

IRRUPTIONS OF THE CLARK NUTCRACKER IN CALIFORNIA

By JOHN DAVIS and LAIDLAW WILLIAMS

The Clark Nutcracker (*Nucifraga columbiana*) is usually restricted in California to the higher mountains, where it occupies "typically, upper forest belt . . . Prime dependence of this bird is upon the seeds of various conifers . . ." (Grinnell and Miller, 1944: 299). The winter range of the nutcracker in California is poorly understood, as few observations have been made of this species in winter. The available evidence suggests that at this season the population is scattered between the breeding range at the higher elevations and the upper-middle and middle altitudes. L. M. Lofberg, who lived at Florence Lake, 7640 feet, Fresno County, from 1926 to 1934, states (written communication) that nutcrackers were present at this locality every winter and that the dominant conifer there is the ponderosa pine (*Pinus ponderosa*). In many winters "there are frequent though irregular wanderings which carry individual birds or small companies in late summer and autumn far and wide, to lowest altitudes and farthest confines of State" (Grinnell and Miller, *loc. cit.*). In addition, in some years relatively large numbers of nutcrackers appear at low elevations, reaching the coastal and desert regions at widely separated points. The frequency of records and the numbers of birds involved indicate that in those years substantial segments of the montane populations have moved from the normal winter range to seek winter quarters elsewhere.

Invasions since 1898.—Since 1898, sight records and specimens in museum collections indicate that five major invasions of nutcrackers have occurred in the fall and winter into the Californian lowlands. In the fall and winter of 1898–1899, six were collected near Santa Cruz, Santa Cruz County (specimens, Museum of Vertebrate Zoology), and a single bird was seen near Riverside, about 35 miles west of the Colorado Desert (Willett, 1912:69).

A second invasion occurred in the fall of 1919, with numbers of nutcrackers remaining at some lowland localities well into 1920. The species was reported from Waddell Creek, Santa Cruz County (specimen, Stanford Museum of Natural History); on the Monterey Peninsula (Fisher, 1920:36; Schlesinger, 1920:41; Mailliard, 1920:161); in and near Santa Barbara (Dawson, 1923:24, 26); on Santa Cruz Island (Hoffmann, 1920:188; Dickey and van Rossem, 1923:127, five specimens, Dickey Collection); on shipboard off Los Angeles (Ferris, 1920:39); on the Colorado Desert near Indio (Esterly, 1920:40); and in the Laguna Mountains, San Diego County (Fortiner, 1920:190).

In 1935, nutcrackers appeared at Santa Cruz (six specimens, Museum of Vertebrate Zoology); on the Monterey Peninsula (L. Williams, MS); at Point Lobos, Monterey County (Grinnell and Linsdale, 1936:90); near Pinnacles, San Benito County (Unglish, 1937:39); near Coalinga, Fresno County (Arnold, 1937:33); near Santa Barbara (Rett, 1938:125); near the mouth of the Santa Clara River, Ventura County (Rett, *loc. cit.*); on the Colorado Desert near Indio (Clary and Clary, 1936:119); and at various localities in San Diego County, with flocks of 50 to 60 reported from the Cuyamaca region (San Diego Soc. Nat. Hist., Nat. Hist. Mus. Bull No. 108, 1935:[1]).

In the fall and winter of 1950–51, reports came from Santa Cruz County (Condor, 53, 1951:104, "Cooper Club Meetings"); from Hastings Reservation, Carmel, and Fremont Peak State Park, all in Monterey County (Audubon Field Notes, 5, 1951:38, 225); the Sierra Nevada foothills near O'Neals, Fresno County (Childs and Howard, 1955:16); near Lompoc, Santa Barbara County (Ken Legg, written communication); Beverly Hills, Los Angeles County (Audubon Field Notes, 5, 1951:40); and South Cuyamaca Peak, San Diego County (Brattstrom and Sams, 1951:204–205).

The latest irruption occurred in the fall of 1955, with records from Prairie Creek, Humboldt County (Ken Legg, written communication); from Marin County, where 30 were seen on March 30, 1956 (H. Cogswell, oral communication); near Santa Cruz (The Sanderling, 12(8), 1956:4); near Watsonville, Santa Cruz County (W. J. Moffat, written communication); Mount Hermon, Santa Cruz County, and the Mount Hamilton Range, east of Gilroy, Santa Clara County (L. R. Mewaldt, written communication); near Jamesburg, Monterey County (specimen, Museum of Vertebrate Zoology); the northern Santa Lucia Mountains, Monterey County; the Monterey Peninsula (unpublished records, several observers); near Fillmore, Ventura County (Condor, 58, 1956:80, "Cooper Society Meetings"); and at various coastal and desert localities in southern California (Audubon Field Notes, 10:59).

