Fred Ferrigno

Clapper rail production survey

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JOB PROGRESS REPORT

State of NEW JERSEY

Project No. W-34-R-13

Job No. 1. Work Plan III

Project Title: ECOLOGY OF SALT MARSH AND COASTAL IMPOUNDMENTS

Job Title: CLAPPER RAIL PRODUCTION SURVEY

Period Covered: April 25 to August 15, 1967

SUMMARY: Extensive investigations on various aspects of the ecology of the clapper rail on New Jersey coastal marshes, have led to valuable information in regard to nesting biology, population dynamics, and habitat association. Studies of a long duration are a definite advantage in properly recording both the usual and unusual occurrences in nature. Because of this long-range study in New Jersey, variations in the breeding biology were recorded based on weather conditions, population fluctuations, and other environmental factors. Production trends over the past thirteen years, indicate that the clapper rail populations are not only affected by tides, but by territorialism as well. Phenologically speaking, a series of good nesting years will lead to a certain degree of crowding, which will reduce production for that year, and start the population cycle over again the following year. Recent decline is indicative of the fact that other decreasing factors are superimposed on the normal population dynamics. Possibly, drought conditions, which retarded nesting and protective cover, are responsible for poorer reproduction and brood survival, accounting for a reduced breeding stock. Pesticides and diseases are also being considered and under investigation.

CONTENTS: Primarily the subject material is concerned with the production of the clapper rail on two study areas in Cape May County. It also includes the population dynamics and the downward trend in recent years of clapper rail populations. Reasons for the recent decline such as climatic conditions and their effect on the environment, pesticides and diseases are discussed. Data on the nesting biology of the clapper rail were analyzed statistically and presented in this report.

BACKGROUND: The clapper rail (Rallus longirostris crepitans Gemelin) has been a game bird of considerable importance on the coastal salt marshes of eastern United States since the days of early settlers. Many ornithologists and game biologists have made periodic studies on this species; however, most of the investigations were of short duration. One or two years were the general rule. The earlier information on the clapper rail was assembled in 1926 (Bent). A firsthand natural history account of this rail was made at Cape May, New Jersey (Stone, 1937). Some aspects of nesting behavior and parental care were studied at Cobb Island, Virginia (Pettingill, 1958). Other investigations were made in Massachusetts, North Carolina, Georgia, and several other states.

In New Jersey, the Division of Fish and Game, realizing the importance of the clapper rail as a game bird, started initial studies in 1948. After a short period of extensive field research, an article was published concerning the nesting habits of the clapper rail in New Jersey (Kozicky and Schmidt, 1959). Even though the Division's personnel have been conducting field investigations since this publication, an adequate census to provide an index of population trends was not established until the early 1950's. From 1955 to 1967 valuable information was gathered by the writer on the population trends and life history of the clapper rail. During this period, the collected information showed a considerable variation in nesting habits based on weather and other environmental factors. In addition, this long term research on two study areas in Cape May County, New Jersey, illustrated that the population trends of the clapper rail are of a cyclic nature. This cyclic pattern is not only affected by adverse tidal inundation, but also by the concept of territoriality and other factors.

With the constant loss of our tidal marshes to channel dredging, housing developments, and agricultural practices, it is also of major significance to determine what effect natural and man-made changes have on clapper rail populations so that management can be directed to optimum conditions on remaining marshes.

Since there has been very little work on the ecology of the clapper, this writer made an extensive study in 1963 and 1964 in all the major vegetational zones of New Jersey's coastal marshes. The bulk of the data in this report pertains to ecological evaluation of plant succession, and other changes have been collected under this two year study and was published in a thesis (Ferrigno, 1965). The information on life history and population dynamics was compiled from the long term investigation on two study areas.

PROCEDURES: The field method used in the long-term study was carried on in a consistent manner on two established study areas, Coneys and Keyes Areas, in Cape May County (Figures 1 and 2). Nests were located by searching methodically, on foot, the natural levee areas within the marsh similar to the manner described by Schmidt and McLain (1951). However, subsequent visits, which were shortened to a nine-day interval, were continued until all nesting had ceased. When a nest was found, a stake was placed near by with a number which designated that particular nest. Each nest was closely observed until it was either destroyed or successfully hatched. Data was collected on most phases pertinent to the nesting biology of the clapper rail. This census method was so well adapted for short saltmarsh cordgrass (*Spartina alterniflora* Loisel), that production trends on these two areas were often comparable to fluctuations on short *S. alterniflora* marshes over twenty-five miles away. Approximately 100 percent of the nests can be found in a typical short S. alterniflora marsh.

