PRELIMINARY REPORT ON BREEDING PERIODICITY AND BROOD MORTALITY IN BOBWHITE QUAIL ON THE AEC SAVANNAH RIVER PLANT

By JOSEPH R. FATORA, ERNEST E. PROVOST, AND JAMES H. JENKINS
School of Forestry
The University of Georgia, Athens, Georgia

INTRODUCTION [1]

While numerous excellent cold weather studies have been conducted on the dynamics of fall and winter populations for most areas within the natural range of the bobwhite quail (*Colinus virginianus*), warm-weather studies of this species have been somewhat slighted. It is generally much easier to analyze winter populations. Hunting returns provide a wealth of raw data on winter populations. These can then be analyzed and extrapolated to yield information on the dynamics of the summer population, *i.e.*, summer adult mortality, peak of hatch, and summer gain. Usually summer observations require more effort due to the denser cover and wider dispersion of birds, resulting in the need for increased man-hours and expenditure. As a result, summer data are sketchy.

While fall and winter collections can be used successfully in determining some aspects of the dynamics of the summer population, the resulting data must be interpreted with extreme care. A biased estimate may occur without some knowledge of the mechanics of summer populations. Census and age classification in autumn have been shown to be poor indices of breeding success on a small area (Errington, 1942). Number of young per adult female in the fall population cannot validly be interpreted to indicate brood size or the number of females in the spring population successfully hatching a brood. Kabat and Thompson (1963) found it necessary to apply a correction factor to remove bias in the data obtained from fall-collected birds used to determine hatching peaks, due to the young in the fall population being weighted in favor of late-hatched young.

It is impossible to determine some aspects of summer population dynamics from winter data. Post-hatching mortality of young during the summer is one example. Studies on brood mortality of bobwhite quail are few. The only previous quantitative reports citing post-hatching mortality rates of quail are those of Klimstra (1950a) in Iowa, Pierce (1951) in Mississippi and Kabat and Thompson (1963) in Wisconsin. No data exist in the literature citing survival rates of young quail in summer for a successive series of years to determine if fluctuations in survival rates occur, although yearly variation in survival rates of young has been demonstrated for other species of game birds, *e.g.*, pheasant (*Phasianus colchicus*) by Stokes (1954) and Shick (1952), and ruffed grouse (*Bonasa umbellus*) by Bump *et al.* (1947). One of the long-range objectives of this continuing study is to determine yearly fluctuation in post-hatching survival rates for South Carolina bobwhite. Brood mortality data have been obtained for one year of the present study.

Kabat and Thompson (1963) state "The characteristics of the distribution of quail hatching dates fail to convincingly suggest why young are produced over such a prolonged period." It has not been satisfactorily demonstrated that bobwhite quail have succeeding peaks of nesting activity associated with renesting efforts, although most authors report quail renest readily, with only a few, however, actually witnessing this behavior. Stanford, quoted by Kabat and Thompson (1963), however, described several successful renesting attempts by different hens. Kabat and Thompson (1963) observed second peaks in five years of a 17-year study in Wisconsin, and Lehmann (1946) reported three peaks of nesting activity from April to mid-August in

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Texas. Kabat and Thompson (1963) suggest that the prolongation of nesting may possibly conceal a peak of renesting activity in many years, thus yielding a sustained level curve. Brood observations from 1964 are used here to demonstrate the breeding periodicity of quail in South Carolina, with supplementary observations from 1965 and 1966 illustrating year to year variations in hatching phenology.

Evidence that both the mated and unmated bobwhite utter the "bobwhite" note during the breeding season is accumulating in favor of all male bobwhite issuing the characteristic call (Klimstra, 1950b; Kabat and Thompson, 1963). Klimstra (1950b) observed that generally the quiet period, when the mated male ceased calling "bobwhite," was about the last week of incubation. Reeves (1954) stated that whistling reached a peak during the incubating period, since the male left his whistling post and joined the hen when she left the nest, thus curtailing his calling after the eggs hatch. Speake and Haugen (1960) observed the June peak of the Lee County, Alabama, call index to have occurred within 10 days of the estimated peak of hatch obtained from aging summer broods for three years' data, suggesting that bobwhite whistling intensity varies up or down with nesting activity and that probably sharp drops in the call index correspond to peaks of hatching. The latter investigators state "It appears that the bobwhite call index can be developed into a useful tool for estimating progress of the nesting season."