In all these irruptions, reports came from southern California as well as from the central part of the state. The record of 1956 from Prairie Creek is the only report from northern California.

Age of invading birds.—Lack (1954:235), summarizing information on irruptions of *Nucifraga caryocatactes* in Europe, states that there is a remarkably high proportion of juveniles in such irruptions. Museum specimens indicate that such may not be the case in California. Of the total of 21 specimens examined by us, 11 were of adults and ten were birds of the year. However, during the 1955–56 invasion of the Monterey Peninsula, we trapped and banded three first-year birds from a small flock observed on a number of occasions. At no time did we observe more than one adult in this flock. Our impression was that most of the birds that we saw on the Peninsula were first-year individuals. Mewaldt (written communication) noted a single first-year bird at Mount Hermon in January, 1956. The evidence from all sources suggests that adults are not rare in groups of nutcrackers invading the lowlands of California and that birds of both age groups take part in such invasions.

The invasion of the Monterey Peninsula Region, 1955–56.—The first indication of a coastward movement in central California in the fall of 1955 came from southern Santa Cruz County. Eight nutcrackers were seen near Watsonville on October 7, and they remained there for almost a month. Inland records for Monterey County are all for October from various stations in the Santa Lucia Mountains (Palo Corona Peak, one seen, October 13; Sid Ormsby Fire Look-out, one seen, October 15; Chew's Ridge, 12 seen, October 23; near Jamesburg, one collected, October 26).

On the Monterey Peninsula, nutcrackers were first recorded (two birds seen) on October 9 in the Rancho Aguajito subdivision, an area heavily wooded with Monterey pine (*Pinus radiata*). On October 13 one was seen at Pacific Grove. Throughout the rest of the fall and winter, 32 persons reported seeing this species at various places in and near Monterey, Pacific Grove, and Carmel. The stations of occurrence are separated by as much as nine and one-half miles (Carmel Highlands to the tip of Point Pinos). At several feeding stations the birds were seen almost daily for a period of several months. Except at two localities, there were no reports of nutcrackers after the end of March, 1956.

Many of the reports came from feeding stations, and when two or more such reports came from stations in the same neighborhood, it is probable that such records referred to the same individuals. Eliminating such duplicating records, 11 separate localities, both feeding stations and natural foraging areas, remain. Nevertheless, because of the probable wandering of nutcrackers from one locality to another, it would be impossible to state the total number of nutcrackers on the Monterey Peninsula during the winter of 1955–56. The maximum number reliably reported from one place at one time is ten.

One of the two places at which nutcrackers were seen after March, 1956, was at

Carmel Woods, near the north boundary of Carmel, where the records centered around one or two feeding stations. The other was at Grove Highlands, two and one-half miles north of Carmel Woods, at the southern boundary of Pacific Grove. The first reports for the Carmel Woods area were for late November, or early December. Almost daily occurrence at the S. R. Turner feeding station in Carmel Woods started on February 15, 1956. According to Mr. Turner, not more than two birds came to his station at one time during the spring of 1956. The last record was for May 26, when one bird was seen. Williams visited this station on February 16, March 15, and May 24. On each visit only one bird could be seen well enough to judge age by plumage characters, and in each case it was a first-year bird. The first record for the Grove Highlands area occurred on October 24, 1955. Some birds persisted in this area until July 8, 1956.

The principal source of information from the Grove Highlands area came from a feeding station maintained by Mr. and Mrs. Fred E. Zimmerman. Suet was put out from November, 1955, until about July 22, 1956, except for an occasional interruption of a few days. This food seemed to be the principal attraction for the birds. Starting on February 13, 1956, Mrs. Zimmerman kept a daily record of the presence or absence of nutcrackers, the maximum seen at one time, and notes on certain aspects of behavior. Such records were maintained until August 20, 1956.

These records show that nutcrackers were present on each day through July 8, 1956, with the exception of May 21 and June 19, and one period of seven days, June 25 to July 1, when suet was not provided. Mrs. Zimmerman was absent from March 24 to 28, but the birds were not entirely absent during this period; they were seen by a neighbor, and Williams noted them at the station on March 28. The numbers of birds seen at the station at one time ranged from one to nine; the average number seen per observation day from February 13 to July 8 was 2.8.