FINDINGS: This investigation was designed to further our knowledge of the major categories of the biology of the clapper rail. Accordingly, those factors which deserve particular attention are discussed under the following headings: (A) Nesting Biology, (B) Population Dynamics, and (C) Reasons for Decline.

(A) Nesting Biology

Some of the nesting data from 1955 to 1964 has been analyzed statistically but was never presented in a job completion report. This information is now presented according to the following data:

A comparison of the present long-term New Jersey study with previous short-term studies can be made on all aspects of the nesting habits of the clapper rail. Data have been recorded on nesting cover, hatching peaks, laying dates, flight stage, fertility, clutch size, and estimating adult breeding populations.

Nesting Cover

There was a definite preference for *Spartina alterniflora* as nesting cover. From a total of 388 nests, 354 (91.23 percent) were situated in *S. alterniflora*. Mixed stands of *S. alterniflora* and *S. patens* ranked next and made up 4.12 percent. Nine nests (2.32 percent) were found in salt-meadow grass (*Spartina patens* Ait). Four other plant types comprised the remaining 2.33 percent: spike grass (*Distichlis spicata* L.), black grass (*Juncus gerardi* Loisel), marsh elder (*Iva frutescens* L.), and bay berry (*Myrica pensylvanica* Loisel) community.

Kozicky and Schmidt (1949) found that 45 (71.5 percent) of 63 nests were situated within 12 feet of a tidal or mosquito ditch. This percentage seems to vary on different areas depending upon the width of the tall

S. alterniflora edge adjacent to ditches and depressions of other types. In other words, where there is an abundance of mosquito ditches and lack of other vegetative types, it is very possible to find all nests in the tall S. alterniflora edge less than 20 feet from the ditch. This is not true on expansive tall S. alterniflora marshes or where there is considerable dispersion of various vegetational types throughout the marsh.

Nesting Peak

In order to determine peak nesting, the amount of nests present on the marsh during various intervals were totaled for the two study areas, Coneys, and Keyes, (Table 2). During each year more nests were recorded within the June 6 to 14 interval than any other time period. Therefore, it did appear as though the 22.33 ± 1.56 nests did represent peak nesting.

A test of significance was made to see if there were any differences between this peak nesting mean and adjacent means. Although this mean appears to represent peak nesting, the statistical test revealed no significant difference at the 5 percent probability level between: (a) June 1-15 and June 6-14 (calculated t = 1.63, tabled t = 2.12, 16 d.f.); (b) June 6-14 and June 15-23 (calculated t = 1.20, tabled t = 2.12, 16 d.f.). Based on these data, we can not assume that peak nesting occurred during the June 6-14 period. More work is needed to determine the exact location of the peak of nesting season, which takes place in June.

Hatching Peak

The heights of the hatching periods have been given by various investigators throughout the eastern United States. By comparing these heights, nesting season hatching peaks for different geographic areas of the Atlantic Coast have the following gradient: Southport, North Carolina, 1956 - May 22 to June 1 (Stewart, 1951); Chincoteque, Virginia, 1950 - June 1 to 10 (Stewart, 1953); and Ocean City, New Jersey, 1948 - June 16 to 21 (Kozicky and Schmidt, 1949). Despite the fact that our data on hatching peaks closely parallels the 1948 study in New Jersey, hatching peaks will fluctuate on the same area depending upon conditions. These variations are of the utmost importance and can only be accurately determined by years of continuous research. With the one or two-year study program, there is always the possibility of encountering an abnormal year.

An example of the misconceptions that can be derived from short-term investigations is evident in the New Jersey studies. In 1948, the height of the hatching period in South Jersey was between June 16 and 21. When this information is compared with data presented in Table 3, it is readily seen that adverse tidal fluctuations have a marked effect on hatching peaks as well as nesting success. In 1955, the northeast storms that lashed the coastal marshes, destroyed early nesting on several occasions. This complete destruction of early nests resulted in a later hatching peak, July 30 to August 8. Due to a high tide, which occurred on May 10, 1956, when rails were just beginning to nest, the height of the hatching period was between July 3 and 11. During 1957, ideal nesting conditions produced the earliest hatching peak; between June 6 and 14. Overall, from 1955 to 1958, only one year, 1958, was comparable to the data published in 1949. If the study was terminated here, one would question the validity of the 1949 data. However, the study was continued and the average from 283 nests over a ten-year period (Table 3) actually supports the findings of Kozicky and Schmidt (1949).

