

WILDLIFE UTILIZATION TRENDS AT
WHITE OAK MARSH IMPOUNDMENT,
NORTH CAROLINA

A Thesis

Presented to
the Faculty of the Department of Biology
East Carolina University

In Partial Fulfillment
of the Requirements for the Degree
Master of Arts in Biology

by

Edward Weaver, Jr.

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by

Edward Weaver, Jr.

APPROVED BY:

SUPERVISOR OF THESIS

Susan J. McDaniel
Susan J. McDaniel

CHAIRMAN OF THE DEPARTMENT OF BIOLOGY

James S. McDaniel
James S. McDaniel

DEAN OF THE GRADUATE SCHOOL

Joseph G. Boyette
Joseph G. Boyette

ABSTRACT

Edward Weaver, Jr. WILDLIFE UTILIZATION TRENDS AT WHITE OAK MARSH IMPOUNDMENT, NORTH CAROLINA. (Under the direction of Dr. Susan J. McDaniel) Department of Biology, April, 1975.

The purpose of this study was to provide quantitative information regarding wildlife, utilizing a particular impounded marshland habitat. The study period extended from March 1 to September 1, 1974. Data were collected by systematic search efforts throughout the 106-acre area, eight hours per day, twice a week. In this manner 1) the species present and their abundance, 2) arrival and departure dates, 3) laying and hatch dates, 4) reproductive success, 5) rate of abandonment, and 6) predation effects were monitored.

Wildlife were divided into two categories: A) those using the impoundment for feeding and refuge purposes only (non-breeding), and B) those utilizing the impoundment habitat to reproduce. River otter, muskrat, marsh hawk, and the endangered alligator were among the 25-30 species that inhabited the area for food and refuge. The wood duck, Florida gallinule, purple gallinule, long-billed marsh wren, least bittern, yellow-bellied turtle, redwinged blackbird, brown and banded watersnake, and cottonmouth utilized the impoundment for nesting (reproduction) and brood rearing. Numbers

of individuals were increased as a result of the available habitat. Purple gallinules nest farther north in this man-made habitat than in previously described natural areas.

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INTRODUCTION

The impoundment of marshland by diking and other artificial means represents a recent attempt at mosquito control by state agencies of North Carolina and other Atlantic Coast states. The purpose of the impoundment is to prevent or reduce tidal fluctuation within the marsh areas and thereby disrupt the reproductive cycle of the salt water mosquito (Aedes sollicitans (Walker)). Mosquito control by impoundment has been a success, resulting in a 65-95% breeding reduction of the salt water mosquito (Chapman, 1959). Furthermore, it has been discovered that these expanses of impounded marshland provide desirable wildlife habitat (Chabreck, 1963). Waterfowl are the most frequent inhabitants using these areas for refuge and feeding stations during fall and spring migrations along the Atlantic flyway. Waterfowl, mostly duck populations, reach and exceed densities of 6 individuals per acre (Donnelly, 1974). Other wildlife are known to dwell and thrive in the marsh impoundment habitat on a permanent and transitory basis. It is thought by some authors that the practice of marsh impoundment is an acceptable alternative to a natural marsh system, one that offers itself to a variety of wildlife species (Teal and Teal, 1969).

In short, new habitat has been produced on the North

Carolina coastline, comprising marshland vegetation and animals, one uncharacteristic of a tidal marsh ecosystem, which lends itself to successful management of plant and wildlife species.

Impoundment practices have recently come under attack by some conservationists, who contend that the natural integrity of the marsh has been destroyed and that the marsh's primary natural value, i.e., estuarine fertilization, has been eliminated. From this ecological standpoint, the marsh impoundment is not conducive to the local estuary-marsh ecosystem, insomuch as the plankton and nutrient-rich water from the marshland should be allowed to circulate to surrounding estuaries.

The purpose of this study was to document the use of this type of wetland habitat for marsh dwelling wildlife in feeding, reproduction, and refuge.* The specific area studied was White Oak Marsh Impoundment, located in northeast Onslow County, North Carolina. The marsh habitat was monitored to determine what wildlife forms were present, their abundance, and some of the seasonal trends they exhibited in their utilization. Such documentation of wildlife usage is

*

The term refuge refers to an area suitable for resting layovers for migrating waterfowl, where sufficient cover allows escape from predators.

necessary for a thorough evaluation of the impoundment concept, substantiation of future impoundment projects, or safeguarding against negligent marsh development and determining the degree to which marsh impoundments are important as effective wildlife management practice. This type of research was described by Hawley (1974) as a demand of the future when he said,

"A research program documenting the values of wetland area (should) be initiated by both state agencies and private groups for North Carolina wetlands. Such a program should place top priority on documenting the trade-offs involved in multiple-use options for wetlands and fully informing the public of its research results. Separate classification schemes (should) be developed by each group (wildlife, forestry, recreation, fisheries) concerned with wetlands based upon the unique attributes of importance to that group."

The Study Area

White Oak Marsh Impoundment lies adjacent to the White Oak River, which separates Onslow, Jones, and Carteret counties in eastern North Carolina (Figure 1). It was accessible only by water or through privately owned land. The impoundment construction was completed in February, 1966, by the Onslow County Health Department in a cooperative agreement with the North Carolina Wildlife Resources Commission for maintenance of the impoundment dike, water level, and plant food species for waterfowl. This is done by periodically

