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ENVIRONMENTAL FACTORS AFFECTING WOOD DUCK ROOSTING FLIGHTS IN SOUTHERN ILLINOIS

M. Douglas Scott[1] and Delbert E. Parr[2]
Department of Zoology
Southern Illinois University at Carbondale 62901

ABSTRACT -- Autumn roosting flights of wood ducks (Aix sponsa) in Southern Illinois were analyzed to determine if they had a pattern and if this pattern could be related to environmental conditions. As the season advanced, first birds arrived progressively closer to sunset, while the last birds always arrived soon after sunset, resulting in a gradual shortening of the duration of the roosting flight and an increase in the percentage of the flight arriving after sunset. Temperature and light intensity constants were not related to the arrival times of the first roosting birds, and a decline in light intensity observed at the arrival of the first birds was caused primarily by the days becoming shorter. The arrival of first birds at a relatively constant time, irrespective of environmental conditions, indicated they used an 'internal clock' to initiate the flight. The last birds' arrival at the roost was not influenced by temperature, but was related to a low light intensity of about 5-10 footcandles. Cloudy weather did not affect the time of initiation of the roosting flight, but did significantly move the arrival time of the last birds ahead. Because of this, the percentage of the flock entering the roost before sunset on cloudy days was about twice that on clear days.

INTRODUCTION

The wood duck is a gregarious species which flies to communal nighttime roosts in swamps and lakes, particularly during the fall and

[1]Present address: Institute of Applied Research, Montana State University, Bozeman, Montana 59717.

[2]Present address: Environmental Engineering Dept., Amax Coal Co., Indianapolis, Indiana 46225.

winter months (Stewart, 1958; Hartowicz, 1965). Seasonal changes in the timing and duration of these evening roosting flights have been documented (Martin and Haugen, 1960; Hester and Quay, 1961; Hein, 1961 and 1965; and Tabberer, et al., 1971), but the exact environmental or physiological factors which trigger the start and finish of the roosting flight have been unknown.

The purpose of this study was to observe the changes in the timing of the wood duck roosting flight in Southern Illinois, and attempt to correlate these changes with various environmental parameters which were simulaneously monitored, so that a cause and effect relationship might be indicated.

MATERIALS AND METHODS

The study roosts were within the 2960 ha Union County Wildlife Refuge, located on the Mississippi River floodplain approximately 13 km west of the town of Anna, Illinois. The refuge contains three open-water lakes, plus several areas of standing timber which are artificially flooded in the fall by Illinois Department of Conservation personnel. There also are scattered swampy areas in which buttonbush (*Cephalanthus occidentalis*) is the principal species. Uplands surrounding the lakes and swamps are composed of grain fields interspersed with the typical oak (*Quercus spp.*) - hickory (*Carya spp.*) forest of Southern Illinois.

Two wood duck roosts (called 'Triangle' and 'Grassy Lake') were located on the study area by following flocks of birds in flight during the evening, as described by Hein and Haugen (1966). Incoming birds were observed from a place where they could be seen crossing open fields or water adjacent to the roost. Counts of birds in relation to time of day were always made by two experienced observers to minimize overlooking ducks. At times, accurate sightings could only be made from a boat. Observations at each roost were made 1 or 2 times per week from 20 August to 30 November 1973.

Observations always started at least 1 hour before sunset, in an attempt to determine when the first bird came to roost. The last bird was assumed to have arrived after a 15-minute period passed during which no more birds were seen.

A Weston Master V Universal exposure meter was used to measure light intensity when the first and last birds came to roost. Day length and maximum, minimum and mean temperature data for correlation purposes were obtained from the nearby town of Anna (Hartline, 1973). Clear versus overcast cloud data were recorded at the individual roost site.

RESULTS

Table 1 summarizes the monthly arrival times at the roost of the first and last birds in relation to sunset. The arrival times of the first birds in August could not be reliably determined, since some birds were known to be flying to the roost before the normal roosting flight

observations began (Parr and Scott, 1978). An overall average calculated for the remaining nine 10-day intervals from 2 September through 30 November 1973 revealed that the first wood duck arrived at the roost an average of 6.0 minutes nearer to sunset for each 10-day period. During the same 90-day period, the last wood duck arrived at the roost an average of only 1.9 minutes more after sunset for each 10-day interval. The duration of flight activity, therefore, became shorter by 38 minutes as the season advanced.

TABLE 1. Time of arrival of first and last wood duck in relation to sunset and mean duration of the roost flight for each month. Positive numbers are minutes before sunset and negative numbers are minutes after sunset. Data are from both the Triangle and Grassy Lake Roosts.