A test of significance was made to determine the reliability of the 10-year peak hatching mean of 7.80 ± 1.77. Computed t-values (calculated $t = 2.23$, tabled $t = 2.10$, 18 d.f.) illustrate a significant difference between this hatching peak mean and the mean for the preceding period, June 6-14. This was also true of a comparison made between the June 15-23 and June 24 - July 2 time periods (calculated $t = 2.75$, tabled $t = 2.10$, 18 d.f.). At the 5 percent probability level, it can be stated that the hatching peak in the studied areas is approximately the third week of June

(June 15-23). Taking into consideration an incubation period average of 20 days, range 18 to 22 days, and an egg laying rate of one per day (Kozicky and Schmidt, 1949), it does appear that the indicated hatching and nesting peaks for respective years are surprisingly close.

Laying Dates

A considerable number of dates were given for the first and last nests observed during a study period. In Massachusetts the breeding dates were listed as April 27 to June 1 (Forbush, 1930). In 1926, 21 records of egg dates were given from May 24 to June 5 (Bent, 1926). Earlier studies in New Jersey pointed out that complete sets of eggs may be found from May 25 to July 20 (Stone, 1937). In this study, the range of initial to the terminal nesting dates have increased over the years. The earliest nest, with 3 eggs, was recorded April 24, 1957. Another rail nest, with 9 eggs and 1 chick, was observed hatching as late as August 23, 1956. Two years later, a still later nest was observed hatching on September 2. These nests represent the earliest laying and the latest hatching dates on record in New Jersey.

With so little banding information on the clapper rail, it is difficult to ascertain when clappers arrive to begin nesting activities and when they depart in the fall. Most writers contend that first arrivals appear in March and that March April, August, September, and October are the months of greatest movement (Steward, 1954). Of the few birds banded in New Jersey during the nesting season, only one distant return was received. This bird was shot in October in Georgia.

Flight Stage

Hatching peaks with respect to flight periods, is important in regard to setting regulations. Actually, more work is needed on the mean time required for a bird to reach the flight stage after the egg has hatched.

The nine-week interval to flight stage (MacNamara, 1955) has been used in the past and was based on development of the primaries of a few birds. By using this information and hatching peak data (Table 4) it was determined that the bulk (over 60 percent) of the young should be able to fly by August 25 when early nesting attempts are successful. The hunting seasons should commence the first Saturday after this date. Flightless birds will always be present during the early part of the season. Some clappers will not reach the flight stage until the end of September as a result of renesting. During years when initial nesting is wiped out by flooding, opening day should be delayed. In other words, there should be some flexibility in setting the season so that we can adequately cope with existing conditions.

Fertility

Infertility varied little from year to year. Estimates of infertile eggs annually ranged from 4.1 to 6.7 percent. Kozicky and Schmidt (1949) found that of 513 eggs, 87.3 percent hatched successfully, 6.2 percent were infertile, and 6.5 percent lost to other causes.

Clutch Size

An average clutch of 8.2 eggs per nest, with a range of 8 to 13 eggs, was reported in Massachusetts (Forbush, 1930). Steward (1951) found the average clutch size (in 8.38, range 5-11, based on 71 nests) to be markedly less than New Jersey (9.97, range 3-14, based on 104 nests). The 104 New Jersey nests were composed of 43 clutches listed in 1937 (Stone, 1937) and 61 found in 1948 (Kozicky and Schmidt, 1949). Although the average number of eggs per clutch may be statistically sound for several of the above areas, variations, if they occur, are important and a necessity for any complete life history study.

During the present study, most of the average annual clutches varied between 8.10 $\pm$ 0.23 and 9.86 $\pm$ 0.20 (Table 4). The 10-year average for 246 nests was 9.16. Significance tests were made to see if the differences between years were real. At the 5 percent probability level significance was not noted in the following comparisons: 1957 versus 1958, 1958 versus 1959, 1960 versus 1961, and 1963 versus 1964. There was a significant difference in 1955 versus 1956 and 1959 versus 1960. Territorial conflicts in 1959 resulted in a production crash; whereas in 1960, the production cycle commenced over again. The largest means were recorded in 1956 and in 1960. During both of these years clappers were a low in their population cycle, making a comeback from the preceding year's crash as a result of tidal inundation (1955) or territorialism (1959). Besides this hypothesis that annual average clutches are larger during low population years and smaller during over-populated years, there seems to be an overall trend toward a smaller annual clutch size. There was a highly significant difference between the annual means of 1956 and 1964. The calculated t-value, with 36 degrees of freedom, was 4.88; whereas the tabled t.01 value with 36 degrees of freedom was 2.72.