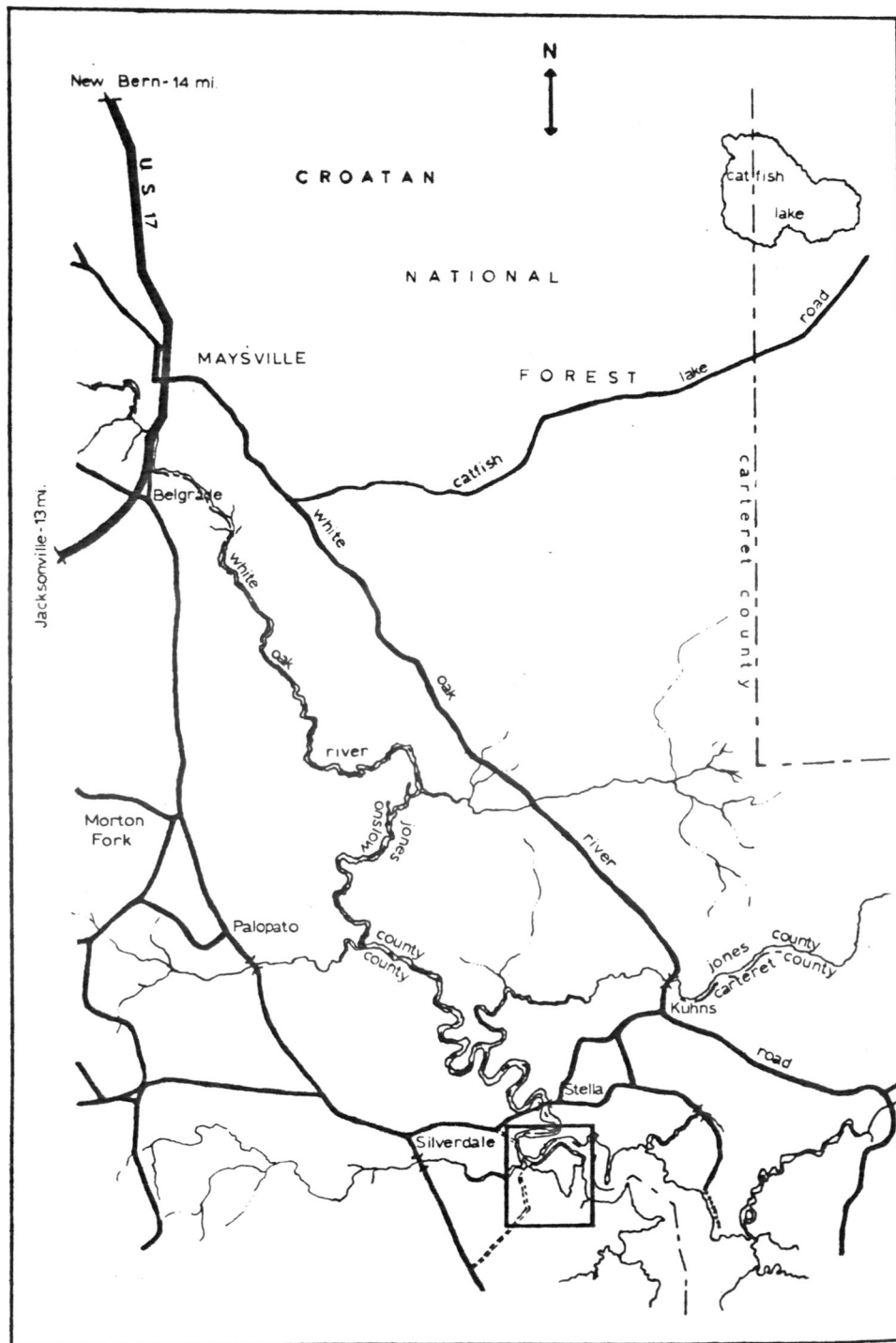


Fig. 1 Study Site Location Map.

repairing floodgates and pumps, as well as close surveillance of the stages of plant succession that the impoundment exhibits. The impoundment complex (dike and interior waters) encompasses approximately 106 acres harboring needlerush (Juncus roemerianus (Sheele)) as the most abundant plant species. Broadleaf cattail (Typha latifolia (Massette)) and narrowleaf cattail (Typha angustifolia (Massette)) follow (Figure 2). Cattail, usually considered a nuisance species because it crowds out desirable Juncus and sunlight for submergent aquatic vegetation, is shown by Figure 2 to have been abundant in certain areas of the impoundment; it also provided necessary cover and refuge for surface-feeding waterfowl. Olney threesquare (Scirpus olneyi (Gray)) and gulf spikerush (Eleocharis cellulosa (Torrey)) were prevalent impoundment species. Isolated patches of softstem bullrush (Scirpus validus (Vahlberg)) and little floating heart (Nymphoides cordatum (Elliott)) were also prevalent. Sawgrass (Cladium jamaicensis (Crantz)) intermingled with needlerush occupies approximately 5% of the area. Extending from the impoundment floor and appearing at the water's surface among stands of Juncus, coast bacopa (Bacopa monnieri (Pennell)) appeared in sizeable amounts. Submergent aquatic vegetation was composed of approximately 95% widgeon grass (Ruppia maritima (Ruppius)) which provided desirable food for water birds of many types.

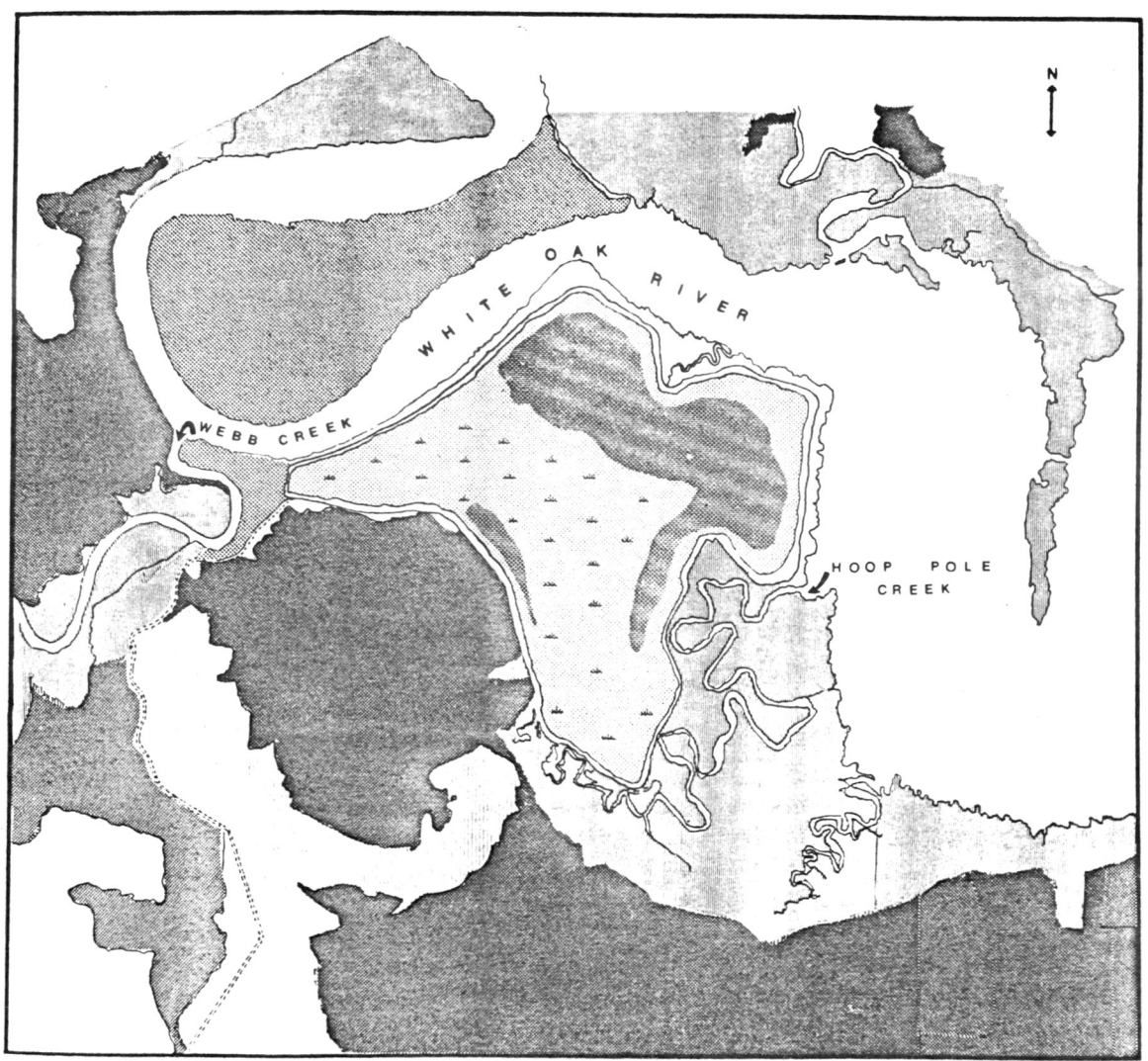
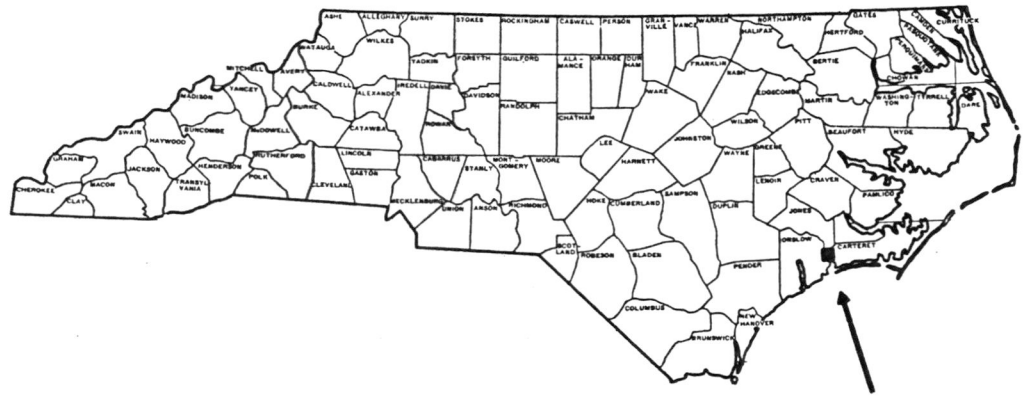