The apparent departure of the nutcrackers after July 8 was abrupt, as from one to four had been seen on each of seven preceding days, but none was seen from July 9 on, although suet was provided for about two weeks more.

At least one adult frequented the Zimmerman station. A single adult was noted by Mrs. Zimmerman on six days, and her diagnosis of age was corroborated by Williams on three other days, and by both of us on one other day. The last day that an adult appeared was on June 17, according to Mrs. Zimmerman.

Behavior of invading birds.—Fisher (1920:36) stated that nutcrackers at Pacific Grove, during the invasion of 1919–20, "seemed to take kindly to the cones of the Monterey pine." Mailliard (1920:160), observing nutcrackers at Pacific Grove in March, 1920, noted that "while they fed to some extent on the Monterey pines, apparently more intent upon the tips of young buds than upon the contents of the cones, they picked also a good many scraps and bits of grain or crumbs in the streets . . ." During the 1935–36 invasion of the Monterey Peninsula, a nutcracker was seen by Williams pecking into the cones of the Monterey pine. On April 19, 1956, Williams observed first one, then another nutcracker hacking at a cone in a Monterey pine. Although the cone could not be examined closely, it appeared to be unopened save for one crack between two rows of scales. It was into this crack that both birds pecked, but it could not be seen what food, if any, was obtained. Mrs. Zimmerman also noted nutcrackers working on Monterey pine cones near her feeding station. One was noted feeding on the nuts of "Himalaya pine" (= *Cedrus deodara*?) in Santa Cruz in November, 1955 (Anna Gayton, oral communication), and one was noted hammering on a cone in a Canary Island pine (*Pinus canariensis*) in Santa Monica, Los Angeles County, on April 23, 1956 (G. T. Hastings, written communication).

Mewaldt (written communication) stated that "a lone, first-year Clark Nutcracker

was approached to within eight feet as it fed, or searched for food in litter on the ground in an open stand of *Pinus ponderosa*" at Mount Hermon, Santa Cruz County, on January 8, 1956. "The bird was apparently in poor condition as judged from the untidy condition of the plumage. What few seeds remained from the pines in the 1955 crop were insect damaged."

It has been observed twice that invading nutcrackers may forage by turning over pieces of dry cow dung and taking objects, either from the under side of the dung or from the ground beneath. Dr. William Graf (*in* Mewaldt, written communication) noted two nutcrackers in the Mount Hamilton Range on February 12, 1956, flipping over dung and taking exposed insects "which were found to be quite abundant." Similar foraging behavior by a single nutcracker was noted at Point Lobos on October 12, 1935 (Grinnell and Linsdale, 1936:90).

A nutcracker collected near Jamesburg on October 26, 1955, had been feeding on yellowjackets. The stomach was crammed with the remains of these insects; other remains were scattered along the small intestine, and a whole yellowjacket, recently swallowed, lay in the esophagus.

On April 14, 1956, Mrs. Zimmerman recorded a nutcracker storing a piece of suet in the garden of her home. She reported having seen both the burying and retrieving of cached pieces of suet on numerous occasions for several weeks thereafter, but the habit did not persist over the entire stay of the flock at her feeding station. The procedure for storing was as follows: retaining a piece of suet between the mandibles, the bird made sidewise motions with the bill, thus making a hole in the soft earth. The suet was then dropped in the hole and pushed farther down with the bill. Then, again with sidewise motions of the bill, earth was replaced over the hole. When exhuming the food the same sidewise motions of the bill were used and the item seized and pulled out. In some cases, at least, the retrieving of buried stores did not seem to Mrs. Zimmerman to come about by random searching, but it appeared that the bird went directly to a particular spot to unearth food. In some instances this direct approach was to sites at which it was known to the observer that a cache had been deposited previously, but it was not known in such cases whether the depositor or some other bird was removing the food. Several times a second bird was seen to rob a cache immediately after it had been made. Even though the bird which had stored the food might still be close by, no obvious attempt was made to defend its store.

