REPRODUCTIVE BEHAVIOR AND PERFORMANCE OF THE FEMALE FLORIDA WILD TURKEY

BY

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A DISSERTATION SUBMITTED TO THE GRADUATE SCHOOL OF THE UNIVERSITY OF FLORIDA IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

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Two hundred forty-eight nests of 202 radio-telemetered wild turkeys (Meleagris gallopavo osceola) were monitored in Florida during the period 1968-1982 to determine nesting phenology and habitats, clutch size, activity patterns, sensitivity to disturbance, predation, renesting tendencies, and nesting success.

Nest initiation began when hens laid eggs, usually in mid-day, in depressions scratched in the soil, and covered them with dry leaves. Incubation began gradually after the fifth egg was laid; first laid eggs experienced about 25 hours more incubation than last eggs. The incubation period was 27 ± 1.3 days. Hatching synchronization seemed to be poorly developed. Fifty-eight percent of the nests were located in saw palmetto (Serenoa repens), 31% in cypress (Taxodium distichum) woods, and 11% in various "other" habitats. Nest predation was greatest in cypress woods and least in the habitat category "other."

Fifty-seven percent of the hens whose nesting was disrupted during the laying period renested; only 28% of those disrupted while incubating renested. Renesting rates were 44% for adults and 22% for yearlings; nearly one-half chose a different habitat for renesting.

Hatching required more than 1 day. Egg hatchability was 89.2%. Sixty-eight percent of the broods departed the nest during morning hours after sunrise.

The earliest clutch was initiated on 6 March and the latest clutch hatched on 2 July. Yearlings began nesting later in the season but finished earlier than adults. Adults laid 10.5 (SE = 0.16) eggs per clutch and yearlings laid 10.0 (SE = 0.28); the mean was 10.3 (SE = 0.14).

Fifty-one percent of the hens flushed from nests did not return. Sixty percent of the incubating hens and 38% of the laying hens returned; 56% of the adult hens returned but only 27% of the yearlings returned. Thirty-nine percent of the hens flushed from nests in cypress woods returned, whereas 59% flushed from nests in palmetto returned.

Approximately 55% of the nests were depredated. When renesting was taken into account, nesting success was 58.7% for nesting hens.

Laying behavior, incubating activites, nest attendance patterns, hatching vocalizations, defensive behavior, and hatching behavior also are discussed.

INTRODUCTION

The wild turkey is endemic to North America. The turkeys were reclassified (American Ornithologists' Union 1982) recently into the family Phasianidae. The only other living species in the turkey subfamily Meleagridinae is the ocellated turkey (*Meleagris ocellata*) of southern Mexico and Central America.

The Florida subspecies of wild turkey (*M. g. osceola*) was named for the Seminole Indian, Osceola, by W. E. D. Scott (1890) from type specimens taken near Tarpon Springs. It is a clinal subspecies that intergrades with the eastern form (*M. g. silvestris*) in a zone from southern South Carolina, across southern Georgia, northern Florida, southern Alabama, southern Mississippi, to eastern Louisiana (Aldrich and Duvall 1955).

Florida had a sizable turkey population in early historic times (Wright 1915), but the species was eliminated by unregulated hunting from some parts of the state by 1948 (Newman and Griffin 1950). In the statewide restocking program that was initiated in 1951 (Powell 1965), turkeys were trapped from protected Florida populations and released in suitable range that was not inhabited by turkeys. Completion of the restocking program in 1970 gave Florida the distinction of being the first state to complete a successful statewide turkey restoration program.

Estimates of the fall population in Florida topped 100,000 in 1964. In 1966 the population and harvest plumetted due to unknown

causes, which resulted in considerable concern. By 1969 turkey populations had recovered to pre-die-off levels, although there was evidence that populations on certain wildlife management areas were suffering from over-harvest during fall, either-sex hunting seasons (Williams et al. 1978).

Curtailment of hen harvest on wildlife management areas, by termination of fall hunting and expansion of spring gobbler hunting, was being contemplated. Because there had been no research on turkey ecology in Florida, effects of spring gobbler hunting on nesting processes were unknown. Consequently, this study on nesting ecology was initiated with emphasis on aspects that relate to possible effects of spring gobbler hunting on reproduction. Specific objectives were to characterize the seasonality of nesting, identify nesting habitats, determine activity patterns of nesting hens, measure the sensitivity of nesting hens to human disturbance, measure renesting tendencies, and generally elucidate the behavioral characteristics of the hen during the reproductive period.

STUDY AREAS

Field work was conducted on Lykes Fisheating Creek Wildlife Management Area (WMA) during 14 of the 15 years from 1968 to 1982 and on Lochloosa WMA during 1969, 1970, 1973 and 1975. The hunting rights on both privately owned areas are leased to the Florida Game and Fresh Water Fish Commission for public hunting.

Fisheating Creek

The Fisheating Creek Study Area (Fig. 1) is located in Glades County, about 20 km west of Lake Okeechobee. The terrain is flat, ranging between 9 m and 17 m above mean sea level. Soils are predominantly sandy. The major soil associations are Fresh Water Marsh and Swamp along the creek to about 1 km outward, Myakka-Pomello-Basinger on the higher areas between the creek and palmetto prairie, and Oldsman-Wabasso-Felda in the palmetto prairie (Florida Department of Administration 1974).

The climate is subtropical. At Ft. Myers, which is approximately 81 km to the southwest (the nearest reference point for complete weather data), the mean maximum and minimum daily temperatures in April are 28.9 C and 16.3 C, respectively. Mean maximum and minimum daily temperatures in July are 32.8 C and 22.9 C, respectively. Mean annual temperature at Moore Haven, about 30 km to the southeast, is 22.8 C. The mean date of the first subfreezing temperature at Moore Haven is December 25 and the mean date of the last winter freeze is January 23 (National Oceanic and Atmospheric Administration 1978).

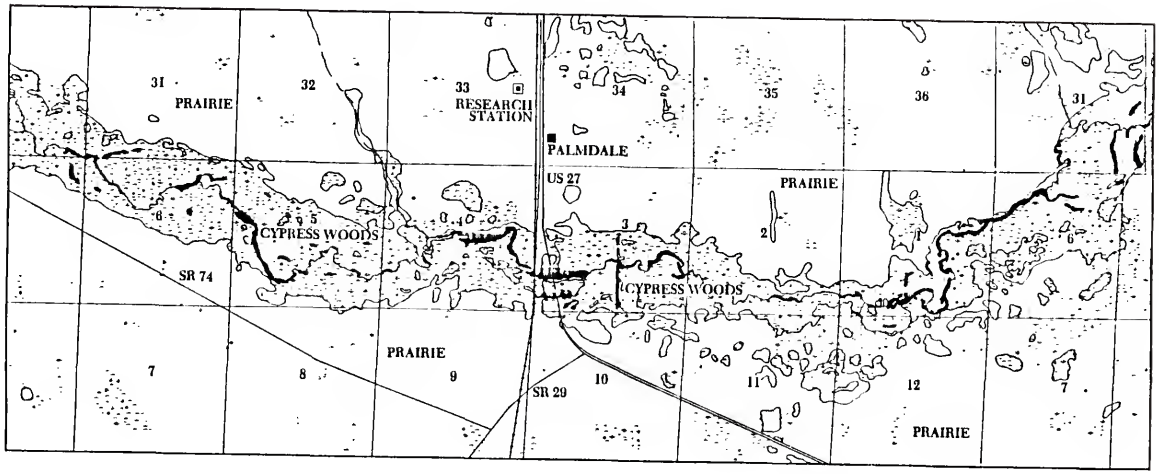

Figure 1. The Fisheating Creek Study Area, Glades County, Florida.

Mean annual precipitation at Moore Haven is 127.9 cm, and at LaBelle, about 25 km to the southwest, 132.5 cm. More than 60% of the annual precipitation comes from thunder showers during the summer months.

Six plant associations with narrow, ill-defined ecotones between them, were delineated at Fisheating Creek. Cypress woods, which comprised 51% of the study area, occurred along the creek (Fig. 2). The creek was subject to shallow flooding at least once annually. Understory shrubs and midstory trees, other than young cypress, were sparse; the ground cover of carpet grass (*Axonopus compressus*), smartweed (*Polygonum* sp.), mistflower (*Eupatorium coelestinum*) and other annual herbs became dense by May (Fig. 3).

Live oak trees (*Quercus virginiana*), which comprised 12% of the study area, occurred in stands called hammocks (Fig. 4). Most hammocks contained small clumps of saw palmetto and cabbage palm (*Sabal palmetto*). A few hammocks contained laurel oak (*Q. laurifolia*), red mulberry (*Morus rubra*), and hackberry (*Celtis laevigata*) also. Trees in the hammocks were draped with Spanish moss (*Tillandsia usneoides*) and other epiphytes.

Glades paralleled the cypress woods, forming zones of short grasses (mainly *Axonopus compressus*) that were dotted with isolated live oak trees and small live oak hammocks (Fig. 5). These open areas were grazed heavily by cattle and had the appearance of semi-improved pastures. Approximately 17% of the study area was glades.

Broadleaf evergreen shrubs (e.g. *Myrica cerifera*), evergreen trees (*Gordonia lasianthus*, *Magnolia virginiana*, and *Persea* spp.), and vines (*Vitis* sp. and *Smilax* spp.) existed in bay heads and swamps which comprised 2% of the study area.

Figure 2. Aerial view of cypress woods on the Fisheating Creek Study Area in spring.

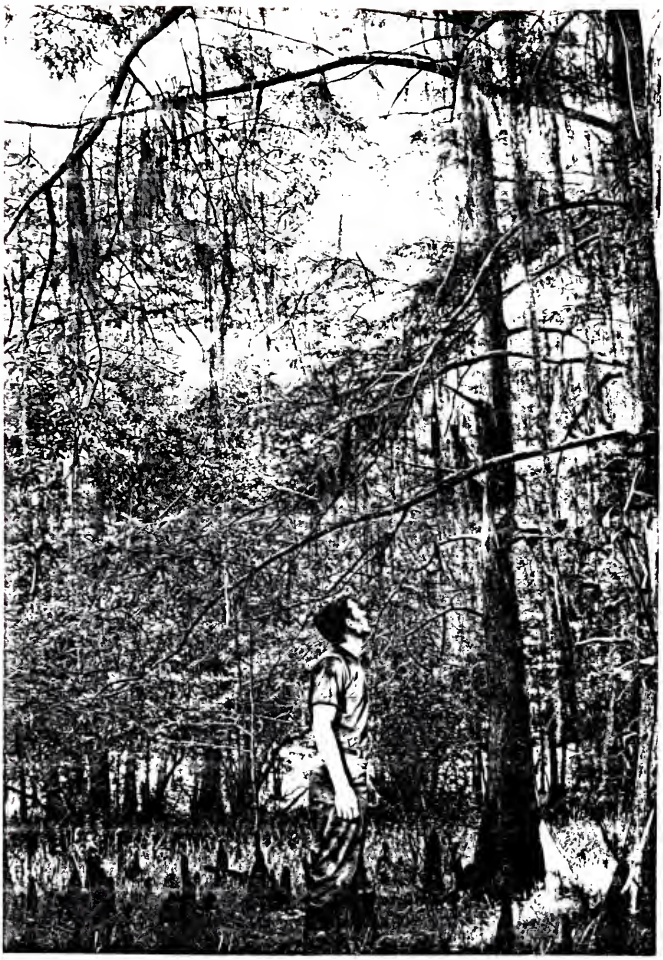

Figure 3. Inside the cypress woods at Fisheating Creek Study Area in May.

Figure 4. An open live oak hammock on Fisheating Creek Study Area in February.

Figure 5. A glade on Fisheating Creek Study Area in winter showing evidence of cattle grazing (foreground).

Bayheads and swamps often contained surface water and supported dense, woody, understory vegetation; the soils contained a relatively high proportion of humus and litter.

Oak scrub, which covered 12% of the area, is an association of small, mostly evergreen oaks (Q. chapmanii, Q. myrtifolia, Q. geminata, and Q. inopina) and other short, woody vegetation (e.g. Lyonia ferruginea, Befaria racemosa, Ilex opaca var. arenicola) on sandy soils that lie about 13 m above mean sea level (Fig. 6). Sand pine (Pinus clausa) was not present.

The prairie is a wide, flat expanse of saw palmetto and wire grass (Aristida stricta), dotted with widely-spaced pine trees (Pinus palustris and P. elliottii) and small islands of oak scrub. The prairie extended for many miles to the north and south of the woodlands along Fisheating Creek and was a travel barrier to turkeys. It was not considered part of the study area except for the ecotones between palmetto prairie and other plant associations. This ecotonal zone was about ½-km wide and comprised approximately 5% of the study area.

Small patches of other plant associations, creeks, ponds, sloughs, and marshes, improved pastures for cattle, and roads made up the remaining 1% of the study area. The major plant associations formed zones approximately parallel to Fisheating Creek (Fig. 7).

The owners ran cattle on the area and feral hogs were present. No special land management practice for turkeys was used on the area.

Lochloosa

Lochloosa WMA is located principally in Alachua County of northern Florida, about 350 km north of Fisheating Creek WMA. The

Figure 6. Oak scrub (background) joins the saw palmetto prairie in a ecotone (foreground) in which some of the characteristic plants of both associations occur together. Fisheating Creek Study Area.

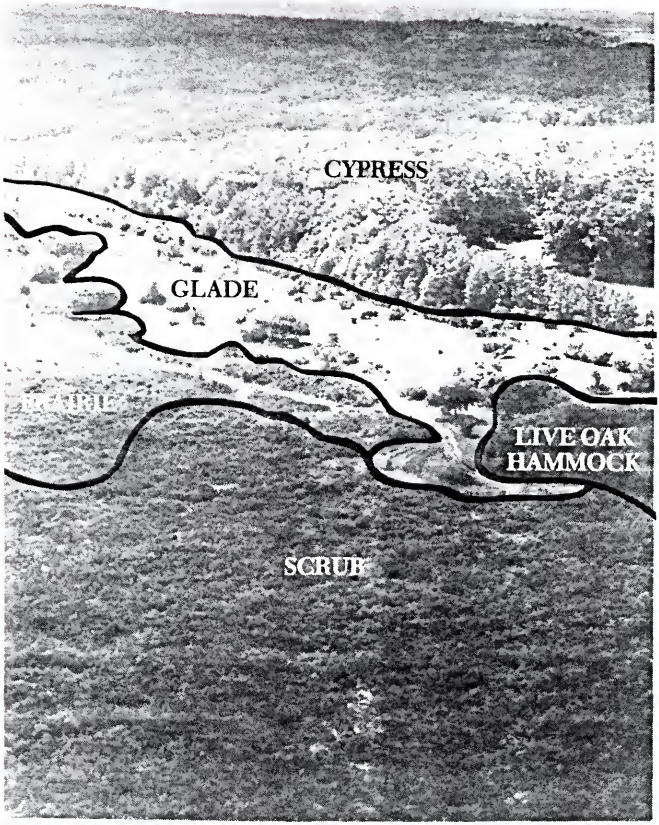

Figure 7. Aerial view of a typical cross-section of the Fisheating Creek Study Area showing cypress woods (top), a glade parallel to the creek, a live oak hammock adjacent to the glade, saw palmetto prairie (left middle), and oak scrub (lower middle).

major land owner, Owen-Illinois, Inc. (Forest Products Division), managed the property primarily for pulpwood. The study was conducted on a sector that comprised about 3,200 ha of the 12,500 ha WMA (Fig. 8).