Fig 2. White Oak Marsh Impoundment and Surrounding Environment

Phragmites (Phragmites communis (Roseau)) was located at irregular intervals in the impoundment, even though attempts were made to destroy it by management practices.

The impoundment dike had unusually heavy vegetation, including blackberry (Rubus spp.) and poison ivy (Rhus radicans (Miller)), making it impassable during the months of July and August. Wax myrtle (Myrica cerifera (Bentham)), loblolly pine (Pinus taeda (Koehne)), black cherry (Prunus serotina (Koehne)), red maple (Acer rubrum (Koch)), red cedar (Juniperus virginiana (Endlicher)), marsh elder (Iva frutescens (Hoffman)), elderberry (Sambucus canadensis (Sureau)), red bay (Persea borbonia (Sprengel)), bitter gallberry (Ilex glabra (Gray)), yellow jessamine (Gelsemium sempervirens (Aiton)), common sumac (Rhus glabra (Green)), holly (Ilex opaca (Gray)), panic grasses (Panicum spp.), and devil's walking stick (Aralia spinosa (Ventenat)) were present. There was no significant spatial distribution of these plant species; they were interspersed in random fashion over the impoundment dike. Big cordgrass (Spartina cynosuroides (Schreb)) existed along the White Oak River impoundment interface, along with cattail, and appeared in dense patches along the dike. Saltmeadow cordgrass (Spartina patens (Aiton)), blackgrass (Juncus gerardi (Loiseleur-Deslongchamps)), and spike grass (Distichlis spicata (Green)) were found only sparingly, probably due to low salinity.

The dike area was unusual in that it is surrounded by three distinct environments 1) open White Oak River, 2) woodland, and 3) natural marsh. It is bounded on the southern side by Hoop Pole Creek, on the West by Webb Creek, and on the North and East by the White Oak River. Hoop Pole Creek runs through ditched marshland and separates privately owned (Morton) woodlands from the impoundment.

Earthen islands, approximately 3 x 4 m. in size, were provided during the impoundment construction, on the premise that they might be attractive to nesting bird populations. There are 27 of these islands within the 106-acre boundary, all mostly covered with poison ivy, big cordgrass, and wax myrtle (Figure 3). The islands extend from 1 to 1.5 m. above the water's surface. Eight nest boxes provide nesting habitat for locally breeding wood ducks (Figure 3). The impoundment floor is composed of a solid mud foundation which is almost totally covered with a dense growth of Ruppia. Holes of an additional .5-.75 m. depth are adjacent to the earthen islands.

Water levels never exceeded 45 cm; they usually ranged between 35-45 cm. Salinity levels ranged between one and two parts per thousand, as compared to a three to four parts per thousand range in the White Oak River. Along the inner border of the dike a one to two m. canal remains as the result

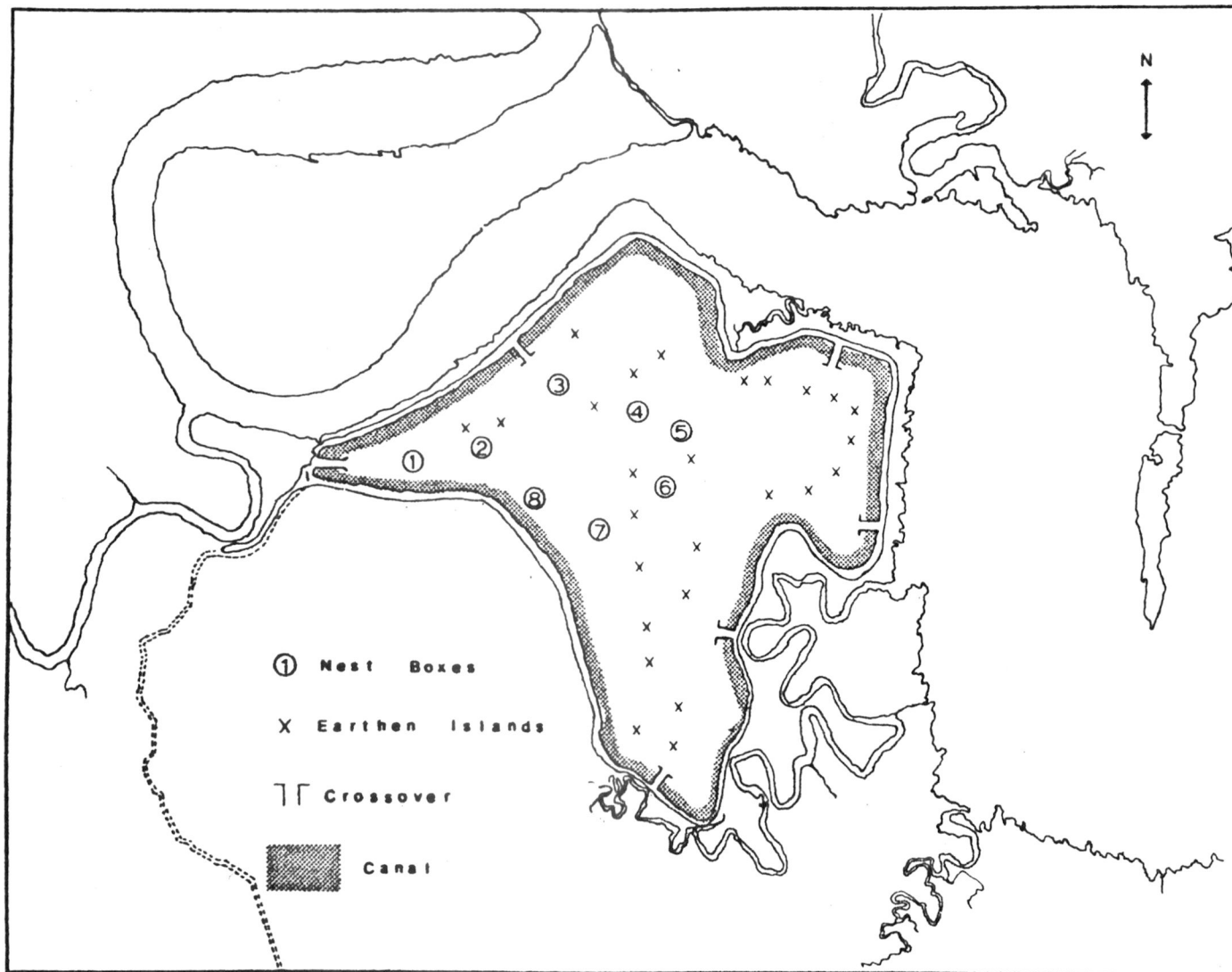


Fig. 3. White Oak Marsh Impoundment Showing Canal, Crossovers, Earthen Islands, Nest Boxes.

of the dragline operation that provided the soil for the dike. In this were species that did not ordinarily live in the more shallow interior. Six marked crossovers presented the only means of a walking entrance into the impoundment interior (Figure 3).

