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BREEDING STRATEGIES OF THE NORTHERN BOBWHITE IN MARGINAL HABITAT

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Abstract: We studied nesting behavior of radio-tagged northern bobwhite (*Colinus virginianus*) in south-central Iowa from 1984 to 1988. Female bobwhite incubated 78% of 81 clutches where incubation was observed and males incubated 22%. On only 1 occasion were both a male and female observed to incubate the same clutch. Incubation was initiated on 73% of the nests by females before 1 July, while incubation was initiated on 56% of the clutches by males after 1 July. Males hatched 16% of all clutches, first nests by females accounted for 69%, renests for 4%, and second clutches by females that had already hatched 1 clutch for 11%. Chicks from 3 of the first broods of females that hatched ≥ 1 brood survived for ≥ 1 week and were not accompanied by other adults. These breeding strategies appear to provide bobwhite populations multiple chances at recruitment in variable environments.

Key words: incubation, nesting, nest success, northern bobwhite.

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Nesting ecology of the northern bobwhite has been extensively studied (e.g., Stoddard 1931, Errington 1933, Klimstra 1950, Simpson 1972, Dimmick 1974, Klimstra and Roseberry 1975, Roseberry and Klimstra 1984). Although these studies have described many aspects of bobwhite population dynamics, many others remain poorly understood. Recent miniaturization of radio electronics allows direct observation of bobwhite nesting, survival, and productivity. Some aspects of bobwhite breeding behavior can only be answered using radio-tagging to follow birds in the wild.

Several studies have documented that males regularly incubate clutches (Stoddard 1931, Klimstra and Roseberry 1975). Usually males appear to incubate nests by themselves. This raises the question about the role males play in overall productivity. Few studies document the relative importance of these activities to overall productivity in wild populations.

Sermons and Speake (1987) observed 2 female bobwhite successfully raise second broods in the wild. Stanford (1972a) observed this phenomenon for pen-reared birds. However, an assessment of the importance of second broods to overall productivity was not addressed by these studies.

This paper deals with part of the results from a larger study on quail population dynamics. The

goal of the larger study was to identify mechanisms that allow quail populations to recover quickly after dramatic declines. Here we will specifically examine what strategies male and female bobwhite use to successfully contribute to productivity.

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STUDY AREA AND METHODS

Two areas were selected, a 794-ha site in Lucas County and a 938-ha site in Wayne County, in south-central Iowa. This is in the heart of Iowa's best remaining bobwhite habitat. It consists of rolling topography with flat, narrow ridges separated by deeply cut drainages. Almost all of the land (about 90%) is used for agriculture either as rowcrops (primarily corn and soybeans) or as pasture and hay ground. The proportion of land in each cover type varied during the study, ranging from 35-45% rowcrops, 20-30% pasture, and 15-20% hay. Topography, however limits field size in most areas and results in a greater interspersed of cover types. Most woody cover is found in small woodlots of remnant oak-hickory (*Quercus-Carya* spp.) forest or along fencerows and riparian areas. These cover types make up about 12% of the area. Most woodlots were grazed.

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We captured bobwhite by nightlighting or with baited traps and fitted adult birds with numbered leg bands and backpack mounted radio transmitters (AVM Instrument Co. Ltd., Livermore, CA). In this paper we only consider the nesting behavior of birds that were captured before 1 April. This should minimize the influence that trapping and handling had on our results. Locations were taken on each bird at least 5 times weekly using vehicles with null-peak, twin yagi antenna systems. Locations were used to identify when bobwhite began incubation. Backdating from the date of hatch for successful nests indicated incubation was usually identified on the first or second day. The general area of the nest was determined using a hand-held antenna and receiver while the bird was on the nest. All nesting birds were monitored several times each day. The exact nest site was located when the bird was off the nest. The fate of each clutch was determined by examining the nest site after the radio-tagged bird moved away from the nest.

Beginning in 1986, we captured and fitted bobwhite chicks with leg bands and subminiature transmitters weighing <1 g (Holohill Systems Ltd., Ontario, Canada) from all broods that were hatched by radio-tagged birds before 15 July and a sample of broods hatched later. Chicks were captured using a modified nightlighting technique at 19-25 days after hatch and followed daily until their transmitters failed.

RESULTS

A total of 190 bobwhite was followed into the nesting season. Males slightly outnumbered females in our sample (Table 1). Males initiated incubation in 22% of all attempts and hatched 16% of all successful clutches. For all nests combined, the success rate for males was not different from females ($X^2 = 2.60$, $P = 0.107$) although the power of the test is low. Comparisons between years indicate that the proportion of males initiating incubation varied over a fairly small range (13-19%), while the proportion of females varied over a much larger range (38-85%). The small number of attempts by males precludes statistical comparisons by year, but again the proportion of females that successfully hatched nests varied considerably. Nest success was fairly constant during the breeding season. For those nests where incubation began before 1 June, 59% hatched. Fifty-eight percent of the nests initiated between 1 June and 1 July and 50% of those after 1 July hatched.