In order to test further this application of the call count census line, plotted call indices obtained in our study for 1964 were compared with the periodic nesting activity determined from brood observations made during the same summer. The data on brood mortality, nesting periodicity, and correlation of call index with nesting activity contained in this report are part of the data obtained from a continuing study of the population dynamics of bobwhite quail conducted on the lands of the Atomic Energy Commission's Savannah River Plant (hereafter referred to as the SRP) near Aiken, South Carolina. The specific objectives of this phase of the study were as follows:

1. To determine the relationship between peaks in calling activity and hatching.
2. To delineate peaks and distribution of hatching dates.
3. To determine brood mortality.

DESCRIPTION OF THE AREA

The SRP, occupying parts of Aiken, Barnwell, and Allendale Counties, South Carolina, consists of a 200,831-acre tract of land located approximately 15 airline miles southeast of Augusta, Georgia, and 12 miles south of Aiken, South Carolina. It is bordered on the southwest by 27 miles of the Savannah River with its associated bottomland hardwood swamps. The SRP lies entirely within the Upper Coastal Plain physiographic province. It is only a short distance south of the Fall Line which demarks the plain from the more elevated Piedmont Plateau physiographic province. The area is divisible into two principal physiographic subregions—the Aiken Plateau (Sandhills), and the Pleistocene Terraces along the Savannah River. The Pleistocene Terraces lie below 270 feet elevation. The Sandhills range from 270 feet elevation to 400 feet on the north edge of the area, and in general, consist of rather rolling terrain. The Sandhills are classified as agriculturally submarginal. The Pleistocene Terraces were intensively cultivated prior to abandonment of the area. Major forest types on the SRP include several bottomland hardwood associations in the river swamp, moist lower slopes, and streambottoms, and the longleaf pine (*Pinus palustris*)—turkey oak (*Quercus laevis*) association on the dry sand ridges. In many places the longleaf pine-turkey oak is replaced by a mixture of scrub oaks, possibly due to severe overcutting of the longleaf and the protection of the area from fire.

In 1951-52 approximately 6,000 people moved off the site, and it was closed to the public on December 14, 1952. Approximately one-third of the area had been in cultivation prior to abandonment; the remaining two-thirds were covered with forest. Approximately 90% of the area is now covered with forest. Most of the abandoned fields, the poorly stocked upland pine forests and the scrub oak forests were progressively planted to loblolly (*Pinus taeda*), slash (*P. elliottii*) or longleaf pine through the efforts of the U. S. Forest Service. The abandoned fields where natural succession was allowed to occur have proceeded through the forb to the broomsedge stage (Golley, 1965). Most of the pine plantations are quite dense, but are still maintaining a thick ground cover of broomsedge-vine. Man-dominated environments, such as along power lines and roadsides, can usually be included in the mixed forb, grass-forb, or upland grass types (Golley, *et al.*, 1965). In many areas of the SRP these provide the only openings for quail. At the time of abandonment, many species of wildlife were near the vanishing point. Many, including the more common predatory species, have since shown significant increases. Direct influence of man on animals is minimal, the populations of various species adjusting to the gradual process of natural and artificial reforestation in the absence of hunting, stocking, and predator control.

METHODS

Observations were made on bobwhite quail broods during the summer months of 1964 and 1966. Three techniques were employed in obtaining brood data. One technique consisted of traversing roads by automobile, at slow speeds, and scanning roadsides for quail with broods. When broods were observed from the vehicle, the observer stopped and dismounted to determine if any young escaped detection when first sighted. The second technique involved the use of trained bird dogs. The third technique involved the capture of quail in standard Stoddard-type funnel traps. This was used only in 1966. The date of observation, size of brood (if an accurate count was possible), and estimated brood age were recorded for each observation. An estimated period of possible hatching dates to be used in determining peaks of nesting activity was extrapolated from the estimated brood age. The majority of the brood observations in 1964 and all in 1966 were made by the senior author, supplemented in 1964 by observations made by a second observer. This observer was checked by the senior author on his ability to age quail broods and had accompanied the senior author while banding quail broods during trapping operations. This held variation attributable to an observer's ability to age broods to a minimum. Experience was gained in aging broods by estimating age of trapped young birds, then determining age from the progression of the primary molt (Petrides and Nestler, 1943). It was found that with a little experience, the age of young quail could be estimated quite accurately in the field by general appearance. When young quail reach an age of 12 weeks their weight is nearly equal to that of an adult bird, with generally 10 per cent or less deviation from adult weight (Haugen and Speake, 1957). While quail of this age are still distinguishable as young birds, it was not possible to estimate age within narrow limits by visual means. All birds in this age group were classified as 12-15 weeks of age.

