4. Following initiation of subimpounding, duck populations increased significantly (especially during period of the average gun season), concentrated earlier and better utilized the total project areas. Average annual fall and winter usage increased 73% (93% during average gun season) on Cheatham. These buildups have occurred during the years of generally low or declining state and flyway populations.
5. Hunting opportunity has been expanded and improved due to the response of the duck populations and increased numbers of quality hunting sites.
6. The experience gained on these projects, especially in regard to water management, should prove of future value in both state and private development of wintering habitat for waterfowl.

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RENESTING AND MULTIPLE BROODING STUDIES OF MARKED CLAPPER RAILS

BY

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Presented at the Seventeenth Annual Conference of the
Southeastern Association of Game and Fish Commissioners
September 30 - October 2, 1963
Hot Springs, Arkansas

Renesting is a recognized phenomenon of clapper rail *(Rallus longirostris)* breeding biology. The occurrence of multiple brooding in this species is not so well recognized; contradictory statements about multiple brooding appear in the clapper rail literature. This paper presents renesting and multiple brooding data based on observations of marked birds. The extent of renesting and multiple brooding, and their significance to clapper rail production are discussed and evaluated.

The renesting tendencies of the clapper rail have been recognized since the days of Audubon (Bent, 1926). Later observers (Sprunt and Chamberlain, 1949; Kozicky and Schmidt, 1949; Stewart, 1951; Schmidt and McLain, 1951; Oney, 1954; Sprunt, 1954; and Adams and Quay. 1958) have concurred with this viewpoint.

The clapper rail is reported to be a two-brooded species by many observers (Wayne, 1910; May, in Forbush, 1939; Sprunt and Chamberlain, op. cit.; Schmidt and McLain, op. cit.; and Sprunt, 1954). Only the observations of Schmidt and McLain in New Jersey were based on marked individuals, though the number of rails marked and observed was not stated in their paper. Forbush (1929) had suggested earlier that the clapper rail might be two-brooded in southern states.

Recent workers have been unable to find evidence of multiple brooding. Their findings were probably influenced by the fact that in no case were marked birds used. Hence, Adams and Quay (op. cit.) in North Carolina, Oney (op. cit.) in Georgia, and Stewart (op. cit.) in Virginia concluded that the clapper rail is a single-brooded species. Kozicky and Schmidt also reported no evidence of multiple brooding in New Jersey two years prior to Schmidt and McLain's work with marked birds.

Definitions

The following definitions are adhered to throughout this paper:

First nest—A breeding pair's first nest of the season containing one or more eggs.

Second nest—A breeding pair's initial nesting attempt (one or more eggs) following the successful hatching and rearing of the young of a previous nest in the same breeding season.

Renest—A nesting attempt following the destruction or desertion of a first nest, second nest, or renest, and in which one or more eggs are deposited.

Renesting Interval—The time between the destruction of one nest and the laying of the first egg in the nest immediately following.

Brooding Interval—The time between the hatching of the first egg of one nest and the laying of the first egg in a second nest.

Production—The total number of young produced; equivalent to the number of eggs hatched.

STUDY AREAS

Nesting studies were conducted on two study areas in the salt marsh habitat of Beaufort County, South Carolina. The field work was conducted from March 12 to August 21, 1963.

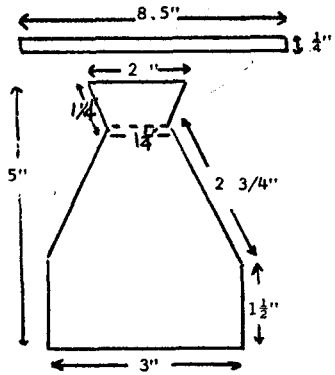
The Albergotti Creek area is a 10-acre shoreline strip, one and three-fourths miles long. It is located north of U. S. Highway 21 west of the Beaufort, S. C. city limits. Salt-water cord-grass (*Spartina alterniflora*: nomenclature from Fernald, 1950) two to four feet in height covers more than 75 per cent of the study area. Tall cord-grass (over four feet) is found along creek banks; short cord-grass (less than two-feet) occurs on a few areas bordering the shoreline. Sea-ox-eye (*Borrichia frutescens*) is common along the salt marsh-upland border; salt-reed grass (*Spartina cynosuroides*), salt-meadow grass (*Spartina patens*), spike grass (*Distichlis spicata*), black rush (*Juncus roemerianus*), and marsh elder (*Iva frutescens*) are found only in small local areas bordering the study area.