It is a general consensus of opinion that renesting usually results in smaller clutches. In order to evaluate this assumption, all the nests with complete clutches prior to July 1 were totaled and compared with those present on the marsh after this date. Nests prior to July 1 numbered 165; the mean was 9.28 $\pm$ 0.10 with a standard deviation of 1.78. Eighty-one nests were recorded after July 1 with their mean amounting to 8.94 $\pm$ 0.20 (standard deviation = 3.31). A comparison between these periods showed no significant difference between the means for pre and post July 1 periods.

Breeding Population

Dogs, driving, and other methods were tried in an effort to determine breeding populations on a given census area. Because of the secretive nature of the birds and interference with pre-nesting activities, this is not recommended. Counts of the total number of nests present on the marsh at peak nesting time or throughout a given year, were also not valid. The best estimate of the number of pairs appears to be the annual number of successful nest hatches for the surveyed area; that is providing clapper rail do not rear more than one brood. Most investigators feel that the clapper rail will re-nest several times but will produce one seasonal brood. During the course of this investigation, this appears to be true. On one occasion, a banded clapper rail was inundated by high tides at hatch time. The flooding destroyed 2 chicks and the remaining eggs. Later this bird renested, hatched the nest successfully, and raised a brood.

(B) Population Dynamics

Nesting Cover

All of the data collected on the population dynamics was compiled from the two study areas, Coneys and Keyes, in Cape May County. Although both of these areas represent short *S. alterniflora* marsh, certain plant successional and physical man-made changes are continually occurring. It is difficult to obtain similar conditions over a period of time. Nevertheless, the two study areas represent an ideal study combination. While one area has been dropping in its level of population fluctuations as a result of detrimental ecological changes, the other has been progressing to higher levels as a result of beneficial vegetational changes.

On Coneys Area, the natural build-ups in elevation adjacent to some ditches in the form of levees, have brought about unfavorable changes in the vegetation by converting the valuable tall saltmarsh cordgrass (*S. alterniflora*) on the edge of ditches to less valuable salt-meadow cordgrass (*S. patens*). In addition, these *S. patens* barriers block daily inundation, dry out the marsh, and adversely affect inhabiting food chain organisms. Fiddler crabs (*Uca pugnax* Smith) and saltmarsh snails (*Melampus* *bidentatus* Say) reductions on Coneys Area have resulted in less use by clapper rails and black ducks. So, as a result of an ever increasing *S. patens* edge, clapper rail production on Coneys Area has been fluctuating at lower levels. This downward trend has been off-set by an upward production trend on Keyes Area. The mosquito ditching that took place here in the early 1930's has accounted for an increase in ditches, tidal flow, tall *Spartina* edge, fiddlers, and saltmarsh snails. Accordingly, fluctuations have progressed to higher levels as a result of improved habitat. On Coneys Area, which comprises 61 acres, there are only 10,510 lineal feet of ditches. Keyes Area, only half this size, 32 acres, has 12,200 lineal feet of ditches. Accordingly, the length of ditches on a per acre basis on Keyes and Coneys Study Areas, is 381 feet and 172 feet, respectively.

Production By Areas

A summary of the clapper rail nest census by areas is presented in Table 5. Changing habitat as well as population trends, have affected clapper rail production on Coneys Area. Plant successional changes have been instrumental in reducing the quality of the habitat, which in turn, increased the size of the territory. In Sections E and F of Table 5, the mean number of lineal feet of ditch for each successfully hatched nest is lower on Coneys Area. On the other hand, successful production on a per acre basis is much higher on Keyes Area. From this data several assumptions can be hypothesized: (1) The size of the territory of the clapper rail is not only determined by mating and nesting, but feeding as well. Adverse vegetational changes accompanied by reductions in food, probably increased the territory size (Coneys Area); whereas beneficial changes in cover and food have substantially decreased the size of the territory (Keyes Area). (2) The shape of the territory must be oblong along ditches. A clapper rail will tolerate a closer nest on another ditch, and (3) Water surface itself may affect territory. For example, on a larger ditch, nests on opposite sides of the ditch were much closer than those on the same side of the ditch. On the smaller, mosquito ditches, this does not occur. The size of the territory must be somewhat affected by one edge of the tall S. alterniflora on a larger ditch and both edges on the smaller ditches.