Standardized morning call count census lines have been run since the closing of the SRP to the public in 1952, similar to those used in Missouri by Bennitt (1951), to indicate population trends and differences due to variation in habitat. Census routes consisted of 20, three-minute stations at one mile intervals. Total calls heard, and all individual birds calling during a three-minute interval were recorded. The route was completed in approximately 2.5 hours.

Wind velocity, wind direction, air temperature, and percentage cloud cover were determined before and after each census. Wind velocity was determined using the Beaufort scale (Bennitt, 1951) and the censuses were not conducted if the velocity exceeded 13 miles per hour. Counts were not made during rainy weather. The census was resumed on the next favorable day following unsuitable weather. All census lines during 1964 and 1966 were run by the senior author. This completely eliminated variation attributable to observer effect, which has been found to be statistically significant under certain conditions (Golley, 1962). In 1965, a second observer was employed and conducted the latter half of the censuses. Census lines traversing both of the physiographic subregions were run in 1964 and 1965, while only the line in the Aiken Plateau was run in 1966. In addition, a short line around two 600-acre study areas situated on the Brandywine Terrace in the Pleistocene Coastal Terraces in Barnwell County supplemented the data from the two regular census lines in 1964. The census lines in the two physiographic subregions followed the same route during all counts.

RESULTS

Brood Mortality—In the late summer of 1964 (Figure 1), fifty-five broods in which it was possible to accurately count and age the young

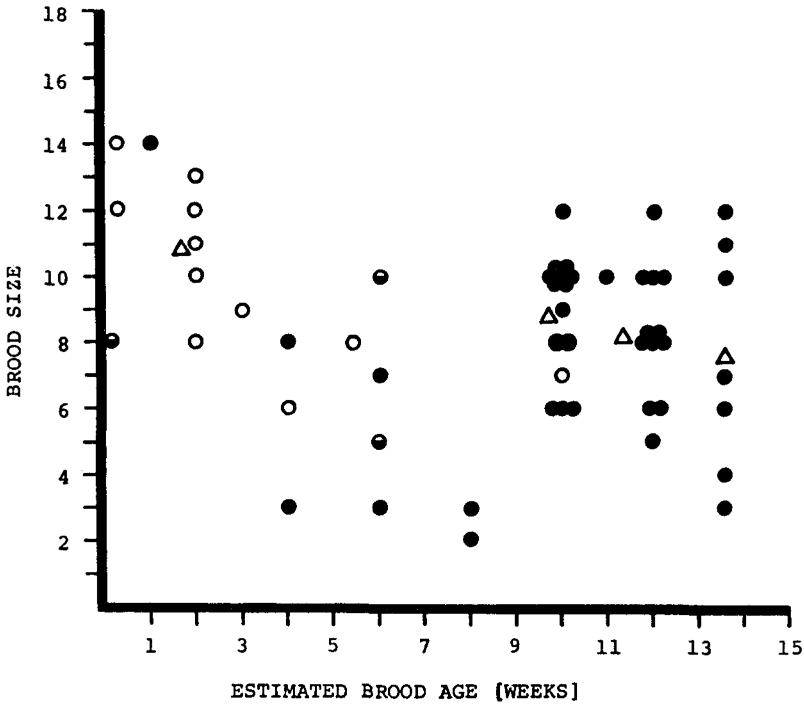

Figure 1. Distribution of 55 brood observations by size and estimated age recorded during the summer of 1964 on the SRP: Circles indicate broods by month of hatch; solid - May and June, hollow - July, semisolid - August and September; hollow triangles are age group means.

were studied intensively. The majority observed (74.5 per cent) were broods hatched during May and June. Most of the 55 broods observed were over ten weeks of age, with only 13 (23.6 per cent) four weeks of age and younger. All of these young broods, with one exception, hatched during July, August, and September. Broods of this age were extremely difficult to locate on the SRP due to the dense ground cover and the protective guidance of the adult birds. Analysis of the data suggest the average mortality in the broods hatched from late May to the end of July is approximately 50 per cent from hatching to 15 weeks of age. Following high mortality in the first two weeks after hatching, the mortality rate is approximately three per cent per week.