The terrain is flat to slightly rolling, ranging 17 m to 30 m above mean sea level. Soil types on the sand ridges are Millhopper, Tavares, and Newnan sands. In the ponds and swamps, the main soils are Monteocha loamy sand, Pomona sand, and Samsula muck, whereas the main flatwoods soil is Pomona sand (U.S. Department of Agriculture 1982).

The mean annual temperature is 22.2° C at Gainesville, 15 km northwest of the area. The mean date of the first and last frost is December 6 and February 14, respectively. Mean annual rainfall is 133.2 cm, with more than 50% occurring in summer (National Oceanic and Atmospheric Administration 1978).

The original upland plant associations were mainly longleaf pine (*Pinus palustris*) and turkey oak (*Quercus laevis*), and slash pine (*P. elliotti*) flatwoods (U.S. Department of Agricuture 1980). These associations were replaced mostly by slash pine plantations during the 1950's. Areas planted were first chopped, burned, and then machine planted at a density of 764 seedlings per ha. Pine woods comprised approximately 50% of the area. About 9% of the study area was in natural slash pine stands. Many of the large live oak hammocks had been eliminated by commercial forest management practices. A hardwood control program implemented during the 1950's was not entirely successful; consequently, the slash pine plantations had nearly as

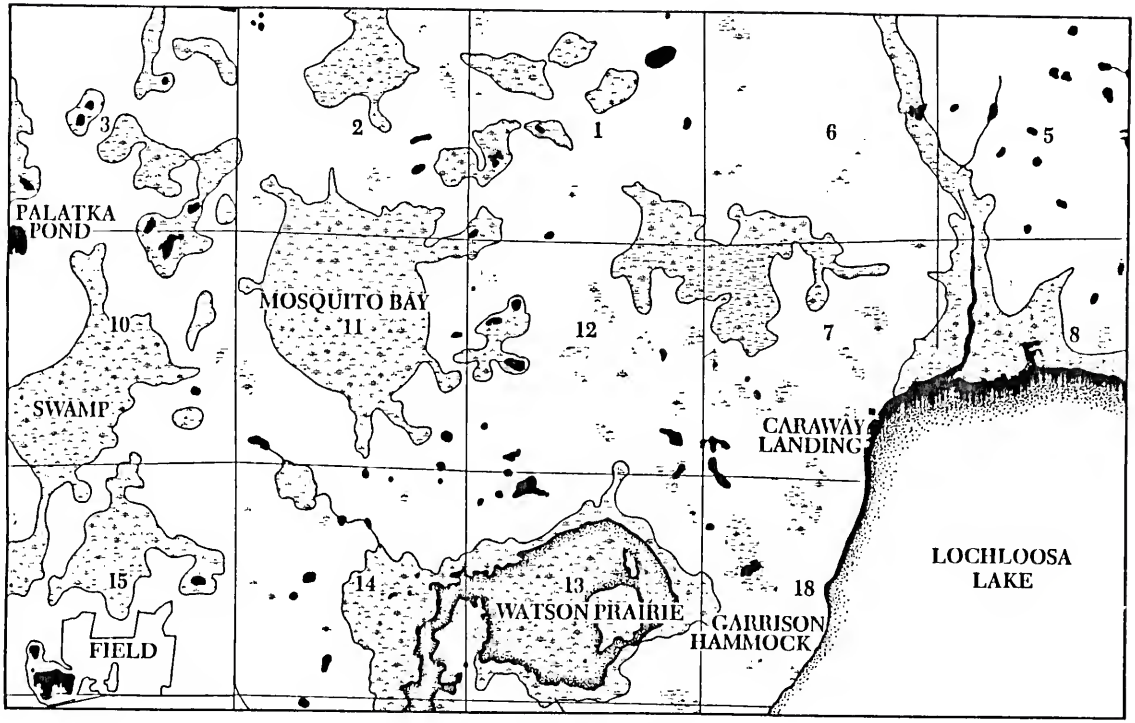

Figure 8. The Lochloosa Study Area, Alachua County, Florida.

much young live oak and laurel oak as pine (Fig. 9). The planted pine and oak association occupied about 15% of the study area.

Pinelands in the study area were logged, primarily by clearcutting, at various times during the study making it difficult to meaningfully catagorize the resulting associations and stages of plant succession.

Recently clearcut pinelands covered approximately 7% of the area and improved cattle pastures, 2%. Cypress heads and hardwood swamps occupied 10% of the area and open ponds comprised about 1%. Approximately 2% of the area was in hardwood hammock; seasonally wet prairies made up the remaining 4%. There were no palmetto flats or grazed glades, as described for Fisheating Creek, but saw palmetto occurred abundantly. The area was grazed by cattle; feral hogs occurred in small numbers.

The wild turkey was eliminated by overhunting in the area that is now in the Lochloosa WMA between 1900 and 1950. The area was restocked with wild-trapped birds from Fisheating Creek WMA in the early 1960's. No other turkey management, except enforcement of hunting regulations, had been practiced. The area was open to year-round public use. The spring gobbler season consisted of 16 half-days of hunting in late March during the study period.

Figure 9. Thirty-year-old planted slash pine woods with oak regeneration on Lochloosa Study Area, Alachua County, Florida, 1980.

METHODS

Hens were captured with cannon nets (Austin 1965), rocket nets, orally administered tribromoethanol (Williams et al. 1973), and alpha-chloralose (Williams 1966). Age classes of the hens were determined by the configuration of the greater upper secondary coverts (Williams 1961). All birds were weighed and banded prior to being radio-instrumented. Turkey handling procedures have been described previously (Austin et al. 1973).

Radio transmitters were attached to 414 hens, 35 on the Lochloosa Study Area and 379 on the Fisheating Creek Study Area. Data were obtained from 248 nests of 202 hens that nested one or more times. Because of the small number of nests (N = 15) on the Lochloosa Study Area, no attempt has been made to contrast the turkey populations on the two study areas.

Transmitters were spaced across the frequency band (150.815 MHz to 151.210 MHz) to provide 24 channels separated by 10 to 15 KHz. Transmitters weighed from 65 g to 90 g, measured approximately 50 mm x 25 mm x 80 mm, and met or exceeded the performance requirements of 2-km range and 6-month signal transmission without battery change.

Transmitters were fitted to the turkeys by underwing loops of latex surgical tubing (3/32-inch wall, 1/16-inch inside diameter). One loop was tied under each wing with a square knot or single beckett bend. Tubing was attached to transmitters with fiberglass tape. The

Table 1. The number of Florida wild turkey hens instrumented and monitored, Fisheating Creek and Lochloosa study areas, 1968-82.

Year	Number instrumented	Found dead before nesting season	Contact lost before nesting season[a]	Monitored during nesting season	Nests found
1968	30	0	0	30	20
1969	26	0	4	22	14
1970	34	0	3	31	19
1971	33	5	4	24	14
1972	35	2	6	27	14
1973	30	1	0	29	20
1974	33	1	4	34	25
1975	25	1	2	22	20
1976	20	0	3	17	12
1978	18	0	1	13	12
1979	21	3	1	17	13
1980	43	5	8	30	28
1981	54	9	4	41	32
1982	12	1	3	8	5
Total	414	28	43	345	248

[a]Not including those found dead.

hens were not noticeably hindered by the transmitter package and those recaptured showed no evidence of serious chafing.

Field monitoring was accomplished with 24-channel, crystal controlled, portable radio receivers. Receiving antennas included 1/4-wave whips on trucks, hand-held yagis for work on foot, and large multi-element directional antennas mounted on trucks. Nests were found by radio signals when instrumented hens were present. Data were collected at nests while the hens were absent.

Electronic devices were used to record nest attendance of the hens. The low-power signal from the transmitter on a hen was monitored by a battery-powered receiver hidden near the nest. This signal was re-transmitted to the field station on a different frequency by a directional antenna; maximum transmission was 8 km. The sensitivity of the receiver at the nest was adjusted to restrict the radius of signal reception to within about 1 m, which made the equipment function as a proximity detector. At headquarters, the incoming signal activated an electronic switch and was recorded on a 30-day time-calibrated Esterline-Angus event recorder, thereby making a continuous record of the time the hen was on the nest. A maximum of 20 nests could be monitored simultaneously. Nests were monitored approximately 8,000 hours by automatic recorders and about 400 hours manually. Visual observations confirmed the reliability of the nest monitors.

Behavior of hens was directly observed with spotting telescopes and binoculars from portable cloth blinds located about 30 m from the nests. Microphones were placed within 1 m of seven nests to monitor and record the sounds of hatching on a 1/4-inch open reel Uher tape

recorder. Sound spectrograms of recorded hen and poult vocalizations were made on a Sona-Graph model 7029A instrument (Kay Electric Company).

All vegetation within 1.5 m of each of 57 nests found on the Fisheating Creek Study Area during the 5 years, 1968-1972, was identified and its coverage estimated visually to the nearest 5%; percent coverage of overhead vegetation within 2 m above each nest was visually estimated. The habitat within 45 m of 236 nests found in the study was classified by the most abundant vegetation present--palmetto, cypress woods, or other. Habitat acreages were measured from aerial photographs (scale 600 feet = 1 inch) with a Model 1211-H-1 Nemonics Corporation electronic digital planimeter.

The Mayfield (1961) method, which utilizers data from nests that were observed during only part of the laying or incubation period, was used to calculate nesting success. The Wilcoxon Rank Sum test was used to compare clutch sizes of first, second, and third nests and of nests in which incubation began before 1 May, between 1 May and 20 May, and after 20 May. Chi-square analyses were used to test for differences in renesting tendencies of hens whose nests were disrupted during the laying vs the incubating periods; differences in the proportions of nests located in the three habitat types and the success and predation rates in each habitat type; differences in predation rates of clutches that hatched before 1 May, between 1 May and 20 May, and after 20 May; differences in the tendencies of hens to return to their nests when flushed; differences in return-after-flushing tendencies of hens nesting in three habitat types; and differences in the proportion of yearling vs adult hens that abandoned

their nests after being flushed. The t-test procedure was used to compare renesting rates of adult and yearling hens and mean length of recesses of incubating hens. The Kolmogorov-Smirnov Z test (Zar 1974) was used to test for differences in the distribution of seasonal nesting curves for adult and yearling hens. Fisher's least significant difference test (SAS Institute Inc. 1982) was used to compare length of recesses during four segments of the period of continuous incubating behavior. The confidence interval on the proportion of recesses hens took in the afternoon followed the form $x \pm t_{\alpha/2,\ df} SE(\bar{x})$.

RESULTS AND DISCUSSION

The mating system of the Florida turkey fits Oring's (1982) description of male-dominance polygyny with intermediate dispersal. Gobbling and strutting activities by males in early February, before the hen flocks dissolved, indicated that gobblers were receptive to mating earlier than hens. Hen flocks dissolved in March prior to the onset of nesting. Hens, upon attainment of sexual receptivity, visited the gobblers for mating.

Before nesting, hens established new home ranges and often roosted alone in small, isolated hammocks and bay-heads where gobblers and non-nesting hens seldom ventured and rarely roosted (Williams et al. 1974). Hens frequently were seen traversing the edge of saw palmetto prairies and the oak scrub-palmetto ecotone as though searching for nesting sites. Tracking effort was concentrated in these areas so that nests could be found early in the laying cycle.

Egg Covering and Nest Construction

Four hens were monitored by telemetry as they established their nests and laid their first eggs. When a hen approached the nesting area she would spend approximately 5-20 minutes moving in a restricted area before becoming still. This behavior pattern suggests that she was in the process of selecting a place for the nest.

The deposition of the first egg followed a definite pattern. The hens scratched shallow depressions in the soil, laid the egg, placed a few dried leaves over the egg, and departed. The mean length

of time spent on the nest while laying the first egg was 70 minutes (N = 4, SE = 28.4). Freshly laid eggs were clean and chalky, with a thin layer of sand adhering only to the side in contact with the ground.

Five additional nests were found at the time that the second or third egg was being laid. In two of these nests, shallow scratched-out depressions were found within 10 m of the nests in what appeared to be suitable nesting places, indicating that these hens had scratched shallow depressions in more than one place before selecting the place they would lay.

Evidently, hens did not transport nesting material to cover their eggs, but rather used debris present at the site. Two hens observed while laying covered their eggs with plant debris picked up from beside their nests; no hen was observed carrying nesting material. About a century ago, an observer reported to Bendire (1892) that Florida turkey nests were lined with dead leaves and grass that were so like the surrounding debris that he wondered whether the material was placed there by the hen or was already present under the eggs.

Although numerous patches of bare ground were available in the vicinity of most nests, only a single nest was established on such a site. The availability of nearby dried plant material may be a factor in nest site selection.

Twenty nests that were observed a total of 90 times during the laying period were covered sparsely with dried leaves. Approximately 160 different nests were inspected at least once while the hens were on recess during the incubating period; none of these nests was covered. These observations indicate a tendency for hens to cover

their eggs while away during the laying period but to leave them uncovered while on recess during the incubation period. Although many writers (e.g., Audubon 1831, McIlhenny 1914, Mosby and Handley 1943, Bailey et al. 1951) have stated that turkey hens cover their eggs with leaves, they did not specify that this occurred only during the laying period. Green (1982) reported that hens in Michigan did not cover their eggs before taking incubation recesses.

Camouflage, rather than insulation, appears to be the function of egg covering by the turkey. If insulation were required, it would be needed also during the incubation period when embryos are more vulnerable to chilling; however, turkeys do not cover the eggs during incubation recesses. Furthermore, the fact that hens use only debris from beside the nest to cover their eggs suggests that the function is to blend the nest with the immediate surroundings.

Egg covering also is the means by which a turkey nest is constructed. When the hen returns to the nest to lay each egg, she does not uncover the nest before laying, which causes more debris to accumulate with the laying of each egg. When the hen turns the eggs, the debris settles to the bottom and sides of the nest and by the time the last egg is laid, the nest depression is well lined with leaves. A typical nest measures 2 cm deep, 20 cm wide, and 24 cm long (Williams et al. 1968).