Production Trends

Figure 3 and Table 6 represent the production trends over the past thirteen years. The 1967 production was still at a low level despite an increase over 1966; it showed a 50.0 percent increase when compared to 1966 and a 49.2 percent decrease from the past thirteen year average. Relatively low periods of production occurred in 1955, 1959, and 1964. It appears that tidal destruction is somewhat responsible for reduced success in 1955, 1960, 1965, and 1967. During these years, initial nesting was practically eliminated by destructive tides accompanied by strong northeasterly winds. It is very possible that the heavy tidal destruction of 1955 reduced to a low level, the breeding population of the following year and this reduced population started the reproductive cycle over again. However, it is felt that several repeated years of ideal phenological conditions conducive to nesting success can result in territorial conflicts and a production crash (1959) due to over-population of clapper on their breeding grounds. Tides in 1965 and 1967 occurred at a time when other unknown decreasing factors were working on the rail population.

Prior to the 1963 study, it was this writer's personal opinion that if ideal weather and water conditions prevailed, bird predation would increase and production would drop substantially. Although the predation was evident, the predicted production crash did not occur (Ferrigno, 1963). The mistake here was that competition for space, similar to 1959, was anticipated. The production drop did occur in 1963, but territorial conflict was no where near as severe. It is very possible that the social behavior, reduced production, and destruction of nests, will vary and depend upon the degree of crowding. There was a marked difference between the two over-populated years, 1959 and 1963. Although clapper rail production in the years (1958 and 1962) preceding the drop was similar, the cover which was so dense in 1958, accounted for excellent survival of young clappers (Ferrigno, 1958). Consequently, when the birds returned in 1959, competition for territories was so intensive that it resulted in interference with pairing, nest building, egg laying, incubation, and rearing of young. Field observations in 1959 illustrated excessive territorial conflict. Fighting was very noticeable; one clapper was observed maliciously destroying a nest, nests were fewer (Table 5-A), eggs destroyed had piercing holes with diameters similar to that of the clapper rail's bills, bird predation suddenly sky-rocketed upward (Table 5-D), and successful nest hatches crashed to its lowest recorded level.

Conditions were not the same in the 1963 drop; territorial competition seemed less severe, although it was definitely there. The number of nests (Table 5-B) did not decline as in 1958 and fewer nests were destroyed completely. However, there was evidence that eleven nests that had hatched had been partially destroyed prior to hatching.

Our data shows that only one out of four or five years is subjected to this territorial conflict. This conflict, which affects production for that year, actually regulates population density and prevents over-population. Therefore, the stronger birds survive this ordeal, the population is lowered to a level where fighting is reduced, and the bulk of their energy is conserved for reproduction and family stability. This is extremely important for many species in the survival and rearing of young. So overall, this concept of territorialism is very beneficial to the species.

If a comparison of annual production is made with the thirteen year average (Table 6), it can readily be seen that after four years of increasing production, a drop of 40.7 percent occurred in 1959 due to territorial conflicts. This was followed by another four plus years and a drop of 15.3 percent in 1964. Thereafter, it was expected that the population would increase. But, this increase in production never occurred. The declining curve from 1964 to 1967 that dropped production 53.2, 66.1, and 49.2 below the 13 year average, is indicative of other decreasing factors presently superimposed on the normal population of the clapper. It is imperative that these decreasing factors, whether they are due to climate, pesticides, or diseases be defined. Presently, the clapper rail population is at a very low level.

(C) Reasons for Decline

Climate

Climate conditions have a marked effect on the marsh environment and cannot be over-looked as a limiting factor. Associated with the downward trend of the clapper rail has been one of the worst droughts on record (Table 7). After two years of heavy rainfall, 1958 and 1959, a severe drought commenced in April, 1960 and lasted to early August of 1966. During this period, the monthly rainfalls for 27 months (79 percent of the months in this period) were below normal. All seven years, 1960 to 1966, had annual means for the five month period of below normal precipitation. This year, 1967, was the first in the past eight years that sufficient rainfall fell during the growing season.

Drought conditions were responsible for reduction in vegetative cover, higher salinities, higher p.H., and other changes in water chemistry. The reduction in rainfall limited the growth of the Spartina alterniflora adjacent to ditches. Accordingly, ramps and built up nests were relatively absent during the drought period. This lack of cover lead to greater nest destruction by tides and possibly poorer brood survival.

