THE BLACK DUCK (Anas rubripes) IN THE UPPER CHESAPEAKE BAY

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In late March, 1953, ecological studies of Maryland's breeding Black Ducks were begun in the Eastern Bay estuary of the Chesapeake Bay, in Queen Anne's County. Breeding population studies were continued in 1954, and repeated in 1956. Research was conducted under Pittman-Robertson Project W-30-R and submitted as partial fulfillment for a Master's Degree (under the direction of Dr. D. E. Davis of The Johns Hopkins University and Dr. S. C. Kendeigh of the University of Illinois) at the University of Illinois (1955).

Data on incubation, hatching, renesting and productivity will be presented here. Additional information pertinent to special interests will be taken up during the discussion period (or by mail).

METHODS

Primary work was conducted on two islands which were 130 acres and 5 acres in size. The larger island was inhabited and had 70 acres under cultivation. The rest of the island was in cordgrass (*Spartina* spp.) marsh and a mixture of loblolly pine (*Pinus taeda*) and hardwoods. The 5-acre island was dominated by loblolly pine. Additional observations were made of similar habitats on the surrounding mainland.

Breeding population numbers were determined by counts along shorelines from a boat and by walking. Since the majority of study was done in wooded areas, nests had to be searched out by systematic traversing of the selected habitat. Occasionally, draglines were used in marshes and cultivated areas. Searches for nests were repeated, generally every three days to a week. Nests were marked in wooded areas with a green shipping tag tied to nearby foliage and in marshes by a cut branch of a nearby shrub. Nest and egg numbers were marked on eggs with a hard-lead pencil.

In 1954, renesting studies were conducted after techniques used by Sowls (1950). In cases where females constructed nests in untrappable sites, a Lunkenheimer No. 5 oil drip-cup partially filled with unthinned enamel was used to mark females as they sat on the nest. The drip-cup was regulated to emit a drop of enamel every 20 seconds and was suspended over the down or leaf-covered nest. Various shades of enamel, and the patterns which evolved from the random drops of enamel, made it possible to recognize females for 60 days. Females trapped on the nest were marked with red, white, and yellow enamel using Magic Enamel Spray manufactured by the Magic Iron Cement Company of Cleveland, Ohio. Some females were marked in 1956, but renesting information was not the primary objective in mind.

INCUBATION

Incubation was computed as that time interval, to the nearest day, between the laying of the last egg and the hatching of the last egg. During the three breeding seasons 36 records of incubation periods under natural conditions were obtained (Table I). Two nests (clutches No. 14 and 21) were located on the tops of offshore duck blinds in direct sunlight. One nest (clutch No. 26) was located in a saltmeadow cordgrass (*Spartina patens*) marsh, and one nest (clutch No. 30) was located in an oats field. All other clutches were located in quite equally shaded wooded areas.

Incubation periods ranged from 23 to 33 days with an average of 26.1 days. The mode of incubation was 25 days (Tables I and II). Trautman (letter dated April 21, 1955) believes the incubation range for black ducks to be 22 to 25 days under constant incubating conditions.

The number of times the female was flushed from the nest seemed to have little effect upon length of incubation (Table III), probably because clutches from which females were flushed were covered immediately with nesting ma-

terials to prevent undue chilling. Females were found to return to the nest in from two to four hours after being flushed. This time interval may be longer if incubation is in the early stages, and vice-versa.

Clutch-size had no noticeable effect on the incubation interval (Table IV), but incubation became significantly shorter as the season (Table V) advanced. However, length of incubation may very well be affected by multiple factors among which would be variation in clutch size, length of time the female spends off the nest, and the air and ground temperatures. The stage of incubation at which the female is scared off the nest may also affect incubation time as indicated by the following data. Thirteen complete clutches were taken during 1954 renesting studies and placed in a 99° F. incubator. Average incubation was 25.6 days, ranging from 22 to 30 days. Clutches incubated the longest by the female before they were taken to incubate artifically, resulted in increased total incubation time: seven clutches taken fresh or in the first week of incubation averaged 23.7 days, two clutches taken during the second week of incubation hatched at 26 and 29 days, or an average of 27.5 days, and four clutches taken during the third week of incubation averaged 28.0 days. The temporary cooling of the eggs while taking them to the incubator seemed to affect the embryos more in later stages. Of course, relatively fresh clutches were artifically incubated under more constant conditions than they would have been under natural conditions.

