percent. This recruitment rate expressed as young per adult female hen, assuming a 50:50 sex ratio in the population, can be figured. Given an over-wintering survival of 12.0 grouse with 6.0 hens; given a pre-season, fall population of 20.3 grouse; and assume that all recruitment is due to reproduction; then each hen must successfully rear 1.4 young grouse to November. This exercise also assumes that hen mortality over the reproductive period is zero, which it certainly is not. Loss of adult hens during the summer months would increase the 1.4 young per hen value to insure a continu8ng, stable population. Other known factors, especially emigration and immigration of grouse in these woodlots, affect recruitment to a great extent. Daily activity and movement patterns also determine to a large degree, the number of grouse in a particular woodlot at any certain time.

SUMMARY

In summation of the findings of this three year study of grouse populations in isolated, small woodlots, I would conclude that there is no supporting evidence that hunting pressure, predation, or any other natural mortality factor has any significant, detrimental effect on successive fall grouse populations. Very low success rates for hunting effort eliminates hunting as a serious diminishing population factor. Little evidence of predation or other natural mortality was observed. In no instance did hunting or other mortality factors affect census results to indicate a reduction in year to year population levels or annual recruitment rates. The major factors influencing grouse population levels and distribution were the availability of preferred food items (especially mast), normal activity patterns in response to weather conditions and feeding, and the reproductive success of over-wintering hens.

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CROP-GLAND ACTIVITY IN MOURNING DOVES DURING HUNTING SEASONS IN VIRGINIA

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ABSTRACT

Breeding populations of the mourning dove (*Zenaidura macroura*) have been declining over the past decade while at the same time hunting pressure and harvest have increased. Thus, minimization of conflict between nesting activity and hunting is important in stabilizing populations. As the crop-gland activity of doves provides an indication of post-hatching nesting activity the proportion of doves with active and regressing crop-glands was studied during the 1971 and

1972 hunting seasons in Virginia. Examination dates, number of adult doves examined, number with active (A) crop-glands, and number of regressing (R) crop-glands were as follows: 4 September 1971, 82 doves, 12.5 percent A, 8.4 percent R; 2 September 1972, 279 doves, 22.6 percent A, 8.2 percent R; 9 September 1972, 89 doves, 23.6 percent A, 14.6 percent R; 16 September 1972, 34 doves, 29.3 percent A, none R; 23 September 1972, 14 doves, 21.4 percent A, 14.3 percent R, 23 December 1972, 11 doves, none A, and none R. Mean weights (+ S.D.) of active, regressing, and inactive crops were 3.50g (± 1.26), 1.38g (± 0.49), and 0.87g (±0.26), respectively. The differences in crop-weights between the above categories were significant ($P<0.001$). Crop weights above 3.0g could be used to segregate active from regressing or inactive crops and crop weights above 2.0g to segregate active from inactive crops (but not regressing). Adult females had eggs in the oviduct on 4 September 1971 (4.3 percent of adult females) and on 2 September 1972 (5.8 percent of adult females). No females had evidence of ovulation on 9 September 1972 or later. The results indicate that substantial proportions of mourning doves were involved in nesting activities during the hunting season in Virginia.

The mourning dove (*Zenaidura macroura*) is a widely distributed species in North America. In addition to being a highly popular game bird, the mourning dove is an important non-game species insofar as it is of attractive appearance and nests in suburban areas. The annual call-count surveys have indicated that breeding populations of mourning doves have been steadily declining over the last decade (Ruos 1970, 1971; Ruos and MacDonald 1970). At the same time hunting pressure has increased (Ruos and MacDonald 1970; Preno and Labisky 1971). Management of mourning doves consists, primarily, of setting hunting seasons and bag limits. Setting the hunting season at a suitable time to prevent disruption of nesting activity would avoid unnecessary wastage of immature birds. Immature birds saved would provide additional birds for hunting and for recruitment to the breeding population.