MATERIALS AND METHODS

Data were collected on biweekly trips from March 1 to September 1, 1974, 8 hours each day. Previous studies by Chabreck (1963) have shown this to be sufficient time per observation for a successful assay of the types of wildlife present, their numbers, their location, and the trends they exhibit.

During March and early April, before active nesting began, the 106-acre impoundment and surrounding area was mapped, noting vegetation types, location of nest boxes and earthen islands. An initial survey of the species of wildlife already present was also made. Low vegetation growth made access to the entire perimeter of the impoundment easy at this time; the interior was always wadeable and accessible.

Routes through the impoundment were changed on consecutive trips, to minimize disturbance to wildlife and environment. Upon the initiation of wood duck nesting, dates of egg laying and hatching, hatch success, rate of abandonment, predation, and incidence of re-nesting were recorded. The nest boxes allowed the top to be removed for inspection of the nest; a portable ladder was used to reach their location 2.3 m. above the impoundment bottom. Arrival dates for other species were noted and systematic searches for their nests

begun upon their arrival. Nesting dates for each species were recorded. Behavioral cues were also used in locating nests. Each individual of a species and its location was recorded daily. When the dike vegetation became too dense for walking a small boat was used in the adjacent deep canal. Photographs of as many wildlife forms as possible provided additional documentation. Temperature and relative humidity were continually recorded at the site with a 7-day hygromograph. Weekly averages in temperature and relative humidity were analysed to determine changes in the wildlife status attributable to these environmental variables (Table I).

TABLE I

WEEKLY AVERAGE TEMPERATURE AND RELATIVE HUMIDITY

WEEK	TEMPERATURE (°C)	RELATIVE HUMIDITY
April 1	13.4	69.8%
2	17.9	72.8%
3	16.8	55.7%
4	18.4	57.4%
May 1	16.8	69.5%
2	20.1	73.2%
3	20.7	79.0%
4	19.9	73.8%
June 1	21.1	81.0%
2	24.9	77.2%
3	22.9	71.9%
4	25.3	66.2%
July 1	24.7	75.8%
2	24.1	63.4%
3	23.4	74.5%
4	23.9	71.4%
August 1	24.9	72.7%
2	25.3	74.1%
3	26.5	76.0%
4	26.7	75.8%

RESULTS AND DISCUSSION

Wildlife species were divided into two categories: a) species that reproduced at the study site and b) species that utilized the study site for purposes other than reproduction (food, refuge, etc.). Each species in the first group was graphically represented (number vs. time). The American coot (Fulica americana (Gmelin)) and the blue-winged teal (Anas discors (Linnaeus)) were not reproductive in the study area but existed in large enough concentration to warrant a graphic representation of their presence.

American coot: The American coot (Fulica americana) remained at White Oak Impoundment nearly year-round, except during the summer breeding months. Large concentrations of coots were common during any winter month but dwindled to zero by late May or early June (Figure 4). Coots did not nest at White Oak; their normal nesting range is farther north or west than the North Carolina coast. The coot does not breed anywhere in the eastern United States and if it does so it "is considered a rare or accidental occurrence. The species is not a common nesting bird east of Indiana" (Bent, 1963). Coots are known to be easy prey for raptorial birds because of their inability to escape effectively by flight or diving as other waterfowl (Bent, 1963). Coot remains found

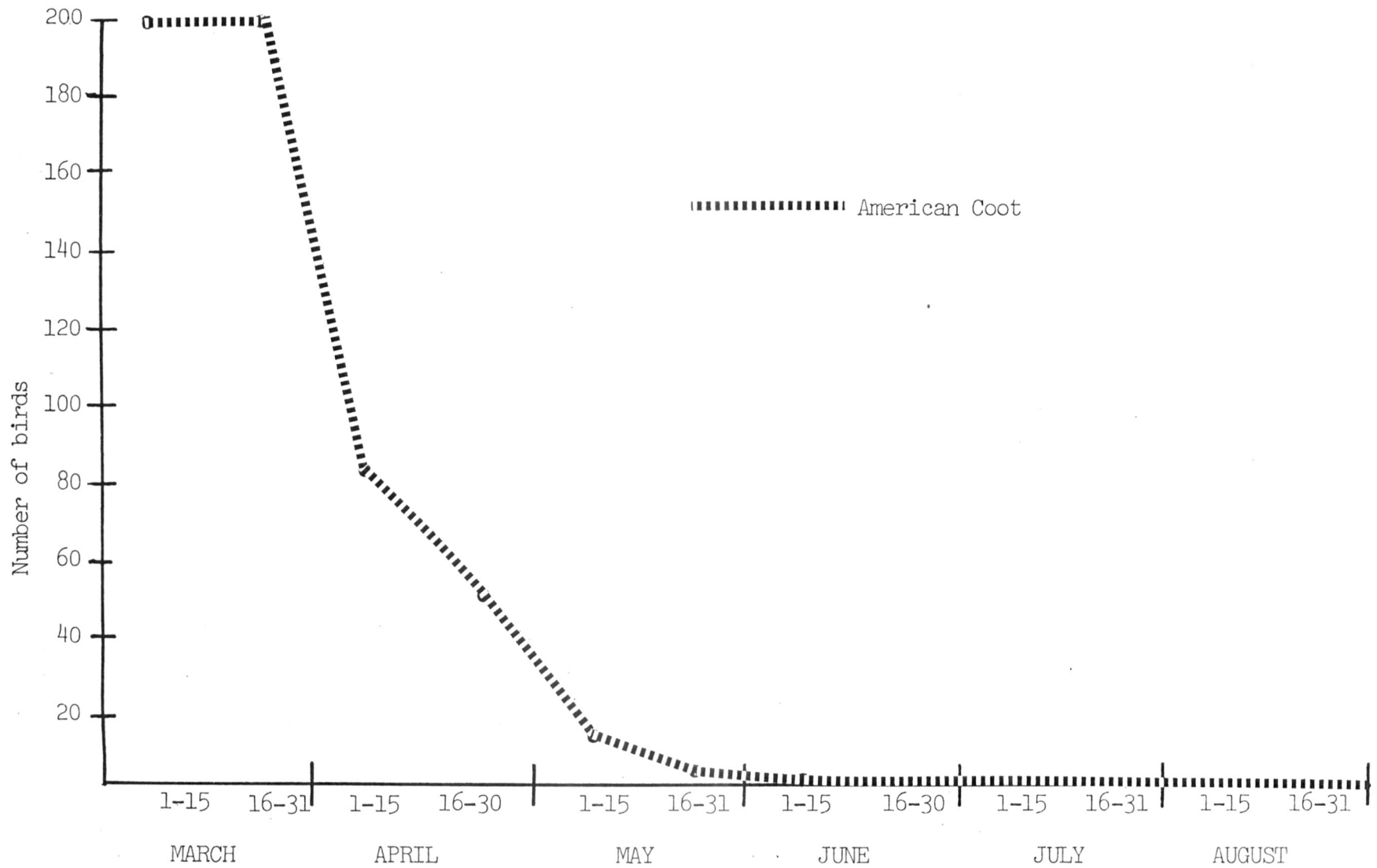


Figure 4. Average number of individuals recorded per day/two week period

atop earthen islands were evidence that the harrier or marsh hawk preyed on these birds in the study area.

