female from other young birds of both sexes in a covey of several family groups. Both birds were well advanced toward their adult plumage, but their immaturity was easily recognizable by their brown scapular feathers. The covey was watched from close range as it moved down to an irrigation canal for water. The young male would rush at any young bird which came within three or four feet of the young female; and he would scold loudly with explosive single noted calls, which have been described as "squill" by Sumner (53, p.203). The immature male would then run back to his female and show very fond attentions by pointing out choice bits of food and grit. Then he would again chase the other young birds away. Adult birds showed no notice of the young male's antics and disregarded him completely. While it was believed that

these young quail were not sexually mature, it was not known whether maturity or sexual stimulation had to be attained before a mate was chosen. Other observations which caused confusion in this regard occurred when various coveys would fly to the vicinity of the artificial roosts just before roosting time. Quite often, if the covey split before it landed on the ground, there would be calling back and forth between individuals of the parted covey. The calling quail would run in a converging direction until they met. Invariably they would be a male and female. These birds would then move back to one of the covey segments. Another action which caused wonder was the usual tendency for male and female quail to fly up to the roost in pairs. Another occurrence which prompted surprise was that three pairs of birds which were held in the holding pen at the research quarters mated with the same individuals for two succeeding years. Insufficient data were available, however, to prove that this was not merely a chance occurrence.

In the spring, fighting and acts of pugnaciousness were not observed until after many of the birds were definitely paired. It seemed reasonable to assume that some of the quail were stimulated sexually before others. If this were true, then, the earlier birds, probably adults, would have no trouble in pairing, and conflict

would, therefore, be avoided unless two males were intent on one female. As the mating season progressed, more and more birds would be stimulated and conflicts would become more numerous. Since males were believed to be in larger numbers than females, the less aggressive males would lose out and be driven from the covey. There was also the possibility that a caste system or peck order might have been in effect. The more aggressive males would in that case take their choice of mates, while other males would be too timid to challenge this action. In either case, the females did not take part in the early mating battles, though they were heard to give the defiant call of "squill", which was contrary to Sumner's observations that only males give this call (53, p.203).

Covey Break Up

During the spring of 1953, while repeated counts were being made at various artificial roosts, it was possible to keep very close observations on covey numbers at roosting time. In the first week of April, the weather was generally cold, snow fell, and minimum temperatures were at 16° F. The second week of April was clear and generally warmer. Minimum temperatures increased from the previous week, and covey dissolution became very apparent. Although occasional pairs of quail had broken away from the winter concentrations since the first of the month,

a warm day occurred, and one of the roosting counts changed from seventy-five to forty-three birds in a single day. That same week, a second covey dropped in number from sixty-one to twenty-two, and a third covey decreased in a similar fashion. By the first of May, winter concentrations could not be found, and for the most part only paired birds were seen.

The call of unmated male birds, described as "cow" by Sumner (53, p.201), was first heard in mid April. It increased in tempo until the end of the month at which time unmated males could be readily observed perched in conspicuous places. Lone males could regularly be seen or heard calling well into June. These unsuccessful males apparently did not become discouraged easily because the last of these calls was not heard until mid July.

Nesting

Evidence of nesting was first observed on April 30, 1953, when a dropped quail egg was found along one of the wasteway trails, and a nest, containing five eggs was found on May 3 in another area a few miles distant. This nest continued to receive eggs until twelve were laid at which time the nest was abandoned.

It was very interesting to note that the first broods were not seen until June 22, 1953, a period of 52 days after first definite nesting was observed. In May, 1953,

there was a great amount of rain which led to the speculation that many early broods were lost because of exposure. It was also probable that many of the early nests were abandoned because of excessive moisture, accidents, or predation. Since 23 days were required for incubation (23, p.529 and 49, p.37), nearly a full month would have elapsed between initial laying and incubation time if the first nests were incubated. There was also the possibility that the female quail were stimulated to continue laying rather than to begin setting. In any case, the spring broods of 1953 were later and larger than the broods of 1952.

For the two nesting seasons under observation, the latest hatch observed was that of a brood of day-old chicks recorded on September 2, 1952. Other young birds were seen from time to time throughout the late summer. The later broods probably represented second and third nesting attempts.

Nesting Sites

The nests of the valley quail were so well hidden that during the two nesting seasons observed, only nine were found in the wild. Four of these were located after incubation had taken place; one was abandoned; one was accidentally destroyed by a farmer; another was found

because a predator had taken the female from the nest and had left eggs and feathers scattered; and two hatched while they were under observation. All of these nests were well hidden, and were discovered only by accident. Of the nests observed, two were in straw stacks; one was at the base of a bitterbrush plant; one was under a sagebrush plant; one was under an overhanging rock; and one was under a brush pile. The remaining four were found in dense weed growths. With the exception of those found in the straw stacks, the nests were slight depressions on the ground lined with grass, leaves, and feathers. Overhanging vegetation prevented the nests from being seen. In addition to the wild nests, six nests were observed in the penned enclosure, though only two of these hatched; all others were abandoned.

Whether or not the female was the sole constructor of the nest could not be determined, but it appeared to be the case as far as the penned birds were concerned. One female built her nest in a corner of the penned enclosure which was easily observed. The bird in question very neatly lined her nest with both green and dried grass. An egg was laid on the same day that the nest was built, and a second egg was laid on the second day. Thereafter, it was not possible to count the eggs, because the female quail pulled grass stems down around the nest, making it difficult to observe, and also making it appear much like

the nests found in the wild.

As the grass continued to grow, it became impossible to see the hidden eggs from any angle. Later, it became apparent that this nest had been abandoned. The closed canopy of grass was parted, and 17 eggs were revealed.

One successful wild nest that was under observation in the 1953 season was either the result of multiple nesting, or the parent female was highly productive. The nest was first located on July 14, 1953. It contained 4 normal sized quail eggs plus one "pewee", or under-developed egg. It was visited again six days later on July 20 at which time 13 eggs were noted. On July 31, it was again observed and 16 eggs were found. It was fortunate that the nest was visited on August 13 because the eggs were in the process of hatching on that date. An afternoon check at this nest indicated that all of the normal sized eggs were fertile, though one of them failed to hatch which made the brood size 14 in number. Since 23 days were required for hatching, it was clear that incubation had started about July 21. In order for one bird to complete this clutch of 16 eggs in so short a time, a consistent number of two eggs per day would have had to be laid, and ordinarily, the valley quail is given credit for the ability to lay but one egg each day (23, p.527). Several observations have been made of more than

one bird laying in a single nest, but there were insufficient data to prove in this case that it was the work of one or of several females. The second successful nest observed contained thirteen eggs, all of which were fertile. This nest was located over one-fourth mile from any known water.