It is important to remember that nesting attempts were only recorded when incubation was recorded. This was done because it was not unusual for telemetry locations to indicate that a bird had become localized to an area. Thus the bird appeared to be laying a clutch but often a nest was never found. Since incubation could be positively identified, we used this as our criterion of what constitutes a nesting attempt. Thus our calculations of such measures as success rates

Table 1. Nesting results for radio-tagged quail in south-central Iowa.

Year	Sex	<i>n</i>	Number of nests		Nest ^a success	% of birds		% of birds alive on 1 Sept that	
			Incubated	Hatched		Reaching incubation	Hatching ≥1 nest	Did not incubate	Did not hatch
1984	Male	8	1	0	0	13	0	100	100
	Female	8	4	3	75	38	38	50	50
1985	Male	15	2	1	50	13	7	75	88
	Female	10	11	7	64	70	50	0	0
1986	Male	27	6	3	50	19	11	56	67
	Female	20	20	14	70	85	55	0	0
1987	Male	30	5	1	20	17	3	67	92
	Female	22	13	5	38	45	23	33	50
1988	Male	26	4	2	50	15	8	73	82
	Female	24	15	9	60	63	38	0	25
Total	Male	106	18	7	39	16	7	70	79
	Female	84	63	38	60	62	39	12	24

^aPercent of nests that hatched where incubation was recorded.

must be interpreted with this in mind, especially when making comparisons with other studies.

The earliest date when incubation was initiated was 10 May and the latest 31 August. The period when the largest proportion of incubation attempts was initiated differed between the sexes ($X^2 = 5.14$, $P = 0.024$). Over 70% of attempts at incubation by females occurred before 1 July (Fig. 1). Attempts by males were more evenly split, with 56% occurring after 1 July. The earliest clutch hatched on 5 June, the latest on 22 September. Females hatching their first clutch (where incubation was recorded) accounted for 86% of all nests hatched prior to 1 July, but only 54% of all nests after that date (Fig. 2). Males accounted for the remaining nests prior to 1 July and 17% of nests afterward. One of the nests by a male during the latter period was from a second nest attempt after an unsuccessful first attempt (renest). Renests and second broods (second nests after successful first attempts) by females were responsible for 8 and 21% of nests hatched after 1 July, respectively.

Females that successfully hatched a clutch, raised a brood for anywhere from 19 to 25 days, abandoned the brood, and then renested, were observed in 3 of 5 years during the study. Of the 7 females that exhibited this behavior, 5 successfully hatched second clutches. The date of hatch for the first nest produced by these females ranged from 10 June to 2 July. In 1986, transmitters were attached to chicks in all broods hatched during this time to determine the fate of the chicks. Three of these females successfully produced a second brood. All 3 first broods were still intact at least 1 week after the hen left. The longest any of these broods was followed was for 3 weeks and that brood was still intact when the last transmitter failed. No adults were observed regularly associated with these broods. Second nests were attempted by 33% of all females that hatched prior to 3 July. In the last 2 years of the study no females attempted a second nest, but only 7 females hatched nests prior to 3 July.

DISCUSSION

Males appear to play a significant role in incubating and hatching nests. Nest incubation by males has been reported before (Stoddard 1931, Klimstra and Roseberry 1975) but it was unclear if these males were associated with females. All of the males we observed performed nesting and brood rearing duties alone and were seldom associated with a female. In 1 instance a male assumed incubation of a nest after the female that

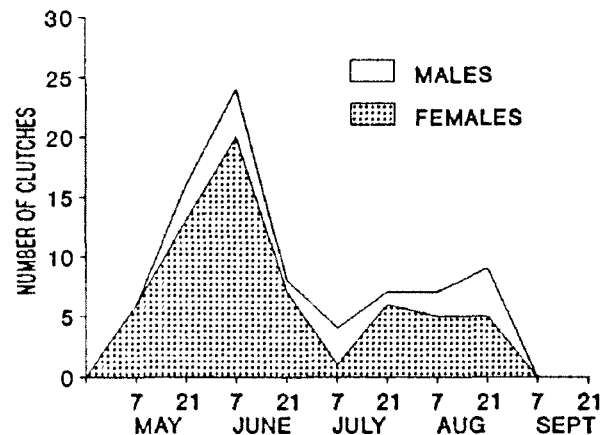


Fig. 1. Dates of initiation of incubation for radio-tagged bobwhite in south-central Iowa, 1984-88.