Blue-winged teal: The blue-winged teal (Anas discors), an early fall and late spring migrant (Kortright, 1943), occurred at the White Oak Impoundment. Two large flocks of 50 or more were present March 1 and remained until mid-April and then seemingly left all at once. They returned on August 19 (Figure 5). Although blue-winged teal are known to nest as far south as Pea Island, North Carolina (Parnell and Quay, 1962), none bred in the study area. The spring sex ratio was approximately three males to one female. It is interesting to note that with an incubation period of 23 to 24 days, blue-wings were absent for only the eight-week period between May 28 and July 30 (Figure 5). Considering the incubation period of over three weeks this leaves less than five weeks for these birds to complete the northward migration, nest, fledge their young to flight, and return to the North Carolina coast. Thus the early fall migrants in August were probably not the same individuals as the late spring migrants, but this presents an interesting possibility.

Wood duck: The wood duck (Aix sponsa (Linnaeus)), a permanent resident in most eastern North Carolina counties, uses nest boxes at White Oak. Wood ducks arrived March 28. Eggs were present on April 4 (Table II); all boxes were

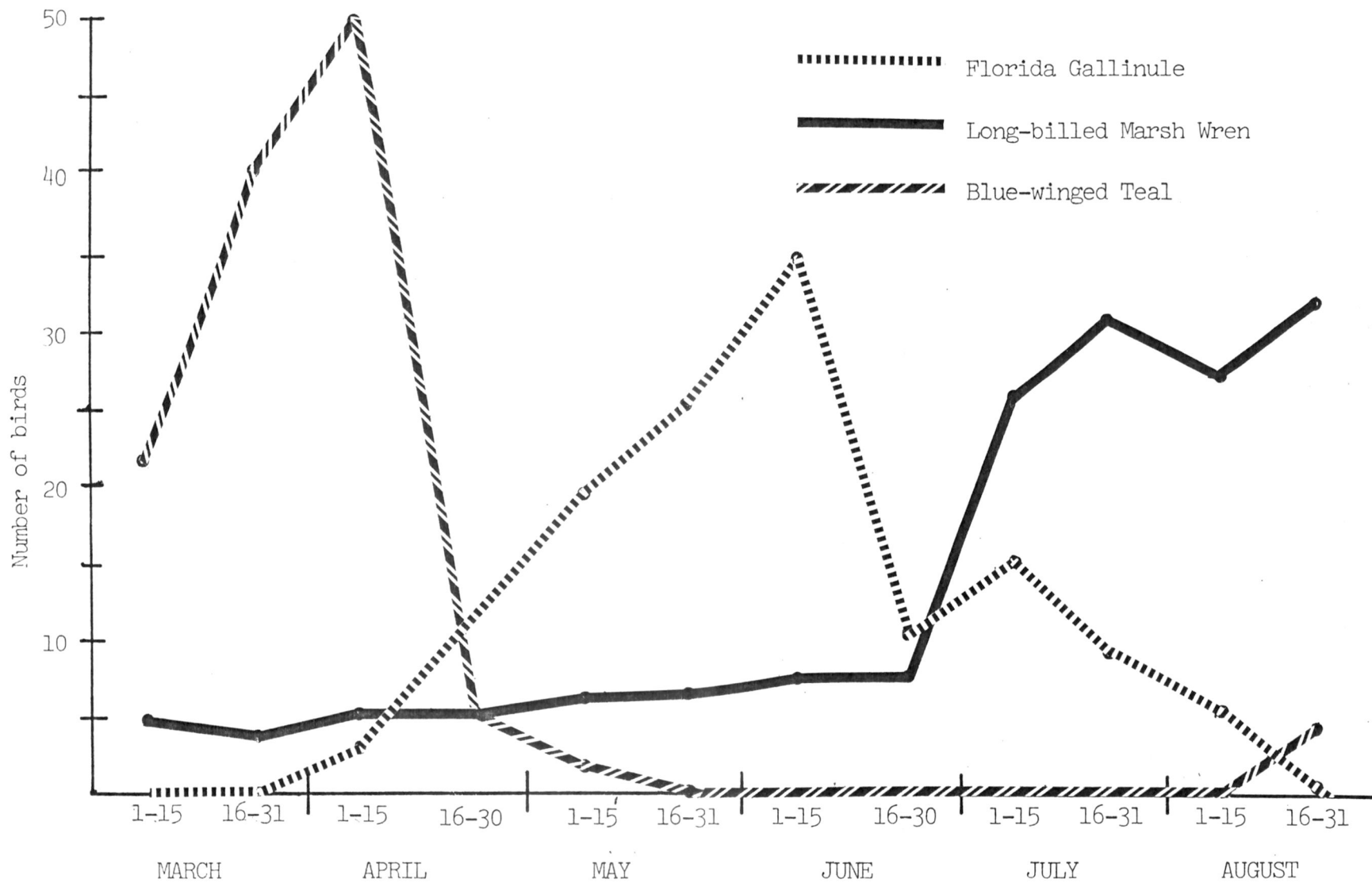


Figure 5. Average number of individuals recorded per day/two week period

TABLE II

SUMMARY OF BREEDING SPECIES AT WHITE OAK MARSH IMPOUNDMENT FROM MARCH 1 TO SEPTEMBER 1, 1974

Species	Arrival Date	Departure Date	Egg Date	Predation losses
Florida gallinule	4/2/74	8/19/74	6/18/74	90%
Red-wing blackbird	Permanent	---	5/18/74	30%
Purple gallinule	5/22/74	7/16/74	6/18/74	100%
Wood duck	3/28/74	---	4/4/74	42%
Long-billed marsh wren	3/2/74*	---	7/16/74	25%
Least bittern	4/2/74	8/15/74	6/14/74	80%
Yellow-bellied turtle	Permanent	---	4/9/74	50%
American alligator	Permanent	---	?	?
Water snakes (banded & brown)	Permanent	---	?	?
Cottonmouth	Permanent	---	?	?