Brood Observations

The degree of precociousness which the quail chicks displayed was amazing. It therefore seemed worthwhile to present the activity which took place during the first day of life of the quail chicks which were hatched at the research headquarters. Since the two broods acted in the same manner, they were included as one observation even though they hatched two weeks apart. Three broods were observed as they came off the nest (one wild, two penned). One penned brood came off the nest at 6:30 a.m.; the other came off the nest at 10:30 a.m.; the wild brood left the nest at 9:30 a.m.

When the young birds first left the nest, the adult quail were very attentive, especially the female. She chose a sunny spot and seemed anxious to brood the chicks, while the male elevated himself and stood guard. The chicks were very wabbly at first, and tumbled with every few steps. They appeared to pick at small food particles on the ground, but did not go more than one foot from the

female bird. Both adults occasionally called softly to the young chicks, and the female occasionally gave a soft throaty sound which was much like that of a broody barnyard hen reassuring her young.

As the day progressed, the chicks seemed to gain in strength, and were seen to run about and do considerable scratching. In the afternoon, a turkey vulture flew overhead at a considerable height, but the adult male gave a warning call which sent the female scurrying for cover with the young ones close behind her. The family remained motionless and did not venture into the open again until the male called them. It could not definitely be stated that this response to the warning call on the part of the young chicks was due to instinct rather than imitation of the female.

The adult male showed increased attention to the young birds on the second day, and was seen several times to brood them. Sometimes he stood beside the female and aided her in brooding the young, and at other times, he warmed the young while the female stood guard. No pugnaciousness was shown toward English sparrows which fed in close proximity to the young birds, but an unmated male valley quail which flew to the top of the enclosure was severely scolded and lashed at through the wire. As this latter belligerent action took place, the female and

young took cover. The daily life of most of the family groups observed on the Madras project seemed to follow this same routine until the young birds began to become somewhat independent of the adult birds.

The young quail in the penned enclosure grew rapidly, and could fly by the time they were ten days old. At two weeks, they could fly quite well, and were at times seen on top of the research quarters.

Sentinels

After pairing had taken place and the winter covey had begun to disband, the normal secretiveness, which had been displayed by the valley quail throughout the winter, was discarded. The males then became very bold. Up to this time, both sexes had been loath to leave protective cover, except for food, but at this season, the male could be seen perched above his mate while he watched for enemies in the form of predators or unmated male quail.

In the few observations that were made, the male bird was seen to advance to the nest with the female during the period that the eggs were being laid. When this took place, the male bird usually concealed himself a few feet from the nest and waited for the female to complete her task. Both birds then walked away from the nesting site, and the male directed his attention to pointing out bits

of food to the female, and occasionally, he flew to the top of a fence post or sagebrush plant to see if any intruders were about.

Although only two observations were made under natural conditions, the male was not in either case observed to stand guard in a conspicuous place while the female incubated her eggs. Under penned conditions, the male followed the same pattern and did not appear to stand guard over the female. Instead he remained out of sight in another part of the pen.

When a pair of quail were with a brood, the male was often seen perched on a fence post or other elevated structure acting as a sentinel, while the young fed below. At various times, the sentinel post was observed to be taken by the female, while the male fed with the brood; but usually the male did the sentry work.

An observation similar to that of Williams in California (59, p.146) was made one morning when the males of four broods seemed to take turns watching for danger while the other birds were actively feeding. There did not seem to be any pattern in this guarding system because some males remained on the post for half an hour while others acted as sentry for only five or ten minutes. There were periods when three of the four males were standing guard at the same time. Shortly before noon,

all sentry duty ceased, and the quail apparently took a mid-day rest.

It appeared that the sentinel duty on the part of the male continued until the chicks were between six and seven weeks old. Thereafter, the guard duty became less consistent and finally ceased entirely. At times, both males and females were seen perched on top of a brush pile, when the birds were in winter coveys, but this seemed to be more of a chance occurrence rather than further sentinel activity.

Injury Feigning

Sumner in California (53, p.221) mentioned one case of a female quail feigning injury, and he cited another case in Oregon that was reported by Bendire (3, p.29). On the study area, three cases of feigning display were noted. One was by a female which was flushed from her nest at hatching time, and the other two were observations of male birds, one of which was penned.

The female bird ran from her nest and squatted a few yards away. She fluttered her wings and gave a peeping distress cry which sounded much like a young chicken that had been caught. The bird then flew away. In the case of the penned male bird, a young chick had escaped from the enclosure and had difficulty finding its way back into the pen. It was therefore caught in order that it could

be returned. The chick began peeping; the penned adult male ran in the general direction of the distress cry and went through the same actions as described for the wild female.

The third case may not have been a feigned injury display, but it served the same purpose. A small covey of quail were flushed in January, 1953, and all of the birds flew away except for one male which appeared to have difficulty flying. He seemed to have a rapid wing beat, but apparently could not coordinate his efforts into swift flight. The bird slowly flew to a tree a few yards away and continually gave warning calls. When this quail was approached again, he remained in the tree until it seemed as if he might be caught. Then the bird, in a laboring fashion, flew to another tree in the opposite direction from that taken by the main covey. When he was approached the third time, he took flight with the swiftness of a normal bird.

Intolerance

At the penned enclosure, observations were made which were believed to illustrate the degree of monogamy and intolerance displayed by the valley quail. During the 1952 mating season, three males and four female valley quail were being observed. Each of the males had paired,

with no apparent antagonism except where the extra female was concerned. Both sexes of the mated birds pecked at her whenever she came near them, but the most severe treatment was received from the mated females. This harassment continued until an unmated wild male, which had been trying to get into the quail enclosure, was trapped and placed with the penned birds. All intolerance stopped immediately, and it appeared that the female was accepted by the other quail as long as she was mated.

The four pairs of quail were left in the holding pen for the 1952 mating season, but it was apparent that conditions were too crowded for successful nesting. Two egg clutches were laid, but they were soon abandoned. During the winter, one of the males died and this again left a female without a mate.

In the 1953 mating season, at the time that wild birds were nesting, it became noticeable that the extra female, though a different individual from the 1952 nesting season, was receiving harsh treatment by the remaining six birds which were apparently mated. The intolerance occurred in the same manner as the previous year except that a different hen was involved. Each bird was recognizable because leg bands and back markers had been placed on them. The interesting thing was that the males paired with the same individual females with which they had mated the year before. Since the mate of the

lone hen had died the previous winter, it appeared that she was now on the unwanted list. When an unpaired wild male began to try to get into the enclosure, the mateless female was released, and thus, three pair of birds were left in the enclosure.