HATCHING

During the last few days of incubation the nesting females remained very close to their nests. They were difficult to flush and in many cases would not go more than a few yards from the nest. This was the pipping stage when the young began their emergence from the eggs.

Weak, sporadic pipping sounds were often heard three to four days before the duckling hatched. About forty-eight hours before emergence, pipping became very strong and regular, and ducklings were sometimes heard to peep at this time. Twenty-four to thirty hours before emergence a pip crack was seen. From twenty-four hours on, pipping became more rapid; the shell was chipped almost completely around its circumference, about one-fourth the distance from the largest diameter, the yolk sac was usually completely absorbed, and the duckling emerged. For instance, at 2:45 p. m. on May 30, 1953, a nest with 10 eggs was visited. No pip sounds were noted. At 2:00 p.m. on June 2, all eggs had pip sounds and at 7:55 a. m. the next morning 7 eggs had pip-cracks. That afternoon at 3:15 p. m. all but one egg were pip-cracked. On June 4, at 8:30 a. m. all eggs were pip-cracked but only one was advanced to the stage where the shell membrane was broken. At 3:40 p. m. all young were hatched, very wet, and very weak. The female was present then and at every previous visit.

During this three- to four-day period the female normally began to show the first signs of the "broken-wing" behavior when alarmed at the nest. One female exhibited this behavior in the fifth week of incubation, although all the embryos had died in the third week of development. Other females feigned as early as 16 to 18 days after incubation began. These latter cases took place late in the nesting season, and were probably by females which had had several nests destroyed.

The eggs of a normal clutch all hatched within three to four hours and some ducklings were dry before the last emerged. The pip-tooth was lost between 36 and 48 hours after the young hatched.

In 1953, data on 51 normal clutches which hatched were recorded. These clutches when complete totaled 462 eggs or an average of 9.0 eggs per clutch. Eleven eggs, or 2.4 per cent were hatching when they were abandoned by the female. Twenty-one, or 4.5 per cent of the 462 eggs were undeveloped; all were believed to be infertile, but some embryos may have perished very early in development. Thus, each successful clutch lost a half-duckling from its potential productivity through abandonment of eggs, infertility, and loss of viability. Other factors such as partial predation and loss of eggs from a clutch while female rebuilt flooded nests resulted in further reduction of productivity.

RENESTING

In 1954, forty-three nesting females were marked while they were on their nests. One hen was later killed by a coon and one was allowed to hatch her eggs. The rest either deserted their nests, had them destroyed by predators, or their eggs were collected. Of the 41 potential renesters, six or 14.6 per cent were observed to renest, one twice (Table VI).

In 1956, twenty-two nesting females were marked on their nests, but in only two instances were females purposefully disturbed to disrupt their normal routine. Of the 22 marked females, six abandoned their nests due to flooding or observer interference, one had her nest destroyed by crows, 13 hatched clutches successfully, one female's clutch was taken during the pipping stage, and one brood was taken as they were ready to leave the nest. Of the nine potential renesters, two renested (Table V). However, one of these renesters had successfully incubated a clutch and was seen with her brood a half-hour after they left the nest. Thus, discounting the other 12 marked females which brought off a brood successfully, eight, or 15.7 per cent of the 51 marked females, renested. All the females which renested may not have been marked on their primary nests, especially those marked in the latter half of April.

One hen that deserted her second renest after incubating two days (No. 1) was seen on June 29, fifteen days later, and on July 10 in an 11-group and 30-group respectively, so it is doubtful if she renested a third time. Three of the other five females, which were once again potential renesters, probably did not renest judging from their behavior following desertion of their renests. Two potential renesters and two females which brought off broods were never seen after they left their renests.

From observations of the other 43 marked nesting females not found on renests, it appeared probable that 13 may have renested, 16 were borderline cases which may or may not have renested, and 14 probably did not attempt renesting activities. Without a doubt, many of these females were renesting when they were nest-trapped and marked. Twenty-six females began their nests after the first week in May, which was considered to be the point at which all subsequent nests were renests. The average complete clutch size was 8.6 eggs for 23 marked, potential-renesting females which began laying after the first week in May.