--- Indicates non-departure by the end of the study period

* Mostly permanent but became obvious at this time

? Could not be determined

utilized by wood ducks except one. Wasps, dirt daubers, snakes, and some species of owls also find these boxes attractive, making periodic management necessary to insure use by wood ducks. Prior to April 4 wasps, spiders, and dirt daubers were removed from six out of eight nest boxes. Each box was supplied with 2-5 cm. of sawdust on the floor. Eggs were laid directly on this substrate and were surrounded by down and feathers. Box number eight remained unoccupied, probably because tall cattail prevented easy entrance and exit of the birds. Table III summarizes nesting activity in each of the numbered nest boxes, showing box number eight least and box number three most productive. Figures 6-8 show the number of eggs each date. The total number of eggs laid in seven boxes was 69, an average of 9.86 eggs/box used. Of these 40 hatched, for a success rate of 58%. The box-use-success value was 87.5%. In 1966-67, of 11 boxes at White Oak, six contained nests for a box-use success of 54.5% (Donnelly, 1967). In general, nest success of altricial birds is about 43%, whereas that of hole-nesters is about 66% (Wing, 1956). Average incubation periods were approximately 28 days, agreeing with the 28-31 day incubation period described by Kortright (1943). Because eggs appeared in the nest boxes from April 4 to June 14, the later clutches probably represented re-nesting attempts for second brood efforts. Egg

TABLE III

WOOD DUCK NEST BOX SURVEY

BOX #	# EGGS	# YOUNG	DUMPED/ABANDONED	PREDATION
1	8	5	4	0
2	4	0	0	4
3	28	23	0	5
4	6	3	3	0
5	12	9	3	0
6	3	0	3	0
7	7	0	0	7
8	0	0	0	0

TABLE IV

SPRING MIGRATORY WATERFOWL POPULATIONS

SPECIES	2/17/74	3/5/74	3/12/74	3/19/74	3/28/74	4/30/74
Black duck	1	3	6	6	4	0
Shoveler	0	0	2	0	1	0
Mallard	0	0	4	2	0	0
Pintail	0	0	0	0	2	0
Lesser scaup	0	0	0	1	1	0
Hooded merganser	1	0	0	0	0	0
American widgeon	0	0	0	2	0	0