In the latter part of April, 1953, one of the females at the holding pen was accidentally killed, and a surplus of one male then existed. Almost immediately, the cock whose hen had died attached himself to one of the mated females and drove her former mate away. He continually forced the less aggressive male to remain out of sight and pecked him severely whenever he attempted to eat or move about. After a few days, the other paired male began to join in on the punishment of the vanquished bird. The beaten male was in very noticeable distress so he was removed from the enclosure. He had been beaten so thoroughly that he died soon afterward. Practically all of the feathers had been picked from his back, and the skin held many lacerations. It was believed, however, that the fatal injury was received when this bird tried to escape by flying into the wire of the pen. The number of penned quail had thus been reduced to two pair, both of which were successful in hatching broods later in the summer.

If these observations of penned quail were representative of birds in the wild, it would seem that certain

principles of valley quail behavior were demonstrated, though there was insufficient evidence to draw definite conclusions. The first principle would appear to be that valley quail may pair with the same mates in subsequent seasons, if each bird lives that long. This might be an explanation why certain birds appear mated throughout the year. The second principle was that unmated birds of both sexes were not tolerated by mated quail. It would seem that the belligerence shown to unmated birds would reduce the possibilities of inbreeding because these birds would surely leave the covey area in search of a mate. Since two pair of quail brought off broods in the enclosure, it appeared to be improbable that high density would be a factor in the failure of quail to breed. Last of all, it was probable that paired birds would attempt to move to areas where there were no unmated males because the prevalence of lone cocks would represent a challenge to the authority and social life of a mated pair. If this occurred, new coveys would become established in depleted sections, or as habitat became established it would be utilized.

On several occasions during the nesting season, cock quail were seen to drive off unmated males when they entered into what was believed to have been a nesting territory. These mated birds would protest loudly with

explosive calls of "squill", and would run or fly at the intruding, unmated bird. No conflict between mated pairs was observed, though cases of this may have occurred. Quite often, however, it was possible to observe several pairs feeding together in the morning and afternoon during the nesting season. This seemed to indicate that no conflict existed between satisfactorily mated birds.

Sex and Age Ratios

Samples of birds for ascertaining sex and age ratios were obtained during the winter of 1952-1953 by intensively trapping and banding five separate coveys of quail. It was believed that this trapping method would produce a much more accurate estimate than sight records and random sampling techniques. The same reasoning was used by Gorsuch on the gambel quail in Arizona (21, p.43). No inhibition against entering traps was noted on the part of quail from different sex or age groups, and it was believed that most of the birds in each covey were trapped at least once during the winter.

To estimate the sex and age ratios, a total of 186 birds was trapped. Of these, 120 were immature while 66 were adults. This made a sample age ratio of 1 adult to 1.82 immature quail, or 55 adults to 100 juveniles. The immature birds consisted of 59 males and 61 females. The sample sex ratio of the young birds was 1 male to

1.03 females, or 96.72 juvenile males to 100 juvenile females. Therefore, the sample sex ratio of immature birds approached the 1 to 1 ratio that would be expected when the number of males and females in the population is equal. The sample of adult birds contained 40 males and 26 females. This gave a ratio of 1.54 adult males to 1 adult female or 153.85 adult males to 100 adult females. When juvenile and adult birds were considered together, a sample ratio of 1.14 males to each female or 113.79 males to 100 females resulted. The sample sex ratio of the combined age groups was somewhat less than the 133 males to 100 females obtained by Williams (58, p.473) in New Zealand for the valley quail. It approached the sample sex ratios of 112.2 males to 100 females obtained by Emlen in California (8, p.92), the 113 males to 100 females obtained by Schwartz in Hawaii (48, p.53), and the interpolated figures of 113 males to 100 females obtained by Sumner in California (53, p.247).

There was no reason to suspect that any statistically significant difference should exist between the numbers of immature male and female quail, and use of the "chi-square" method of analysis showed no such difference. When this method of analysis was applied to the sample of adult birds, the difference in numbers of males and females approached the 0.05 level of significance rather closely,

but the difference could not quite be declared significant at this level. A larger sample of birds would probably have resulted in a significant difference at the 0.05 level.

Other evidence suggested that adult males outnumbered adult females in the winter of 1952-1953. For example, in four of the five trapped coveys, adult males outnumbered the adult females, in some instances by as much as 2 to 1. In the remaining covey, however, the adult females numbered 7 birds while the adult males numbered only 6 birds. In the spring and early summer of 1953 unmated males were seen and heard calling as they attempted to attract a mate. The number of unpaired males seemed to indicate that there were not enough females to go around. Finally, data from the quail hunting season of November 1954 denoted that 24 adult males and 12 adult females were taken which made a sample sex ratio of 200 adult males to 100 adult females. As would be expected, the sexes within the immature quail sample were fairly close to equal. A total of 90 juvenile males and 80 juvenile females were taken which made a sample sex ratio of 112.5 young males to 100 young females.

Adult females were believed to be in fewer numbers than adult males because the hen may be highly vulnerable to predation at nesting time. Since males have not been observed to incubate, except in the one case reported by

Glading in California (17, p.261), they would not be exposed to this added danger; and would, therefore, be expected to exist in larger numbers. The slight excess of males would probably be to the advantage of a monogamous species because every female, except in rare cases, would have a chance to mate.

Brood Count Comparisons

During the hatching seasons of 1952 and 1953, records were kept of the number of chicks in valley quail broods seen on the study area. This was done in order to provide a comparison between the brood sizes of the two seasons. In relating the results of the two years, the only counts of young used were those in which it was believed that every individual chick had been counted. When the completeness of a brood count was questionable, it was not used. Only valley quail which were believed to be less than four weeks old were considered.

The majority of the complete counts were obtained by driving along an unimproved road and watching for adult quail in the early morning or in the late afternoon. When adult birds were seen at the side of the road, the car was stopped about 100 yards away, and the birds were watched through 7 power binoculars with 50 millimeter objective lenses. If a brood were present, the adults

usually remained fairly close to cover, and did not wander about without their chicks. When the situation appeared safe to the adult birds, the male might occasionally choose to lead the young quail to the opposite side of the road, at which time it was possible to count every chick. Broods incidentally discovered while areas were being visited were not used in this comparison because there was usually some question as to whether all of the young birds had been observed.

In the 1952 season, 16 broods totaling 157 chicks were counted. The average number of young per adult pair in the sample was 9.8. The smallest brood observed was 3, and the largest was 15. In the 1953 season, 18 broods, believed complete, were counted. A total of 263 chicks was recorded, and the average number of young per adult pair for this sample was 14.6. The smallest brood observed was 7 and the largest was 25. Brood counts of 1953 appeared to be much larger than those of 1952, and use of the "t test" indicated that the difference between the brood samples was highly significant at the 0.05 level (Appendix table H). Weather conditions as discussed on page 125 were believed to be mainly responsible for the difference between the broods of the two years.