The eight renesting females began their nests between April 1 and April 22 with the average at April 13. They laid an average clutch of 9.1 eggs. Six females for which the clutches were not successful, incubated an average of 14.8 days with a range of 8 to 19 days. Two females with successful clutches hatched their eggs after 28 and 33 days of incubation. The average incubation for all 8 females was 20.0 days. There was no noticeable difference between the renesting interval of successful and unsuccessful females; the average interval was 17.7 days. Two females laid equal primary and renest clutches, two females had a decline in clutch-size of one egg, two renest clutches decreased two eggs, one renest clutch decreased three eggs, and one female laid one more egg in her second nest than in her first. The average renest clutch-size was 8.1 eggs, or an average reduction of 1.0 eggs between first nests and renests. The renesting distance ranged from 50 yards to 785 yards with an average of 297 yards. On mainland areas, renesting distances would probably average much greater. The three renests on the largest island would be most indicative of such areas, there, the renesting distances averaged 540 yards.

The females were not restrictive in their choice of nesting habitat where a variety of cover was available. The female which renested twice constructed her first nest under a honeysuckle tangle in a hardwood grove, her second nest in a brush pile in a hardwood grove, and her third nest in a red clover field. Another female constructed her first nest in a barley field and her renest in blackberry brambles in a hardwood grove.

It seems probable that a hen will renest several times if each of her nests are destroyed while she is laying or within a day or two after incubation begins. Sowls (1951) followed one female through two renesting attempts. Similarly one female (No. 1) on the study area renested twice. Engeling (1949) found one female that renested four times. Furthermore, it is believed

that the majority of nests begun after the nesting peak is past, are renests. on such areas as the study area where early-season nest losses are high. If so, then a minimum of 41.2 per cent of the 1953 nests (161), 28.8 per cent were renests. The clutch size up to the nesting peak averaged 9.6 eggs in 1953 and 1954, and 9.7 eggs in 1956. Beyond the peak clutch-size averaged 8.0, 8.5 and 8.6 in 1953, 1954 and 1956 respectively.

Generally, nesting in the area was fairly common up through the first week in June. After that date nesting decreased rapidly and no nests were found which were started after mid-July. One of the factors limiting further nesting may be the availability of breeding males. For instance, in 1954, flocking males became very common by May 19. During summer trapping operations only three males in breeding plumage were trapped after June 29, and on July 16, the last male in brooding plumage was caught. It is significant that only four nests were found which were started after June 21, and that none were found which was started after July 4.

In any case, renesting is of great importance in areas such as the study area where early-season nest losses are very high. If nest mortality can be held to a minimum until the majority of the primary nests are well into incubation, the chances for success are increased manyfold with the result that more and larger broods are produced.

PRODUCTIVITY

The actual productivity of a species is generally impossible to determine even for a restricted area. However, it is possible to compute certain indices to production. Because the data for two islands in 1953 is believed to be indicative and very nearly normal, productivity will be considered only for

Forty-nine of 147 nests were successful. One nest was not found until shortly after hatching occurred. Its location was such that partial mortality was doubtful and, since all eggs hatched, it is given a clutch-size equal to the average of the other 48 successful clutches. Thus, these nests contained 442 eggs or an average of 9.0 eggs per nest. Of this total, 40 or 9.0 per cent were removed by crows. Twenty-one or 4.8 per cent failed to develop or were infertile. An additional 7 eggs or 1.6 per cent were pipped but were abandoned by the female. Thus, 374 eggs or 84.6 per cent hatched, making an average success of 7.6 young per nest.

Aerial brood counts in the area on July 11, 1953, showed that the average brood size of Class III broods was 6.9 (Nicholson, 1953) or a reduction in average brood size at the point of flying of only 0.7. These figures suggest a brood mortality of 9.2 per cent.

Although only 33.3 per cent of all nests were successful, 62.0 per cent of the breeding population produced a brood. The estimated breeding population for the two islands was 79 pairs. In terms of breeding pairs, the number of young to leave the nest was 4.7 per breeding pair and the number to reach flying age successfully was 4.3 per breeding pair. If true, this figure compares very favorably with other parts of the country. However, these figures must be considered to be relative. Birds which first nest on the two islands may later renest on the mainland when their nests are destroyed. Similarly, hens which first nest on the mainland may renest on the two islands so that they may cancel each other.