The Chowan Creek area is located between Ladies Island, S. C. and St. Helena Island, S. C., four miles southeast of Beaufort, S. C. The area is 40 acres and is bordered on the north by a causeway, part of U. S. Highway 21. Vegetation is similar to that on the Albergotti Creek area except that several growth forms of cord-grass occur, and medium-height cord-grass comprises less than 50 per cent of the cord-grass vegetation. In addition, woody glasswort (*Salicornia sp.*) occurs locally on sandy, well-drained areas near the upland border. Approximately 15 acres of this area is suitable nesting habitat.

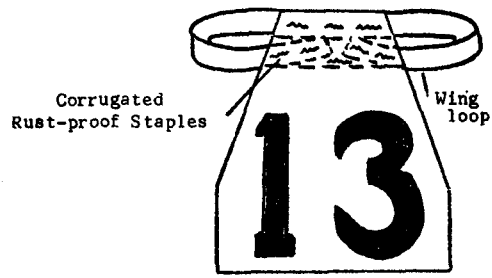
Methods and Materials

Backtags

Backtags similar to those described by Labisky and Mann (1962) were used to mark captured birds. Yellow U. S. Fiberthin (U. S. Rubber Co.) was used for the tags and straps. Numerals were painted black with Ram Cote plastic paint (Ram Cote, Chicago). Figure 1. shows the design of the tag used (See citation for details of construction). Although the authors reported no broken or lost tags on pheasants after 18 months of use, four tags were known to be lost during the nesting season. In addition, the polyvinyl coating on the shoulder straps was completely worn away on several tags exposing the nylon threads. Wearing was severe because rails rub against cord-grass plants and debris constantly.

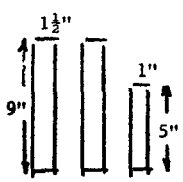


Pre-assembled Tag

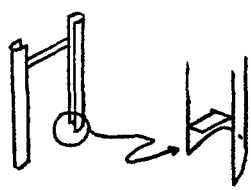


Assembled Tag

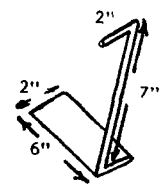
Figure 1. Backtag Design



Gate-guides

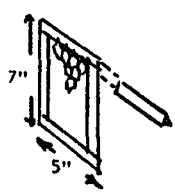


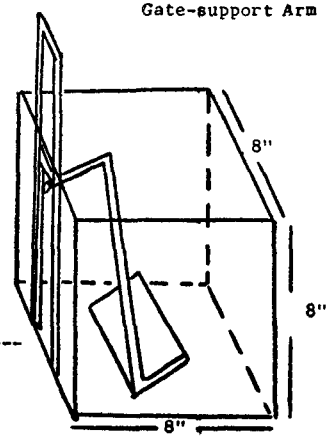
Gate-stop



Gate-release Treadle
and
Gate-support Arm

Gate trimming





Trap in Operation ---

Figure 2. Construction of a Clapper Rail Nest Trap

Traps

Four methods of capturing rails for banding and marking were used originally. Three methods: the all-purpose drift trap, a smaller modified version of the drift trap, and an airboat rigged with lights for night operation were discontinued because of the time involved and the difficulty of locating the nests of birds trapped off their nests.

A nest trap was developed to capture rails on their nests. Trap dimensions and method of construction are illustrated in Figure 2. The walls and top of the trap are made from one-inch mesh chicken wire. The floor is constructed from one-quarter inch mesh hardware cloth (to prevent egg damage). One-quarter inch mesh hardware cloth was also used for the gate-release treadle. The gate-support arm was made of nine-gauge galvanized tie-wire and the metal gate-guides and gate trimming were constructed from 30-gauge galvanized sheet metal.

To construct the trap, the sides, top and bottom are fastened together with wire or small pig-rings. An entrance measuring four and one-half inches wide by seven inches high is cut from one side. The gate-guides and supporting bar are soldered into an H-shaped frame so that when the framework is soldered to the edges of the entrance, the cross bar rests across the top of the opening.