Month	(n)	First Bird			Last Bird			Mean Duration of Flight
		Earliest	Latest	Mean[a]	Earliest	Latest	Mean	
August	(2)	--	--	--	2	- 7	- 3	--
September	(9)	78	36	53	- 9	-24	-13	67
October	(13)	68	9	36	-16	-32	-23	59
November	(5)	21	-16	- 1	-25	-34	-30	29

[a]Mean time of the first bird arriving at the roost could not be reliably determined in August, due to some birds flying to the roost before regular observations began.

Relationship of Light Intensity and Temperature to Roosting Flight Times

Light intensity readings recorded at the arrival of the first birds on both roosts showed a decline as the season advanced (Figure 1). Computer regression analysis (Nie et al., 1970) revealed a strong relationship ($p<0.01$), between the level of light intensity at which the first bird came to roost and the declining day length. The two variables were also highly correlated ($p<0.01$), producing a correlation coefficient of .91. Thus, the decline in day length was the major cause of the lower light intensity at the arrival time of the first bird as the season progressed, and the birds were not using some constant light intensity level as a signal to go to roost.

In 21 out of 27 observations during September, October and November, when the roosting flight pattern had stabilized, the first wood ducks entering the roost always arrived between 16:30 and 17:00. No daily trends in time of arrival were seen, in spite of the fact that

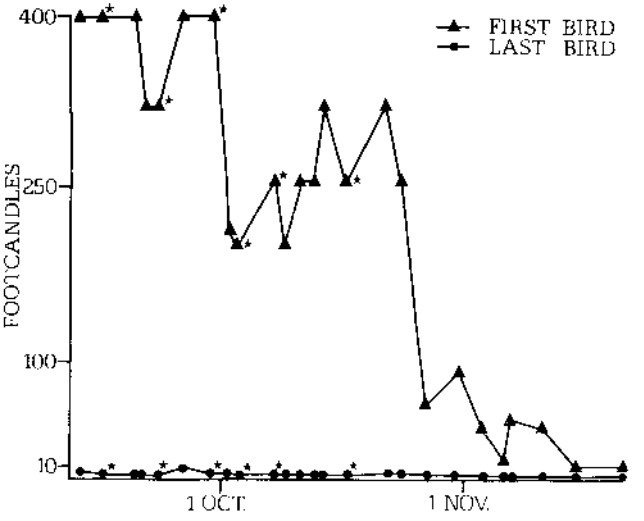

Fig. 1. Level of light intensity at which the first and last wood duck arrived at the Triangle Roost or Grassy Lake Roost during the evening roosting flight. Four hundred footcandles (+) represented full daylight, and so was recorded at a variety of times during September, due to early entering of roosts by ducks during this period. Stars indicate Grassy Lake data.

days were becoming progressively shorter. Stepwise multiple regression analysis revealed no significant relationship ($p>0.01$) between the time at which the first bird came to roost and any combination of daily maximum, minimum or mean temperature, or the number of birds being counted.

The timing of the last bird's arrival at the roost during all 4 months did, however, appear to be related to light intensity. This is shown in Figure 1, where it can be seen that a relatively uniform low light intensity of 5-10 footcandles was recorded at the arrival time of the last bird. Analysis of these times demonstrated that wood ducks arrived progressively slightly later (1.9 minutes per 10-day interval) in relation to sunset as the season advanced. This slight delay was not enough, however, to cause a significant decline in the light intensity readings.

No relationship ($p>0.01$) was seen between the arrival times of the last birds and any combination of maximum, minimum or mean temperatures, or the number of birds being counted.

Because of the inflexibility in the absolute arrival time of the first birds, the total percentage of birds arriving at the roost before sunset decreased as the season advanced (Figure 2). Regression analysis revealed a significant relationship ($p<0.01$) between the declining percent of the total flight arriving before sunset and the declining day length, for both cloudy and clear days separately. Percent of the birds arriving before sunset for all days combined was also highly correlated with day length ($r = .97$).

Multiple-regression analysis revealed no relationship ($p>0.01$) between the percent of the flight arriving before sunset and minimum, maximum or mean temperature, or the total number of birds being counted.

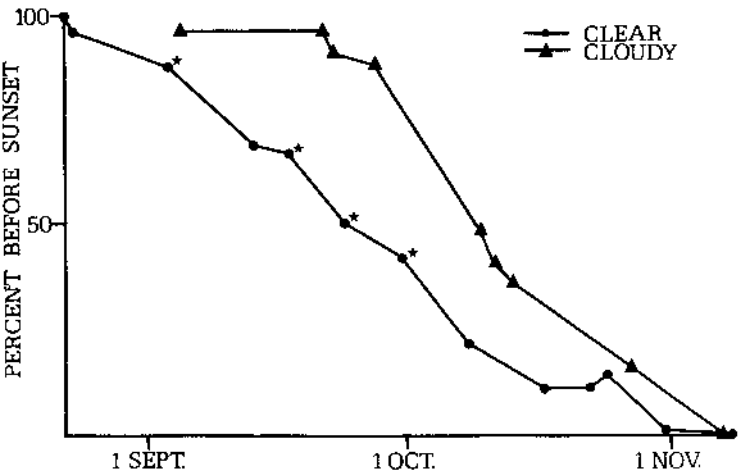

Fig. 2. Percentage of wood ducks arriving at the Triangle Roost or the Grassy Lake Roost before sunset on cloudy and clear days. Stars indicate Grassy Lake data.