Hatching Peaks—Estimated hatching dates extrapolated from estimated ages of 58 broods observed during the summer of 1964 indicated a definite first peak of hatching around the 12th of June, with the number of broods hatching increasing from the 5th of May and decreasing to a low around the 2nd of July (Figure 2). The number of broods hatching then increased to a second peak around the 18th of July, before sharply dropping off to a low around the 28th of July. Although the sample

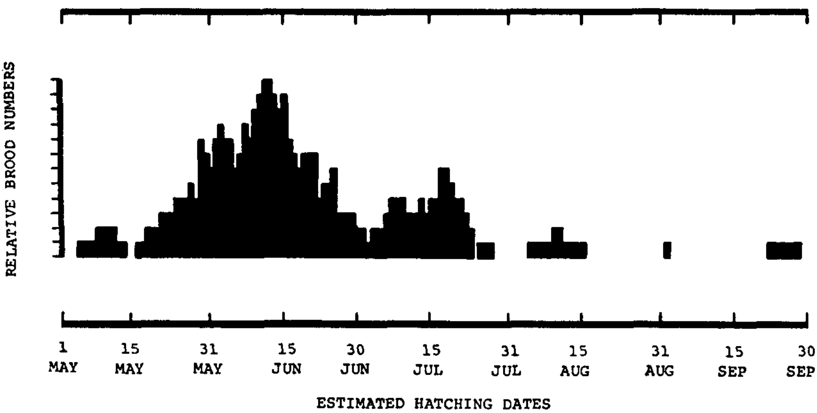

Figure 2. Hatching peaks on the SRP during the nesting season of 1964 determined from estimated age of 58 broods.

size is small, a third peak is indicated the second week of August, with some broods continuing to hatch until the end of September. The last brood observed was estimated to have hatched around the 25th of September. Nesting activity was staggered enough so that there were large numbers of broods hatching on the SRP on any one date from the 5th of May to the end of July, with late broods continuing to hatch from the first of August to the end of September. In each period nesting activity appeared to increase gradually and drop off sharply. Hatching spanned a five-month period in 1964, from the beginning of May to the end of September. The second hatching peak occurred approximately 36 days following the first peak. Incomplete data suggest a third peak approximately 23 days after the second peak.

Yearly variation in hatching peaks is indicated by the data from 1965 and 1966, in which the first hatching peaks occurred about June 28 and June 12-18, respectively.

Correlation of calling activity and hatching—The CI (call index, or average number of birds heard per station calling "bobwhite") indicated a peak in calling activity about the 4th of June on the Aiken Plateau and the Pleistocene Coastal Terraces followed by a sharp decline in calling activity (Figure 3). This peak in calling activity occurred approximately one week prior to the first peak of hatching. The CI on the Aiken Plateau continued to decrease until the third of July when a low in calling activity occurred. This low in calling activity closely corresponded with a low in hatching. The CI on the Aiken Plateau then increased to the 10th of July when the census line was discontinued. The CI on the Pleistocene Coastal Terrace decreased until the line was discontinued on the 21st of June. The census lines were not originally intended to indicate fluctuation in hatching activity, but were run for the annual spring census. Therefore, they were sometimes run at widely spaced intervals and peaks or lows in calling activity might not have been determined precisely in some instances. However, peaks and lows in calling activity occurred within a week of peaks and lows of hatching. The census line on the Pleistocene Coastal Terrace Study Areas indicated a peak in calling activity on the 15th of July, within a week of the second hatching peak. However, neither this line nor the Aiken Plateau line were continued past this date to indicate the second decline in calling activity.

