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PROBABLE NON-BREEDERS AMONG FEMALE BLUE GROUSE

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Parallel studies on increasing (Zwickel 1972) and decreasing (Bendell et al. 1972) populations of Blue Grouse (*Dendragapus obscurus fuliginosus*) on Vancouver Island, British Columbia demonstrated that large numbers of yearlings of both sexes were available in spring for breeding in areas that had been largely depleted of residents the previous year. Replacement of former residents was mainly by yearlings, indicating that yearlings, not adults, were the individuals recruited in spring. These data suggest that a "surplus" of yearlings exists in spring and that these birds are excluded by residents. The fate of surplus birds is not known, nor are the factors determining which birds eventually enter the breeding population.

When only yearlings were removed from an experimental area on Vancouver Island, 1974 through 1976, more were collected than were identified on a nearby control area (Zwickel, unpubl. data). This experiment again demonstrated the presence of surplus yearlings available for breeding if others were removed. Thus, collections from 1974 through 1976 should contain both "surplus" (potentially non-breeding) and resident (potentially breeding) birds. If individuals in these two groups are identified, comparisons can be made which may indicate the factors important in determining which individuals enter the breeding population.

Using material collected from 1974 through 1976, we found that surplus and resident yearling females did exist. We compared these groups to answer the following questions. Are surplus birds excluded before peak breeding begins, as suggested by Bendell et al. (1972) and Zwickel (1972)? Are birds that are present on breeding areas early in the season more likely to breed than those arriving later? Do surplus birds weigh less than breeders?

STUDY AREAS

Specimens were collected on Vancouver Island, from Tsolum Main and an adjacent area as described by Hannon (1978). Comox Burn, located 2 km S of Tsolum Main, was the control area. For a more complete description of study areas see Zwickel (1977) and Hannon (1978).

METHODS

We used the following measurements from collected hens: weight of oviduct, size of largest unovulated follicle, and total body weight.

Weight of oviduct was used as the main indicator of reproductive status for three reasons: 1) Mackie and Buechner (1963) noted that weight of oviduct varied less than ovarian weight during the breeding period because of the rapid change caused by follicular development and ovulation, 2) several ovaries had lost yolk from follicles through mishandling or shot penetration, and 3) oviducts are extremely sensitive to changes in estrogen level (Sturkie 1976).

Weights of oviducts collected from 21 April (date the first hen was shot) up to 22 May (when most hens had started laying) are best described by the following regression equations (Hannon 1978):

$$\text{Adults } Y = 0.04 + 0.88X \ (P < 0.05) \ (N = 13)$$
$$\text{Yearlings } Y = -3.73 + 0.63X \ (P < 0.01) \ (N = 85),$$

where X = number of days from 21 April and Y = weight of oviduct.

Mean oviduct weight for laying hens was 25.5 g ($N = 12$) for adults and 21.6 g ($N = 28$) for yearlings (Hannon 1978). These are significantly different ($P < 0.01$). The predicted time required for the oviduct of each pre-laying bird (adult or yearling) to reach laying size was determined using the rate of development (slope) from the above equations. A hypothetical date for laying of the first egg for each collected hen was calculated by adding this amount of time to the capture date. Since the data used to calculate the equation for yearlings include both possible breeders and potential non-breeders, the rate of oviduct development is lower than if only breeders were used. Thus, the predicted date of laying of the first egg will be slightly late for potential breeders and early for potential non-breeders.

Date of laying of first eggs was calculated for yearling and adult hens with broods on Tsolum Main and Comox Burn, 1974 through 1976 as follows: the mean age of brood was determined (Zwickel and Lance 1966, Redfield and Zwickel 1976) and added to 26 days (for incubation) plus 9 days (for laying; Standing 1960), and the total subtracted from capture date. Data from Comox Burn were adjusted to conform to those at Tsolum Main (Zwickel 1975). This correction brought the peak of laying into synchrony at all areas. These birds, which obviously had bred, were used as controls against which collected birds could be compared. The peak laying period was defined as the consecutive 2-week period when most clutches were begun.