There have been 177 direct and indirect returns from 1,256 black ducks banded at two stations during the summers of 1953 and 1954. This is a return of 14.1 per cent. Of these returns, 155, or 87.6 per cent of the total returns, were taken within 50 miles of the banding stations. Band returns show just how important the summer-resident Black Duck is to the early-season waterfowl hunter of Maryland.

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TABLE I

INCUBATION PERIOD ACCORDING TO DATE LAST EGG LAID

Clutch Number	*Clutch Size*	*Date Last Egg Laid*	*Min. Times Hen Flushed*	*Incubation Period*
1	12	4/ 7/54	8	30
2	11	4/12/56	8	28
3	8	4/13/56	17	33
4	12	4/17/56	15	26
5	8	4/19/56	13	31
6	8	4/20/56	8	26
7	10	4/20/53	5	28
8	11	4/25/53	5	26
9	11	4/26/53	9	27
10	11 *	4/26/56	5	32
11	8	4/28/56	11	28
12	9	4/29/53	10	26
13	10	4/29/53	4	24
April Average	9.9	April 21	9.1	28.1
14	11	5/ 1/56	9	25
15	9	5/ 7/56	9	29
16	10	5/ 8/53	8	25
17	9	5/ 9/56	9	25
18	11	5/11/53	9	24
19	5	5/16/53	5	26
20	10	5/16/56	10	27
21	10	5/20/56	2	24
22	8	5/21/53	10	27
23	8	5/22/53	4	23
24	6	5/29/53	10	29
May Average	8.8	May 16	7.7	25.8
25	9	6/ 1/56	12	25
26	8	6/ 4/56	11	24
27	7	6/ 5/53	7	25
28	10	6/ 7/54	8	25
29	7	6/ 7/56	10	27
30	9	6/ 8/56	3	23
31	9	6/10/56	10	25
32	9	6/12/53	7	23
33	10	6/14/53	7	23
34	10	6/14/56	7	24
35	6	6/17/53	7	25
36	9	6/21/56	7	23
June Average	8.6	June 11	8.0	24.3
Total Average	9.1	May 10	8.3	26.1

* Plus six (6) Pheasant eggs.

TABLE II

FREQUENCY OF INDIVIDUAL INCUBATION PERIODS (1953, 1954, 1956)

Days of Incubation	23	24	25	26	27	28	29	30	31	32	33
Number of Clutches	4	5	9	4	5	3	2	1	1	1	1

TABLE III

INCUBATION PERIODS ACCORDING TO MINIMUM NUMBER OF TIMES HEN FLUSHED FROM NEST (1953, 1954, 1956)

Times Female Flushed	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	Total
Number of Clutches	1	1	2	4	0	6	5	5	6	2	1	1	0	1	0	1	36
Average Incubation Period	24.0	23.0	23.5	28.0	. . .	24.2	26.8	26.0	26.8	26.0	25.0	31.0	. . .	26.0	0	33.0	26.1
Standard Deviation	0.00	0.00	0.50	2.45	. . .	0.85	1.93	1.79	1.21	2.00	0.00	0.00	. . .	0.00	. . .	0.00	2.50

TABLE IV

INCUBATION PERIOD ACCORDING TO CLUTCH SIZE

Clutch Size	*No. Clutches*	*Range*	*Average*
5	1	26-	26.0
6	2	25-29	27.0
7	2	25-27	26.0
8	7	23-33	27.4
9	8	23-29	24.8
10	8	23-28	25.0
11	6	24-32	27.0
12	2	26-30	28.0
TOTAL	36	23-33	26.0

TABLE V

SIGNIFICANCE OF SEASON UPON AVERAGE INCUBATION PERIOD

Comparison of Incubation Periods	*April-May*	*May-June*	*April-June*
Difference in Average Incubation	2.3 days	1.5 days	3.8 days
Significance	Insignificant	Insignificant	Significant