On February 28, Mrs. Zimmerman reported that she had witnessed courtship feeding at her station. She stated that one bird, in a begging posture, fluttered its wings and gaped at a second nutcracker which was feeding on suet. At first the feeding bird made aggressive pecking motions at the begging bird but finally came near it and put bits of suet in the latter's mouth. On the afternoon of the same day, Mrs. Zimmerman and Williams observed similar begging actions but at that time the bird at the suet reacted only aggressively to the begging bird. In the latter instance at least, both birds involved were in first-year plumage. Begging behavior was reported by Mrs. Zimmerman on February 24, and it was witnessed by Williams on May 8, but no delivery of food from one bird to another occurred at these times. Courtship feeding by the Clark Nutcracker in Montana has been reported by Mewaldt (1956:7).

An instance of abortive breeding behavior in an invading bird was recorded by Mailliard (1920:160-161). It was reported to him that on March 20, 1920, a nutcracker seen near Pacific Grove gathered "sticks and other nest-building material" and flew with them to a stand of pines. No nest or further nest-building activities were seen by Mailliard at the same location on the following day.

Possible causes of invasion.—In seeking for possible causes for the sporadic irrup-

tions of nutcrackers in California, the most probable cause seemed to us a shortage of the normal winter food supply. Such a shortage could be caused by a failure of the food supply, or by the build-up of the population to a level so high that a normal food supply would not be adequate, or by a combination of both circumstances.

The winter food of the Clark Nutcracker is not well known. These birds are nearly omnivorous and have been reported to eat insects, acorns, juniper berries, other types of berries, carcasses of animals, and grain of various sorts. Near human habitation they will eat a variety of unnatural foods offered them. However, observations made from the spring through the fall, both in California and in other parts of the range, indicate that nutcrackers depend mainly on the seeds of various conifers. During the winter, on the normal montane range, there would be little else for nutcrackers to eat except conifer seed. The ground in the mountains of California is covered by a heavy snowpack during the winter, and the soil and forest litter would be accessible in only a relatively few protected sites. The insect population would have largely disappeared, and nearly all of the small diurnal rodents, which might furnish some food, would be underground by the time of the first heavy snowfall.

On the west slope of the Sierra Nevada, whence most of the nutcrackers invading the coastal regions of north-central California are probably derived, the main winter diet would probably be the seeds of the white-bark and Jeffrey pines (*Pinus albicaulis* and *P. jeffreyi*) for those birds remaining at high elevations and the seeds of the ponderosa pine for those birds wintering at lower elevations. In addition, the sugar pine (*P. lambertiana*) and the white fir (*Abies concolor*) are widely distributed throughout the middle and upper-middle elevations of the western Sierra Nevada and would probably be of some importance in providing seed for wintering nutcrackers. The most important sources of seed would be those remaining in the cones during the winter period (Fowells and Schubert, 1956:35) and those stored by the birds in advance of severe winter conditions. The storing of seeds and nuts for winter use has been reported by a number of ornithologists for the genus *Nucifraga*. Two observations in particular suggest that Clark Nutcrackers store seed in sites which would be accessible during the period of heavy winter snowfall. French (1955:61) noted a bird storing objects, presumably seeds, on a ledge on the face of a cliff, a site which this observer stated would have been accessible to the bird throughout the winter. Farner (1952:86) noted a nutcracker storing peanuts offered by humans; these were being stored in a hole in a nearby white-bark pine. Although the height of the hole was not noted, it may have been above the normal winter snow line.

Some evidence is available for annual cone production by the ponderosa and sugar pines and the white fir on the west slope of the Sierra Nevada. Fowells and Schubert (1956:19-21) reported on annual cone counts of these three species made on a series of experimental plots totaling 46.8 acres in the Stanislaus Experimental Forest. This station is in the western Sierra Nevada, due east of the northern part of San Francisco Bay, at 6000 feet altitude. Counts were made from 1933 to 1942, and from 1948 to 1953, in the late summer of each year shortly before the seeds were shed. Cone counts for ponderosa and sugar pines and white fir made on the experimental plots in 1954 were forwarded by G. H. Schubert. For 1955, cone crop estimates for these species, plus Jeffrey pine, on the entire west slope of the Sierra Nevada have been published by Schubert (1955:1-3). The irruptions of 1935, 1950, and 1955 are thus included in the periods for which some information on cone crops is available.