Laying Posture

Three hens were observed laying a total of 11 eggs. Hens sat on, or crouched over, their nests before laying. The laying of the egg was accomplished from a partially erect body position. They trembled

as they laid, with wings drooped slightly and tails raised. The back feathers were ventilated. Eggs were laid on the ground beside the other eggs and not on top of them. Of the more than 2,000 turkey eggs examined, only two were cracked in a manner that would suggest one egg had struck another while being laid.

Multiple Nesting

Some bird species, for example the ring-necked pheasant (*Phasianus colchicus*), have very large clutches when more than one hen lays in the same nest. Such multiple nesting has been reported for the wild turkey (Bent 1932, Mosby and Handley 1943). However, the only previous evidence of multiple nesting is Bendire's (1892) report of a turkey hen seen on a nest while another hen was seen standing close by and presumed to be waiting to lay in the same nest; Audubon (1831) also mentioned three hens on the same nest.

In the present study, two hens were observed visiting the same nest on three occasions and both were seen sitting on the nest although never at the same time. Telemetry data indicated that these hens did not associate with each other. More than one egg per day was laid in the nest on two occasions and it seems almost certain that both hens laid in this nest. The nest was deserted after the twelfth egg was laid.

Another nest was photographed after the hen had been flushed deliberately. When the nest was examined about 2 hours later, one egg had been added. The setting hen had passed the twentieth day of incubating behavior; therefore, the extra egg must have been laid by another hen.

The potential for multiple nesting exists in Florida turkey populations; however, it is probably not very common. If multiple nesting depends upon chance encounters, it should be expected to be more prevalent when nest density is higher, which would partly explain the much higher incidence of multiple nesting observed in the ring-necked pheasant (Labisky 1968).

Egg Dropping

Some birds occasionally lay single eggs where there is no nest. Stoddard (1931) reported this phenomenon as common in the northern bobwhite (*Colinus virginianus*). Single eggs that were never incubated constituted a minimum of 8% of the annual egg production of ring-necked pheasants in Illinois (Labisky 1968). In the present study, only seven turkey eggs not associated with a nest were observed in approximately 30,000 man-hours of field work during the nesting season, indicating that egg-dropping is not prevalent among Florida turkeys.

Nest Attendance During the Laying Period

Blakey (1937:7) provides the only reference about the pattern of egg laying by the wild turkey by saying "Study of artificially propagated wild turkey shows that, when . . . [egg laying] . . . becomes regular, one egg is laid daily, approximately one hour later each day, beginning at about one hour after sunrise and continuing until sundown terminates the cycle. Then the hen may skip a day and begin over again at the early morning hour and repeat the cycle."

In four nests monitored from the deposition of the first egg, the hens came to lay between 1120 hours and 1300 hours (x = 1234 hours). In all laying events observed, only 8 of 74 eggs were laid before 1100

hours. Two of the four hens that were monitored from the laying of the first egg skipped laying the day after laying the first egg; one of these hens skipped laying also the day after laying the second egg. The other two hens that were monitored from the laying of the first egg skipped laying early in the laying period--one skipped the day after the third egg and the other skipped after laying both the second and third eggs. In a total of 103 laying events by 22 hens, the only additional skipped days observed were after the first, fourth, and ninth eggs. Thus, hens did not exhibit a regular pattern of skipping a day in laying after the fifth egg of the clutch had been laid.

To test the hypothesis that wild turkeys laid approximately 1 hour later each day, the time of laying of 29 pairs of consecutively laid eggs was compared. This comparison revealed that 50% were laid within the same hour as the previous egg, 17% were laid at least 1 hour earlier, and only 24% were laid 1 hour later. Furthermore, in 65% of the laying events monitored, hens came to the nest to lay between 1000 and 1500 hours. This pattern of laying in mid-day compares closely with the pattern reported for the domestic turkey (Stockton and Asmundson 1950) but not with the pattern reported for wild turkeys by Blakey (1937).

In 74 observations of laying events in 22 nests, only 2 days were skipped after the fourth egg was laid, and in neither of these cases was laying resumed in the early morning of the following day. Thus there was no evidence that early morning laying followed skipped days late in the laying period.

In summary, the first egg of the Florida turkey is usually laid in mid-day and is followed by a lapse day; the second egg is laid on

the third day and is sometimes followed by a lapse day. A few hens skip laying one additional day after the third egg, but very few lapses occur later in the laying period. The fourth through final eggs are usually laid on consecutive days with a tendency to lay a few minutes later and to remain on the nest longer each day. The clutch is typically completed in late afternoon (Fig. 10). Hens failed to lay only 4 of 76 times they were observed visiting their nests during the laying period.

Hens remained on their nests an average of 55 minutes while laying each of eggs one through five. The apparent decrease ($\bar{x}$ = -7.3 minutes, SE = 11.3) in mean attendance during the laying of each of the first five eggs was not significant ($\underline{P}$ = 0.531) (Fig. 11). Hens remained on their nests an average of 50 minutes (SE = 12.8) longer as they laid each of eggs 5 through 12. Hens were remaining on the nest about 348 minutes with the laying of the eleventh egg. Thus, incubating behavior began gradually with the laying of the sixth egg and the length of incubating sessions increased with the laying of each successive egg. The first egg was subjected to about 25 hours of incubation, on the average, before the twelfth, or last, egg was laid.

No hen began continuous incubating behavior with fewer than five eggs. This finding, coupled with the observed tendency of hens to begin incubating with the laying of the sixth egg, suggested that at least five eggs are required to stimulate the gradual onset of incubating behavior. This hypothesis was tested by manipulating eggs in three nests during the laying period. In one nest, four eggs were removed from a clutch of seven, and then one egg was removed each day to maintain the clutch at three eggs. The hen abandoned this nest

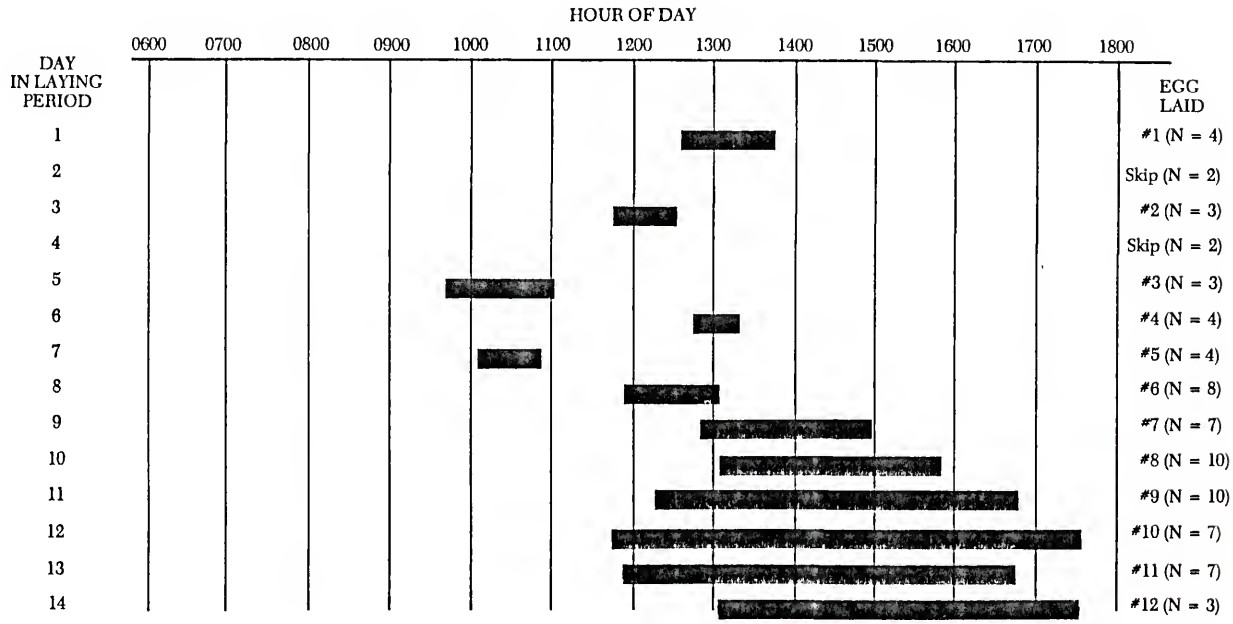

Figure 10. Generalized schematic of the laying pattern observed in the Florida wild turkey. The horizontal lines begin and end with the mean time (EST) of nest arrival and departure, respectively, for the number of hens indicated in the far right column. The diagram is based on 74 laying events of 22 hens, Fisheating Creek Study Area, 1968-82.

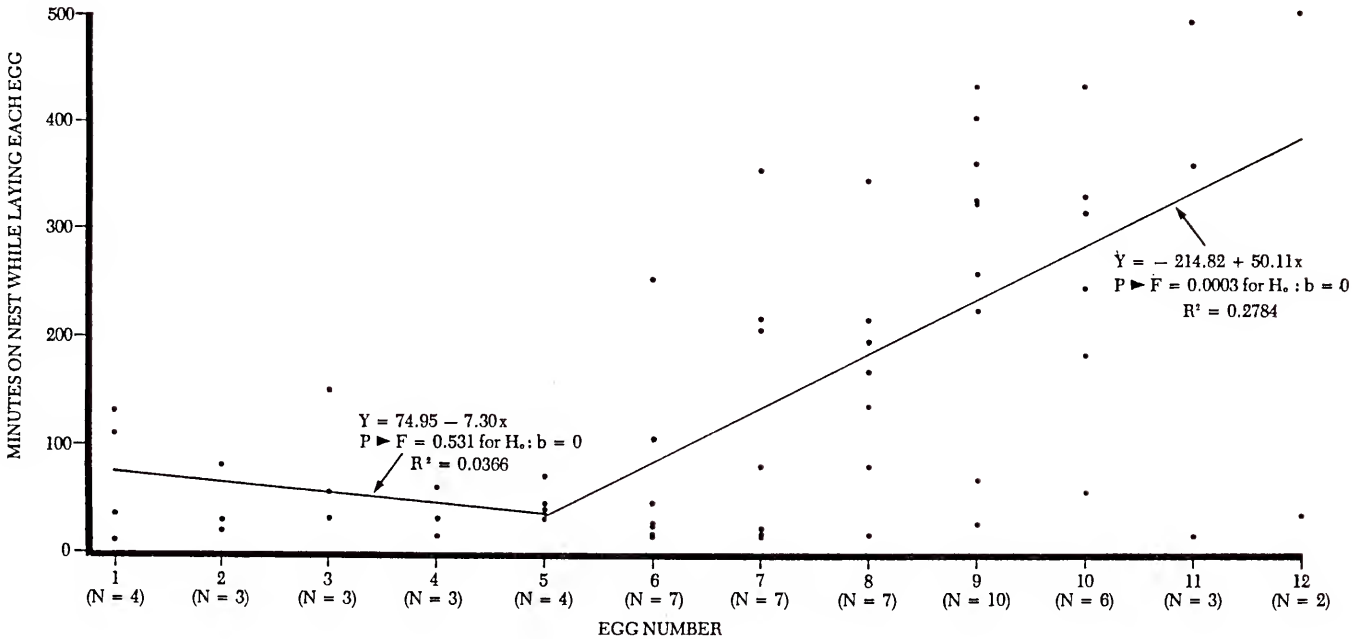

Figure 11. The length of time Florida wild turkey hens spent on the nest with the laying of each egg, Fisheating Creek Study Area, Glades County, Florida, 1968-82. The lines are separate least squares linear regression lines for eggs 1 through 5 and 5 through 12 (N = 59).

after laying the ninth egg. In another nest, three of six eggs were removed at the time the nest was found; this clutch also was maintained as a three-egg clutch. This hen abandoned the nest after laying 12 eggs without initiating continuous incubating behavior. The electronic monitor indicated that the hen did not exhibit the normal pattern of gradually lengthening incubating behavior late in the laying cycle; she remained at the nest no more than 34 minutes while laying any egg, thereby demonstrating behavior typical of a hen in the laying cycle. Another nest was found with four eggs and the clutch was held at that number by daily removal of eggs during the remainder of the laying period. This hen abandoned the nest after laying the ninth egg. The abandonment of the three manipulated clutches supports the hypothesis that approximately five eggs in the nest are required to stimulate the gradual onset of incubating behavior.

If the turkey were a so-called "indeterminant" layer (Cole 1917), these hens would have laid a greater number of eggs than represented in normal clutches. The result indicates that the wild turkey is a "determinant" layer and will not continue to lay indefinitely merely because its eggs are removed as they are laid.

The gradual onset of incubating behavior is stimulated by five eggs, probably through visual or tactile cues. Termination of laying occurs several days after the onset of gradual incubation, probably caused by increasing prolactin secretions as incubating behavior progresses (Eisner 1958). The daily increase in the secretion of prolactin would effectively determine the clutch size in the species by leading to the termination of laying.

Clutch Size

A clutch is complete when no additional eggs are laid. Clutch size averaged 10.3 eggs in 179 complete clutches (Table 2). Clutch size of yearling hens, which averaged 10.0 differed significantly (Wilcoxon two-sample test, S = 2248, Z = 1.6245, P = 0.104) from those of adult hens, which averaged 10.5 eggs. Sixty-seven percent of the complete clutches had 9, 10, or 11 eggs; the modal clutch size was 10 eggs (Fig. 12). No complete clutch contained fewer than five eggs. Mean clutch size did not vary significantly among years (F = 1.50, df = 178, P = 0.12).

The Wilcoxon Rank Sum test indicated that mean clutch size of the first ($\bar{x}$ = 10.4, N = 150), second (x = 10.2, N = 26), and third ($\bar{x}$ = 9.8, N = 4) nests of the same hens within the the same year did not differ significantly (first *vs*. second: Z = 0.088, P = 0.93; second *vs*. third, Z = 0.751, P = 0.45; first *vs*. third: Z = 0.836, P = 0.40). Mean clutch size among nests in which incubating behavior began before 1 May ($\bar{x}$ = 10.2, N = 99), between 1 May and 20 May ($\bar{x}$ = 10.0, N = 33), and after 20 May ($\bar{x}$ = 9.6, N = 8) did not differ significantly (Kruskal-Wallis X^2 = 1.25, df = 2, P = 0.54).

Mean clutch sizes of the wild turkey in other regions of the United States indicated that clutches in Florida populations may be smaller than in eastern wild turkey populations in Alabama, Mississippi, Missouri and Virginia, but larger than those in populations of the Rio Grande turkey in Texas (Fig. 13). Comparisons using the Student's t-test indicated no significant difference in mean clutch sizes between Florida and Mississippi (t = 1.15, df = 189, P > 0.01) or Florida and Texas (t = 0.73, df = 213, P > 0.01). The

Table 2. Mean clutch size, by year, of complete wild turkey clutches, Fisheating Creek and Lochloosa study area, 1968-82.