TABLE VI

RECORDS OF MARKED FEMALES KNOWN TO RENEST

	Female									
Chronology	1a, b	1c	2[1]	3[2]	4	5	6	7[3]	8[4]	Average
Began laying	4/1/54	..	4/2/56	4/6/56	4/13/54	4/14/54	4/15/54	4/16/54	4/22/54	4/13
Clutch size	10	..	11	8	9	8	11	9	7	9.1
Number days incubated	14	..	28	33	18	12	18	19	8	20.0
Fate of clutch	A	..	H	H	C	A	C	C	A	. . .
Male when nest-fate complete	Ab	..	Ab	Ab	Ab	?	Ab	Ab	Ab	. . .
Renesting interval (days)	14	13	18	17	17	16	15	23	26	17.7
Renesting distance (yards)	690	785	135	390	170	145	50	335	70	296.7
Renest clutch size	9	5[5]	9	9	8	8	8	7	7	8.1[6]
Number of days incubated	7	2	25	25	6	11	5	15	15	12.3
Fate of nest	C	A	H	H	C	C	C	C	C	. . .
Male when nest-fate complete	P	P	Ab	Ab	P	P	P	Ab	Ab	. . .

1 Incubating a clutch of 9 eggs on 6/29/54 at a nest site 20 yards away.
2 Tagged with a fingerling fish tag on 6/28/54 at 18 days of age 0.6 miles away.
3 Incubating a clutch of 9 eggs on 6/17/56 at a nest site 90 yards from first nest.
4 Incubating a clutch of 7 eggs on 7/2/56 at a nest site 210 yards from first nest and 250 from second nest all very nearly in a direct line.
5 Female deserted her nest after laying 5 eggs but returned to incubate 4 days later, therefore, she may have dropped 3 eggs elsewhere.
6 Number 1 female's third clutch (5 eggs) not included.
A—Abandoned C—Collected H—Hatched Ab—Absent P—Present

TABLE VII

PRODUCTIVITY OF PARSON AND BODKIN ISLANDS BREEDING POPULATION

	1953	*Number*	*% of Total*
1.	Total breeding-pair population	79	100.0
2.	Total number of nests	147	100.0
3.	Number of successful pairs	49	62.0
4.	Number of successful nests	49	33.3
5.	Total number of eggs in successful nests	442	100.0
6.	Average number of eggs in successful nests	9.0	. . .
7.	Clutch mortality:		
	a. Partial destruction (eggs)	40	9.0
	b. Undeveloped and infertile eggs	21	4.8
	c. Eggs hatching but abandoned	7	1.6
8.	Total number of successful eggs	374	84.6
9.	Average number of eggs in successful nests	7.6	. . .
10.	Average Class III brood-size	6.9	. . .
11.	Brood mortality	0.7	9.2
12.	Average brood-size at hatching for total breeding-pair population	4.7	. . .
13.	Average flying brood-size of breeding-pair population	4.3	. . .

A RECENTLY DEVELOPED FORESTRY PLANTING TECHNIQUE FAVORABLE TO BOBWHITE QUAIL

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Despite the general acceptance of the Bobwhite Quail (*Colinus virginianus*) as a farm game species, an important segment of the annual hunting effort in Louisiana takes place in the woodlands, often miles from agriculture. Even with recent small scale efforts on the part of forest landowners and the Louisiana Wild Life and Fisheries Commission to do quail habitat development work in the pine type, the bulk of the population owes its existence to the land use in practice.

The role of many factors known to affect, or suspected of affecting quail numbers are not yet thoroughly understood. Research throughout the bobwhite range will provide answers to many of today's questions as well as pose new ones to be answered in the distant future.

One outstanding factor seemingly important in regulating all animal numbers is the strata they occupy in plant and animal succession. We can safely classify the bobwhite as a pioneer who is much more successful during the early stages of plant succession. We can also generally state that better quail habitat is provided where an interspersion of plant communities occurs.

While the game biologist generally understands the basic facts of meeting year-round food and cover needs of quail by plant community manipulations, he is at present lacking in knowledge necessary to accurately predict cost and results of such management.

The modern trend toward more efficient land use aimed at producing more goods of known monetary value has often adversely affected game populations. The field worker today realizes the futility of attempting to halt progress in the name of better game populations. Instead he should realize that his management recommendations must be compatible with the economics of modern land management.

While some of the recent developments in forest management techniques have been discouraging to the game manager, others show promise of materially