Up to 1953, two types of cone counts were made in the Stanislaus Experimental Forest: cones produced per acre (table 1), and cones produced per dominant tree (Fowells and Schubert, 1956:21). Dominant trees are those with a diameter at breast height of

Table 1

Cone Counts per Acre, Stanislaus Experimental Forest (from Fowells and Schubert, 1956)

Year	Ponderosa pine	Sugar pine	White fir
1933	237	65	24
1934	203	90	685
1935	0	2	5
1936	338	158	67
1937	12	13	54
1938	18	52	38
1939	5	0	5
1940	72	2	296
1941	166	138	36
1942	7	1	38
1948	105	113	1622
1949	154	4	33
1950	7	0	0
1951	0	0	466
1952	291	267	6
1953	169	4	0

over 19.5 inches. For 1954, only the latter type of count is at hand. Each crop was rated by Fowells and Schubert (*op. cit.*:20) as none, light, medium, heavy, or very heavy, according to the production of cones per dominant tree. This information is contained in table 2.

Information for the cone crops of 1955 is presented in table 3. The estimates are for the west slope of the Sierra Nevada, which was divided into four zones for purposes of seed collection. Zones II and III are for the west slope of the northern Sierra Nevada, and Zones IV and V are for the west slope of the southern Sierra Nevada. Estimated crops were rated none, very poor, poor, fair, and good. Obviously such ratings as "None to good" are too general to be of use in this study.

In 1935, when there was an invasion of nutcrackers, a virtual failure in the cone crops of all three species occurred in the Stanislaus Experimental Forest (tables 1 and 2).

Table 2

Cone Ratings, Stanislaus Experimental Forest (after Fowells and Schubert, 1956)

Year	Ponderosa pine	Sugar pine	White fir
1933	Very heavy	Medium	Light
1934	Heavy	Heavy	Very heavy
1935	None	Light	Light
1936	Very heavy	Heavy	Light
1937	Light	Light	Light
1938	Light	Medium	Light
1939	Light	None	Light
1940	Medium	Light	Medium
1941	Heavy	Heavy	Light
1942	Light	Light	Light
1948	Medium	Heavy	Very heavy
1949	Heavy	Light	Light
1950	Light	None	None
1951	None	None	Heavy
1952	Very heavy	Very heavy	Light
1953	Heavy	Light	Light
1954	Medium	Medium to heavy	Very heavy

However, during the preceding two years, at least one of the species produced a crop rated as either heavy or very heavy. A similar pattern is evident for the invasion years of 1950 and 1955, with very poor crops in those years but one or more heavy or very heavy crops in 1948 and 1949, and from 1951 through 1954 (tables 1, 2, and 3). It appears from the data gathered by Fowells and Schubert that when two or more years of high cone production by at least one of the three species studied by them was followed by a sharp decline in the cone crops of all three, an invasion occurred. Single years of high cone production followed by sharp cone crop decline, such as 1936-37, and 1941-42, did not result in an invasion.

Table 3

Cone-crop Estimates, Sierra Nevada, West Side, 1955 (from Schubert, 1955)

Zone	Ponderosa pine	Sugar pine	Jeffrey pine	White fir
II	None to poor	Very poor to poor	None to poor	Poor
III	Very poor to poor	None to poor	Poor
IV	None to poor	None to good	None to poor	None to good
V	None	Poor	None to poor	None

It seems possible that a relative abundance of winter food might lead to a build-up in the population of nutcrackers in the western Sierra Nevada, since the survival of overwintering birds might be well above average with a good supply of food on the winter range. However, two or more years of good winter food supply might be needed to build the general nutcracker population to such a high level that a poor cone year would lead to substantial numbers of birds leaving the usual winter range. A pronounced build-up of the breeding population would undoubtedly take at least two years, as Clark Nutcrackers do not breed at the end of their first year, but must be at least two years old in order to breed (Mewaldt, 1952:361). Two or more years of successful overwintering might well build up the numbers of two-year old potential breeding birds, thus causing a definite increase in the general breeding population. Although no information is available on the incidence of breeding or on nesting success in any one year, a large potential breeding population in the Sierra Nevada in the spring of 1935, 1950, and 1955 might well have set the stage for a heavy concentration of nutcrackers in the fall of those years, when the pronounced decline in cone crops would be evident. Invasions of nutcrackers into the lowlands presumably occurred, then, as a result of preceding build-up of the general nutcracker population, and particularly of the breeding population, just prior to failure of the winter food supply.