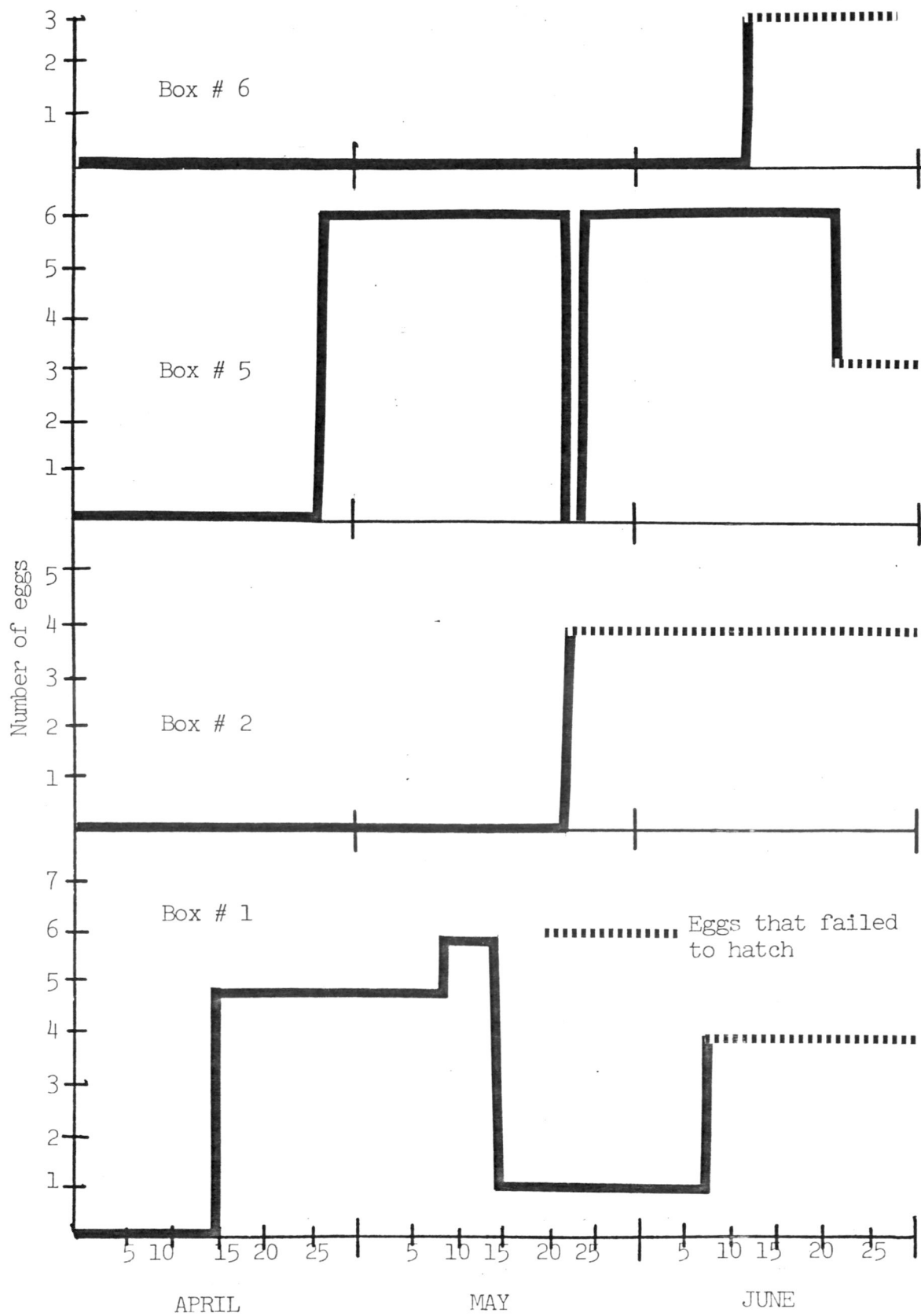


Figure 6 . Wood Duck nest box success

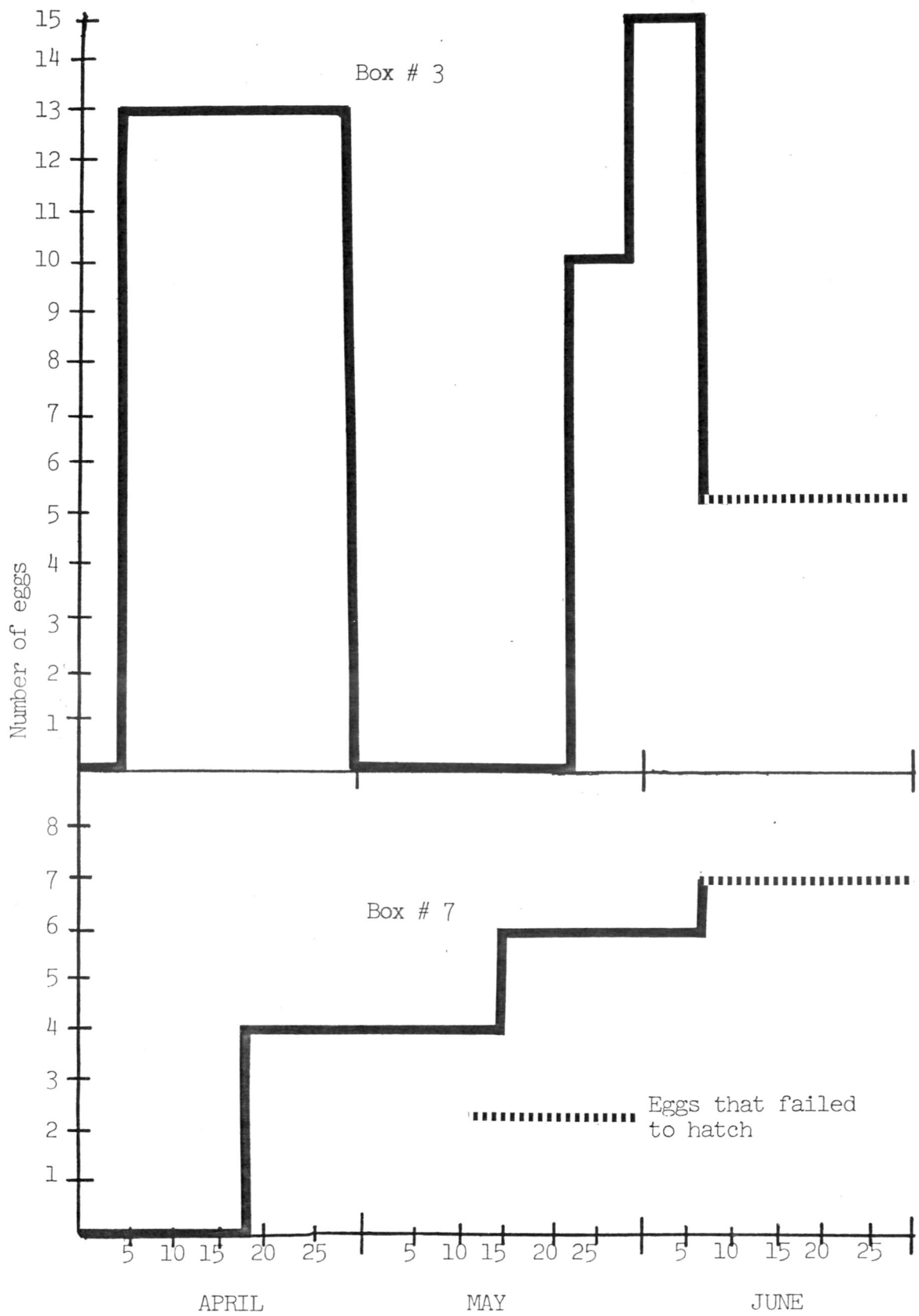


Figure 7 . Wood Duck nest. box success

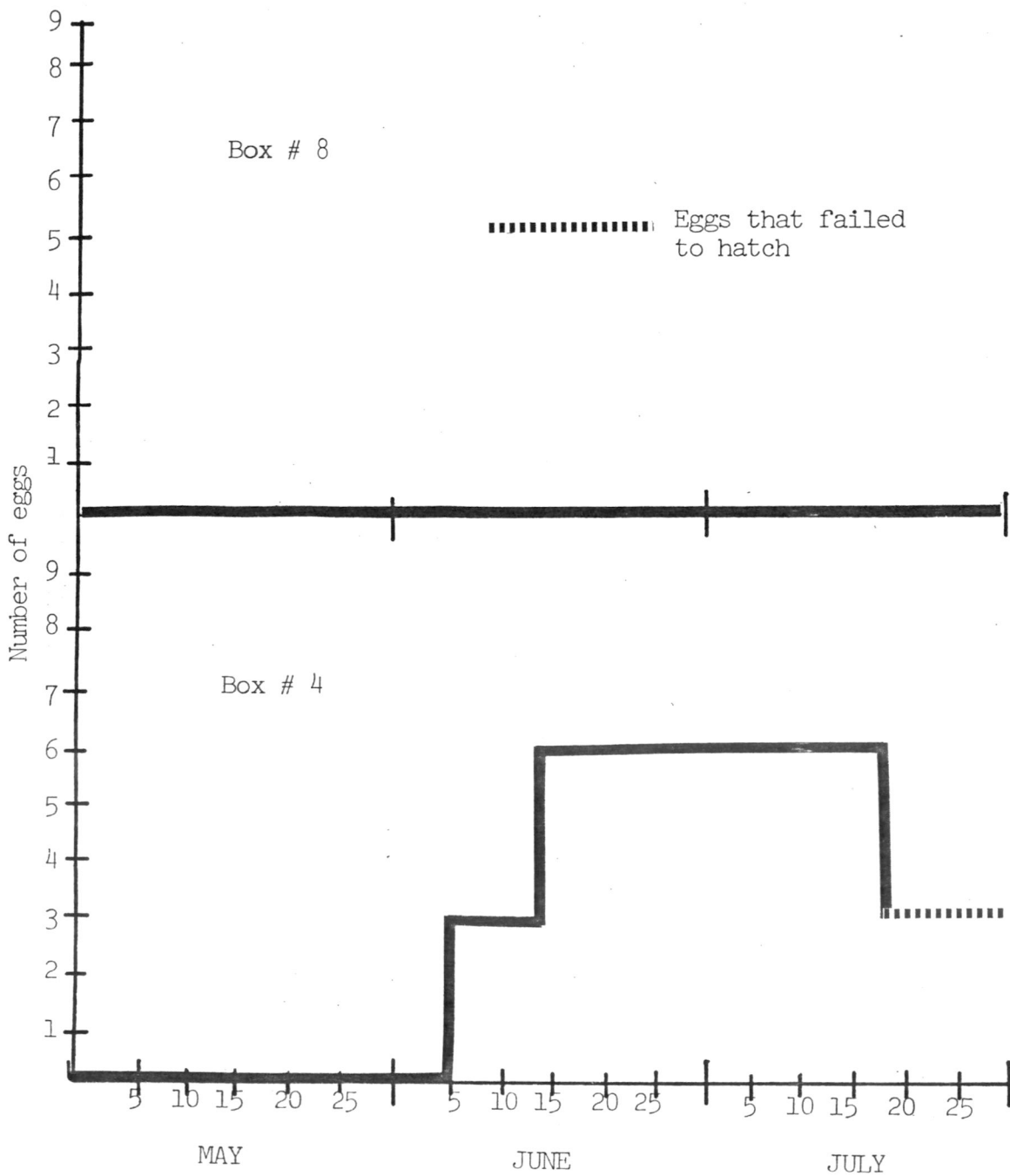


Figure 8. Wood Duck nest box success

production for first nesting reached a peak on April 16. Eggs attributed to re-nesting occurred from May 17 to June 14, with a peak on May 31. The first nesting produced 28 eggs. The more diverse second nesting produced 41 eggs, some of which could overlap into late first clutches. These 41 eggs include most of the abandoned and dumped eggs. Egg "dumping" by wood ducks is a phenomenon not completely understood. Female wood ducks have been known to deposit partial clutches or single eggs on the ground and in nest boxes containing eggs other than their own. In cases where an established clutch of eggs is in the process of incubation and suddenly one to three additional eggs appear, it is assumed that they have been laid (dumped) by a second female. The eggs in the clutch hatched at differing times and the partially incubated eggs are left behind after the original eggs hatch. The distinction between abandonment and dumping is not always clear when eggs are deposited in an unused nest box. Table III makes reference to abandonment, dumping, and predation in individual nest boxes. Biologists have approached the population implications of dump nesting with differing opinions. Jones and Leopold (1967) and McLaughlin and Grice (1952) view dump nesting as the expression of stresses of population density somewhat like those already described by

Wagner, Besadny and Kabat (1965) for the pheasant (Phasianus colchicus (Linnaeus)). They report that dump nesting actually acts as a population regulatory mechanism, by high incidence of nest abandonment and low hatch percentage in the dump nests.

Dump nesting can contribute to the production of young in two ways: 1) the persistence of the wood duck to nest (those that participate in dump nesting will probably also start a nest of their own) and 2) when dump nests are successful, considerably more young are hatched than in an equal number of normal nests (Morse and Wight, 1969). Morse and Wight, in a three-year study, found that in box-nesting wood ducks dump nesting was responsible for the addition of 37.5% more ducklings to the population.