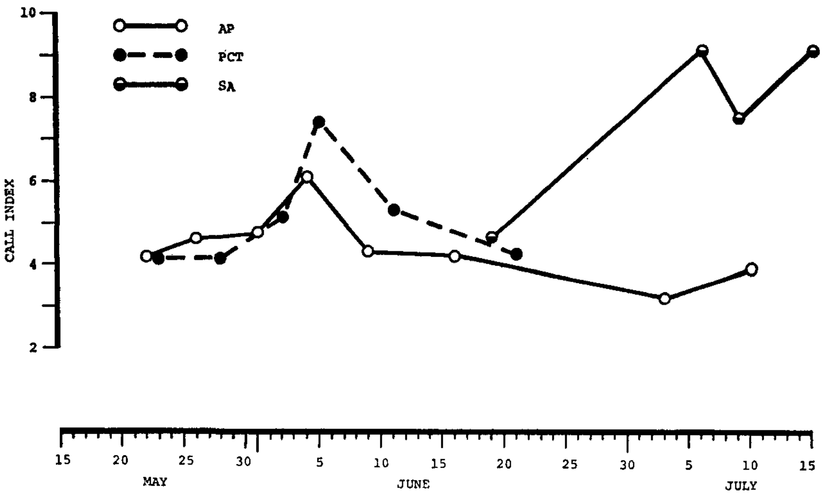

Figure 3. Fluctuation in call index on the Aiken Plateau [AP], Pleistocene Coastal Terrace [PCT], and Pleistocene Coastal Terrace Study Areas [SA], on the SRP in 1964.

DISCUSSION

Brood mortality on the SRP appears to be approximately 50 per cent from hatching until 15 weeks of age, with a high mortality from hatching until two weeks of age. After two weeks of age, the mortality rate then apparently averages three per cent per week. These data are consistent with findings of other investigators (Klimstra, 1950a; Kabat and Thompson, 1963). Pierce (1951) estimated 25 per cent of the chicks were lost each month on a Mississippi study area presumably including mortality of all age classes.

The interval between peaks agrees closely with Stoddard's (1931) estimate of time required for laying a clutch of eggs and incubating the eggs to hatching. Although it is generally agreed that quail renest readily, quantitative data on renesting attempts are lacking, and few investigators have actually witnessed this behavior. Assuming that the majority of birds nesting after the first main peak of nesting activity are birds renesting because of nest loss in first nesting attempts, the time interval between peaks suggests a high nest loss very close to hatching.

Blouch and Eberhardt (1953) concluded that small peaks of pheasant renesting, a species generally having only one peak period of nesting activity, probably resulted from nest destruction at about the same time possibly caused by plowing in agricultural areas. For bobwhite, Kabat and Thompson (1963) observed an apparent second peak for five years from data spanning a period of 17 years from 1944 to 1960 for Wisconsin. Lehmann (1946) reported three peaks of nesting activity indicated by number of nests being started for the breeding season of 1943 in southwestern Texas. The second peak of nesting activity followed the first peak by approximately 42 days, with the third peak following the second by an approximately equal interval.

The prolonged hatching period from the beginning of May to the end of September, or approximately 22 weeks, for the SRP is essentially identical to the seasonal distribution of quail hatching dates found in other areas, including Wisconsin (Kabat and Thompson, 1963), the red hills region between Tallahassee, Florida, and Thomasville, Georgia (Stoddard, 1931), eastern Texas (Lay, 1952), Indiana (Reeves, 1954), and Alabama (Haugen and Speake, 1958), indicating a prolonged hatching period is an inherent characteristic of bobwhite quail throughout their range.

Sources of variation affecting call count census line results are attributable to many factors. However, some of these were eliminated or were of no concern in the present study. Variation attributable to the observer's ability or experience in recording calling quail was eliminated, as only one observer ran the lines, with the exception of 1965. As the census lines followed the same route, variation in audibility attributable to terrain, habitat, and other influencing factors, such as traffic noise and construction noise, was eliminated. Since comparisons were limited to differences in the CI at various dates for the same route, the two most important variables are considered to be differences in meteorologic conditions and calling activity. Some of the meteorologic conditions suspected as a possible source of variation have been subjected to a statistical test. Bennitt (1951) found no statistically significant relationship between call index and relative humidity, degree of cloudiness, and wind velocity within the limits set for the census. However, Golley (1962) found wind effect to be statistically significant for two out of seven years, but not a significant variable when all years were considered together. Bennitt (1951) found that the Missouri CI had to be corrected for temperature, as increasing temperature decreases the number of calling birds. However, on the SRP, Golley (1962) found the effect of temperature was statistically significant when all years were considered together but for only two out of the seven years on a year-by-year analysis. Possibly other weather conditions affect the propensity of a quail to call or the audibility of the "bobwhite" note, but most of the day-to-day variation is undoubtedly attributable to differences in calling activity.