Potential surplus (non-breeding) birds from among the collected specimens were identified as those in which: 1) the calculated date of first egg fell on or after the last day of peak laying of yearling brood hens (i.e. would have laid later than most resident yearlings), 2) the largest follicle was less than 6 mm in diameter (ovary in the slow phase of recrudescence, Hannon 1978), and 3) both largest follicle diameter and weight of oviduct were less than the mean for all yearlings captured the same week (Hannon 1978). Collectively, these criteria were used to identify females who were not sufficiently developed reproductively to have bred during the period when most yearlings are known to breed. Those that fit all three criteria were defined as potential non-breeders and the remainder were classed as breeders.

RESULTS

COMPARISON OF FIRST EGG DATES BETWEEN KNOWN BREEDERS AND COLLECTED BIRDS

Dates of laying first eggs of collected adults (presumed residents) were compared to values obtained by backdating from mean age of brood for resident adults on Tsolum Main. The peak period of laying first eggs was the same for both groups (Fig. 1). This is the expected result if each group contained resident birds only. Thus, the method for calculating first egg date from weight of oviduct appears acceptable.

Dates of laying of first eggs were plotted for yearlings with broods on Comox Burn and Tsolum Main, and for collected yearlings on Tsolum Main (Fig. 2). Yearlings with broods had a peak laying period from 21 May to 4 June, whereas collected birds would have had a peak laying period 28 May to 11 June, a week later. When the distribution of these two groups after the end of peak laying (4 June for brood females) was compared, 13% (13/96) of brood females and 44% (37/85) of collected birds would have laid first eggs after 4 June ($\chi^2 = 20.28$, $P < 0.01$). Clearly, there was a large group of collected yearlings which, had they lived and bred, would have laid their first eggs later than most members of the population. However, very few resident hens (brood hens) laid eggs after the peak laying period. Thus, among the collected birds, there must be a large number that were not likely to have bred.

COMPARISON BETWEEN YEARLINGS NOT LIKELY TO HAVE BRED AND BREEDING YEARLINGS

Since all resident yearlings did not lay eggs before 4 June (13%), the collected yearlings could include a few potentially breeding birds that would have laid past peak breeding. Hence, the three criteria noted above identified birds whose gonads would not have developed in time to breed. Thirty-nine yearlings were identified as likely non-breeders and 46 as breeders. Differences between the two groups may help explain why certain yearlings are excluded from the breeding population.

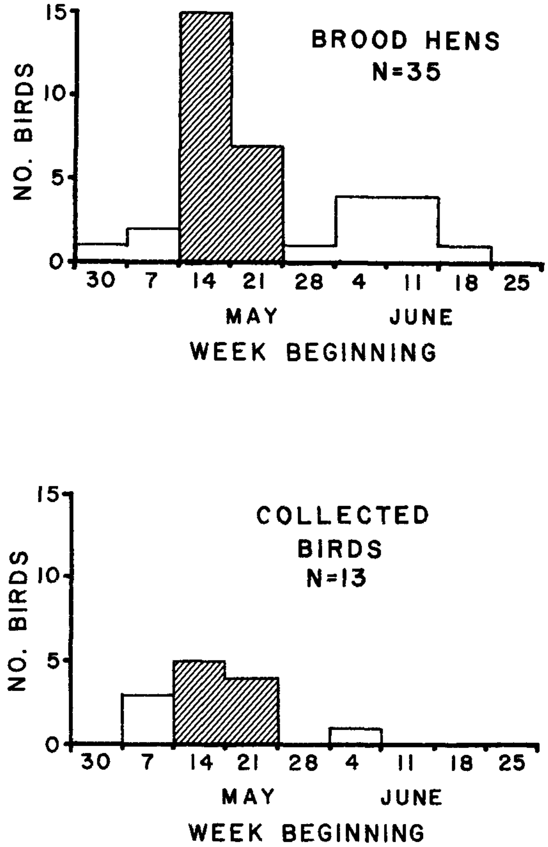

FIGURE 1. Extrapolations of first egg dates for adult brood hens and collected adult hens. Peak periods of laying are shaded.