A unique aspect of the reproductive physiology of the family Columbidae facilitates study of post-hatching nesting activity of adults. Members of the Columbidae nourish their young by the production and feeding of cropmilk (Levi 1941). The crop wall undergoes anatomical changes and sloughs off layers of cells which constitute the caseinous cropmilk (Riddle and Bates 1939). This development of the crop is known to be under the influence of the pituitary hormone prolaction (Riddle et al. 1932). The anatomical changes in the crop associated with cropmilk production provide an indication of post-hatching nesting activity.

Relatively little use has been made of this property in managing mourning doves. Nevertheless some reports are available from several states on the proportion of doves with cropmilk production activity during the hunting season. Studies of mourning doves in North Carolina indicate that among adult specimens taken during September in each of the years 1939, 1940, and 1941, crop activity was present in 18, 23 and 26 percent, respectively (Quay 1951). Hanson and Kossack (1963) found 38 percent of the adults in the hunters' kill in northeastern Illinois had various degrees of crop development, 31 percent in central Illinois had developed crops. Crop development was observed in 6.8 percent of hunter harvested doves (adults plus young) in Missouri (Korschgen 1953). Caldwell (1957) found 42 percent of 36 adult doves shot in September in Michigan had "thickened" crop walls. Jenkins (1955) found that 35 percent of 79 adult doves collected in Georgia in September had crop gland activity.

This report presents data on the proportion of adult doves with active crop-glands during two hunting seasons in Virginia, on weights of active, regressing, and inactive crops and on gonad activity of adult doves during the hunting season.

MATERIALS AND METHODS

This investigation was conducted on mourning doves harvested by hunters during the hunting seasons of 1971 and 1972. The study was conducted at Elm Hill Wildlife Management Area, Mecklenburg County, Virginia. Hunters were asked to donate carcasses of birds after the breasts were removed at the check station. The birds were separated by sex and age (adult or immature) and placed in 10 percent formalin for future detailed examination at the laboratory. Specimens were collected on the following dates: 4 September 1971; 2 September 1972; 9 September 1972; 16 September 1972; 23 September 1972; and 23 December 1973.

The following data were recorded for specimens examined in detail in the laboratory: sex of bird, age of bird, primary feather replacement, presence or absence of crop-milk production activity, weight of empty crop, weight of testes in males, weight of ovary in females, weight of oviduct in females, diameter of the three largest follicles in the ovary, and presence or absence of eggs in the reproductive tract of females. The development of the crop-gland was recorded as active, regressing or inactive. Crops were processed for histological examination and examined to confirm the development classification assigned at first examination. Comparisons were made based on histological examinations of cropmilk producing crops of other species of Columbidae (March and Sadleir 1970). Aging techniques used were those described by Swank (1955). Those birds with white edges on the wing covert feathers were considered juvenile. The pattern of primary feather replacement was used to estimate the age of juvenile birds (i.e., the time of hatching).

RESULTS

Data on numbers of adult doves examined and the proportion of doves with active or regressive crop-gland development are presented in Table 1. A substantial proportion (12.5 percent) of adults collected 4 September 1971 had active crop-glands. Among those doves collected during September 1972 more than 20 percent of adults had active crop-glands. There was a significant difference between 4 September 1971 and 2 September 1972 in the proportion of doves with active crop glands ($P<0.05$; $X^2=4.20$, 1 d.f.). In addition to those doves with active crop-glands a substantial proportion had evidence of regressing crop-gland development. The proportion with crop-gland development (active plus regressing) was 20.9 percent among doves collected on 4 September 1971 and approached or exceeded 30 percent among doves collected in September 1972. The difference between 4 September 1971 and 2 September 1972 in

Table 1. Crop-gland activity in adult mourning doves collected during the 1971 and 1972 hunting seasons in Mecklenburg County, Virginia.