In 1967, cover improved and despite tidal destruction of initial nesting attempts, the number of successful hatches increased 50.0 percent over the proceeding year. If climate is responsible and the next few years are characterized by normal rainfall and limited inundation by storm tides .hen, a upward trend in the clapper rail population should commence.

Considerable increase in salinity and water quality could affect many organisms. Little is known of the effects of higher salinities on the salt glands of both the adult and young clapper rail population.

Pesticides

On September 16, 1967, hurricane Doria passed off of the New Jersey coast. During the high tides and winds, clapper rail died all along the Atlantic coastal marshes. After dying, dead birds drifted into the causways, dikes, and old railroad beds running in an east-west direction. Between 100 and 200 birds were observed dead in each of the following areas: Cape-May-Wildwood Blvd., Wildwood-Rio Grande Blvd., North Wildwood Blvd., Stone Harbor Blvd., Avalon Blvd., old railroad beds at Sea Isle City and Seaville, Palermo Railroad, and Ocean City - Marmora Blvd. Other biologists at Nacote Creek picked up dead birds on the dikes of the Brigatine Refuge and other areas in Ocean County.

Since clapper rail never died like this, even in worst storms, it was suspected that pesticides or disease was weakening these birds, lowering their resistance, and the slightest storm stress would cause a mortality. Accordingly, 10 specimens were submitted to Dalare Associates in Philadelphia for analysis for DDT. At the time, they were not able to analyze for malathion. The results are presented in Table 8.

The specimens from Atlantic County showed significantly higher concentration of DDT than those birds collected in Cape May County. It is encouraging to note that Cape May County, that has been subjected to terrible indiscriminate spraying of DDT for years, (Reicheland Addy, 1968, showed between 1.2 and 17.4 p.p.m of DDT in black duck eggs in the county in 1964), was actually lower than Atlantic County. Because of the build-up of DDT throughout the food chains of marsh organisms and some resistance in mosquitoes, Cape May County Mosquito Commission agreed to switch from DDT to malathion for aerial adulticide spraying of mosquitoes. Therefore, there was no spraying of DDT on the marshes in 1967 and this could have accounted for the difference in the two counties.

Although malathion breaks down more rapidly than the chlorinated hydrocarbons, some heavy kills of fish, crabs, and fiddlers, were recorded at application time. On the basis of these findings, Cape May County has agreed to eliminate all insecticide contamination of the Atlantic coastal marshes with the exception of some spraying just behind some of the resort areas.

The rail mortality attributed to Hurricane Doria and the pesticide analysis were discussed with Dr. Kurtz of Dalare Laboratories. According to Dr. Kurtz, the level of DDT in the liver of the rail was not sufficient to kill the bird. However, he also mentioned that there is approximately five times that amount in the fat of the liver and other organs. During stress, a bird using its fat reserves would be subjected to DDT of higher concentrations. Such concentrations could affect the central nervous system of the bird making it more vulnerable to death during periods of stress, such as storms, starvation, or diseases. Such a situation would be very difficult to prove. Nevertheless, continued spraying of the coastal marshes is not worth the chance. In such a valuable environment, more permanent physical controls of mosquitoes is desirable and chemical contamination by insecticides undesirable.

Diseases

Very little work has been accomplished on the d seases of the clapper rail. Inasmuch as bird malaria is prominent in other birds, blood smears should be taken of a sample of the population.

Project personnel assisted Richard Heard, Jr., Department of Zoology, University of Georgia, with the collection of 20 clapper rail in regard to a study of the parasites of clappers in New Jersey. The ecto and endoparasites identified by R. Heard are presented in Table 8. Heavy infestations of trematodes and nematodes of the genera Maritrema, Parorchis, Levinseniella, Acuariid, Skrjabinobronema, Capillaria, and Skrjabinoclava were evident in most specimens. How these parasites affect the health and resistance of the clapper rail is unknown.

RECOMMENDATIONS:

The study of the population dynamics of the clapper rail should be continued. More study is needed in regard to the reasons for the recent decline and downward trend of the clapper rail population.

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Table 1. Vegetational species composition of nesting cover from 388 clapper rail nests on New Jersey salt marshes, 1955 - 1964.

Type	Nests Per Vegetational Type	
	Number	Percent
S. alterniflora	354	91.23
S. alterniflora - S. patens (mixed)	16	4.12
S. patens	9	2.32
D. spicata	4	1.03
J. gerardi	2	.52
I. frutescens	2	.52
M. pensylvanica	1	.26
Totals	388	100.00

Table 2. Number of nests present on Coneys and Keyes Study Areas for various intervals throughout the nesting season (Ocean City, 1956-1964).