Presence on the breeding area. Dates of removal give a relative comparison of presence of yearlings on the breeding range and are plotted for probable non-breeders and breeders in Figure 3. Both classes of birds were captured in April. Arriving early did not appear to give an individual an advantage for joining the breeding population. Zwickel (1972) suggested that exclusion of yearlings was complete by peak breeding (7 May on Tsolum Main; Zwickel 1977), yet 35% of our potential non-breeders were captured after that date, indicating that non-breeding yearlings were still present on the area after peak breeding began. However, only 3% of likely non-breeders were captured after peak laying for yearling brood hens had begun (21 May; Zwickel 1977). Twenty-two percent of breed-

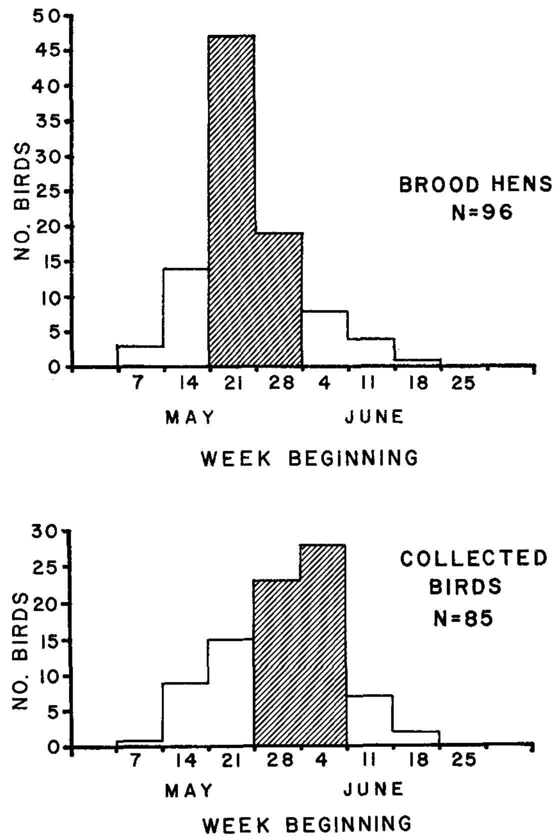

FIGURE 2. Extrapolations of first egg dates for yearling brood hens and collected yearling females. Peak periods of laying are shaded.