The importance of a successful quail breeding year from the standpoint of increasing the population was

Figure 6. A wild valley quail chick approximately two days old.

illustrated when hunter-success data for the 1953 quail season on the study area were tabulated. Of the 206 quail checked, 170 were juveniles while 36 were adults. This made a sample age ratio of 472.2 young to 100 adults indicating that juvenile quail were probably dominant in the 1953 fall population to the extent that most of the individuals were birds of the year. It was remotely possible that young quail may have been less wary and therefore easier to shoot than birds of the older age groups.

FACTORS INFLUENCING POPULATION NUMBERS OF VALLEY QUAIL

Predation

Predation of a game bird species such as the valley quail is a complex problem. Recent authors have begun to illustrate the role which predation plays in population dynamics rather than emphasizing the loss which would take place regardless of the number of predators present. This is regarded as a contribution to better management of wild forms.

Food habit studies have indicated that many of the predacious species are much more beneficial than they are harmful. The red tail hawk is an example. Errington (11, pp.372-374) has mentioned that there will be losses regardless of the numbers of individual predators present,

and that each range has an optimum carrying capacity above which predation becomes prevalent and below which predation becomes negligible.

Predation on the study area at times appeared to be quite noticeable, but was probably at no time excessive during 1952 and 1953. In addition to reports furnished by local farmers, sixty individual cases of predation were examined. In a few instances, identification of the predator was possible by observing the characteristics of the kill. Occasionally the actual act was observed, but a large proportion of the kills remained unidentified. Noticeable predation took place in the individual quail coveys in the fall and winter months. At times the reduction of quail could be attributed to bird movement from areas of insufficient food, but generally, predation appeared to be the answer.

Probably no predacious species is wholly dependent on quail for food, but many forms take them occasionally. It appears to be a matter of quail abundance and ease of catching. Especially in the fall and winter is the effect of predation noticeable. Much of the vegetation is defoliated, and winter influence has reduced cover to a minimum. At such times, the family groups are banded together in coveys often numbering 200 birds or more. These coveys undoubtedly appear very attractive to the

house cat or the Cooper's and sharp-shinned hawks.

When the quail were in large concentrations, they appeared to be much more vulnerable to predation than when they were in small family groups because the birds seemed to be less alert. On a number of occasions during the winter of 1952-1953, while evening and morning observations were being made from a blind at an artificial roost, quail actually ran through and often stopped to stretch or pick up a choice food morsel in the same brush pile that was being used for concealment. Naturally, a slight movement would send them noisily away twittering warnings, but often, the quail left the blind never having known that they were being watched. A house cat would have little difficulty obtaining a meal in this situation. Following is a résumé of predators which are known or suspected of causing at least occasional mortality to the valley quail on the study area. Scientific and common names were recorded as listed by Bailey in The Mammals and Life Zones of Oregon (1, pp.1-416) and Gabrielson and Jewett in Birds of Oregon (16, pp.1-650).

Mountain Coyote

In the past few years, mountain coyotes, Canis latrans lestes Merriam, have been rigidly controlled by poisoning campaigns in which Fish and Wildlife Service

predator control agents used sodium fluroacetate (1080). The few animals which remained in the Madras area at the time of the study were not suspected of being important to the survival of quail. Since the removal of the coyote, many local farmers have considered the desirability of bringing the coyote back to help control the increasing rabbit and rodent problem on their lands.

Domestic Dog

A number of domestic dogs, Canis familiaris Linnaeus, were seen at times running rabbits and flushing pheasants and quail. Their role as predators was probably slight, but they may have caused a considerable number of nest desertions.

Arizona Weasel

Although only one Arizona weasel, Mustela longicauda arizonensis (Mearns), was seen on the study area, tracks were often found near rim-rocks. Few of these animals were believed present on the area, and they were not regarded as being important predators on quail. The weasel was thought to be primarily beneficial as a control on small rodents.

California Badger

The California badger, Taxidea taxus neglecta Mearns,

was abundant in Central Oregon. It may have caused nest desertions while it hunted for rodents, or it may at times have taken the eggs and young of quail. It undoubtedly did a great deal more good than harm as far as quail were concerned by eliminating some of the rodent competition. It appeared to be very valuable as a predator on the Douglas's ground squirrel, a decided enemy of the valley quail at nesting time.

Snake River Valley Raccoon

The presence of irrigation water has increased the habitat of the raccoon, Procyon lotor excelsus Nelson and Goldman, on the study area and has enabled it to expand its range. Formerly it was generally confined to the Deschutes River and Trout Creek, but now it may be found on all parts of the project area. It is a known despoiler of bird nests and probably will occasionally take young and adult quail. One case of predation on adult quail was attributed to the raccoon. In an area where a farmer had been losing considerable numbers of chickens, presumably to these mammals, quantities of quail feathers were found beneath a roosting tree in November, 1952. The fact that there was a great amount of raccoon sign in the area was the only thing that pointed this animal out as the possible predator.

These animals probably were at times very beneficial in the taking of rodents, snakes, and other marauders of quail nests. In late April, 1953, it was noted that raccoon reduced the magpie population by destroying the young in four nests which were located in juniper trees along wasteways.

Great Basin Spotted Skunk

Since only the small civet cat or great basin spotted skunk, Spilogale gracilis saxatilis Merriam, was found in the Madras area, predation was believed to be limited, and was probably confined to nests. On one occasion, however, a female quail lay dead in one of the quail traps. Her head had been eaten, and there was an unmistakable odor of skunk. The regular diet of these forms was reported to include mainly insects and rodents (1, p.314).

Rocky Mountain Bobcat

In Central Oregon, the valley quail were frequently found in wasteway areas where bobcats, Lynx rufus uinta Merriam, were fairly numerous. On September 3, 1952, feathers and other remains of a quail tagged by James Mohr (research assistant during 1951-1952) were found in the feces of this mammal. The scat also contained the leg

band and the plastic tag which had been used to mark quail. On another occasion the feathers of a ringnecked pheasant were found in a bobcat feces. Considerable trouble was caused by the bobcats when they chose to visit the quail traps which were in operation for banding purposes. A total of 10 quail were lost and one trap was torn apart by the actions of this form. Food habit studies in California have indicated that the bobcat lives on rodents and rabbits to a large extent. This mammal was probably not a severe predator on quail (29, pp.527-538).

Douglas's Ground Squirrel

Douglas's ground squirrel, Citellus beecheyi douglasii Richardson, has proved to be of great importance as an egg predator. Stanton in Western Oregon (51, pp.1-74) and Horn in California (27, p.59) have presented conclusive evidence that these rodents exhibit a harmful degree of influence on the nest and eggs of game birds. Considerable quantities of quail eggs as well as those of ringnecked pheasants and Hungarian partridges were believed to be taken in the Madras area. Large numbers of quail and pheasant egg shells were found strewn over locations where these rodents were common.

Figure 7. A bobcat feces containing the remains of a tagged valley quail (note the plastic tag).