	Adult				Yearling				Overall[a]			
Year	N	$\bar{x}$	SE	Range	N	$\bar{x}$	SE	Range	N	$\bar{x}$	SE	Range
1968	9	9.9	0.72	5-12	3	9.7	0.33	9-10	12	9.8	0.53	5-12
1969	3	9.0	1.15	7-11	3	10.3	0.33	10-11	12	9.0	0.51	5-11
1970	14	9.9	0.44	6-12	2	9.5	1.50	8-11	16	9.8	0.41	6-12
1971	5	10.6	0.40	10-12	7	9.3	0.71	7-12	12	9.8	0.47	7-12
1972	7	10.6	0.84	7-14	2	10.5	0.50	10-11	9	10.5	0.65	7-14
1973	15	10.9	0.40	9-13	1	15.0	--	--	18	11.1	0.42	9-15
1974	7	10.7	0.57	9-13	2	11.0	1.00	10-12	14	10.5	0.39	8-13
1975	14	10.4	0.39	7-13	2	11.0	1.00	10-12	16	10.5	0.35	7-13
1976	5	10.2	0.73	8-12	2	10.0	1.00	9-11	7	10.1	0.55	8-12
1978	6	10.3	0.76	8-13	--	--	--	--	6	10.3	0.76	8-13
1979	7	10.3	1.06	7-15	1	8.0	--	--	8	10.0	0.96	7-15
1980	19	11.4	0.55	8-17	1	10.0	--	--	21	11.2	0.51	8-17
1981	19	10.3	0.40	8-14	6	9.5	0.43	8-11	25	10.0	0.32	8-14
1982	2	10.5	0.50	10-11	--	--	--	--	3	10.3	0.33	10-11
Totals and means	132	10.5	0.16	5-17	32	10.0	0.28	7-15	179	10.3	0.14	5-17

[a]Includes clutches of hens of uncertain age (N = 15, $\bar{x}$ = 9.4, SE = 0.46, range = 5-12).

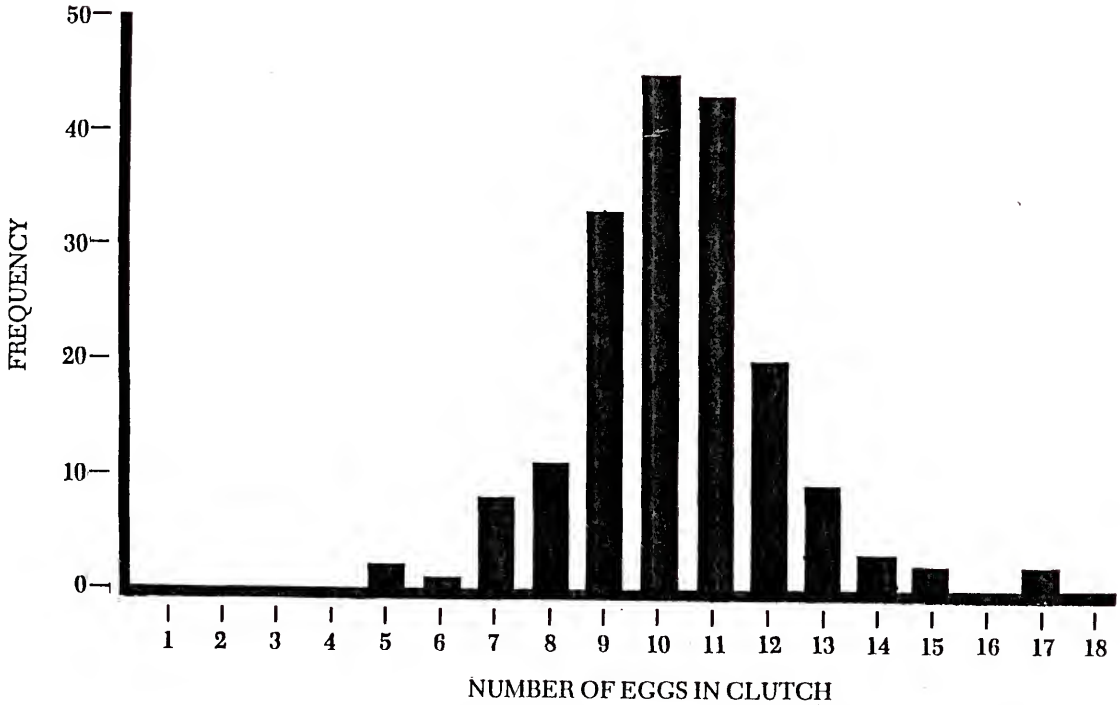

Figure 12. Frequency distribution of the number of eggs in 179 complete wild turkey clutches, Fisheating Creek and Lochloosa study areas, 1968-82.

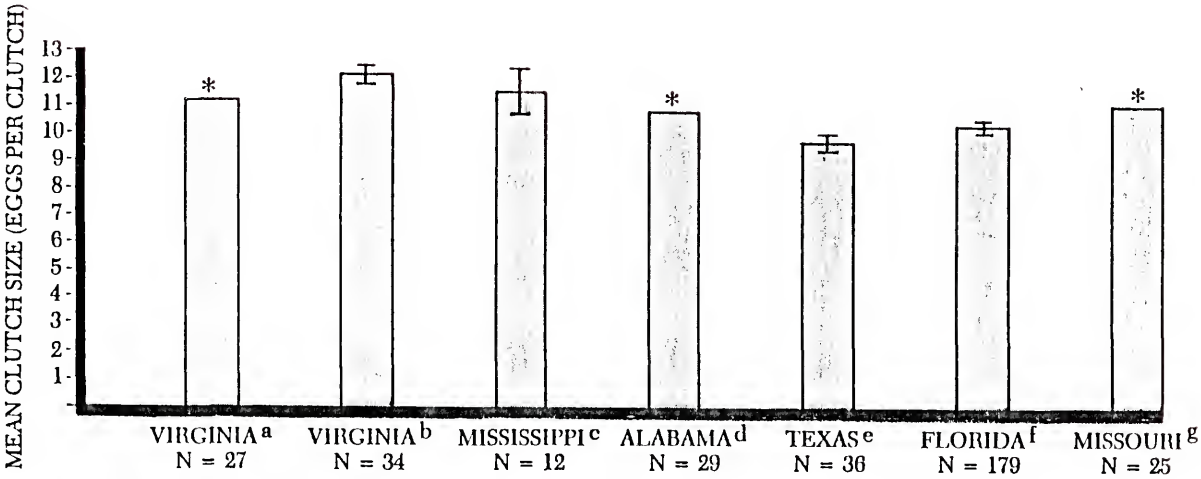

Figure 13. Mean clutch sizes (± SE) of the wild turkey as reported in seven studies from six regions. Data sources are: [a]Mosby and Handley (1943), [b]McDowell (1956), [c]Schumacher (1977), [d]Everett et al. (1980), [e]Reagan and Morgan (1980), [f]this study, and [g]Dalke et al. (1946). Asterisk (*) denotes SE unavailable.

clutch size reported in one of the Virginia studies (McDowell 1956) was larger than in the present Florida study ($t = 2.77$, $df = 211$, $P < 0.01$). Mean clutch size in the turkey may be under genetic control and may vary among populations, but the genetic component is outweighed by the combined effects of experimental error and small sample size in the data presently available from other regions.

Renesting

Hens carrying transmitters emitting weak signals and those that moved away from the study areas were not monitored closely. Some of these hens probably had their nests destroyed by predators without the nests being detected in the study. Consequently, the renesting statistics are minimum estimates.

Nearly fifty-seven percent (56.6%) of 30 hens that had their nests disrupted during the laying period renested, whereas only 28% of 93 hens renested after their nests were disrupted during the period of continuous incubating behavior ($N = 123$, $X^2 = 8.223$, $df = 1$, $P = 0.004$) (Fig. 14). No hen renested after incubating longer than 18 days. Adult hens renested with greater frequency than yearlings; 44% of 80 adults nested at least twice in the same year whereas only 22% of 23 yearlings renested ($t = 2.1$, df 1, $P < 0.05$) (Fig. 14).

Nest Disturbance by Man

Sixty-two percent of 38 hens that were flushed from their nests during the laying period did not return. Since 43% of 30 hens whose nests were disrupted did not renest, the loss to the population of potential reproduction was 0.27 (0.62 x 0.43) nests per hen flushed during the laying period. During the incubation period, 40% of 38 hens that had been flushed abandoned their nests and 72% ($N = 93$) of

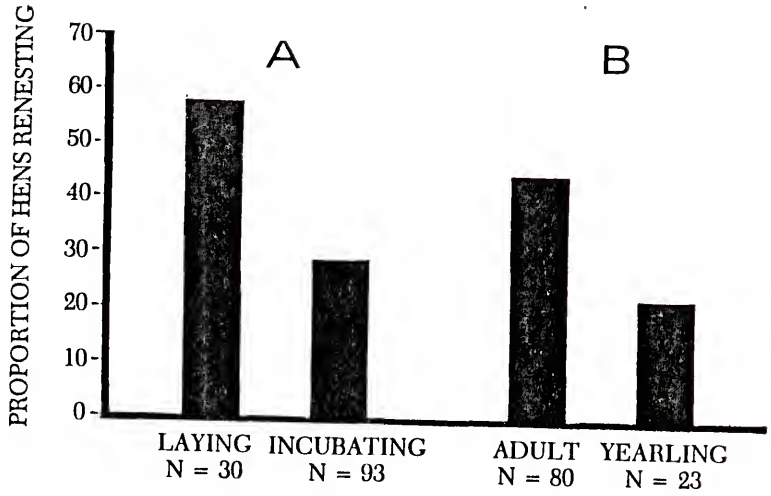

Figure 14. Proportions of Florida wild turkey hens that renested following nest disruption, Fisheating Creek and Lochloosa study areas, 1968-82. A. Laying vs incubating hens. B. Adult vs yearling hens.

them did not renest, representing a loss of approximately 0.29 (0.40 x 0.72) nests per hen flushed. Thus, it would make little difference whether a hen were flushed during the laying or the incubation period with respect to the net impact on annual reproduction. Five (2%) of 218 nests were deserted for no apparent reason.

Incubating Behavior

The term "incubation" as commonly used has two meanings, namely 1) the behavior of the hen sitting on or standing over the eggs and 2) the embryonic developmental processes that take place inside the egg shell. These components are independent--a hen can carry on incubating behavior whether or not embryonic development takes place (as with infertile or artificial eggs) and the embryo can develop without a parent incubating it (as in artificial or natural incubators). When the term incubation is applied to the behavior of the hen, it involves a presumption that embryonic development is occurring in the eggs, which may not be the case. Therefore, the sitting of the hen would better be called "incubating behavior" to distinguish it from the incubation process that occurs within the egg-shell. In the Florida turkey, incubating behavior consists of gradually lengthening afternoon incubating sessions after the fifth egg is laid, followed by continuous day and night incubating sessions upon completion of the clutch.

Twenty-four hens began incubating overnight on either the day before laying the final egg, the same day of laying the final egg, or the day after laying the final egg (Fig. 15). Two eggs were laid in 4 of the 24 nests after continuous incubating behavior began. Of these eight additional eggs, only one was left unhatched despite

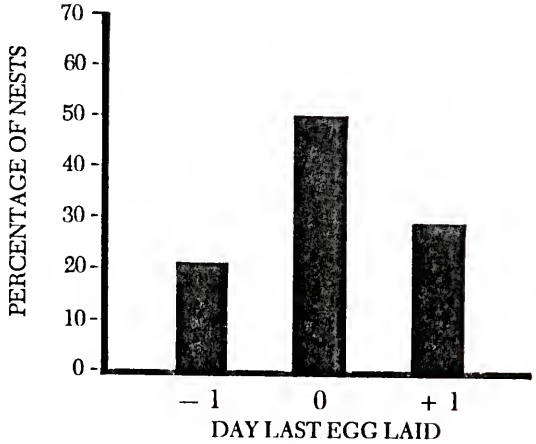

Figure 15. Percentage of Florida wild turkey hens (N = 24) that laid their final eggs on the day before beginning continuous incuabtion behavior (-1), on the day of beginning continuous incubation behavior (0), or on the day after beginning continuous incubation behavior (+1), Fisheating Creek and Lochloosa study areas, 1968-82.

the fact that the last laid egg in each nest had been incubated at least 2 days less than the rest of the clutch.

Stoddard (1931) stated that the northern bobwhite leaves its eggs unincubated for as long as 1 week after the last egg is laid. No turkey clutch went unincubated for as long as a whole day after the last egg was laid. This behavioral trait of the turkey would minimize the risk of nest predation by lessening the time the nest is exposed to predators.

Approximately 400 man-hours were spent observing nine different hens on their nests during continuous incubating behavior. While sitting, the hens' body parts were positioned as in standing except that their legs were folded at the upper tarsal joints forward under the breast. While sleeping in the nest during daylight hours, the head and neck were drawn in, the eyes were closed, and the wings drooped along the sides.

When turning eggs, hens crouched by flexing the intertarsal joints; they did not stand erect. Several eggs were usually rearranged with a single motion of the head but the activity seemed to be directed at only a single egg at a time. The motion of the head not only turned the eggs, but also repositioned them in the nest so that no egg remained in the same part of the nest for more than a few hours at a time. Hens often arose and gazed down at their eggs for a few seconds, and sometimes settled back without turning them. They usually gazed intently before turning an egg--the gazing behavior seemed to involve some cue that led to egg turning.

While standing in the nest, the bird's body posture was the same as when it stood at other times. Hens settled back on the nest after standing or crouching by moving the body forward with an upward swinging motion that placed some of the breast feathers over the eggs in front of the hen, thereby covering all the eggs.

As air temperatures increased during late morning, incubating hens began to pant, with partly open bills, and sometimes ventilated back feathers. Panting became faster, with the bill opened wider, as mid-day temperatures increased. The sequence was reversed as temperatures decreased in the afternoon. Hens would move their heads or change positions to avoid spots of direct sunlight that penetrated the overhead vegetation.

Two incubating hens retrieved single eggs that had rolled from their nests; however, the retrival process was not observed. Two hens deserted their nests when most of their eggs had been rolled out intact by the rooting of armadillos. One hen continued to incubate a clutch containing one broken egg; 12 hens deserted nests that contained one or two broken eggs. It could not be determined whether desertion was due to the presence of the broken eggs or to the disturbance that caused the eggs to be broken.

Nest Attendance During the Incubation Period

Incubating hens recessed for 98 minutes at a mean interval of 1.9 days (Table 3). Four monitored hens remained continuously on their nests for 3 days; the longest period of uninterrupted sitting was 4 days. A few hens recessed twice each day on several days. The period of nest attendance immediately preceding hatching averaged 2.4 days ($N = 5$).