Period	'56	'57	'58	'59	'60	'61	'62	'63	'64	Total	Ave. ± Standard Error
May											
1-15	3	18	4	4	2	3	6	2	2	44	4.89 ± 1.70
16-31	13	20	16	11	10	11	17	23	2	123	13.67 ± 2.16
June											
1-5	14	13	18	16	16	20	21	31	17	166	18.44 ± 1.79
6-14	20	19	24	17	20	27	25	31	18	201	22.33 ± 1.56
15-23	18	15	24	16	15	21	22	29	17	177	19.67 ± 1.58
24-2*	19	17	21	6	10	16	10	6	5	110	12.22 ± 2.01
July											
3-11	13	14	22	4	14	11	10	16	4	108	12.00 ± 1.89
12-20	5	8	18	3	12	6	11	12	4	79	8.78 ± 1.62
21-29	3	6	10	0	8	2	10	3	0	42	4.67 ± 1.32
30-8**	0	4	2	0	1	0	2	0	0	9	1.00 ± 0.47

*July ** August

Table 3. Dates of nest hatching intervals from 1955 through 1964, Cape May County, New Jersey

Period	No. of Nest Hatches Per Time Interval										Total	Mean + Standard Error
	'55	'56	'57	'58	'59	'60	'61	'62	'63	'64		
May												
25-31	0	0	4	0	0	0	0	0	0	0	4	.40 ± 0.40
June												
1-5	0	0	4	0	1	3	0	0	2	1	11	1.10 ± 0.46
6-14	0	0	7	2	1	3	8	7	4	1	33	3.30 ± 0.97
15-23	0	6	1	9	6	5	9	19	10	13	78	7.80 ± 1.77
24-2*	1	6	3	3	1	3	5	2	2	1	27	2.70 ± 0.54
July												
3-11	0	8	5	7	2	1	4	0	5	0	32	3.20 ± 0.95
12-20	0	2	3	7	3	2	4	1	7	4	33	3.30 ± 0.73
21-29	0	3	3	7	0	7	3	8	2	0	33	3.30 ± 0.97
30-8**	23	0	2	2	0	1	0	2	2	0	32	3.20 ± 2.22

* July ** August

Table 4. Annual variation in the average clutch size of the clapper rail.

Year	No. of Nests	Mean ± Standard Error
1955	15	8.73 ± 0.32
1956	21	9.86 ± 0.20
1957	32	9.75 ± 0.40
1958	36	8.89 ± 0.72
1959	10	8.10 ± 0.23
1960	26	9.54 ± 0.34
1961	28	8.93 ± 0.19
1962	29	8.90 ± 0.21
1963	32	8.72 ± 0.16
1964	17	8.24 ± 0.26

Table 5. Results of the clapper rail nest census over a thirteen-year period.

Area	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967
					(A) Number of Observed Nests								
Coneys	29	20	26	26	13	18	14	12	21	8	9	5	12
Keyes	7	10	18	19	16	19	23	28	28	15	15	6	12
Totals	36	30	44	45	29	37	27	40	49	23	24	11	24
					(B) Number Hatched Successfully								
Coneys	20	16	19	20	6	13	11	12	14	8	4	4	7
Keyes	4	9	13	17	8	12	22	27	20	12	7	4	5
Totals	24	25	32	37	14	25	33	39	34	20	11	8	12
					(C) Number Destroyed by Tides								
Coneys	9	4	5	5	2	4	2	0	2	0	5	1	5
Keyes	3	1	4	2	2	6	1	1	5	3	8	2	7
Totals	12	5	9	7	4	10	3	1	7	3	13	3	12
					(D) Number Destroyed by Predators								
Coneys	0	0	2	1	5	1	1	0	5	0	0	0	0
Keyes	0	0	1	0	6	1	0	0	3	0	0	0	0
Totals	0	0	3	1	11	2	1	0	8	0	0	0	0
					(E) Mean No. Lineal Pt. of Ditch Success Nest								
Coneys (10,510)	526	657	553	516	1,752	809	956	876	751	1,314	2,628	2,628	1,501
Keyes (12,200)	3,050	1,355	937	718	1,525	1,016	555	452	610	1,017	1,743	3,050	2,440
Totals (22,710)	1,030	908	709	614	1,622	908	688	582	668	1,135	2,065	2,839	1,893
					(F) Acres/Successful Hatch								
Coneys (61)	3.05	3.81	3.21	3.05	10.18	4.69	5.55	5.08	4.36	7.63	15.25	15.25	8.71
Keyes (32)	8.00	3.55	2.46	1.88	4.00	2.66	1.45	1.19	1.60	2.66	4.57	8.00	6.40
Totals (93	3.88	3.72	2.91	2.51	6.74	3.72	2.82	2.38	2.74	4.65	8.45	11.63	7.75