Domestic House-Cat

Although the house-cat, Felis catus Linnaeus, has been exonerated in the food habit studies that have been made in the Willamette Valley of Oregon, and elsewhere (39, pp.1-78), it was thought to be more harmful than the other mammalian predators on the Madras project, with the possible exception of Douglas's ground squirrel. In December and January, snow often remains on the ground for a week or more. At this time, many local farmers feed quail in their farm yards, and the birds become quite tame. Concentrations of over 100 birds have been reported in past years at such feeding stations. When the birds move into the farm yard, old tabby may not be as innocent as he appears to be. Many times house-cats have left tell-tale clues to their activity on front lawns. Their habit of eating such meals in hiding often minimizes the evidence. The nocturnal habits of these creatures make them adept at catching rodents and ground roosting birds. When quail choose to roost on the ground, they are vulnerable to such depredation.

Of two wild broods of quail hatched at the Madras air base in July, 1953, which numbered 16 and 18 birds respectively, only 4 young survived until September of that year. House-cats were the only predators known to be actively engaged in catching these young quail. A family

of 13 Hungarian partridges also was severely depleted by house-cats in the same area. Several attempts were made to relieve the situation, but the wary cats escaped.

Yellow Bellied Marmot

The yellow bellied marmot, Marmota flaviventris avara (Bangs), is listed here as a possible predator on the eggs of quail. In rim-rock areas, they appeared to be quite numerous, but whether or not they took eggs was not determined. One observation in May, 1953, was made of a pair of valley quail scolding several marmots, but no predation was seen.

Western Goshawk

The western goshawk, Astur atricapilus (Wilson), may be expected in the Madras area from mid October to late March. It is ordinarily found in the coniferous areas where it is a predator on the grouse and other birds. When cold weather begins, it may move into the lower areas where it causes damage to barnyard fowl and game birds. Fortunately, these raptors are not abundant because their ability for killing is well known. One adult male was collected on February 2, 1953, and young of the year and other adults were seen from time to time on the study area.

Sharp-Shinned Hawk

The sharp-shinned hawk, Accipiter velox velox (Wilson), the smallest of the accipiters, is probably as vicious and pugnacious as any of the birds of prey on the area. It appears to enjoy making its kill and carries out this practice much like the Cooper's hawk. It flies from place to place, a few feet above the vegetation, until it locates its quarry. If ensuing dives do not produce results, the sharp-shin may pursue its prey on foot. On February 9, 1953, the activity of a sharp-shin was being watched as it harassed a covey of about 40 quail. The quail were very skillfully using sagebrush and rabbit brush as escape cover. The hawk made several darts at the covey which hurried to the opposite side of the brush. This activity continued about two minutes. The members of the covey then noticed that they were being observed and took flight. The sharp-shin easily overtook a female which realized her plight and dived into a brush pile. The hawk flew in after her and a moment later the cries of the quail revealed plainly what had taken place. Later examination showed that the hawk had killed the prey by pressing its talons through the muscles and bones of the back. Apparently only the female sharp-shin is large enough to take quail. The size of the male bird usually restricts it to smaller sized prey.

Figure 8. A tagged valley quail, killed and eaten by a sharp-shinned hawk. (Carcass in non-typical condition)

Cooper's Hawk

Only three Cooper's hawks, Accipiter cooperi (Bonaparte), were seen in the Madras area, but in two of these observations, the hawks were harassing quail. Sumner in California (53, p.237) has listed this bird as the most destructive of the quail predators. Fortunately, the Cooper's hawk does not appear to be an abundant resident of the study area, for they are very adept at bird predation.

Western Red-Tailed Hawk

In eleven of the nests of the western red-tailed hawk, Buteo borealis calurus Cassin, which were checked in areas of good quail habitat, none were ever found to contain quail. On one occasion, an unidentified chick, presumably that of a shore bird, was found in a red-tailed hawk nest, but no other birds were found. It was possible to check one of the nests 12 times in order to record the food items brought to the hawklets; the only items found were rodents, rabbits, and snakes.

On two occasions, once in the fall of 1952, and once in the winter of 1952-1953, adult red-tailed hawks were seen eating Hungarian partridges. The previous research assistant, James Mohr, mentioned seeing one of these hawks with a valley quail in the winter of 1951-1952. The

observations may well have been direct items of predation, but personal notations have proven that red-tails are not adverse to picking up road kills, which incidentally are very numerous in winter. This is the suggestion for these three cases. At Camp Adair, a game farm near Corvallis, Oregon, these hawks have been seen by game farm attendants to take game farm pheasants, and the same thing has been true when game farm birds have been released. Food habit studies have indicated that the red-tail hawk is mainly a rodent eater (33, pp.13-14).

Swainson's Hawk

Those who kill the Swainson's hawk, Buteo swainsoni Bonaparte, with the idea that they are saving game birds are probably doing just the reverse. This magnificent broadwing is known to be largely a rodent and insect eater and should not be molested. Every ground squirrel that it takes is a contribution toward good quail management. On the Madras area, the Swainson's hawk was common in March, but was seldom seen in the summer.

Marsh Hawk

The role of the marsh hawk, Circus hudsonius (Linnaeus), as a predator on game birds is not completely understood. Its diet indicated that it would take most

any bird or mammal that it could catch. Many bird species respected its presence. Mourning doves, sparrows, pheasants, and quail have been seen to hurry for cover when a marsh hawk was present, and many times the marsh hawk has been seen hovering over areas where valley quail were known to be hiding. Glading suggests that the activity of this species may be important on young quail chicks (20, p.178). It is believed that the marsh hawk would take what it could catch since its hunting methods seem to rely upon surprise. Rodents were probably taken in far greater amounts than other forms.

Prairie Falcon

Another of the raptors capable of taking quail with little effort is the prairie falcon, Falco mexicanus Schlegel. Its food habits probably lead it to the capture of larger or different types of prey. Predation on quail by this falcon was not witnessed.

Western Pigeon Hawk

According to Gabrielson and Jewett (16, p.205), the western pigeon hawk, Falco columbarius bendirei Swann, is only an occasional migrant through Oregon. Where this falcon occurs on its migratory flight, it undoubtedly takes quail because it is very adept at killing and holding its prey. No positive identifications of this

bird were made on the study area; however, one was collected at Hood River, Oregon, in 1951, and one near Corvallis, Oregon, in November 1953.

Pacific Horned Owl

The horned owl, Bubo virginianus pacificus Cassin, was believed to be more beneficial than harmful to the valley quail on the Madras area. Its diet is composed mainly of rodents. The few game birds taken may well be insignificant. Some control may be necessary when quail are in concentrations, but generally such effort should not be needed.