Table 3. Nest attendance by eight Florida wild turkey hens monitored daily during the period of continuous incubating behavior, Fisheating Creek and Lochloosa study areas, 1968-82.

Band number	Number of full days monitored	Times recessed	Recesses per day	Recess interval (days)	Length of recess (minutes)			Fate of nest
					$\bar{x}$	SD	Range	
255R	20	13	0.65	1.5	80	17.6	55-111	Hatched
2875	24	13	0.54	1.8	116	57.8	64-305	Hatched
476R	23	9	0.39	2.5	277	460.3	53-1445	Abandoned
484R	24	15	0.63	1.6	70	33.3	34-177	Hatched
485R	24	13	0.54	1.8	80	47.2	3-186	Hatched
487R	27	13	0.48	2.1	132	113.7	36-487	Hatched
489R	26	23	0.88	1.1	106	53.3	15-261	Abandoned
461R	16	7	0.44	2.3	109	55.6	75-231	Predator
Means[a]			0.55	1.9	98			

[a]Means calculated only for the six nests that were not abandoned.

There was a tendency for a given hen to recess in morning or afternoon on several consecutive days (Table 4). Consecutive daily recesses were during the same morning, noon, or afternoon period 32 times and during a different period 30 times. None of the five hens observed completed the entire incubation period without changing recess patterns from morning or noon to afternoon, or vice versa, at least once. Thus hens do not recess at the same time of day throughout the duration of the incubating activity.

Thirty-nine percent of 67 recesses by five hens began before noon and 61% began after noon (Table 4), indicating a tendency for the hens to take more recesses in the afternoon. Only 16% of the recesses of these five hens included noontime (1200 hours).

Blakey (1937) reported that turkey hens tended to recess at mid-day after the first few days of incubating, and Hillestad (1970) stated that mid-day would be the best time for hens to recess because air temperatures then most nearly approach required incubation temperatures. The mid-day recess pattern was not predominant in this Florida population. Only 10% (27) of 271 recesses occurred between 1130 and 1230 hours. A similar tendency for hens to avoid recessing at mid-day was noted in a recent study in Michigan (Green 1982). Recesses were less frequent in early afternoon than during late afternoon (Fig. 16).

In Florida, the traditional closure of spring gobbler hunting each day in early afternoon probably lessens the risk of incubating hens on recess being shot by hunters.

The period of absence from the nest for hens that recessed at noon averaged 137 minutes, whereas hens on recess in the morning

Table 4. Consecutive nest recesses of five Florida wild turkey hens monitored during the period of continuous incubating behavior. Fisheating Creek and Lochloosa study areas, 1968-82.

Period of day of recess[a]	Length of recess (minutes)	Date	Day of incubating behavior
		BAND 255R	
Afternoon	94	18 May	7
Afternoon	76	20 May	9
Noon	111	22 May	11
Morning	90	24 May	13
Morning	85	26 May	15
Afternoon	60	27 May	16
Afternoon	106	28 May	17
Afternoon	76	29 May	18
Noon	55	31 May	20
Afternoon	80	2 June	22
Morning	78	4 June	24
Morning	58	5 June	25
Morning	66	6 June	26
		BAND 2875	
Afternoon	305	22 April	1
Afternoon	96	23 April	2
Morning	90	26 April	5
Morning	103	27 April	6
Noon	164	28 April	7
Morning	105	29 April	8
Afternoon	103	1 May	10
Afternoon	99	3 May	12
Afternoon	91	7 May	16
Afternoon	78	9 May	18
Afternoon	117	11 May	20
Noon	95	13 May	22
Afternoon	64	14 May	23
		BAND 484R	
Afternoon	59	19 April	2
Afternoon	34	20 April	3
Noon	56	21 April	4
Morning	73	22 April	5
Noon	177	23 April	6
Afternoon	81	24 April	7
Noon	58	26 April	9

Table 4, continued.

Period of day of recess[a]	Length of recess (minutes)	Date	Day of incubating behavior
Noon	87	28 April	11
Afternoon	55	29 April	12
Morning	49	2 May	15
Afternoon	46	3 May	16
Afternoon	80	5 May	18
Afternoon	54	7 May	20
Afternoon	82	10 May	23
Afternoon	59	12 May	25
	BAND 485R		
Afternoon	79	12 April	2
Morning	26	13 April	3
Afternoon	130	15 April	5
Morning	62	18 April	8
Morning	68	21 April	11
Afternoon	96	21 April	11
Noon	186	22 April	12
Afternoon	82	24 April	14
Afternoon	3	26 April	16
Afternoon	73	27 April	17
Morning	34	30 April	20
Morning	80	2 May	22
Afternoon	116	4 May	24
	BAND 487R		
Noon	487	23 May	2
Afternoon	137	24 May	3
Afternoon	66	28 May	7
Afternoon	36	28 May	7
Afternoon	66	31 May	10
Afternoon	115	1 June	11
Afternoon	119	4 June	14
Afternoon	56	5 June	15
Afternoon	175	7 June	17
Afternoon	136	11 June	21
Afternoon	129	13 June	23
Afternoon	78	14 June	24
Noon	125	16 June	26

[a]Morning recesses ended before noon; noon recesses began before and ended after noon; afternoon recesses began after noon.

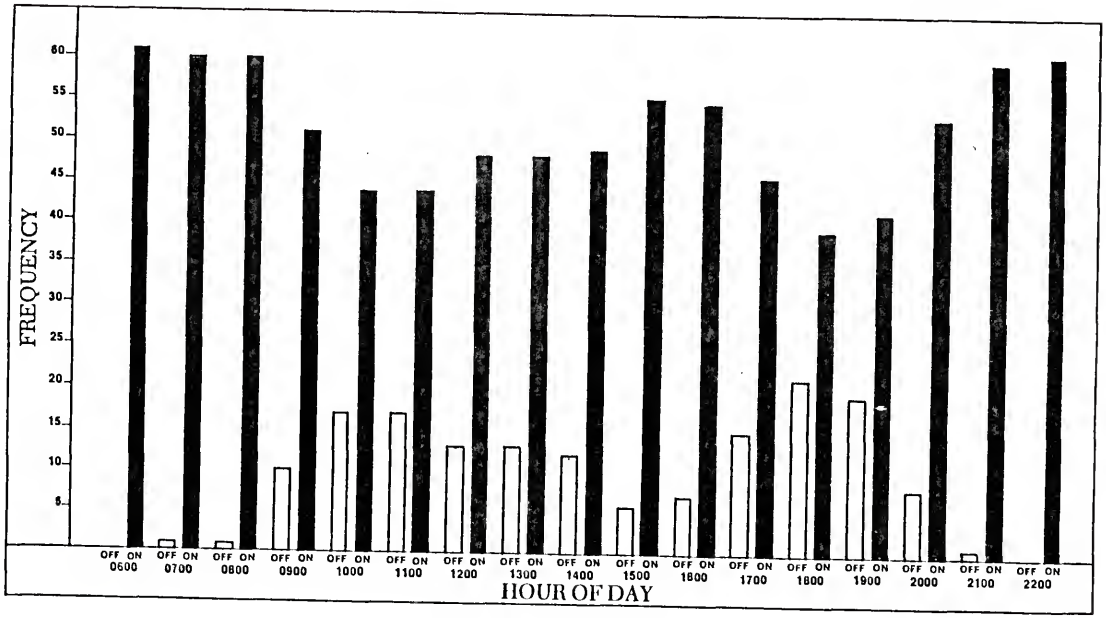

Figure 16. Mean daily recess (open bars) and nest attendance (solid bars) pattern of 22 incubating Florida wild turkey hens monitored 162 days, Fisheating Creek and Lochloosa study areas, 1968-82.

stayed away 129 minutes; the difference was not statistically significant ($P > 0.05$). Mean noon recess period of 137 minutes was greater than the afternoon period of 91 minutes ($Z = 2.03$, $P = .021$). The mean length of recesses for 128 adult and 32 yearling hens of 106 and 103 minutes, respectively, did not differ significantly ($t = 0.097$, $P > 0.50$). Recesses averaged 109, 95, 84, and 140 minutes during the first through fourth weeks of continuous incubating behavior, respectively (Table 5). The percentage of time hens spent off their nests was greatest (10%) during the final week of incubation.

Green (1982) reported a mean recess time of 53 minutes for four hens in Michigan ($N = 41$). The mean for 67 recesses of five Florida hens was 95 minutes. The difference between the length of recesses in Florida and Michigan was highly significant ($t = 4.24$, $df = 113$, $P = 0.001$). The Michigan study was conducted on a stocked population more than 100 km north of the northern limit of the turkey's range in Michigan; the present study was at the southern limit of the wild turkey's range in the eastern U.S. The longer recesses in Florida may be an adaptation to the warmer air and soil temperatures in Florida where the eggs would not cool as rapidly in the hen's absence as they might in Michigan.

The Incubation Period

The periods from the beginning of continuous incubating behavior until the first poult hatched and until the brood left the nest averaged 26 days ($N = 7$) and 27 days ($N = 8$), respectively (Table 6). Healy et al. (1975) reported a mean incubation period of 28.6 days for captive wild turkeys, but did not define the period or note the

Table 5. Average length of Florida wild turkey hen nesting recesses during the period of continuous incubating behavior, Fisheating Creek and Lochloosa study areas, 1968-82.

Interval of incubating behavior (days)	Sample size	Mean length of recesses (minutes)	Mean percentage of time off nest
1- 7	38	109	8
8-14	35	95	7
15-21	48	84*	6
22+	37	140*	10

*The difference between these means was significant (Fisher's least significant difference test, df = 154, t = 1.98, LSD = 55.66, $\underline{P}$ = 0.05).

Table 6. Time intervals between events observed during the incubation periods of nine Florida wild turkey hens, Fisheating Creek Study Area, 1969-81.

Band no.	Date and hour incubating began	Days until first poult hatched	Days until brood left nest	Clutch size	No. of eggs hatched
436R	11 Apr 1100	25.9	27.0	10	9
398R	23 Apr 1000	25.3	26.3	10	10
287R	20 Apr 1000	--	27.0	13	13
485R	11 Apr 1000	27.0	--	10	10
506R	2 Apr 1100	25.3	30.0	12	12
567R	5 May 1100	26.4	27.0	13	13
276R	12 May 0900	--	26.0	11	11
342R	24 Apr 1000	25.2	26.2	6	5
374R	21 Apr 1200	26.6	27.0	4[a]	4
Means		26.0	27.0	9.9	9.7
SD		0.7	1.3	3.1	3.1

[a]This clutch was reduced to only four eggs, probably by predation, after continuous incubating behavior had begun.

occurrence of gradual onset of incubating behavior. In artificial incubators, domestic turkey eggs require 26.92 days to hatch and another 0.33 day for the poults to dry, which totals 27.25 days (Abbott and Craig 1960). This latter figure does not provide for the several hours required for imprinting in wild broods and therefore would be more comparable to the 26-day period required for the first poult to hatch in wild Florida turkey nests.

The 27-day period of continuous incubating behavior for Florida turkey hens measured in the present study was briefer than the 28 days reported by Mosby and Handley (1943) or the 27.3 days (Abbott and Craig 1960) and 28 days (Marsden and Martin 1949) reported as the incubation period of domestic turkey eggs in incubators. The reason for the disparity in incubation periods is that Florida wild turkey eggs are incubated for approximately 25 hours during the laying period before continuous incubating behavior begins. No incubation occurs during the laying period when artificial incubators are used because the eggs are removed from the nests and stored at cool temperatures until they are placed in the incubator.

Little published data exist concerning the time required for whole clutches of wild turkey eggs to hatch after the first egg has pipped. Most writers, such as Mosby and Handley (1943), state that the hatching of the entire clutch requires about 24 hours. Healy et al. (1975) reported that an artificially incubated wild turkey egg hatches within an interval of 4 to 21 hours, that whole clutches hatch in 12 to 48 hours and that 8 hours are required for a poult to become dry. Cook (1972) reported that two wild clutches hatched in 23.3 and 26.2 hours. In the present study, the interval between the time the

first egg of a clutch was observed pipping and the time at least one poult was seen hatched ranged from less than 1 hour to 52 hours (Table 7).

Hatching Behavior

Hatching behavior was monitored in 14 nests, 7 by direct observation and 7 by electronic nest recorders. Eight of the 14 nests were inspected during the hen's last recess prior to hatching. In two nests, one egg was pipped; in another, two eggs were pipped; none was pipped in the other five nests. None of the 14 hens recessed after the pipping stage.

Vocalizations of hens and poults in three nests were recorded by monitoring microphones during the hatching process. Brood hens made a number of calls that are used by turkeys at other times; however, two calls were restricted to the hatching period. One is a hatching yelp (Williams 1984) that begins with single notes at 500 Hz spaced about 0.5 to 1.0 second apart (Fig. 17); it is sometimes accelerated to more than four notes per second. Images in sonograms have a resemblance to quarter notes in standard musical notation. The hatching yelp is uttered by the hen immediately after the poult peeps. Another previously undescribed call peculiar to the hatching period, termed the hatching hoot (Fig. 18), consists of a prolonged, 600 Hz note that is given irregularly throughout the hatching period.

While in the nest, poults give peeping calls of three types (Fig. 19): a single note that is repeated; a two-part ascending and descending note; and a multi-syllable call resembling the lost whistling call that poults use when they become separated from the hen.

Table 7. Elapsed time from pipping of the first egg until three wild turkey broods left the nest, Fisheating Creek Study Area.