Field observations reported by Dixon (1956:386) tend to support the view that the breeding population of nutcrackers in the Sierra Nevada was unusually high in the spring of 1935. Although the observations were made at Gull Lake, Mono County, on the east slope of the Sierra Nevada, they may be indicative of conditions on the west slope as well. On April 19, Dixon noted adult nutcrackers at one nest feeding their young pieces of flesh torn from the carcasses of Belding ground squirrels (*Citellus beldingi*) which they had killed. This is a most unusual food for nestling nutcrackers, which are fed mainly shelled pine seeds, with some insect material as well. Twice Dixon noted nutcrackers attacking chipmunks (*Eutamias* sp.). In one instance, the chipmunk escaped, but in the other, the chipmunk was killed and eaten by the attacking bird. He stated that in 26 years spent in the Mono Basin region (1930-1955, J. B. Dixon, written communication), this was the only season in which he had seen such behavior in nutcrackers, and further, that "in 1935 there was an unusually large number of nesting nutcrackers" in the area. The nesting population was apparently so high that some adults were forced to give their young a highly unusual type of food, and the usual sources of food for full-

grown nutcrackers had evidently been so nearly depleted that some individuals were turning to chipmunks to eke out their own diets. Mr. Dixon also writes us that in 1950 he noted "an unusual number of nutcrackers nesting near June Lake [Mono Basin] but no indications of their preying upon small mammals."

In the invasion of 1935, nutcrackers were recorded in the lowlands in September and early October, and in 1955 they had reached the coast near Watsonville, Santa Cruz County, as early as October 7 (eight seen), and they were on the Monterey Peninsula as early as October 9 (two seen). This suggests that some birds start leaving the mountains by the first week in October at the latest. Records for 1935 and 1955 from six weather stations in the Sierra Nevada indicate that some nutcrackers were far from the usual winter range well in advance of any severe drop in temperature and before the first heavy snowfall of the year. Thus, unseasonal onset of severe weather does not appear to be the primary stimulus initiating movement from the winter range; such movement is apparently started in response to the shortage of cones.

It seems likely that storing of seeds starts in September and October, the months during which the cones of most Sierran conifers open and shed seed. Grinnell, Dixon, and Linsdale (1930:304) noted several nutcrackers in the Lassen Peak region of California on October 19, apparently carrying off and storing the seeds of ponderosa pine. A bird that was collected had 34 seeds in its mouth and throat. Grinnell and Storer (1924:395) collected two nutcrackers on the east slope of the Sierra Nevada on September 22 and 25; their throats held 72 seeds of the pinyon (*Pinus monophylla*) and 65 seeds of the white-bark pine, respectively. Farner (1952:85) noted that in the fall at Crater Lake, Oregon, nutcrackers "instinctively" stored peanuts given them by humans. It seems probable that the appearance of storing behavior in the nutcracker coincides with the time of cone opening and seed fall, when extraction of seeds from the open cones would be relatively easy and fallen seed could be harvested readily. Thus, invasions may get under way at the time when many birds start to make their winter stores, but when they fail to find adequate supplies of seeds. The search for seeds might lead nutcrackers to lower altitudes, but in years of severe cone crop decline, many birds apparently fail to find adequate supplies at these low elevations. Further wandering would lead them out of the mountains and eventually to the coastal or desert regions.

The survival value of irruptions of nutcrackers is evident, since the continuance of an unusually large population on the normal winter range despite a very low food supply could bring about depletion of all available food by early or mid-winter, thus jeopardizing the entire population. The situation described by Dixon at Gull Lake in 1935 suggests what might happen when a large nutcracker population is faced by a short food supply, and such a situation would be far worse in winter, when small diurnal rodents would be underground. Storing behavior may perhaps be of survival value in two different ways, primarily in getting the average nutcracker through the average winter, and secondarily in stimulating irruptions in years of high population and low food supply.

It is of significance that in 1935 and 1955 nutcrackers invaded widely separated areas in the southwestern United States. Gilman (1936:41) noted single birds in Death Valley, California, on September 11 and October 11, 1935. These individuals probably came from the Panamint Mountains bordering Death Valley on the west. In these mountains, the conifers are entirely different from those on the west slope of the Sierra Nevada; the genus *Abies* is absent, and the only pines present are the pinyon, the limber pine (*Pinus flexilis*), and the bristle-cone pine (*P. aristata*). Nonetheless, Gilman stated that "this season the nutcrackers were extremely numerous in the Panamint Mountains, as many as forty being in sight at once," again suggestive of a population build-up prior to irruption.