The only evidence of predation on quail by this owl was the finding of the foot and leg bones of a quail strewn among some owl pellets on October 10, 1952. All of the other pellets examined contained the bones and fur of rodents and rabbits, except for one other occasion when the foot of another owl was contained in a pellet. Two horned owl nests were examined in the spring of 1953. Both contained the feathers of hen pheasants, and one contained a meadow lark's remains. A horned owl found one of the artificial roosts to his liking, and was flushed from it several times during the winter of 1952-1953. The valley quail refused to use the roost until the owl had been removed.

American Magpie

The American magpie, Pica pica hudsonia (Sabine), a very numerous species on the study area, was often seen in the spring with an egg in its beak. Numbers of quail, pheasant, and Hungarian partridge egg shells were found under trees where they had been dropped by these birds. The extent of the nest predation by the magpie was not known, but it may be considerable. This bird may also be important as a predator on quail chicks, although nothing of this sort was observed.

American Raven and Western Crow

American ravens, Corvus corax sinuatus Wagler, and western crows, Corvus brachyrhynchos hesperis Ridgway, were not at all numerous on the study area. Those which were seen were mainly confined to areas near the Deschutes River where quail were not found. These birds may at times have taken eggs and chicks of quail, but it is doubtful if they were of any importance because these marauders were not numerous on the study area.

Snakes

Three snakes were common in the Madras area, the Pacific rattlesnake, Crotalus viridis oreganus Holbrook, the yellow bellied racer, Coluber constrictor marmon

Baird and Girard, and the great basin gopher snake, Pituophis catenifer deserticola Steineger. No direct observations of predation were noted; however Pierce in California (44, p.62) lists the rattlesnake as a predator on mountain quail, and Bent (4, p.76) records the actions of this form at a valley quail nest. The yellow bellied racer was often seen in areas where quail were abundant. The importance of this form as a nest and chick predator may be quite great. Gorsuch in Arizona (21, p.75) reported one observation of this genus attacking an adult gambel quail. Several instances of nest predation by the bull snake have been recorded in California (26, p.75 and 34, p.6). One land owner mentioned killing a large bull snake which had partly ingested a pheasant chick. The bull snakes which were collected contained only small rodents.

Ants

No evidence was found of ants causing nest mortality. Gorsuch in Arizona (21, p.76) and Emlen in California (6, pp.85-86) listed them as mortality factors. There is no reason to suspect that they do not cause some losses, especially in the drier regions of the study area.

Unidentified Predation

As was mentioned above, the bulk of the predation which was examined could not be attributed to a specific mammal or bird. When the remains of predator kills were found, they usually consisted of a few feathers or perhaps only wing tips. Occasionally, typical sharp-shin hawk kills could be found in the lower branches of trees. These usually had severed heads and consisted of feathers and bones which still hung together by skin and cartilage.

In mid August, 1953, a mass of egg shell fragments and eleven quail chicks were found in a dried pile in the middle of a trail. This obviously was not a nest that had been stepped on, but was probably the regurgitation of a mammal which had found a quail nest just before hatching time. It may have eaten the eggs and chicks and then may have become sick.

Another confusing item found in August 1953 consisted of an unbroken quail egg which was found in a weathered mass of mouse bones and fur. All spots had been dissolved from the egg, but no feathers were found. Apparently, this egg was either regurgitated as a pellet or it was passed through the alimentary canal of some animal.

Accidents

Accidents during the 1952-1953 period of observation

appeared to be a continual source of valley quail mortality on the Madras study area. A total of fifteen accidental deaths were recorded throughout the fall and winter, although no particular emphasis was made in search of such events. They were recorded whenever they were found. The most serious cause of accidental deaths appeared to be from road kills, with 12 quail known to have been killed from this cause. An additional 3 birds died from such accidents as being stepped on and flying into fences. On January 7, 1953 an immature male quail was trapped which had apparently flown into a barbed wire fence or some other sharp object, for its crop had been partly torn open. It seemed to be healing, but the bird was obviously weak. The weight of the bird was only 144 grams as compared to the average of 189 grams for other juvenile quail during that month.

While the bulk of the recorded accidents occurred from September, 1952, through March, 1953, there was no reason to believe that young and old birds alike did not die throughout the summer from mishaps of various origins, especially by passing traffic. Through the hot summer months, the period of time that a road kill remained recognizable was from a few hours to two or three days depending upon the size of the victim or whether the bird was a chick or an adult. The chance of finding road

accidents at such times would be negligible unless particular effort was made to search for them. Then too, the many miles of road on the project would have to be checked every few days because some of the kills would disappear in a short time from the effects of intense heat, as well as scavengers.

The actual importance of the mortality from accidents probably existed only in particular coveys. For example, 6 road kills were found at various times in one covey area, but more deaths of that type probably occurred there. A highway bisected the covey range, and the quail involved often were seen to cross over it. In the case of this group of valley quail, mishaps with passing traffic were believed to be the most serious limiting factor to the covey's existence. Other birds near roads which were seldom traveled probably suffered minimum mortality from road kills, and accidents were probably confined to an occasional collision with a fence or sharp object. Mishaps from flying into stationary objects were believed to have been the result of predator harassment.

Unlawful Killing

Poaching of valley quail on the study area took place in the form of illegal hunting and trapping mainly in the winter months. While evidence of shooting usually consisted of shotgun shells, crippled quail, and an

occasional dead bird which was found from time to time, it was not believed that such activity seriously depleted the quail population on the study areas. Poaching on ringnecked pheasants may have been more of a problem because some local farmers openly admitted that they shot the latter birds whenever they had the chance.

In every known case but one, poaching mortality of quail was detected from circumstantial evidence, but on November 4, 1952, an actual case of illegal quail hunting was observed. The violator's bag consisted of 5 female quail.

Only from talking with farmers who were interested in the esthetic value of valley quail was it learned that quail trapping sometimes was carried out by unethical residents of the project area. The usual procedure apparently was to bait traps in the farm yard when the birds moved to those areas for food during severe winters. Quite fortunately for the valley quail, such practices were looked upon with much disfavor by the majority of the land owners. Most of the people of the area fed the quail in a sincere effort to help the birds through severe weather.

Parasites

Time and available facilities limited parasite studies to those involved with valley quail blood. While species of ectoparasites and endoparasites may have

Figure 9. A group of five female valley quail taken by a game violator.

existed in large numbers, they were mainly disregarded because there was not sufficient time to give them proper treatment. Of the 186 valley quail which were trapped in the five covey areas and the additional 99 which were taken from other coveys, all were hurriedly examined for external parasites, but only biting bird lice of the order Mallophaga were found. These appeared to infest most of the quail examined.