Collection Date	No. Adults Examined	Active Crops (Percent)	Regressing Crops (Percent)	Active Plus Regressing Crops (Percent)
1971 Sept. 4	82	12.5	8.1	20.9
1972 Sept. 2	279	22.6	8.2	30.8
1972 Sept. 9	89	23.6	14.6	38.2
1972 Sept. 16	34	29.3	nil	29.3
1972 Sept. 23	14	21.4	14.3	35.7
1972 Dec. 23	11	nil	nil	nil

proportion with crop-gland development (active plus regressing) approached statistical significance ($P<0.10$, $X^2=3.24$, 1 d.f.). There was no evidence of crop-gland development among doves collected on 23 December 1972. Also there was no evidence of crop-gland development among immature doves.

Data on mean weights of crops from doves with active, regressing or inactive crop-glands are presented in Table 2. The data indicates that there was a substantial increase in weights in the crop when there was crop-milk production activity. Statistically significant differences ($P<0.001$) were observed between active, regressing and inactive crops and also between regressing and inactive crops. Data on the range of crop weights are also given in Table 2. These data indicate that there is considerable overlap in weights of crops from doves with active, regressing, and inactive crop-glands. However, the data indicate that when crop weight was greater than 3.0g there was an active crop-gland present and in all cases with inactive crop-glands the weight of the crop did not exceed 2.0 g.

Examination of female doves indicated that there was still ovarian activity present during the first week of September in 1971 and 1972. Data on ovarian activity of doves examined are presented in Table 3. The proportion of doves with eggs in the oviduct was 4.3 percent on 4 September 1971 and 5.8 percent on 2 September 1972. In addition, there were some doves collected on the above dates with large follicles (i.e., greater than 100 mm diameter) which may have yet laid eggs had they survived. There were no eggs in the oviducts of doves collected on 9 September 1972 or later and large follicles (i.e., greater than 10 mm diameter) were not observed on 9 September 1972 or later.

Table 2. Mean weight (g ± S.D.) of crops from doves with active, regressing and inactive crop-glands collected in Mecklenburg County, Virginia in September, 1972.

	Active (Adult)	Regressing (Adult)	Inactive (Adult)	Immature*
Number Birds Examined	97	39	292	128
Mean Weight (g) (+ S.D.)	3.50 (+1.26)	1.38 (+0.49)	0.87 (+0.26)	0.65 (+0.18)
Range	0.94-7.24	0.55-2.79	0.33-1.62	0.33-1.39

*All had inactive crop-glands.

Table 3. Proportion of doves with eggs in the oviduct or large follicles in the ovary during the hunting seasons 1971 and 1972 in Mecklenburg County, Virginia.

Examination Date	Number Adult Females Examined	Number with follicles greater than 10 mm diameter in the ovary	Number with eggs in oviduct
Sept. 4, 1971	46	1	2
Sept. 2, 1972	103	2	6
Sept. 9, 1972	38	0	0
Sept. 16, 1972	13	0	0
Sept. 23, 1972	7	0	0
Dec. 23, 1972	3	0	0

Data on the estimated hatching dates of all juvenile doves collected in 1972 are presented in Table 4. The data indicate that a majority of juvenile doves collected were hatched successfully after mid-July. The data also indicate that there was a substantial destruction of nests during the hurricane Agnes (19 to 23 June 1973) and that nesting activity was still continuing at high levels in mid and late August.

Table 4. Estimated hatching dates of juvenile doves collected during the 1972 hunting season, Mecklenburg County, Virginia.