Table 6. Production trends of the clapper rail from 1955 to 1967

Year	Number of Successful Hatches	Percent of Change: Compared with Previous Year	Percent of Change: Compared with 13 Year Average (23.6)
1955	24	-------	+ 1.7
1956	25	+ 4.2	+ 5.9
1957	32	+ 28.0	+35.6
1958	37	+ 15.6	+56.8
1959	14	- 62.2	-40.7
1960	25	+ 78.6	+ 5.9
1961	33	+ 32.0	+39.8
1962	39	+ 18.2	+65.3
1963	34	- 12.3	+40.7
1964	20	- 40.9	-15.3
1965	11	- 45.0	-53.4
1966	8	- 27.3	-66.1
1967	12	+ 50.0	-49.2

Table 7. Monthly Precipitation Departures (in inches) from the Normal Amount

Year	April	May	June	July	August	Total*
1955	- .64	-2.89	+2.46	-1.49	+2.39	+0.85
1956	- .70	-1.15	+0.29	+1.01	- .26	-0.81
1957	-1.13	-2.97	-0.07	-3.41	+1.52	-6.06
1958	+0.92	+1.91	+1.55	+6.00	+4.58	+14.96
1959	-0.08	+2.52	-1.54	+9.37	-1.33	+8.94
1960	-1.17	-0.77	-2.22	+2.14	-2.22	-4.24
1961	-0.21	+0.19	-0.01	- .30	-2.85	-3.16
1962	+0.17	-1.74	+1.37	-1.05	+0.39	-0.86
1963	-2.02	-0.56	+0.24	-1.15	-1.97	-5.56
1964	+4.18	-1.86	-1.99	- .93	-3.27	-3.87
1965	-1.41	- .92	-1.59	-1.17	-1.11	-6.20
1966	-0.83	-0.34	-0.82	-1.16	+4.14**	+ .99
1967	-0.65	+0.17	-1.46	+0.47	+7.08	+5.61

* Total departure from the normal for the five-month period.

** Heavy rain in late August disturbed the precipitation figure for the five month period.

Table 8. Insecticide Analysis of Clapper Rail That Died During Hurricane Doria, September 16, 1967

Area	Sample No.	DDT Found in Liver (parts/millions)
Atlantic County		
Brigantine Refuge (Nacote Creek)	1	0.15
	2	0.11
	3	0.36
	4	0.29
	5	0.25
Mean		0.23
Cape May County		
Palermo Railroad	1	0.19
	2	0.16
Stone Harbor Blvd.	3	0.15
	4	0.08
Avalon Blvd.	5	0.15
Mean		0.15

Table 9. Parasites of Clapper Rail in Cape May County (August 13-22, 1966) Collected and Identified by R. Heard in Cooperation with New Jersey Division of Fish and Game.

Parasite	Site of Infection	*No. of Birds Infected
Trematodes		
Maritrema sp.	Small Intestine	20
Parorchis acanthus	Cloaca	15
Levinseniella byrdi	Ceca	12
Odhneri raminellae	Ceca	4
Himasthla quissetensis	Small Intestine, Rectum	4
Prosthogonimus sp.	Bursa	3
Notocotylus sp.	Ceca	2
Carneophallus turgidus	Small Intestine	1
Lyperosomum sp.	Rectum	1
Tanasia fedschenkoi	Kidney	1
Echinochasmus schwartzi	Small Intestine	1
Cestodes		
Raillietina sp.	Small Intestine	4
Nematodes		
Acuariid larva	Gizzard Lining	20
Skrjabinobronema spp.	" "	17
Capillaria sp.	Ceca	12
Skrjabinoclava sp.	Proventriculus	11
Dispharynx nasuta	Esophagus	9
Mites		
Nasal mites (unidentified)	Nares	3
Malophaga		
Rallicola ortygometrae	Breast Feathers	3
Pseudomenopon sp.	" "	1

* **Sample involved** 20 clapper rail which included 14 immatures, 3 chicks, and 3 **adults.**

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