The Z-shaped gate-support arm is soldered to one side of the gate-release treadle. When the treadle is fastened in place as indicated, the gate support arm is bent laterally toward the center of the trap so that the upper portion of the gate-support arm will come in contact with the gate at the center of its bottom edge. Gate-guides and trimming are formed by pressing each metal strip over the sharp edge of an angle iron along its median line. The strip is then bent into final shape by hand in the case of the gate-guides, or hammered flat over the edges of the gate to complete the trimming.

Five nest traps were constructed. Whenever possible, all traps were set out. By the time the last trap was set, the first trap, and then each successive trap could be checked. Trapping time varied from 50 seconds to approximately three hours; most birds were captured within 30 minutes to an hour.

Results

Trapping

Sixty-nine birds were marked and banded: 33 on the Albergotti Creek area (four known pairs), 32 on the Chowan Creek area (six known pairs) and four off the study areas. Fifty-two of the birds were captured in nest traps, four in drift traps, and the remaining 13 were netted from an airboat at night. Nest desertion occurred in 29 instances following nest trapping (15 first nests, 12 renests, two second nests).

Forty birds were not observed again after being marked. However, the fate of 22 of 26 nests occupied by 31 (five pairs) of the 40 birds was determined. The other nine birds were not nest trapped; they were never associated with a particular nest, though their mates may have been marked and observed.

The 29 remaining birds were observed 228 times. Backtag numerals were readable at distances up to 150 yards using 10x binoculars, and up to about 40 yards with the unaided eye under ideal conditions. A light coating of mud made identification of some tags difficult. Curled tag edges sometimes prevented reading a tag number except when the rail was facing away from the observer.

Renesting

The importance of renesting to total production has been ignored in most species of birds. Sowls (1955), who studied five species of prairie nesting ducks, has conducted the most comprehensive investigation of renesting of game birds to date. Clapper rails are faced with many natural enemies including raccoons, crows, and spring tides. Addition of young to the population through renesting attempts might be considerable, especially in years when spring tides are severe during the nesting season.

How many clapper rails renest when their first nest is destroyed?

How many times will an individual renest if its nests are destroyed repeatedly? What percentage of renests succeed, and how much do those successful renests contribute to total production? These are a few of the questions this study has endeavored to answer.

Clutch Size

Oney (op. cit.) was unable to make any distinction in the clutch size of first nests and renests. Kozicky and Schmidt (op. cit.) and Stone (1937) presented their nesting data without reference to renests, probably combining clutch sizes of first nests and renests.

TABLE 1. — CLUTCH SIZES (Complete clutches only)

Type of Nest	No. of Records	Frequency of Clutch Sizes 4	5	6	7	8	9	10	11	12	Average
First Nests	42	1	2	6	10	8	7	6	1	1	7.9
Renests	15	1		6*	4*	4					6.7
Second Nests	6			5	1						6.2

* Includes one renest of a second nest.

Data in Table 1, indicate that the average clutch size of a renest is one egg smaller than the average clutch size of a first nest. However, so much overlap occurs among all types of nests observed that it is not possible to separate a first nest, second nest, or renest from each other on the basis of clutch size.

Appearance of Renests

There are no apparent differences in the appearance of first nests, second nests and renests. Nests built late in the season generally are as well constructed and concealed as earlier nests.

Renesting Intervals

Sowls (op. cit.), reviewing the physiological processes involved in renesting, states that for single-brooded species, the further the incubation period has progressed at the time of nest destruction the longer will be the renesting interval. In the case of two-brooded species the renesting interval is shortest when the nest is destroyed late in the incubation period. This is the result of a renewed growth of the follicles in two-brooded species in preparation for the second nest.

TABLE 2. — RENESTING INTERVALS

Stage of Incubation (in days)	Interval (in days)	Ave. Interval at different stages of nesting	Range (in days)
Egg-laying	7		
Egg-laying	8	8.3 (egg-laying)	4
Egg-laying	10		
2	13		
9	8	10.3 (1-14 days)	7
9	13		
14	7		
15	11		
18	4		
18	9	7.6 (15-23 days)	6
23	7		
		8.8 (Ave. for all data)	

Data on renesting intervals was recorded from 11 nests (Table 2). The longest renesting intervals occurred in the first two weeks of incubation, decreasing as the incubation period progressed beyond the second week. Although the data are few at present, the renesting pattern closely follows that described by Sowls for a two-brooded species. It appears that there is less variation in the renesting interval when a

nest is destroyed during the egg-laying stage. At this point in the nesting cycle it may be possible for the bird to rebuild some follicles that have started to regress.