Laboratory examination of prepared blood slides by Doctors E. M. Dickinson and J. L. Weibel of the Veterinary Medicine Department revealed that 16 birds from the 117 sampled or 13.68 per cent were infected with a blood parasite of the genus Haemoproteus Kruse, bird malaria. It appeared likely that the parasite species was Haemoproteus lophortyx O'Roke which has been recorded in California as a possible mortality factor (40, p.230 and 24, p.299). Unfortunately the protozoan species had not been confirmed at this writing. It was interesting to note that louse flies of the order Hippoboscidae, the vectors of bird malaria, were not found on examined valley quail. The insects could have been easily overlooked, but it was also possible that the hippoboscid flies were not present at the time the quail were checked because Sumner in California (53, p.244) recorded them on quail only between July 29 and October 7, 1933. On the Madras

area, no birds were checked before November, 1952, and none were checked after mid April, 1953.

A second blood protozoan of the genus Leucocytozoon Danilewsky was also found. The prepared blood slides were still being studied at this writing and the number of slide samples indicating Leucocytozoon was therefore not available. As far as is known, blood protozoans of this genus have not previously been recorded in valley quail.

Weather Conditions

Weather conditions were believed to be among the most dynamic determinants of valley quail populations on the study area. When severe, a large number of quail were annihilated; but with fortuitous timing, conditions were created which were so advantageous that the results in population increase were nothing short of phenomenal. Both extremes in valley quail population, as influenced by weather, occurred under the surveillance of personnel from the Wildlife Research Unit during the years from 1949 through 1953.

The fall of 1949 found valley quail in such large numbers that they were recalled by the local populace as numbering in the thousands. The winter of 1949-1950 was very severe, and snow completely covered the ground for long periods. In January of that year, crusted snow

covered the ground for eighteen consecutive days. The coldest temperature was -31° F, and freezing temperatures occurred throughout the entire month (55, p.29). The following spring, Glen Carter, research assistant during the 1950-1951 period, found the remains of over 500 dead quail cramped in rock crevices along one canyon wall where they had apparently tried unsuccessfully to find food and shelter. Other small groups of quail skeletons were found in juniper trees where the birds were believed to have been frozen as they roosted (5, pp.15-16).

The kill was apparently wide spread because in the spring of 1950 valley quail populations on the Madras project were estimated to number only a few hundred individuals, where "thousands" had been the estimate the previous fall. Gallinaceous and passerine birds alike had died in great numbers. It was quite clear that starvation was the main factor in the decimation of the quail; however, the intense cold was probably the immediate cause of death.

Tribe, working in Utah with valley quail in 1937, recorded similar winter observations to those of Carter. He reported that one adult male quail, in good condition, was found frozen solid under three inches of snow. The bird had apparently died as a result of a cold snap. A female, in fair condition, was found frozen where it had

roosted in a box elder tree. In the case of the former bird, the crop was filled with winter wheat and other acceptable quail foods, while the latter's crop contained a large amount of grit but little actual food material. The crop contents of the female bird would clearly indicate that malnutrition was probably taking place. Other dead quail, as reported by local townspeople to Tribe, were found on the shores of a large fresh-water pond, and additional birds were found dead in willow trees (54, pp.14-15).

Local farmers who were consulted regarding the winter loss of quail in Central Oregon, recalled that every winter quail came to their farm yard where they were usually given clover screenings or chicken scratch. If the winter was mild, only a few quail would come to be fed. For the winter of 1949-1950, those consulted were in general agreement that the valley quail did not immediately die when the cold weather arrived, but that they remained for a week or so in heavy concentrations and then began to die out. Many hundreds of quail sought refuge in farm yards where they generally received good treatment, except for house cats which were reported to have taken sizeable numbers. Many farmers insisted that they had fed between four and five hundred quail. While the word of these men was not questioned, it was probably true that some were feeding the same birds, especially where farm

yards were fairly close together. These birds also picked up leaves and seeds around hay and straw stacks, and quite a large number roosted on harvesting equipment that was stored in sheds. Some birds, which were located in coveys apart from farm buildings were fed by local sportsmen, but many of these quail died. Quite often the birds were beyond help when food was put out for them, consequently they died even though their crops were full.

Road-kills were exceedingly numerous because the birds went to the highways to pick up seeds which fell from transport trucks and gravel which was applied to the roads for traffic safety.

It does not follow that cold temperatures alone would cause a severe die-off in a quail population. If that were the case, similar winter kills would have occurred in other years when cold temperatures approaching that of the 1949-1950 season, were indicated. The starvation study mentioned on page 69 rather conclusively showed that valley quail must have a continual food supply in order to maintain their body weight and health. Leopold (30, p.262) supported this conclusion when he mentioned that four to six foodless days would kill a fat (bobwhite) quail in cold weather.

The winter of 1950-1951 was cold, but snowfall did not remain for long periods. No winter loss of quail was

observed. The spring hatch of 1951 was successful, and quail numbers increased markedly. The winter of 1951-1952 was not as cold as the foregoing winter, but snow remained long enough that very large winter concentrations were built up. Farm yards were again plentifully supplied with quail, and some starvation may have occurred in limited areas, although none was reported. The spring of 1952 was somewhat dry, and no great quantities of spring vegetation were produced. The spring quail crop began to hatch with fair numbers, but unseasonable rains were believed to have caused some mortality in young quail. The average number of quail young was somewhat less than what was believed to be normal. The winter of 1952-1953 was very mild. Snowfall was light, few birds visited farm yards, and no winter kill was observed. The rainfall was nearly double the yearly average of 8.80 inches. Consequently, range vegetation did very well, and spring food was plentiful. Quail did not leave the large concentrations as early as they did the previous year. Nesting occurred somewhat later during 1953. Spring rains continued up to mid June which caused observers to predict poor game bird hatches. The rains ceased abruptly in mid June and a few days later the first quail young were seen. Earlier broods probably died of exposure. The broods appeared to be much larger than those of the previous year, and the 1953 quail

population was greatly increased over that of 1952. Very large coveys, some numbering over 200 birds, were formed in the fall.

Weather conditions were believed to have a very definite effect on valley quail populations, but the degree of benefit or harm seemed to be largely a matter of chance. Several hypothetical weather conditions could be mentioned which might be entirely beneficial, entirely harmful, or an intergradation between the two extremes. Winter loss could be augmented by general conditions which preceded the severe weather, such as a dry summer which would produce very little food in the form of range grass and weeds. This, supplemented with a long snow period, would produce an added loss by starvation. If food were scarce, it would be to little avail for the bird to scratch through deep snow. If food conditions were good, scratching through snow would probably produce food. Similarly, a comparatively dry spring followed by rains at the height of the hatching season might reduce the population. A wet spring which cleared up at hatching time might provide for substantial production by conditioning the adult birds with essential food elements as it appeared to do in the spring of 1953. The effects of a mild winter might be canceled out by an adverse spring, while the reverse might also be true.