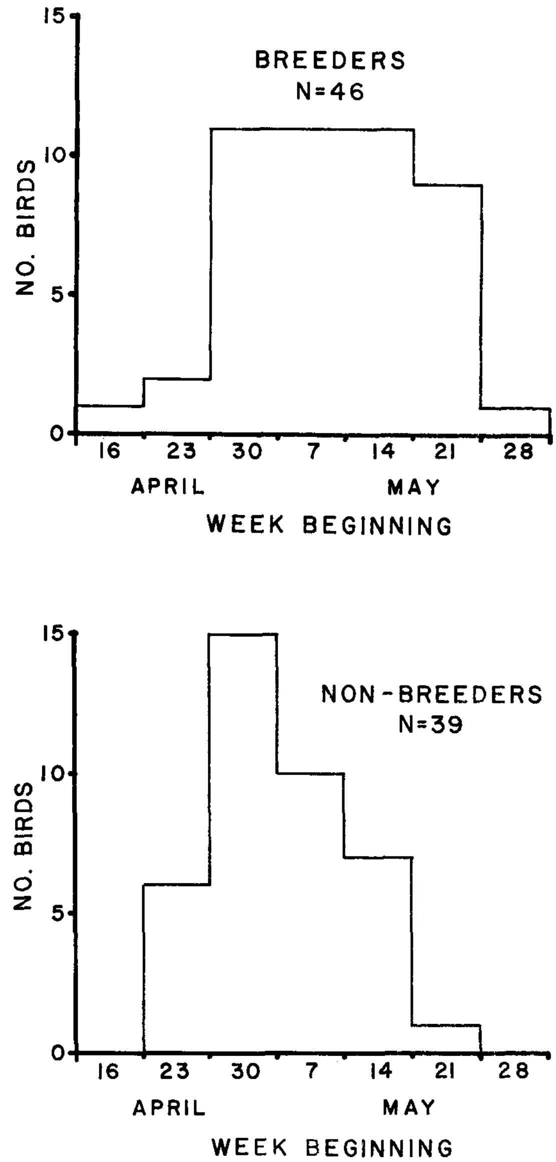

FIGURE 3. Dates of removal (weekly groups) of potentially breeding yearling hens and non-breeding yearling hens.

ers were captured after this date. Thus, recruitment of yearlings appears to stop after most yearlings have started laying, at least in populations where birds are being removed.

Although some birds that we believe would not have bred were caught early, these birds were captured over a shorter period than breeders (Fig. 3; Kruskal-Wallis test, $P < 0.01$) and either were not present or were not captured on the study area after most established yearlings began to lay eggs.

Body weight. Mean body weights of females not likely to have bred and of breeding females were compared with an unpaired t-test (Table 1). Only body weights of hens captured before 17 May were used because few non-breeders were captured after that date. Breeding females weighed more than non-breeders, comparing both total body weight and body weight minus the gonad ($P < 0.01$). Breeders may have joined the population because they weighed more or they may have weighed more because they had been able to settle and were building up resources for egg laying and incubation (Redfield 1973). Therefore, birds captured early in the season (prior to 4 May), before body weight gains are significant, were compared (Table 1). Birds classified as breeders weighed significantly more than non-breeders ($P < 0.05$).

DISCUSSION

Many studies have demonstrated the presence of surplus birds which are available to re-

TABLE 1. Mean body weights of non-breeding and potentially breeding yearlings.

	Non-breeders	SE	N	Breeders	SE	N
Prior to 17 May						
Total body weight	828.51	11.81	37	918.34	12.46	29
Body weight (no gonads)	825.24	11.69	37	902.97	11.37	29
April to 4 May						
Body weight	803.00	23.08	14	912.50	22.51	8

place removed residents (Stewart and Aldrich 1951, Orians 1961, Watson and Jenkins 1968, Bendell et al. 1972, Zwickel 1972). In the absence of resident mortality, surplus individuals are difficult to find. Our study presents the first direct evidence that some yearling female Blue Grouse may be non-breeders and that they differ qualitatively from birds which become breeders.

Our results indicate that the process of exclusion of non-breeding or surplus yearlings is not a sudden phenomenon occurring before peak breeding as suggested by Bendell et al. (1972) and Zwickel (1972). Rather, it appears that a group of yearlings looking for a place to settle exists on the breeding areas until late May and that when space is made available by mortality or other factors some may settle and breed. Others may disappear during peak laying.

Hens without a brood patch are rarely caught on the study areas in mid- to late June, July, and August (Zwickel and Bendell 1967), indicating that most hens found in late summer have laid eggs, and hence are members of the breeding population. Perhaps non-breeding females migrate to winter range earlier than other birds, as do non-breeding yearling males (Bendell and Elliott 1967). Non-breeding hens may travel widely or remain in suboptimal habitat where they would be less likely to be captured. The fate of such yearlings has yet to be determined.

What factors allow some yearlings to breed while others do not? Early presence on the breeding range does not appear to confer special advantage, but hens that weighed more seemed more likely to breed. Perhaps larger birds are more capable of securing a home range or nest site and protecting it against intruders. Other possibilities remain to be tested, such as aggressiveness and general body condition of potential breeders. The problem remains of identifying breeding and non-breeding individuals, particularly when studying live birds.

SUMMARY

Two groups of yearling females were identified from a series of Blue Grouse examined on Vancouver Island, British Columbia. Birds collected during a continuous yearling-only removal had a high proportion of apparent non-breeders when compared to hens that had bred. Early presence on the breeding range did not increase or decrease the chance of joining the breeding population, but the heaviest birds were most likely to become established.

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