Relationship of Cloud Cover to Roosting Flight Times

The mean arrival times of the first bird for cloudy versus clear days revealed no significant difference between the two (mean for clear days = 34.0 minutes before sunset; mean for cloudy days = 40.2 minutes; $p>0.10$, students t-test), thus indicating that first birds continued to arrive at a set absolute time.

Comparison of the mean arrival times of last birds, however, in-

dicated that they flew to the roost significantly earlier on cloudy days than on clear days (mean for cloudy days = 17.8 minutes after sunset; mean for clear days = 25.3 minutes, $p<0.10$, students t-test, August flights omitted). As we noted before, it appeared that the time of arrival of the last bird was related to light intensity. In this case, a cloudy day caused the ultimate low light intensity to be reached earlier in relation to sunset; thus last birds flew to roost earlier on cloudy days. Since a cloud cover at the 16:30 - 17:00 time did not cause a reduction in available light to the critical level, the first birds did not show the marked tendency to fly to the roost earlier at that hour.

As a result of these arrival times, a larger total percentage of the flight arrived at the roost before sunset on cloudy (overcast) days than on clear days (Figure 2). The total percent of the flight arriving before sunset on cloudy days averaged approximately twice as much as on clear days. Regression lines and confidence belts (Snedecor and Cochran, 1967: 154) of percent of birds arriving before sunset on cloudy and clear days revealed that the difference was significant ($p<0.01$) for days more than 665 minutes long - equaling from the start of the study in August through 17 October 1973 ($Y = -400.96 + .697X$ for cloudy days; $Y = -338.05 + .538X$ for clear days, where Y = percent before sunset and X = day length in minutes). For days shorter than 665 minutes long (18 October 1973 to the end of observations on 30 November 1973), the percent of birds arriving before sunset for cloudy and clear days was not significantly different. This was expected since, at this time, nearly all birds were arriving after sunset on both cloudy and clear days because sunset was occurring close to or after 17:00, which was about the average arrival time for the first bird.

The noticeable effect of cloud cover on the total percent of the birds coming to roost before sunset (Figure 2) was the result of the cloud cover's influence on the last birds' time of arrival. Each roost count was observed to take on the shape of a normal curve with slight negative skewness - in that after the first bird was seen, the numbers entering the roost gradually reached a peak, and then more abruptly tapered off as the last birds arrived (Parr and Scott, 1978). By shifting the last birds' arrival times an average of 7.5 minutes earlier (which occurred on cloudy days), but not shifting the arrival time of the first birds', the shape of the resultant model roost curve (Figure 3) is changed enough so that it very closely predicts the observed percentage differences for clear versus cloudy days contained in Figure 2.

DISCUSSION AND CONCLUSIONS

In this study, mean September arrival times were 53 minutes before sunset for first birds, while last birds arrived at the roost a mean of 13 minutes after sunset. This corresponds with the findings of Martin and Haugen (1960), who reported early fall roosting flights began about 45 minutes before sunset, with little activity after sunset, but differed from Hein (1961), who reported early season wood duck flights lasted from about 30 minutes before sunset to 30 minutes after sunset.