Renesting After Loss of Brood

One bird is suspected of renesting after the loss of her brood. (This is not included in the calculations for renesting data.) On June 27, bird No. 57 hatched seven eggs of an eight-egg clutch. Fourteen days later (July 11) bird No. 57 was observed on a nest containing three eggs; the final clutch size was six eggs. Bird No. 57's mate was observed from a blind on two occasions but no young were observed. The renesting interval in this case is probably less than 12 days since it is unlikely that all seven chicks of the brood died simultaneously. This renest was destroyed in the second week of incubation by an unknown agent.

Location of Renests

Banding data collected during the past two years indicate that clapper rails in South Carolina are restricted in their movements to an area probably not exceeding 200-300 yards in radius (data not available for November through January). Within this area only a small portion is utilized for nesting. Choice of a renest site appears to be based on cover, concealment, and support for the nest. If such a site exists near the old nest, it is likely to be used. In one instance, a bird used the same nest twice.

TABLE 3. — NESTING DISTANCES (in feet)

Kind of nest	No. of nests	Maximum Distance	Minimum Distance	Average Distance
Renest #1	11	334	9	96
#2	4	63	27	40
#3	2	50	36	43
#4	1	(renested in same nest)		
#5	1	42	42	42
Second Nest	6	146	15	55
Renest #1	2	107	5	56

Renesting distances for 27 nests are summarized in Table 3. Though the average renesting distance of first renests is 96 feet, distances of 20 to 60 feet are more usual. The two greatest renesting distances (334 feet and 311 feet) were both cases in which unoccupied nests were used.

Number of Unsuccessful Hens That Renest

Several factors may affect data on the number of birds that renest:

1. Nests recorded as first nest may actually be renests.
2. Renests may not be located.
3. No birds will be observed on some active nests.
4. Nests may be destroyed before the adult can be observed on the nest or nest trapped.
5. Marked birds may lose their backtags and escape observation.

In view of the possible sources of error, the data below probably represent nearly minimum values.

Eight of 15 hens (53.3 per cent) renested following the destruction of their first nests on the Chowan Creek area. Ten nests were found that could not be associated with a marked bird. Some were probably renests of marked birds.

Only five of 19 (26.3 per cent) hens unsuccessful in their first nesting attempts renested on the Albergotti Creek area. Because this area is a narrow shoreline strip, I suspect that many birds renested outside the area. Attempts were made to locate nests of marked birds outside the area but none were found. The data for the Albergotti Creek area are strongly biased against renests, as the possible nesting habitat along

the one and three-quarter-mile border of the study area comprises too great an area to be adequately searched.

Persistence in Renesting

Clapper rails will renest more than once if necessary to hatch a brood. As the nesting season progresses renesting is curtailed, though some renesting continues into July. The latest renest observed was started about July 11.

Nine birds renested one time, two renested twice, one renested three times and one renested five times. Seven of the nine birds (77.7 per cent) that renested once hatched a brood. One of two birds (50.0 per cent) renesting twice hatched a brood, and the bird renesting three times was unsuccessful on its third renesting attempt. Bird No. five built a first nest, five renests and an additional nest in which no eggs were laid. This individual failed to hatch a clutch.

The renesting tendency is strong in clapper rails, but persistence varies with individual birds. The data do not show that all birds renest but a large segment of the population does, and this may have an important influence on total production.

Renesting and Total Production

Renests represented nearly one-fourth of all nesting attempts on the Chowan Creek area and 14 per cent of all nesting attempts on the Albergotti Creek area (Table 4). Young produced from renests increased production by 23.0 per cent and 12.5 per cent on the Chowan Creek and Albergotti Creek areas, respectively (Table 5). Nesting success was nearly the same for first nests and renests on both areas. The proportion of nests that are renests will vary each year depending upon the extent of nest losses. In some years renesting may not contribute greatly to the year's production, but in other years renesting may account for most of the young produced.