Date and hour first egg pipped	Date and hour first poults seen	Elapsed time from pipping to first poult seen (hours)	Date and hour brood left nest		No. poults	Elapsed time from pipping to departure (hours)
29 May 1025	30 May 1500	28.6	31 May	0955	8	47.5
29 May 1400	31 May 1830	52.5	1 June	0840	13	66.7
10 May 1430	10 May 1458	0.3	11 May	1340	9	23.2

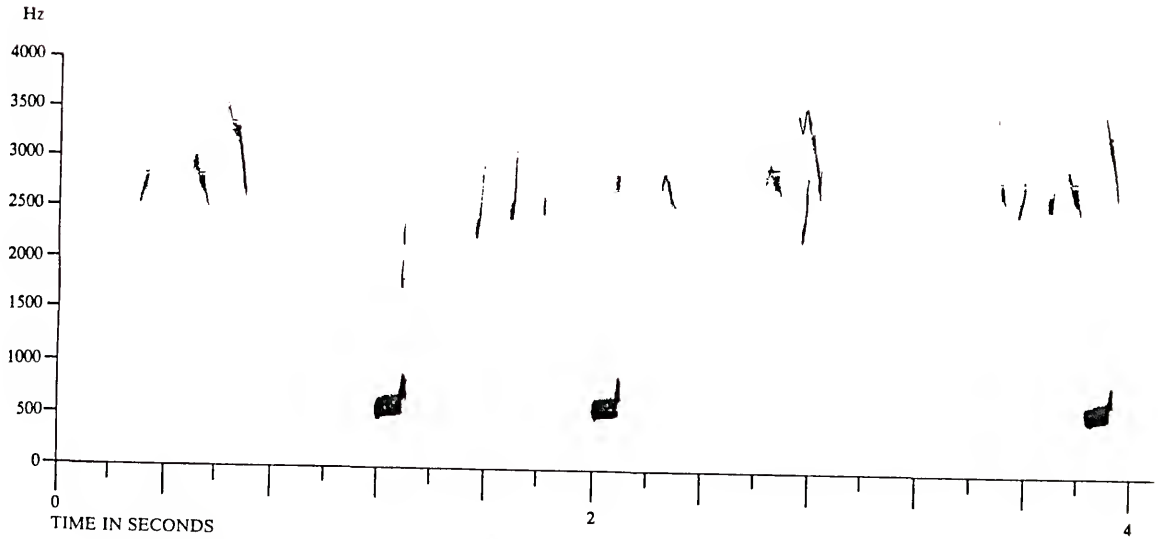

Figure 17. Sonogram of the "peeping" of Florida wild turkey poults (upper images) and the "hatching yelps" of the hen (lower images), recorded simultaneously during hatching, Fisheating Creek Study Area, April 1972.

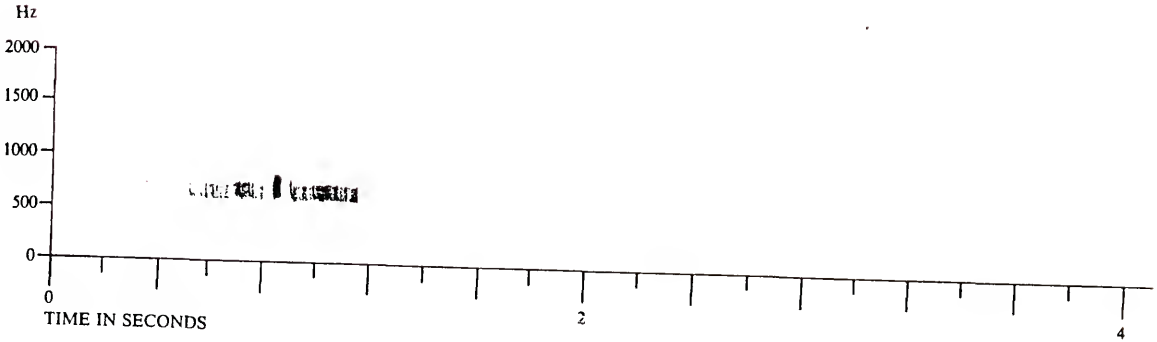

Figure 18. Sonogram of the "hatching hoot" of a Florida wild turkey brood hen, Fisheating Creek Study Area, April 1972. The call may consist of three syllables, as shown here, or only one or two syllables.

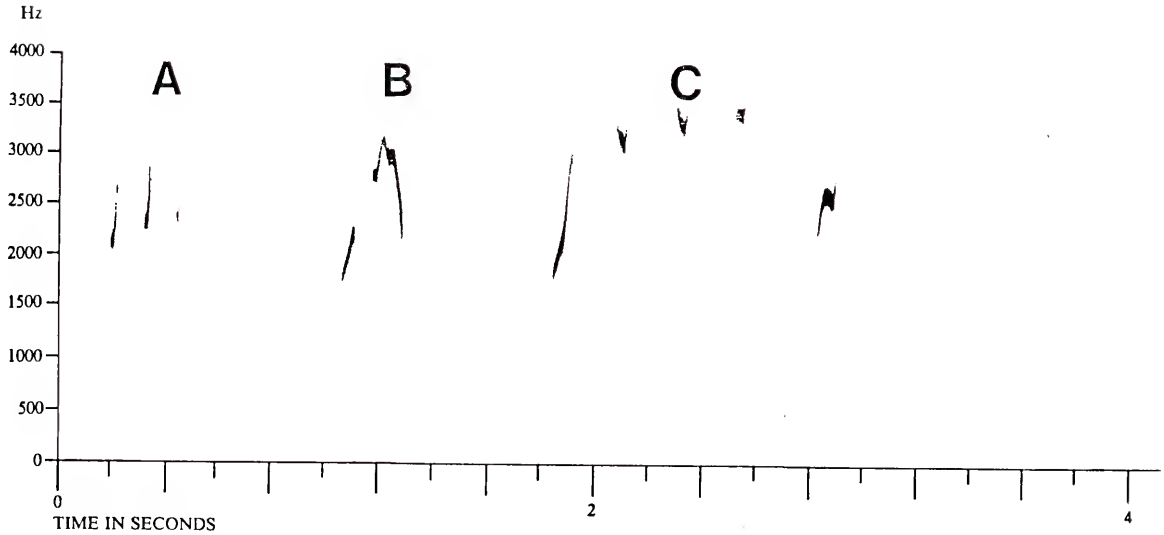

Figure 19. Sonogram of Florida wild turkey vocalizations during the hatching period, Fisheating Creek Study Area, April 1972. A. Peeping notes, uttered singly or in groups of two to six. B. A two-part call with rising and falling pitch. C. A probable distress call.

These five calls, which were heard from all seven nests monitored by microphone, appear to be the basic vocal communications between the hen and her poults. These are the sounds that enable the poults to learn to distinguish the voice of their mother from other hens by the second day of life (Ramsay 1951).

As the poults hatched and the nest became crowded, the hen moved farther back, surrendering the front of the nest to the young. Poults napped, mainly under the sides, tail, and drooped wings of the hen, and sometimes ventured outside the nest during periods of activity. When a poult ventured as far as 1 m from the nest, the hen would yelp for it to return. Hens did not leave the nest or respond in any way other than vocally when poults ventured out of the nest.

Egg Hatchability

Hatchability was 89% (SD = 0.14) of 839 eggs in 85 undisturbed nests. McDowell (1956) reported a hatching rate of 97% in 13 nests in Virginia, and Everett et al. (1980) reported a rate of 95% in 14 nests in Alabama. Green (1982) reported only 72% hatchability in a Michigan study in which the stock was descended from pen reared turkeys.

The Imprinting Period

Parental imprinting is a learning process by which young birds of many species become socially attached to their parents and gain self identity as members of their own species (Lorenz 1937). Imprinting takes place during the first few hours of life and is crucial for wild nidifugous birds. Imprinting is said to be irreversible in the turkey (Schein 1963). Although there is some dispute about the

irreversibility of imprinting (Salzen and Meyer 1968), it is, at the least, persistent and very difficult to reverse (Fabricius 1962).

Much of the research on imprinting has been conducted with the mallard (Anas platyrhynchos). Ducklings remain in the nest for 24-62 hours after hatching (Hess 1972), which is 10-12 hours after the last hatched duckling is dry (Kear 1965). Imprinting is compete (Bjarvall 1967) or nearly so (Fabricius and Boyd 1954) by the time of nest departure. Both auditory and visual cues are involved in imprinting (Ramsay 1951). Auditory cues strengthen with time, reaching their peak effect several hours after visual cues. This is probably because the need for audible communication between the hen and ducklings is greatest after they leave the nest and travel in vegetation where visibility is obscured (Fabricius 1964). Visual cues for imprinting are enhanced and following behavior is strengthed when ducklings make short excursions from the nest and can see the hen while she is calling (Bjarvall 1967). Ducklings without visual reinforcement probably would not follow as strongly upon nest departure.

The imprinting process in the wild turkey is similar to that of the mallard. Observations of seven turkey broods indicated that the broods remained in the nest for variable intervals of time after the last-hatched poult was dry and active. Hens vocalized softly during this time and the poults made short excursions out of the nest and returned at the vocal command of the hen. During the 10-minute period prior to nest departure, hens called more frequently than before. Upon departure, hens arose abruptly, stepped out of the nest without hesitating, and moved slowly away while continuing to yelp softly to the poults.

In each of the seven brood departures, there was a gradient in the strength of the following response among poults--some followed at the hen's side whereas others straggled behind. In three cases, a few poults failed to follow the hen farther than about 1 m from the nest, which caused the hen to stop and yelp. In two cases, a few poults remained in the nest, apparently more strongly attracted to it than to the hen. They followed the hen only after she returned to the nest and called to them.

Once an observation blind was erected too near a nest, which caused the brood to depart prematurely about 6 hours after the last poult had hatched. Three of the poults remained in the nest for 5 minutes during which time the hen called to them from a distance of about 2 m. The hen had to return to within 1 m of the nest repeatedly before the poults finally followed her.

Another brood hatched on 30 May and, due to investigative disturbance, left the nest about 12 hours later. Four poults did not follow the hen despite her continuous yelping. The observers left the area so that the brood could reassemble; however, the next morning one poult was found alone near the nest. Radio signals indicated that the hen was still near. The observers again left the area. The following morning, the four stray poults were found near the nest--the hen had left the area without them. Three of the poults were captured eventually by playing-back the sounds of hatching that had been recorded at the nest 3 days earlier. The poults later became parent-imprinted on humans, which indicated that they had not imprinted on the brood hen. The foregoing observations suggest that

one of the reasons poults remain in the nest as long as they do after hatching is to become adequately imprinted on the hen.

Time of Nest Departure by Broods

None of 28 broods departed the nest before sunrise or after sunset (Fig. 20). Nineteen (68%) departed during morning hours. Brood departure at mid-day was infrequent, corresponding to the reluctance of incubating hens to recess at that time. Only one brood departed after 1800 hours and it traveled only about 10 m before roosting that night. No brood returned to its nest after departing.

Hatching Synchrony

Some birds with large clutches have adaptations that hasten the hatching of the last laid eggs so that all the eggs hatch at nearly the same time. Synchronized hatching is advantageous for nidifugous birds with large clutches because it facilitates nearly simultaneous parental imprinting and early nest departure of the brood. Hatching synchronization is so well developed in the northern bobwhite that the entire clutch usually hatches in less than 2 hours (Vince 1969).

If hatching is synchronized, the time required for hatching should be less than the total incubating time experienced by the first egg before the last egg is laid. The regression equation for the onset of incubating behavior in the turkey (Fig. 11) shows that, on average, the first eggs received approximately 25 hours of incubation by the time the twelfth egg was laid. It would appear then, that in taking more than 24 hours to hatch the clutch, the turkey exhibits poorly developed synchronizing mechanisms.

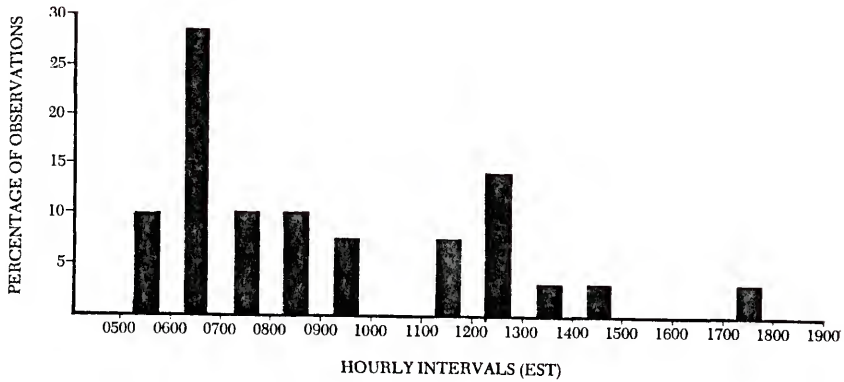

Figure 20. Time of day during which 28 Florida wild turkey broods departed the nest site, Fisheating Creek Study Area, 1968-82.

Attendance of Infertile Eggs

Two incubating hens attended infertile clutches for 35 and 64 days. The hen that incubated continuously for 64 days exceeded the normal incubation period by 37 days, incubating about 2.5 times the normal period. The northern bobwhite has been reported to sit on unhatched eggs as long as 56 days, or 2.4 times its 23-day incubation period (Stoddard 1931).

Nesting Habitat

There were too few nests on the Lochloosa Study Area to warrant a detailed analysis of nesting habitat. Of 236 nests on Fisheating Creek Study Area, 58% were in palmetto, 31% were in cypress woods, and 11% were in miscellaneous types of habitat (Table 8). The proportions of the three habitats were 5%, 51%, and 44% for palmetto ecotone, cypress woods, and miscellaneous types, respectively. Hens selected nesting habitats in different proportions than they occurred on the area (X^2 = 1328, df = 2, $\underline{P}$ < 0.001).

Cypress woods and palmetto habitats differed in plant species composition (Table 9) and structure. The major structural difference was a tree canopy in the cypress woods (Fig. 21), which was absent from the palmetto ecotone (Fig. 22). Low vegetation in the cypress woods habitat was fast-growing in contrast to the relatively unchanging composition and structure of the woody vegetation that predominated in the palmetto habitat.

Saw palmetto and wire grass occurred at all 44 nest sites in the palmetto ecotone (Table 9). The foliar coverage of palmetto and wire grass occupied more than 50% of the area within 1.5 m of 80% of the nests and no less than 20% of the area near any nest site in this

Table 8. Number and proportion of 236 Florida wild turkey nests in three habitat categories, Fisheating Creek and Lochloosa study areas, 1968-82.

	Nesting habitat type		
Year	Palmetto	Cypress woods	Other
1968	16 (84%)	3 (16%)	0
1969	12 (86%)	2 (14%)	0
1970	15 (79%)	4 (21%)	0
1971	10 (71%)	1 (7%)	3 (21%)
1972	7 (50%)	7 (50%)	0
1973	12 (67%)	5 (28%)	1 (6%)
1974	12 (55%)	6 (27%)	4 (18%)
1975	11 (65%)	5 (29%)	1 (6%)
1976	7 (58%)	5 (42%)	0
1978	9 (75%)	0	3 (25%)
1979	5 (50%)	3 (30%)	2 (20%)
1980	8 (29%)	15 (54%)	5 (18%)
1981	12 (38%)	14 (44%)	6 (19%)
1982	1 (20%)	3 (60%)	1 (20%)
Total	137 (58%)	73 (31%)	26 (11%)

Table 9. Major plants[a] occurring within 1.5 m of 63 Florida wild turkey nest sites, Fisheating Creek Study Area, 1968-72.