Taylor and Vorhies (1936:42) noted single nutcrackers on the desert in extreme southwestern Arizona on October 22 and 23, 1935. One bird was described as "young." They note that the nearest mountains whence the birds could have come are at least 100 miles away. Presnall (1936:36-37) described a notable invasion of nutcrackers in southwestern Utah between August 15 and October 1, 1935. Again, large numbers of birds were involved, indicative of an abnormally high population on the move. One observer estimated a flock of 200 individuals in one area. Another flock of "over 100" was noted. An apparent invasion of nutcrackers occurred in northeastern Arizona in the fall of 1935. Woodbury and Russell (1945:90-91) reported that either an invasion had occurred in this area, or that the population resident in nearby high mountain country, but normally ranging to lower elevations in search of food and water, was unusually high. Phillips (*in* Woodbury and Russell, *op. cit.*:90) and Wetherill and Phillips (1949:101) were of the opinion that a true invasion had occurred, with numbers of birds appearing at localities outside the normal range. In 1955, a notable influx of nutcrackers was reported from the Salt Lake City region, Utah. D. W. McCullough (written communication) noted nutcrackers in Salt Lake City, and at Ophir and Jordan Narrows, on nine dates between November 15, 1955, and June 10, 1956. The greatest number seen at one time was nine. The suggestion of population build-up prior to the occurrence of some of these unusual winter records is evident.

Lack (1954:236), discussing the irruptions of certain European birds, including *Nucifraga caryocatactes*, states that the proximate factor stimulating large scale irruptions appears to be overcrowding, but that if we are to assume that irruptions have survival value, then food shortage may still be the ultimate factor involved. Irruptions of nutcrackers in California usually occur in September and October at the earliest, judging by the time of reports of nutcrackers outside the usual winter range, and there is only one record of a nutcracker at an unusual station as early as August, a single bird found dead at Encinitas, San Diego County, on August 24, 1955 (Audubon Field Notes, 9:404). In other words, the invasions do not start before a scarcity of cones is evident, since mature cones are readily visible in August, and it is during this month that foresters actually make cone counts and crop estimates. In the irruption reported in 1935 in southwestern Utah by Presnall (1936:36), the records for August and early September are actually for unusually large numbers of birds moving about within the normal range of the species, and it was not until later in September that records of nutcrackers outside the normal range were reported.

It would appear, then, that irruptions of nutcrackers in the southwestern United States, exclusive of western California, are correlated with unusually large populations, but such irruptions occur at a time when a shortage of food would be evident to the birds. Since we have no information on the cone crops of 1935 in Utah, Arizona, and the Panamint Mountains of California, nor on the cone crop of 1955 in Utah, it is not possible to say whether the invasions recorded in those years resulted only from overcrowding, or whether food shortage was also a factor. The invasions in western California appear to correlate with food shortage and with the possibility of population build-up suggested by periods of high cone production prior to the cone shortage coincident with invasion.

ACKNOWLEDGMENTS

Frank A. Pitelka made the original suggestion that we gather information on the nutcracker invasion of 1955-56 on the Monterey Peninsula. We wish to thank the following persons for furnishing records of nutcrackers and other information: R. P. Parsons, L. R. Mewaldt, S. R. Turner, Ken Legg, Lila M. Lofberg, Beatrice Howitt, D. W.

McCullough, G. T. Hastings, and J. B. Dixon. G. H. Schubert was most helpful in supplying information on annual cone crops in the Sierra Nevada. We wish to thank especially Mrs. Fred E. Zimmerman, whose long series of records provided our major source of information on the behavior and length of stay of nutcrackers on the Monterey Peninsula in 1955-56. Specimens from the Stanford Natural History Museum and the Dickey Collection were forwarded through the courtesy of Drs. Margaret Storey and Thomas R. Howell, respectively.

SUMMARY

Irruptions of the Clark Nutcracker have occurred in California in 1898, 1919, 1935, 1950, and 1955.

The invasion of the Monterey Bay region in 1955 and the behavior of the invading birds are discussed.

Nutcrackers depend on pine cones for winter food. Californian irruptions appear to occur when an unusually large population of nutcrackers is faced with a low supply of food on the normal winter range. The irruptions correlate with severe and widespread failure of cone crops following two or more years of large crops, during which the nutcracker population in general, and the breeding population in particular, apparently increases significantly as a result of abundance of winter food.

Invasions in other parts of the southwestern United States in 1935 and 1955 seem to correlate with prior population build-up. Since cone-crop data are not available for these regions, the role of food supply in stimulating these invasions cannot be assessed.