Hatching Date	Number of Birds	Percent of Total
April 12-18	6	4.5
April 24-30	5	3.7
June 12-18	3	2.2
June 24-30	8	5.9
July 06-12	7	5.2
July 12-18	2	1.5
July 18-24	12	8.9
July 24-31	19	14.2
August 01-06	16	11.9
August 06-12	14	10.4
August 12-18	31	23.1
August 18-24	14	10.4
August 24-31	4	2.9
Sept. 01-06	1	0.7

DISCUSSION

The fact that a substantial proportion of adult doves had crop-gland activity during the hunting season indicates that many doves may have been still tending nests or young during the hunting season in Virginia. While many authors (Quay 1951, Korschgen 1953, Jenkins 1955, Caldwell 1957, and Hansson and Kossack 1963) have indicated that doves had crop-gland development during hunting seasons in several states the significance of such findings is not fully known. At the same time the implications of hunting activities clashing with nesting activities of doves are worthy of consideration in view of the downward trends in mourning dove populations over the past decade and the increase in numbers of hunters of this species.

While Goforth (1964) has documented one instance of a single dove parent successfully hatching and raising young in captivity the indications from studies of free-ranging doves are that removal of one parent bird will adversely affect the chances of successful raising of young. Laub (1956) found that upon loss of its partner the remaining parent was either unable or unwilling to continue hatching. A single parent was unable to raise to fledgling stage a single nestling younger than four days post-hatching or a pair of nestlings younger than seven days post-hatching. Consequently, removal of one parent during the early phases of raising young is likely to militate against successful fledging of young and is a valid reason for minimizing conflict between the hunting season and nesting activities of doves.

Caldwell (1957) has questioned whether the presence of crop-gland development necessarily reflects nesting activity of doves. He studied crops of 36 doves harvested in Michigan and found 42 percent had anatomical development of the crop-gland. Based on his knowledge of nesting activities of doves in the

area he considered that the use of "crop-thickening" probably over-estimated the proportion of nesting doves. He cited other literature (Hopkins and Odum 1953, Jenkins 1955) which he felt supported his contention that the presence of crop-gland development over-estimated nesting activity. It is not clear that the data in the references cited (Hopkins and Odum 1953, Jenkins 1955) was collected simultaneously but in any event only a small number of adults (79 adults) were studied by Jenkins (1955). Information of the persistence of crop-gland development are lacking for doves. Laub (1956) indicates that development is still present fourteen days after hatching. Studies in this laboratory (Guynn 1973) have indicated that crop development induced in captive feral pigeons (*Columba livia*) by exogenous prolaction regressed rapidly (in less than three days).The fact that in the first week of September 1971 and 1972 that several females were actively laying eggs (4.3 percent and 5.8 percent, respectively) indicates that a substantial proportion of doves were still engaged in nesting activity.

A significant difference was found in the proportion of doves with crop activity on 4 September 1971 and on 2 September 1972. This may indicate that the intensity of nesting during the latter portion of the nesting season was responsive to earlier nesting successes. Analysis of primary feather replacement patterns was used to estimate the time of hatching of the immature doves harvested. The data thus obtained indicated that few nestlings or unhatched eggs survived the hurricane (Agnes) which occurred 19 to 23 June 1972, and that the majority of immature birds recovered were hatched later than mid-July. The occurrence of the hurricane in the early portion of the nesting season may have been a factor contributing to nesting activity during September in a larger segment of the population.

CONCLUSIONS

A substantial proportion of mourning doves shot during hunting seasons of 1971 and 1972 had evidence of crop-gland development (greater than 20 percent, and greater than 30 percent, respectively). This information plus data on laying birds indicates possible conflicts between hunting seasons and nesting activity. Further research on the persistance of crop-gland development in crops of mourning doves is necessary to fully interpret the significance of the presence of crop-gland development in hunter harvested doves.

Significant differences between hunting seasons were found in the proportion of doves with crop-gland development. Consequently, sampling must be done over several seasons to eliminate annual variations in estimating the proportion of doves nesting in September.

Further evaluations of the effects of major weather upsets on nesting activity is warranted. In this report the possibility that a hurricane in June contributed to nesting activity in September is discussed. Should major weather upsets operate to delay or nullify nesting activities, such information could be incorporated into the decision making process when setting the time of the hunting season.

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