From the results of other studies and our own, both mated and unmated quail utter the characteristic "bobwhite" note. Klimstra (1950b), as a result of observing individual males in the vicinity of the nest, noted that early in the period of incubation cocks did considerable calling during the morning hours. As incubation advanced, the intensity of calling gradually tapered off until no calls occurred except those which were heard in the vicinity of the nest around feeding time. In most cases the male ceased calling about the last week of incubation.

On the SRP, the peak of calling activity occurred approximately one week prior to the first hatching peak in 1964. This nearly identical correlation with the theoretical situation is probably more good fortune than accuracy of method, as the call count lines were run at intervals of at least four days. Also the technique of aging by general appearance is certainly no more accurate than the technique of aging young by the progression of the primary molt, which only permits determining the week the bird hatched (Loveless, 1958). However, our data show that sharp declines in calling activity are closely associated with periods of peak hatching activity. Theoretically, this decline should commence approximately one week prior to the peak hatching. It appears that peaks of renesting may also be indicated by a decline in calling activity, but probably late peaks in calling would be obscured by the persistent calling of unmated birds. Speake and Haugen (1960) observed the peak of the Lee County, Alabama, calling activity occurred within ten days of the estimated peak of the hatch obtained from aging summer broods, and suggested that sharp drops in the call index correspond to peaks of hatching. It appears, then, that the call index can be used as an index to determine periods of peak hatching, as well as an index to winter quail populations (Rosene, 1957), and an index to hunting success (Bennitt, 1951).

SUMMARY

Data on brood mortality, periodicity of hatching peaks, seasonal distribution of hatching dates, and correlation of peaks of the call index with hatching peaks are discussed for the Savannah River Plant in South Carolina. A description of the area is presented, as are the methods employed in obtaining brood observations and conducting the call count census lines. The data from 55 brood observations indicate a mortality of approximately 50 per cent from hatching to 15 weeks of age, with a mortality rate of three per cent per week after the initial high mortality immediately after hatching. Data on 58 broods indicated

a first peak in hatching activity around the 12th of June for 1964, with a second peak around the 18th of July, approximately 36 days later. A third peak in August is indicated. Periodic hatching peaks at intervals approximating the time required for renesting and incubating a clutch suggest heavy losses late in incubation. Hatching dates in 1964 spanned a period of 22 weeks, from the first week of May to the last week of September. Data for three years reveal that the main period of the hatch occurred in June. Peaks in calling activity were correlated with hatching peaks. The decline in calling activity appears to occur approximately one week prior to the peak of the hatch. The fluctuating call index thus can serve as an index to hatching activity.

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PROGRESS REPORT: PRODUCTIVITY STUDY OF WHISTLING SWANS WINTERING IN CHESAPEAKE BAY

By E. B. CHAMBERLAIN, *Flyway Biologist*
Bureau of Sport Fisheries & Wildlife

ABSTRACT

During the past four winters an effort has been made to devise a satisfactory method of estimating the percent of young among the whistling swan population wintering in the Chesapeake Bay. Work to date indicates that this can be done by use of well distributed 35-mm. aerial color slides. Combining photography with direct visual appraisal was tried in the winter of 1965. The tentative conclusion from this was that use of aerial photos for large, densely packed flocks and visual appraisal for widely dispersed flocks would give accurate results at somewhat less expense than using the photographic method exclusively. In addition to percent young, average brood and family size can also be determined by these methods. It was also noted that the percent of "gray" birds observed decreases steadily throughout the winter. Data from the 1964 breeding season indicate that cygnets from the western areas have a higher mortality rate than those from eastern areas.

INTRODUCTION

This paper is a progress report on a continuing study. It is hoped that this study can be completed during the winter of 1966-67. At that time a final report will be made. Until then any statements or conclusions are to be considered tentative and subject to revision.

Prior to 1962 the percent of young in the whistling swan population of the Chesapeake Bay area had been estimated by use of two aerial observers, one estimating total birds in flocks and the other estimating number of young in each flock. This method was not considered entirely satisfactory. Although the gray-headed young birds were readily observed from the air, recording the number present in large flocks became a tiring and time consuming process with accuracy varying