TABLE 4. — NESTING ATTEMPTS

Area	Number of Each Type of Nest				Total
	1st Nest	Renest	2nd nest	Renest	No. Nests
Chowan Creek	32 (69.6%)*	11 (23.9%)	3 (6.5%)	0 (0.0%)	46 (100.0%)
Albergotti Creek	39 (78.0%)	5 (10.0%)	4 (8.0%)	2 (4.0%)	50 (100.0%)
Totals	71	16	7	2	96

* Per cent of total in row.

TABLE 5. — TOTAL PRODUCTION

Area	Number of Eggs				Total Hatched	Per Cent of Total as Renests & Second Nests
	First Nests	Renests	Second Nests	Renests		
Chowan Creek	92 (65.5%)*	24 (23.0%)	12 (11.5%)	0 (0.0%)	128	34.5 (36 eggs)
Albergotti Creek	106 (77.9%)	13 (9.6%)	13 (9.6%)	4 (2.9%)	136	22.1 (30 eggs)
Totals	198	37	25	4	264	

* Per cent of total in row.

Multiple Brooding

Proof that multiple brooding occurs in New Jersey (Schmidt and McLain, op. cit.) suggested that multiple brooding must exist in South Carolina where the nesting season is longer. Lack (1954) has suggested that a multiple-brooded species will raise as many broods as it is able to care for. Following this hypothesis, one might expect multiple brooding to occur more frequently along the southern coast than in northern

coastal areas because of the longer nesting season and milder climatic conditions.

Multiple brooding has been determined positively for seven of 11 birds whose first nests hatched prior to May 31. May 7 is the latest hatching date of the 11 first nests under consideration. In addition, a marked bird observed on May 23 with a brood of two-week-old downy young was observed on July 24 with a brood of young about four weeks old.

Let us consider that no pair whose first brood hatches after May 31 will attempt a second nest. Therefore, seven of 11 (63.6 per cent) birds capable of starting a second nest did so. Obviously, the production potential would be much greater in years when most early nests are successful, other factors being equal.

Clutch Size

Table 2 indicates that the clutch size of second nests is smaller and less variable than those of first nests and renests. However, the difference is not great enough to permit identification of second nests on the basis of clutch size. Two renests of second nests contained the same number of eggs as their second nest, six and seven eggs, respectively.

Brood Interval

The brood interval of six birds ranged from 37 to 56 days with 48.2 days the average. This corresponds closely with the brood-rearing period of the adults. No adults have been observed with young older than six weeks. The length of the brood interval is probably influenced by the physiological condition of the adults, the lateness of the season, and the rate of development of the first brood.

Location of Second Nests

Second nests are located in close proximity to first nests. Though the average distance from first nests is 55 feet (Table 3), distances of 20 to 40 feet are more usual. Renests of second nests are similar in all characteristics to renests of first nests.

Multiple Brooding and Total Production

Second nests are fewer in number than first nests and renests (Table 4). However, second nests help to compensate for the losses of birds that fail to renest or that renest without hatching a clutch. As indicated in Table 5, production of second nests during the 1963 season represented a significant proportion of the total production of both study areas.

Discussion

The contribution of renesting and multiple brooding to total production will vary from year to year. Under certain conditions this variance may be great. When the hatching success of early nests is high, second nests will be numerous. If the hatching success of these nests is not abnormally low, then a large proportion of the total production will be attributable to second nests. The importance of second nests in such situations would be greatly increased should spring tides cause severe losses of renesting attempts in May or June.

Renests assume special significance when hatching success is poor early in the nesting season. Under these conditions first nesting attempts will produce relatively few young. In extreme cases, nearly all production might be attributable to renesting attempts.

Our first year of work with marked clapper rails has brought to light two basic facts: multiple brooding occurs as a part of clapper rail nesting in South Carolina; renesting and multiple brooding make important contributions to clapper rail production.

SUMMARY

1. Renesting and multiple brooding studies of marked clapper rails were conducted on two study areas from March 12 to August 21, 1963.
2. A new type of nest trap successfully used with clapper rails is described.

3. Renesting is an important component of clapper rail nesting. Several important characteristics of renests and renesting are described and discussed.
4. Proof of occurrence of multiple brooding is established. The significance of multiple brooding is discussed, and its essential characteristics are described.
5. The importance of renesting and multiple brooding to total production will vary from year to year depending upon nesting success.

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