Plant name	Percentage occurrence in habitat		
	Palmetto (N = 44)	Cypress woods (N = 15)	Miscellaneous (N = 4)
Trees			
Taxodium distichum		100	
Shrubs			
Baccharis hamlimifolia			25
Callicarpa americana	20		25
Ilex glabra			25
Lyonia ferruginea	36		
Lyonia lucida	73		25
Myrica cerifera			25
Quercus chapmanii	32		
Quercus geminata	18		
Serenoa repens	100		25
Vines			
Smilax spp.	25		25
Rubus sp.			25
Vitis sp.			25
Herbs			
Aristida stricta	100		25
Quercus minima	64		
Andropogon sp.	32		
Vaccinium myrsinites	25		
Panicum sp.	36		25
Axonopus compressus		95	25
Hydrocotyle umbellata		33	
Centella asiatica		47	
Saururus cernuus		20	
Polygonum sp.		40	
Rhus radicans		47	
Hypericum sp.			25
Iris savannarum			25
Eupatorium coelestinum		73	
Eichhornia crassipes		33	25

[a] Nineteen additional plants, mostly immature seedlings, that did not occur at more than two nest sites, are not listed.

Figure 21. Investigator standing beside turkey nest in cypress woods habitat, Fisheating Creek Study Area, 1981.

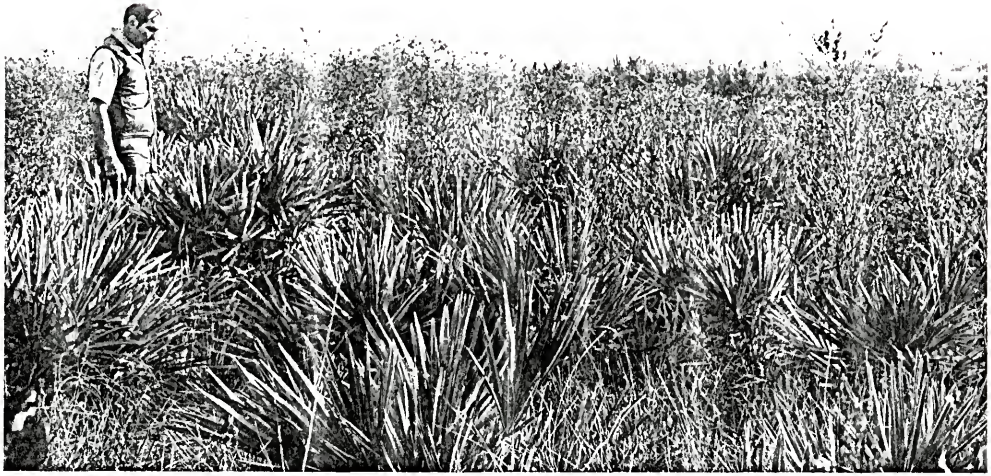

Figure 22. Investigator standing beside a turkey nest in palmetto habitat, Fisheating Creek Study Area, 1982.

habitat. Lyonia lucida was the second most prevalent shrub at palmetto nests, occurring at 32 sites (73%).

In cypress woods, cypress trees occurred within 1.5 m of all 15 nests, and the grass Axonopus compressus occurred near 13 nests. Nests in the cypress woods usually were in the densest ground cover available, which often was in semi-aquatic vegetation such as Centella asiatica, Saururus cernuus, and Polygonum spp. (Table 9).

Each of the four nest sites in the miscellaneous habitat category was in distinctly different vegetation: a narrow, dry ditch; a flood control dike; a high, isolated saw palmetto clump; and a wax myrtle thicket along a fence row.

Ninety-five percent of the 20 cypress woods nests and 87% of the 62 nests in palmetto had 40% or more vegetative cover within 2 m above them (Table 10). Only one nest (5%) in the cypress woods and two (3%) in the palmetto ecotone had less than 10% overhead cover. Thirty-eight percent of the nests in palmetto had 70% overhead cover, and 24% had more than 90% overhead cover. None of the nests in cypress woods had more than 90% overhead cover.

Saw palmetto was favored for first, second, or third seasonal nesting attempts (Table 11). Nesting habitat was used in similar proportions by adults and yearlings (N = 223, X^2 = 0.68, df = 2, P = 0.712). A higher proportion (68%) of nests in saw palmetto was successful than in cypress woods (45%) (N = 148, X^2 = 8.043, df = 2, P = 0.018).

Forty-two percent of 36 hens that were first observed nesting in the palmetto ecotone renested in another habitat; 33% first observed nesting in the "other" habitat type renested elsewhere; and 22% first

Table 10. Cover within 2 m above 82 nests located in cypress woods and palmetto nesting habitats, Fisheating Creek Study Area, 1968-72.

Percentage[a] overhead cover	Number and percentage of nests	
	Cypress woods	Palmetto
< 30	1 (5%)	4 (6%)
31-40	2 (10%)	10 (17%)
51-70	6 (30%)	10 (17%)
> 70	11 (55%)	38 (61%)
Totals	20 (100%)	62 (100%)

[a]Visually estimated.

Table 11. Proportions of first, second, and third nests of Florida wild turkeys, established within a single season, by habitat type, Fisheating Creek Study Area, 1968-82.

Habitat type	Percentage of nests			
	First[a] nests (N = 191)	Second[a] nests (N = 38)	Third[a] nests (N = 7)	All nests (N = 236)
Palmetto	60	47	57	58
Cypress woods	30	37	14	31
Other	10	16	28	11
	100	100	100	100

[a]These were the first, second, or third nests observed. A few nests were probably depredated during early laying stages; thus some nests listed as second may have actually been third *et cetera*.

observed nesting in cypress woods renested in another habitat (Table 12). Although there seemed to be a preference for nesting in saw palmetto cover, there was considerable variability in the nesting habitat used in different years (Table 8). The tendency to change freely from one habitat to another for renesting in the same year, and between years, suggests that habitat imprinting may not be an important factor in nesting habitat selection by the Florida turkey.

Nesting Seasonality

The earliest egg found in the study was laid on 6 March; the last egg was laid on 6 June. The last clutch hatched on 2 July. The median date of laying the first egg was 23 March (x = 25 March) and the median date the last clutch hatched was 8 June (x = 10 June) (Fig. 23). Nests that were initiated after 1 May were probably the second or third nests of the respective individual hens that season. The molting pattern (Williams and Austin *in press*) of at least 3,000 juvenile turkeys examined during summer and fall on the Lochlossa and Fisheating Creek WMAs substantiated that few poults were hatched after early July.

Yearling hens began nesting about 2 weeks later and completed nesting about 2 weeks earlier than adults (Fig. 24). The difference was significant (N_1 = 88, N_2 = 25, Kolmogorov-Smirnov Z = 1.923, maximum difference = 0.436, 2-tailed P = 0.001). Later initiation of nesting by yearlings apparently occurs also in the Rio Grande turkey as Smith (1977) reported that adult hens in Texas began copulating before leaving their winter range whereas yearlings did not begin copulating until after reaching their spring range.

Table 12. Percentages of successive Florida wild turkey nests in the same or different habitat types, Fisheating Creek Study Area, 1968-82.

First nest in "cypress woods" (N = 9)				First nest in "palmetto" (N = 24)				First nest in "other" (N = 3)			
Second in cypress	Second in palmetto	Second in other	Total switching	Second in cypress	Second in palmetto	Second in other	Total switching	Second in cypress	Second in palmetto	Second in other	Total switching
78%	22%	0%	22%	29%	58%	13%	42%	0%	33%	67%	33%

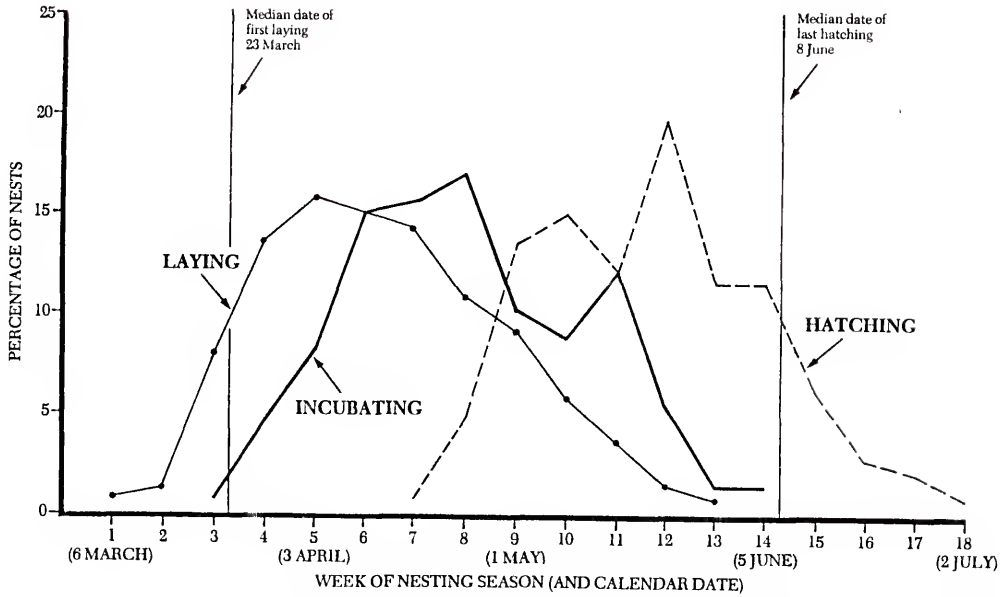

Figure 23. The nesting season for 121 Florida wild turkey hens on Fisheating Creek (1968-82) and Lochloosa (1969-75) study areas.

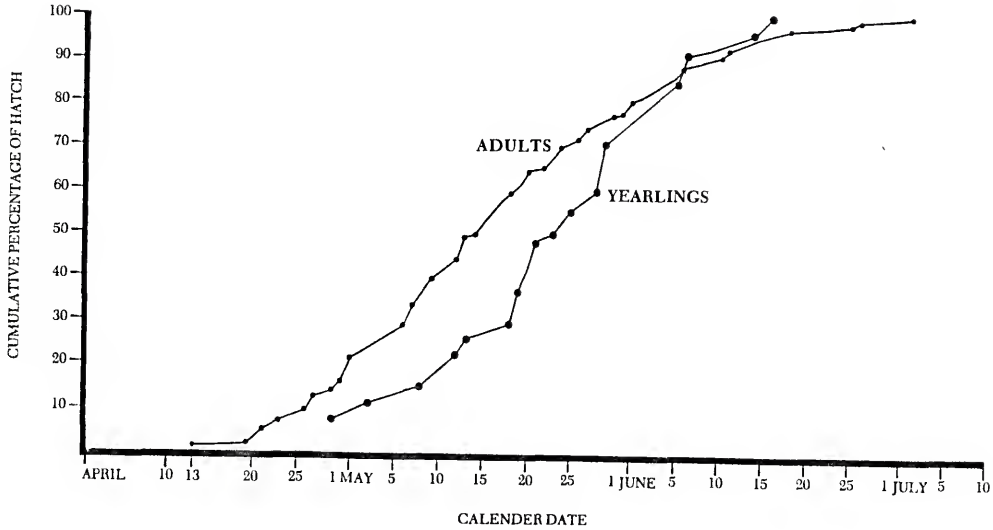

Figure 24. Cumulative percentage of clutches hatching by adult (N = 88) and yearling (N = 25) Florida wild turkey hens, Fisheating Creek and Lochloosa study areas, 1968-82.

Nesting Success and Predation

Sixty percent of the 171 nests that were not disturbed by investigative activities were successful (Table 13). This rate of nest success is not necessarily an accurate estimate, however, because not all the nests were observed from the time of clutch initiation, a factor that would tend to bias nest discovery in favor of successful nests. The Mayfield (1961) method, which provides an appropriate adjustment for nests observed during only a portion of their full terms, was used to calculate nesting success. During the 14-year study, eight nests were lost to predators during 218 days of exposure within the laying period (Table 14). Thus 0.0367 (8/218) nests were lost per day during the laying period. The daily probability of survival for any nest would be 0.963 (1-0.0367). Inasmuch as approximately 12 days are required for a clutch of 10 eggs to be laid (one egg per day plus two lapse days in a typical clutch), the entire laying period would be 12 days and the probability of a nest surviving the 12-day laying period would be 0.963^{12} or 0.638. The probability of survival to hatching for each nest during the incubating period, using 27 as the number of days in the incubation period, was 0.708 (38/2987 - 1.0 = 0.0.9873; 0.09873^{27} = 0.708). The probability of a nest hatching would be 0.638 x 0.708 = 0.452. Thus, the proportion of nests surviving was 63.8% during the laying period, 70.8% during the period of continuous incubating behavior, and 45.2% during the entire nesting period. As expected, the latter figure is lower than the 60% hatching success recorded for all nests under observation (Table 13).

Table 13. Fates of Florida wild turkey nests under observation, Fisheating Creek and Lochloosa study areas, 1968-82.

	All nests (N = 237)		Nests not disturbed by investigators (N = 171)	
Fate	Number	Percentage	Number	Percentage
Hatched	103	43	103	60
Predator	59	25	59	35
Flushed	42[a]	18		
Deserted	31[b]	13	8	5
Flooded	2	1	2	1

[a]Includes 15 hens that were flushed intentionally; not all flushed hens deserted.

[b]Includes 23 hens that may have been disturbed by the investigators.

Table 14. Nest survival data used to calculate the probability of successful nesting by Florida wild turkey hens, Fisheating Creek and Lochloosa study areas, 1968-82.

	Laying period		Incubation period	
Year	Number of nests depredated	Days of nest exposure	Number of nests depredated	Days of nest exposure
1968	1	5	7	260
1969	0	0	2	108
1970	0	29	1	298
1971	1	25	1	196
1972	1	8	2	187
1973	1	17	2	297
1974	1	34	7	337
1975	0	14	2	195
1976	0	7	2	183
1977	0	0	0	0
1978	2	21	1	153
1979	1	22	1	174
1980	0	10	5	259
1981	0	26	3	377
1982	0	0	2	63
Total	8	218	38	2987

It is possible to take renesting into account in estimating the success of the nesting hen population by using the probabilities calculated previously:

0.566 = the probability that a hen will renest if the nest is lost during the laying period (see Renesting);

0.280 = the probability that a hen will renest if the nest is lost during the incubation period (see Renesting);

0.638 = the probability that a laying hen will reach the incubating stage;

0.708 = the probability that a clutch that reaches the stage of being continuously incubated will hatch;

0.362 = (1-0.638) = the probability that any nest will be lost during the laying period;

0.292 (1-0.708) = the probability that any nest will be lost during the incubation period.

In calculating nesting success of the population, it is assumed that all hens will attempt to nest and will renest once if the nest is disrupted during the incubating period and twice if disrupted during the laying period. These calculations yield

(0.638)(0.708) = 0.452 as the proportion of the first time nesters that will be successful,

(0.362)(0.566)(0.638)(0.708) = 0.093 as the proportion of hens losing their nests during the laying period that will successfully renest,

(0.638)(0.292)(0.280)(0.638)(0.708) = 0.024 as the proportion of hens losing their nests during the incubating period that will successfully renest, and

(0.362)(0.566)(0.362)(0.566)(0.638)(0.708) = 0.019. as the proportion of hens losing their nests twice during the laying period that will eventually be successful.