A bird in good condition would probably be able to

stand cold temperatures much better than a bird in poor flesh. Such poor condition might be caused by disease or a food shortage. Since food was believed to be at its minimum in quantity and quality in the late winter, a bird would naturally be at an increased disadvantage if a prolonged snow or cold snap were to occur at that season.

SUMMARY

This report is the result of an ecological study of the valley quail in the Madras area of Central Oregon from July 17, 1952, to September 10, 1953. The birds involved were believed to be from a successful introduction of wild stock trapped in Jackson and Josephine Counties, Oregon, and liberated on March 7, 1914, by the Oregon Fish and Game Commission. These birds have since spread widely over the study area and have come to occupy most of the available habitat. Food and cover seemed to be the primary concern of the quail because some were observed during all seasons of the year in areas where free water was not believed to be available.

A total of 186 adult and juvenile valley quail from five individual coveys was trapped, banded, weighed, and tagged with plastic markers which could be seen when the bird flushed. The covey habitats were compared, and it was found that the bird weights in an overgrazed area were

significantly less than those from a moderately grazed area. There were no significant differences between the sample mean weights of adult males (197.80 grams) and adult females (198.00 grams) or between sample mean weights of juvenile males (188.46 grams) and juvenile females (184.84 grams). Weight fluctuations by months occurred and were believed to be due to the quantity and quality of available foods. Weight of both adults and juveniles reached a winter maximum in early December and then began to decline. Significant differences existed in the sample weights between November and December, 1952, and between January and February, 1953, in both adult and juvenile quail.

The mean weight of ingested food was determined by holding 57 quail for 24 hours without food or water. The mean weight lost during this period was 18.05 grams. The 95 per cent confidence limits were 16.87 grams and 19.24 grams. Quail held for 54 hours without food lost weight very rapidly, but the presence or absence of water apparently had no effect on the weight curve. This experiment illustrated quite clearly that starvation might take place quickly if no food were available.

Blood smears were taken from 117 quail from 16 random coveys for a blood parasite study in which two protozoan genera were found. Haemoproteus Kruse, bird malaria,

infested 13.68 per cent of the birds sampled. Leucocytozoon Danilewsky was listed as being present.

Sex ratios for the winter of 1952-1953, which were taken from trapping records of 186 quail, appeared to favor the males, but there were insufficient data to make this a definite conclusion. The ratio of total males to total females was 113.79 to 100. Adult males to adult females resulted in a ratio of 153.85 males to 100 females. Juvenile males to juvenile females resulted in a ratio of 96.72 males to 100 females.

Movements ranging up to one and one-fourth miles were noted in the spring when the winter coveys dispersed. In the fall and early winter, covey range was not observed to extend over one-fourth mile from the roosting area. Late winter movements were believed to be caused mainly by a lack of suitable food.

The grass family, Gramineae, made up the largest amount of fall and winter foods. In the fall, wheat groats were found in greater quantities than other foods, but in the winter, Sandberg's bluegrass made up the greater part of the diet. In the spring, the seed pods of early spring annuals were observed to replace other foods.

Some causes of decrease in valley quail numbers were considered. These included predation, poaching, accidents, parasites, and weather conditions. Favorable weather was

believed to have resulted in a general population increase in 1953 over 1952, as exemplified by brood count comparisons for the two years. A mean of 9.8 chicks per adult pair was recorded for 1952, while a mean of 14.6 chicks per adult pair was recorded for 1953.

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APPENDIX

TABLE A.

WEIGHT COMPARISONS OF ADULT QUAIL IN ALL COVEYS

Statistic	Symbol	Males	Females	
Sample Mean	$\bar{x}$	197.80	198.00	
Standard Deviation	s	11.77	8.75	
Sample Size	n	40	26	
Standard Error	$s_{\bar{x}}$	1.86	1.72	
"t" Value	t			-0.08
Degrees of Freedom	df			65

TABLE B.

WEIGHT COMPARISONS OF JUVENILE QUAIL IN ALL COVEYS

Statistic	Symbol	Males	Females	
Sample Mean	$\bar{x}$	188.46	184.84	
Standard Deviation	s	11.36	11.37	
Sample Size	n	59	61	
Standard Error	$s_{\bar{x}}$	1.48	1.46	
"t" value	t			1.75
Degrees of Freedom	df			120

TABLE C.

WEIGHT COMPARISONS OF ADULT QUAIL BETWEEN COVEYS

Statistic	Symbol	Covey Designation				
		1	2	3	4	5
Sample Mean	$\bar{x}$	204.13	197.07	197.38	196.77	192.27
Sample Size	n	15	14	13	13	11
		Mean Square		Degrees of Freedom		F
Between Coveys		240.20		4		
Within Coveys		104.20		61		2.305

TABLE D.

WEIGHT COMPARISONS OF JUVENILE QUAIL BETWEEN COVEYS

Statistic	Symbol	Covey Designation				
		1	2	3	4	5
Sample Mean	$\bar{x}$	191.83	186.68	185.23	184.83	182.10
Sample Size	n	29	31	22	18	20
		Mean Square		Degrees of Freedom		F
Between Coveys		323.82		4		
Within Coveys		124.65		115		
						2.598

TABLE E.

WEIGHT COMPARISON OF ADULT QUAIL BY MONTHS

Statistic	Symbol	Month			
		November	December	January	February
Sample Mean	$\bar{x}$	194.70	202.35	200.39	190.69
Sample Size	n	30	31	18	13
		Mean Square	Degrees of Freedom		F
Between Coveys		569.59	3		
Within Coveys		91.53	88		
					6.223

TABLE F.

WEIGHT COMPARISON OF JUVENILE QUAIL BY MONTHS

Statistic	Symbol	Month			
		November	December	January	February
Sample Mean	$\bar{x}$	181.70	192.89	189.36	181.55
Sample Size	n	53	53	33	22
		Mean Square	Degrees of Freedom		F
Between Coveys		1388.22	3		
Within Coveys		122.72	157		
					11.312

TABLE G.

WEIGHT COMPARISONS OF STARVED QUAIL WITH WATER (A) AND WITHOUT WATER(B)

Statistic	Symbol	Group A	Group B	
Sample Mean	$\bar{x}$	18.60	17.75	
Standard Deviation	s	3.21	4.11	
Sample Size	n	5	4	
Standard Error	$s_{\bar{x}}$	1.44	2.06	
"t" Value	t			0.34
Degrees of Freedom	df			7

TABLE H.

BROOD COUNT COMPARISON BETWEEN THE 1952 AND 1953 SEASONS

Statistic	Symbol	1952	1953	
Sample Mean	$\bar{x}$	9.8	14.6	
Standard Deviation	s	4.10	4.50	
Sample Size	n	16	18	
Standard Error	$s_{\bar{x}}$	1.03	1.06	
"t" Value	t			-3.25
Degrees of Freedom	df			32