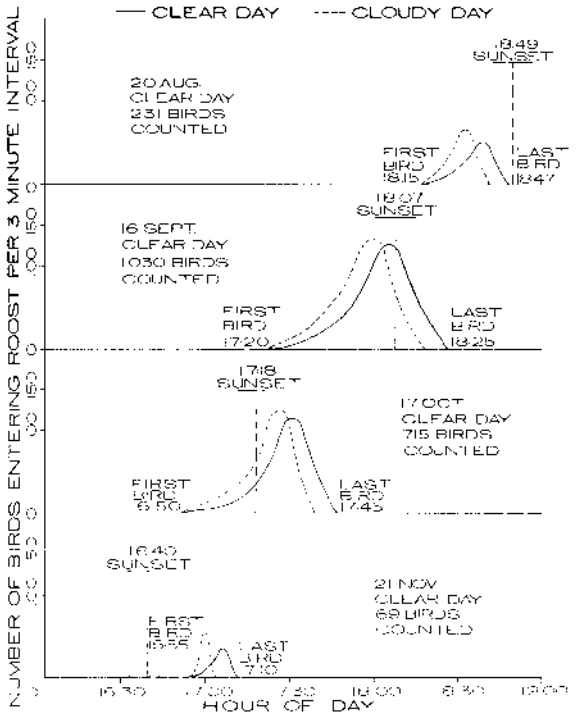

Fig. 3. Model of observed monthly roost arrival curves of wood ducks in relation to sunset on clear days, with predicted different cloudy weather arrival curves caused by a mean 7.5-minute earlier arrival of the last birds. August 20th with 100 percent arriving before sunset on a clear day and 100 percent on a cloudy day; 16 September with 70 percent arriving before sunset on a clear day and 96 percent on a cloudy day; 17 October with 12 percent arriving before sunset on a clear day and 30 percent on a cloudy day; 21 November with 0 percent arriving before sunset on a clear day and a cloudy day.

Martin and Haugen (1960) found that the first wood duck arrived at the roost an average of 7 minutes later for each 10-day period in the fall, which was similar to our results of 6 minutes.

The seasonal decline in light intensity at the arrival of the first bird which we, and other workers (Martin and Haugen, 1960; Hester and Quay, 1961; Hein, 1965) observed, is evidence that wood ducks do not use some constant light level as a signal to begin the roosting flight.

Likewise, the gradually cooler temperatures occurring in the autumn were not found to influence wood duck roosting flight initiation.

Because first birds were consistently arriving at the roost between 16:30 and 17:00 throughout the autumn, they were apparently using some internal or external absolute timing mechanism. Examples of biochronometry are well known among many groups of animals, including birds (Palmer, 1976; Saunders, 1977), so it is not surprising that wood ducks also are capable of exhibiting this phenomenon.

The last birds' arrival at the roost was correlated with a low light intensity level of about 5-10 footcandles, possibly because this limited how well the birds could see suitable safe roosting niches.

Since autumn days become shorter in Southern Illinois, and since first birds kept flying to the roost at the same absolute time, a progressively greater percentage of the total roosting flight arrived after sunset as the season progressed, which agrees with the findings of Martin and Haugen (1960), Hein (1961), and Tabberer, et al. (1971).

Last birds going to the roost only slightly delayed their relative arrival times due to limiting low light levels, while first birds kept arriving at about the same absolute time, and this is the cause of the decline in the duration of the flight activity noted by us and other workers (Martin and Haugen, 1960; Hein, 1961 and 1965).

Cloudy weather did not cause first birds to go to roost earlier, because no limiting low light intensity was reached. Cloud cover did cause last birds to go to roost earlier, probably because of lowered light levels, and the resultant shift in the total roosting flight caused a significantly greater percentage of the birds (about two times as many) to enter the roost before sunset on cloudy days.

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LITERATURE CITED

HARTLINE, Bonn. 1973. Personal communication with the authors.

HARTOWICZ, E. 1965. Evening roosting habits of wood ducks in southeast Missouri. J. Wildl. Manage. 29:399-401.

HEIN, D. 1961. Wood duck roosting flights at Paint Creek, Iowa. Iowa Acad. Sci. 68:264-270.

_____. 1965. Wood duck roosting flight phenomena. Ph.D. Thesis, Iowa State Univ., Ames.

_____, and A. O. Haugen. 1966. Autumn roosting flight counts as an index to wood duck abundance. J. Wildl. Manage. 30:657-668.

HESTER, F. E. and T. L. Quay. 1961. A three-year study of the fall migration and roosting-flight habits of the wood duck in east central North Carolina. Proc. Southeastern Assoc. Game and Fish Commissioners. 15:55-60.

MARTIN, E. M. and A. O. Haugen. 1960. Seasonal changes in wood duck roosting flight habits. Wilson Bull. 72:238-243.

NIE, N. H., D. H. Bent and C. H. Hull. 1970. Statistical package for the social sciences. McGraw-Hill Book Company, New York, N. Y.

PALMER, J. D. 1976. An introduction to biological rhythms. Academic Press, New York.

PARR, D. E. and M. D. Scott. 1978. Analysis of roosting counts as an index to wood duck population size. Wilson Bull. In Press.

SAUNDERS, D. S. 1977. An introduction to biological rhythms. Halsted Press, New York.

SNEDECOR, G. W. and W. G. Cochran. 1967. Statistical Methods. 6th ed. Iowa State College Press, Ames.

STEWART, P. A. 1958. Local movements of wood ducks Aix sponsa. Auk 75:157-168.

TABBERER, D. K., J. D. Newsom, P. E. Schilling and H. A. Bateman. 1971. The wood duck roost count as an index to wood duck abundance in Louisiana. Proc. Southeastern Assoc. Game and Fish Commissioners 25:254-261.