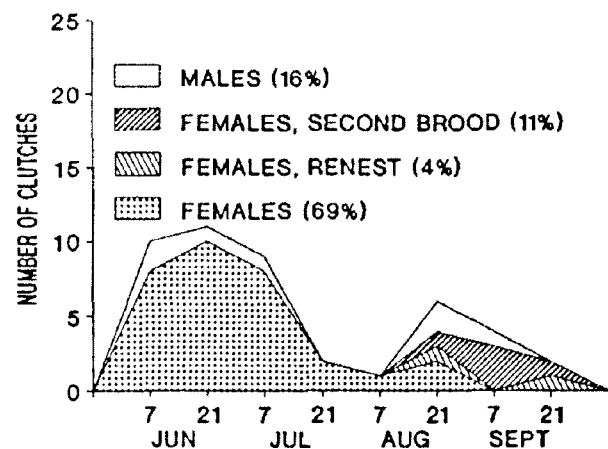


Fig. 2. Dates of hatch for clutches by radio-tagged bobwhite in south-central Iowa, 1984-88.

was incubating the nest was killed away from the nest site. In most instances it appeared the female that laid the eggs was apparently free to continue breeding activities.

The proportion of males that initiated incubation was fairly consistent from year to year, while the proportion of females varied considerably. The proportion of birds that hatched clutches varied widely from year to year for both males and females, although this may be an artifact of the small numbers of nests in any year. Only 39% of females alive on 1 April were ultimately successful in producing a nest. This is considerably below the 75% minimum suggested by others (Stoddard 1931, Kabat and Thompson 1963, Klimstra and Roseberry 1975). These previous studies could not account for multiple nests and nests hatched by

males when making their estimates. But even if we divide the number of nests hatched for all birds by the number of females entering the nesting season, only about 55% produce nests. Nesting effort did not appear lacking, as almost 90% of females still alive on 1 September had at least initiated incubation on 1 nest and 70% had hatched 1 or more nests. Almost 20% of males still alive had also hatched a nest, with 30% having initiated incubation.

Nest success recorded for both males and females was higher than most studies reported (Stoddard 1931, Dimmick 1974, Klimstra and Roseberry 1975). This may be because nest success in those studies was calculated for all nests, whereas we only used nests that reached incubation. If nests have a different rate of loss during the egg-laying and the incubation stage as suggested by Klimstra and Roseberry (1975), then our higher success rates might be expected. The timing of nest establishment had little effect on nest success. Nests established late in the nesting season hatched only slightly less frequently than those established at any other time. Other studies have reported a difference in success rates between nests established during these different periods (Simpson 1972, Klimstra and Roseberry 1975), although the period with the higher success rates differed.

Nesting chronology of our birds closely resembles that reported by Stanford (1972b) in Missouri. Both initiation of incubation and hatching dates were distinctly bimodal, with peaks about 8 weeks apart. First nests by females made up the majority of clutches hatched before 1 July. Clutches hatched after that date were fairly equally divided among first nests by females, second nests by females, and nests by males. Renests by females made up a surprisingly small part of the nesting effort, although this again may reflect our definition of what constitutes a nest attempt. If, as suggested by Klimstra and Roseberry (1975), all nests established after 2 June were renests, then nests where incubation was initiated after 15 June would count as renests. Using this definition, about 18% of all nests hatched by females were renests, 13% were second nests after successful first nests, and 68% were first nests.

We found that a significant number of females did produce second nests after hatching first nests. These females typically raised broods to

approximately 3 weeks of age, left, and became paired with males. The dates of hatch for first nests and timing of brood abandonment are nearly identical to what Sermons and Speake (1987) described. Fortunately we were able to determine the fate of 3 broods abandoned by these females. These broods appeared to do as well as broods accompanied by adult birds. The frequency with which this was observed was surprising but has been suggested by Stanford (1972a). It appears that double broods are an important aspect of bobwhite productivity. The fact that we did not observe this during the last 2 years of the study may be coincidental because only 2 females in 1987 and 5 in 1988 hatched nests prior to 5 July. If we were to view these second nests as if they were random events, then there is about a 10% probability that we would not observe this simply by random chance. Since bobwhite numbers on the study areas were higher during the last 2 years than during the first 3 years, this behavior could be related to population densities.

MANAGEMENT IMPLICATIONS

Bobwhite populations appear to recover very quickly from catastrophic weather events such as prolonged cold and heavy snows (Suchy et al. 1991). These events drastically reduce bobwhite numbers in states like Iowa which are on the fringe of their range. We have described several mechanisms that might contribute significantly to these recoveries and we have more clearly defined what roles male and female bobwhite play in recruitment into these populations. Management efforts directed to take advantage of this tremendous reproductive potential may provide real dividends. Efforts to provide undisturbed, quality nesting cover throughout the nesting season might improve the success of these various reproductive strategies.

We believe we raise some interesting questions. Does the breeding behavior observed occur in other areas or are these behaviors the result of natural selection in areas where large voids intermittently occur in the population? How variable are these behaviors from year to year? Are they affected by population density? Whatever the answers, this increased understanding of the breeding behavior of northern bobwhite will allow wildlife professionals to better understand the impacts of management activities on bobwhite.

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