Overall nesting success would be the sum of the products:

0.452 + 0.093 + 0.024 + 0.019 = 0.588 or 58.8%.

The calculated rate of nesting success may not accurately reflect nesting success of the entire population because hens that were not known to nest are not included in the calculations. If some of them did not attempt to nest, which is likely, the overall nesting success rate would be lower. Turkey populations on the study areas increased during the period of study despite the nest losses to predators.

Nest predation was distributed evenly throughout the incubation period (Fig. 25). Predatory species responsible for nest losses could not be ascertained in every case, but evidence at nest sites indicated that the raccoon (*Procyon lotor*) was a prominant predator in the cypress woods, and that the striped skunk (*Mephitis mephitis*) and spotted skunk (*Spilogale putorius*) were major predators in oak scrub and palmetto. Other predators included the opossum (*Didelphis virginianus*), gray fox (*Urocyon cinereoargenteus*), bobcat (*Felis rufus*), and domestic dog. The American crow (*Corvus brachyrhynchos*) destroyed only a single nest.

Potential nest predators that were not known to take eggs included the feral hog (*Sus scrofa*), which has been reported to depredate turkey nests (Barkalow 1942, Blakey 1937), and the armadillo (*Dasypus novemcinctus*), which is suspected by many laymen of taking

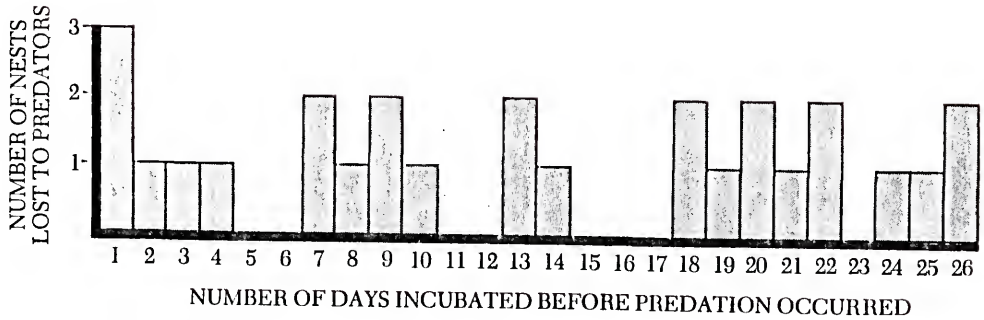

Figure 25. Distribution of Florida wild turkey nest predation incidents (N = 27) with respect to stage of incubating, Fisheating Creek and Lochloosa study areas, 1968-82.

turkey eggs. Although armadillos did not eat any turkey eggs, they rooted through two nests, rolling out some of the eggs and causing the hens to abandon the nests.

A higher proportion of nests was depredated in the cypress woods (55%) than in saw palmetto (32%) or in the "other" (21%) habitats (N = 148, X^2 = 8.043, df = 2, P = 0.018). The "other" habitat category was heterogeneous in plant species composition and structure, whereas the cypress woods and palmetto were relatively homogenous. The lower predation rate in the heterogeneous "other" habitats supports the experimental findings of Bowman and Harris (1980), who predicted that predation rates would be higher in homogeneous habitats.

Predator success is reportedly high when prey is abundant and increases with hunting experience of the predators (Tinbergen et al. 1967). If these factors were important in the present study, nest losses should have been higher in mid- or late season nests than in early nests. However, predation rates did not differ among early-season (hatching before 1 May), mid-season (hatching 1 May through 20 May) or late-season (hatching after 20 May) nests (N = 117, X^2 = 2.6, df = 2, P = 0.26).

Defensive Behavior

Predation is an important factor in the life and evolution of the wild turkey. Nest losses to predators were 54.8% as previously calculated and poult losses during the first 2 weeks were about 70% (Williams and Austin in press). The annual turnover rate in turkey populations has been estimated to range from 30% (Logan 1973) to 50% (Smith 1977).

The major behavioral adaptations of the turkey hen to avoid nest predation are 1) selecting a well-hidden nest site, 2) laying eggs in mid-day when the common nest predators are inactive, 3) covering the nest with debris before leaving it during the laying period, 4) minimizing activity near the nest, 5) remaining on the nest when predators approach, and 6) sometimes flying to and from the nest rather than walking.

The plumage of the hen is cryptically marked with brown and black. Natural colors of the ground litter at nesting sites tend to optimize the camouflage effect. Nests are covered lightly with a few dead leaves when left unattended during the laying period. Overhead cover of nests is at least 40% and sunlight through the vegetation creates a broken pattern of light and dark spots, which accentuates the cryptic effect of the hen's speckled back pattern or the camouflage of dried litter covering the eggs.

Hens lay in mid-day at which time the major nest predators (raccoon, opossum, and skunks) are inactive. It is unlikely that predators would see the hen approaching her nest at mid-day or would track her by scent when they emerge to hunt several hours later.

Hens do not linger near their nests. Laying hens spend their inactive daylight hours away from the nest and roost at least 0.5 km from the nest (Williams et al. 1974). When approaching the nest to lay, hens move steadily and enter the nest quickly. If a hen sees a person as she returns to the nest, she delays her approach but returns quickly to the nest when the person leaves the area.

Eight hens were monitored from observation blinds and by telemetry as they left their nests during the laying period. They did

not dust, rest, or feed until they had moved at least 200 m from the nest. Only two hens of the eight were known to visit their nests except to lay or incubate and each did so only once.

Hens chose dense cover for nesting, and remained motionless if approached on the nest. The turkey's strategy of holding tightly to the nest is a general defense strategy of many prey animals (Edmunds 1974). An observer approached within 6 m of 13 nests located in palmetto habitat a total of 19 times; in no case did the hen flush unless the investigator passed closer than 2 m. In seven cases, hens returning to their nests were frightened away by an investigator who was within 5 m of their nests; none abandoned.

In approximately 40,000 man-hours of field work only one active nest was found accidentally. This finding, coupled with the observations on nest holding behavior, suggests that disturbance of hens on their nests by humans in cover conditions such as those on the study areas, is minimal.

Turkey hens in Alabama (Wheeler 1948) and in the Rocky Mountains (Ligon 1946) have been observed flying to and from their nests. In the present study, 20% ($\underline{N}$ = 140) of the hens flew from or to the nest site. In flying to their nests, turkeys usually landed 3-15 m away and walked the remaining distance; when flying from the nest, they took two to five steps before flying, often taking wing within 3 m of the nest.

Much has been written about nest abandonment as a result of human disturbance of nesting hens (see Schorger 1966:265-266 for a review). Logan (1973) reported that seven of nine hens in Oklahoma were flushed repeatedly from their nests without abandoning. The two hens that did

abandon their nests were flushed during the laying period--the other seven were flushed while incubating. Hens apparently have differing tolerances to being flushed from the nest. Of the 38 hens flushed from their nests a single time in the present study, 55% did not return (Table 15).

It is widely believed that nesting hens are more likely to abandon their nests if flushed during the laying period than if flushed during the period of continuous incubating behavior (Schorger 1966). In this study, 60% of the hens that were flushed during the period of continuous incubating behavior returned to their nests in contrast to 38% of those flushed during the laying period (Table 15). Although the observed behavior supports the concensus view on the subject (Schorger 1966), the difference was not significant (X^2 = 1.29, df = 1, $\underline{P}$ = 0.255).

There is evidence that a hen is more likely to return to her nest if flushed late in the incubation period than during laying or early in the incubation period. The return rate was 38% for hens flushed during the laying period, 42% for hens that had incubated less than 8 days when flushed, and 60% for hens that had incubated longer than 8 days (Table 15); these differences, however, were not statistically significant (X^2 = 0.84, df = 2, $\underline{P}$ = 0.359).

Habitat type appeared not to influence nest abandonment. Thirty-nine percent of the hens flushed from nests in the cypress woods returned as compared to 59% returning to nests in palmetto (X^2 = 1.61, df = 1, $\underline{P}$ = 0.446) (Table 16). However, a higher proportion of yearling hens (73%) abandoned their nests after being flushed than did adults (44%) (X^2 = 2.751, df = 1, $\underline{P}$ = 0.097).

Table 15. Number and percentage of Florida wild turkey hens returning to their nests after being deliberately flushed a single time by an observer, Fisheating Creek Study Area, 1968-82.

Nesting period	Number of hens flushed	Hens returning	
		N	%
Laying period	8	3	38
First week of incubation	19	8	42
After first week of incubation	10	6	60
Incubation period	30	18	60
Entire nesting period	38	21	49

Table 16. Number and percentage of Florida wild turkey hens by age class and habitat type that returned to their nests after deliberately being flushed by an observer during the laying and incubation period combined, Fisheating Creek and Lochloosa study areas, 1968-82.

Habitat type or age class	Number of hens flushed	Hens returning	
		N	%
Palmetto	22	13	59
Cypress woods	18	7	39
Adult	32	18	56
Yearling	11	3	27

SUMMARY

Wild turkey hen flocks dissolved in spring as the hens established new home ranges and began to visit nesting cover. Nests were not prepared in advance of laying. Hens scratched away leaves and soil to make shallow depressions and deposited their first eggs on the bare soil in mid-day. Saw palmetto with wiregrass, in an ecotone between oak scrub and saw palmetto prairie, was the favored nesting habitat. A substantial proportion of the hens also nested in cypress woods and in miscellaneous habitats. There was much variation in the use of different nesting habitat from year to year and from one nest to the next within the same season by the same hen.

Before a hen departed the nest after laying, she partially covered the eggs with leaf litter picked up from beside the nest. Each time she returned to lay another egg, the hen settled on the nest without removing the litter. This habit camouflaged the nest and produced the leafy lining characteristic of the completed nest.

Hens averaged about 1 hour at the nest while laying each of the first 5 eggs, which were deposited from a standing position. Laying was irregular at first--1 to 3 days being skipped early in the laying period before laying became a daily event. Hens rarely visited their nests except to lay or incubate. After five eggs had been laid, hens remained on the nest longer with each subsequent laying. This behavior initiated incubating behavior gradually. By the time the last egg was laid, hens were remaining on their nests from mid-day

until late afternoon. Most hens remained on the nest overnight for the first time on the same day the last egg was laid, and continued to incubate overnight except for daytime recesses during the remainder of the incubation period. Incidents of more than one hen laying in the same nest and of egg-dropping occurred only infrequently. The hens exhibited characteristics of a determinant laying species.

Hens usually left their nests only once every 2 days although some hens remained on the nest for a span of 4 days without a recess. Recesses averaged 98 minutes. Most recesses were taken in the morning or afternoon; mid-day recesses were infrequent. Successive recesses were not routinely taken during the same time of day.

Hens did not cover their eggs when on recess during the incubation period as they did during the laying period. Hens turned their eggs during both the laying and incubation periods. Eggs rolled intact from the nest were sometimes placed back in the nest by the hen; however, hens usually abandoned nests containing a broken egg.

The first poult was hatched after about 26 days of continuous incubating behavior. Although the gradual onset of incubating behavior resulted in about 25 hours disparity in the amount of incubation experienced by the first and last eggs, hatching synchronization appeared to be poorly developed. The brood remained in the nest for at least one-half day after the hatching of the last poult. Parental imprinting of the poults was facilitated by frequent voice communications between the hen and brood. The brood usually

departed the nest in the morning before the end of the twenty-seventh day after the beginning of continuous incubating behavior.

Average clutch size was 10.3 eggs. Clutch size of adults and yearlings differed, being 10.5 and 10.0 eggs, respectively. There was no difference in the number of eggs in first, second, or third nests or for early vs late nests in the same year. The two largest clutches contained 17 eggs. Incubated clutches with fewer than five eggs were not found, probably because hens are not adequately stimulated to incubate fewer than five eggs. Egg hatchability averaged 89%.

Turkey nests were established in heavy ground cover and were well camouflaged. Incubating hens held tightly to their nests when approached by a human or potential predator. This behavior probably increased nesting success inasmuch as flight by the hen usually would reveal the location of the nest, and thereby increase the probability of its destruction. About one-half of the nests were destroyed by predators; however, when renesting was considered, nearly 60% of the nesting hens were successful in hatching a brood. Major nest predators were the raccoon, stripped skunk, spotted skunk, and opossum. Predation incidents were distributed evenly throughout the period of continuous incubating behavior. Laying hens renested more readily than incubating hens; adults renested at about twice the rate of yearlings.

The nesting season extended from early March, when the first nests were established, to early July, when the last clutch hatched. The median date of nest establishment was 23 March; the median date of the last hatching was 8 June. Thus, the nesting season for the

Florida turkey is essentially restricted to the months of April, May, and June.

Nesting Florida turkey hens are secure from serious levels of disturbance associated with spring gobbler hunting or other human presence in their habitat because of the dense nesting cover used and the tenacity with which they hold to the nest in the presence of humans. Even when disturbed, approximately half of the hens that were flushed from their nests returned and continued normal nesting activities. Furthermore, 39% of the flushed hens that abandoned their nests renested.

Incubating hens leave their nests infrequently for very short periods and would not likely be encountered by hunters. Furthermore, more than half of their recesses are taken in afternoon during which time spring gobbler hunting in Florida is not permitted. There would be no advantage in setting the spring gobbler hunting season to coincide with peak incubation activity for the purpose of protecting nests from dispruption because the net impact on reproduction is the same regardless of whether the hen is flushed while laying or while incubating.

Although hens exhibited a strong preference for nesting in the ecotone between oak scrub and saw palmetto prairie, and in cypress woods, the highest rate of nest success occurred in habitats other than palmetto or cypress. Because of the great variation in nesting habitat used from year to year and the strong tendency of hens to renest freely in a habitat different from that of the earlier nest, manipulation of nesting cover is not warranted at this time. However,

it would probably be beneficial to preserve much of the palmetto-scrub ecotone in habitat occupied by the turkey in Florida.

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Lovett E. Williams, Jr., was born 10 May 1935 in Perry, Florida. He attended elementary and high schools in Quincy, Florida, and graduated from Lamar Union High School in Lamar, Colorado, in 1953. In 1954 he completed his freshman year at Sunflower Junior College in Moorhead, Mississippi, and in 1957 received the Bachelor of Science degree from Florida State University, majoring in vertebrate zoology. In 1959 he received the degree of Master of Science in game management from Alabama Polytechnic Institute (Auburn University). After serving 3 years in the U.S. Coast Guard (1959-62), he became a wildlife biologist with the Florida Game and Fresh Water Fish Commission with which agency he is presently employed. In 1985 he completed requirements for Doctor of Philosophy degree in the School of Forest Resources and Conservation at the University of Florida, specializing in wildlife ecology.

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

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