LITERATURE CITED

- Arnold, J. R.
1937. Birds of the Coalinga area, Fresno County, California. *Condor*, 39:31-35.
- Brattstrom, B. H., and Sams, J. R.
1951. The Clark nutcracker in San Diego County, California. *Condor*, 53:204-205.
- Childs, H. E., Jr., and Howard, W. E.
1955. The vertebrate fauna of the San Joaquin Experimental Range. U. S. Dept. Agr., Forest Serv., Calif. Forest and Range Exp. Sta., Misc. Paper No. 19:1-20.
- Clary, B., and Clary, M.
1936. Clark nutcracker again visits Colorado Desert. *Condor*, 38:119.
- Dawson, W. L.
1923. The birds of California. Format de Luxe, Sunset Edition. Vol. 1 (South Molton Company, San Diego, etc.), xvii + 522 pp.
- Dickey, D. R., and van Rossem, A. J.
1923. Additional notes from the coastal islands of southern California. *Condor*, 25:126-129.
- Dixon, J. B.
1956. Clark nutcrackers preying on ground squirrels and chipmunks. *Condor*, 58:386.
- Esterly, C. O.
1920. Clark nutcracker on the Colorado Desert. *Condor*, 22:40.
- Farner, D. S.
1952. The birds of Crater Lake National Park (University of Kansas Press, Lawrence, Kansas), xi + 187 pp.
- Ferris, G. F.
1920. Clarke nutcracker at sea. *Condor*, 22:39.
- Fisher, W. K.
1920. The Clarke nutcracker at Point Pinos, Monterey County, California. *Condor*, 22:36.
- Fortiner, J. C.
1920. Clark nutcracker and white-winged dove in southern California. *Condor*, 22:190.

Fowells, H. A., and Schubert, G. H.

1956. Seed crops of forest trees in the pine region of California. U. S. Dept. Agr., Tech. Bull. No. 1150:1-48.

French, N. R.

1955. Foraging behavior and predation by Clark nutcracker. *Condor*, 57:61-62.

Gilman, M. F.

1936. Additional bird records from Death Valley. *Condor*, 38:40-41.

Grinnell, J., Dixon, J., and Linsdale, J. M.

1930. Vertebrate natural history of a section of northern California through the Lassen Peak region. *Univ. Calif. Publ. Zool.*, 35:v + 594 pp.

Grinnell, J., and Linsdale, J. M.

1936. Vertebrate animals of Point Lobos Reserve, 1934-35. *Carnegie Inst. Wash. Publ. No.* 481:vi + 159 pp.

Grinnell, J., and Miller, A. H.

1944. The distribution of the birds of California. *Pacific Coast Avif. No.* 27:1-608.

Grinnell, J., and Storer, T. I.

1924. Animal life in the Yosemite (University of California Press, Berkeley), xviii + 752 pp.

Hoffmann, R.

1920. Notes on some birds of Santa Cruz Island, California. *Condor*, 22:187-188.

Lack, D.

1954. The natural regulation of animal numbers (Clarendon Press, Oxford), viii + 343 pp.

Mailliard, J.

1920. Notes on nutcrackers in Monterey County, California. *Condor*, 22:160-161.

Mewaldt, L. R.

1952. The incubation patch of the Clark nutcracker. *Condor*, 54:361.

Presnall, C. C.

1936. Clark nutcrackers invade southwestern Utah. *Condor*, 38:36-37.

Rett, E. Z.

1938. The Clark nutcracker at sea level. *Condor*, 40:125.

Schlesinger, J. L.

1920. Clarke nutcracker at Carmel. *Condor*, 22:41.

Schubert, G. H.

1955. California cone crop—1955. U. S. Dept. Agr., Forest Serv., Calif. Forest and Range Expt. Sta., Forest Res. Notes No. 97:1-3.

Taylor, W. P., and Vorhies, C. T.

1936. The Clark nutcracker in extreme southwestern Arizona. *Condor*, 38:42.

Unglish, W. E.

1937. A few unusual records from central California. *Condor*, 39:39-40.

Wetherill, M. A., and Phillips, A. R.

1949. Bird records from the Navajo country. *Condor*, 51:100-102.

Willett, G.

1912. Birds of the Pacific slope of southern California. *Pacific Coast Avif. No.* 7:1-122.

Woodbury, A. M., and Russell, H. N., Jr.

1945. Birds of the Navajo country. *Bull. Univ. Utah*, 35 (14):1-160.

Hastings Reservation, University of California, Carmel Valley, California, and Carmel, California, June 9, 1957.