The major difference between the Morse-Wight study and this study is that dump nesting occurred in pre-occupied nests with eggs at a concurrent or acceptable stage of development in the former, while in the White Oak study dump nesting occurred at all stages of incubation and had no discernible positive effect. Figures 6-8 show that the early nesting efforts were considerably more successful, with broken lines indicating eggs that never hatched. Figure 9 demonstrates the average number of wood duck individuals recorded per day/two week period.

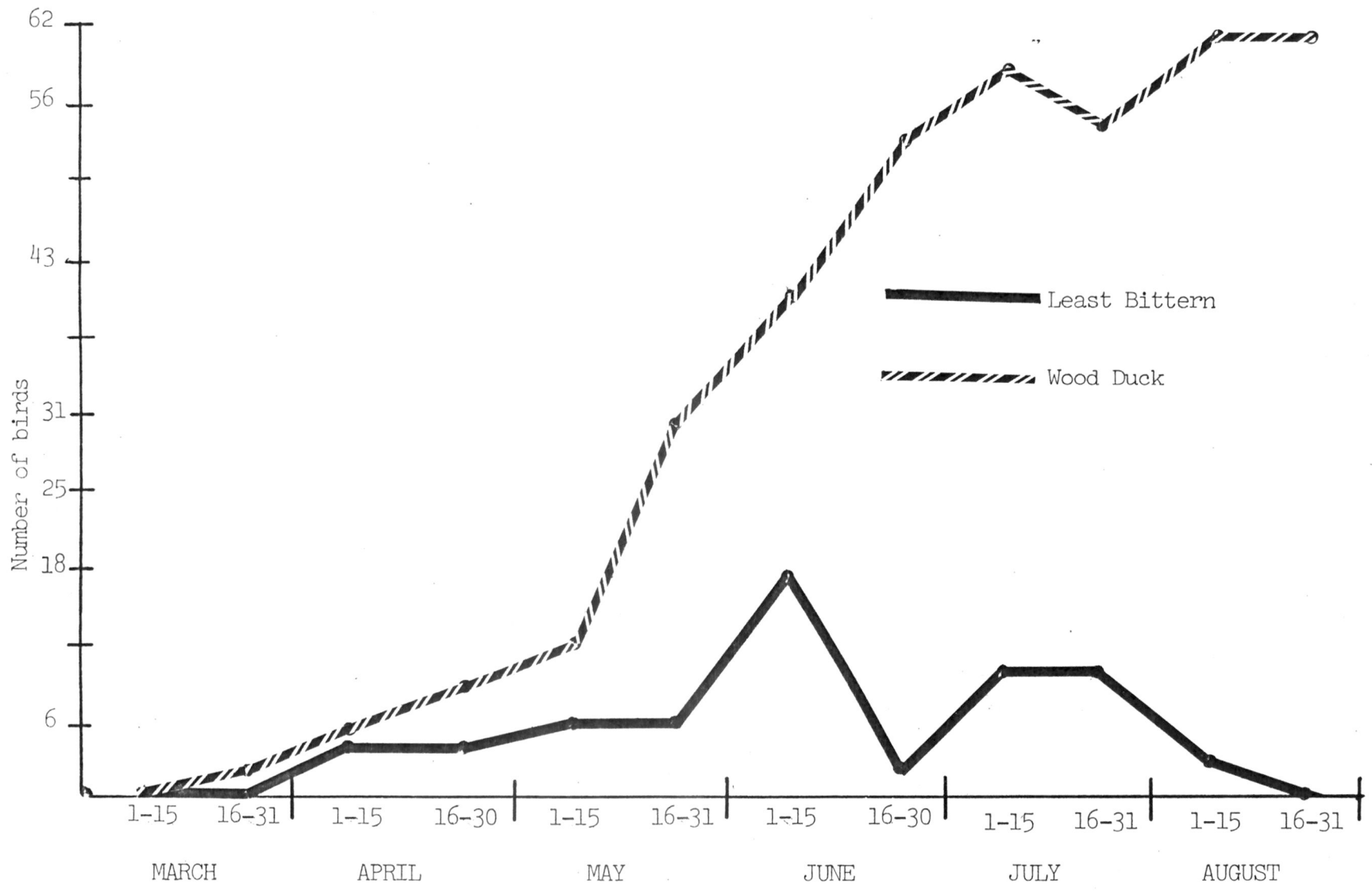


Figure 9. Average number of individuals recorded per day/two week period

Wood duck hatching reached peaks on May 17 and June 21. The usual clutch size in wood ducks is from 10-15 eggs (Kortright, 1943). The average at White Oak was 10 eggs. This number is low, compared with the established 10-15, due to partial clutches deposited and abandoned. Predation was also a factor. At least two clutches within the usual range were laid. Egg color was creamy to pale pink.

According to the United States Department of Interior (1964) some coastal areas support 10 wood duck pairs per 100 acres, but fewer than 100,000 acres on the east coast approach this level of productivity. White Oak is moderately high on this productive scale for wood duck habitat.

Nests, eggs, or other evidence of nesting of wood ducks or any other birds was not found on any of the 27 earthen islands. Wood ducklings did use these islands for refuge and escape from predators. Islands with their abundance of vegetation overhanging the water provided excellent cover.

There was evidence of predation on wood ducklings mostly from the marsh hawk or harrier (Circus cyaneus hudsonius (Linnaeus)). Duckling remains were found atop earthen islands and nest boxes. The American alligator (Alligator mississippiensis (Daudin)) also presented some possible danger to young wood ducks, although the two species were rarely seen

in the same vicinity. Snakes presented problems for nesting birds; a brown water snake (Natrix taxispilota (Holbrook)) of approximately 2.5 m. length was found in a nest box; it had consumed three eggs. This was the only verified occasion of snake predation, but such activity was likely common. Raccoons (Procyon lotor (Linnaeus)) did no significant damage, even though predator shields were not present on the poles supporting the nest boxes.

I believe that there was no nest desertion, increased predation, or reproductive failure directly related to my presence. Nest boxes were checked once every one and one-half to two weeks. When there was evidence of an incubating female, the nest was left undisturbed. Recommendations for increased wood duck productivity through management are 1) relocation of Box #8 and repair of box #6 (pole is leaning due to soft foundation), 2) five to seven additional boxes should be added, 3) general repairs to all existing boxes, 4) box #1 should be relocated farther east.

Florida gallinule: The Florida gallinule (Gallinula chloropus cachinnans (Bangs)) arrived at White Oak April 2 and began its nesting activities. This bird is not considered a common winter resident in North Carolina; it is in South Carolina, where Spartanburg County is recorded as the northern

limit during the fall and winter months (Sprunt and Chamberlain, 1970). Florida gallinules are found in spring migration on the east coast as far north as New Jersey. Comparable arrival dates have been recorded as District of Columbia-April 19; Richmond, Virginia-March 17; and Cambridge, Massachusetts-April 30 (Bent, 1963). Eight to twelve pairs of nesting gallinules were present in the impoundment, with a total of approximately 33 residents from April through August (Figure 5). These birds are known to nest in their northern extremes, which includes North Carolina, and then return south as far as South America. South Carolina retains a sizable wintering population of Florida gallinules, although far fewer than as are present in the spring and summer. North Carolina retains few, if any.

Departure from the study area was on August 19, in agreement with fall departure dates published by Bent (1963). An unusually late departure of November 16 was reported by Bent from Vicksburg, Virginia; ordinarily these gallinules leave the northern breeding grounds by August or September. Eggs were found in the study area on June 18; this is comparable to the May 22 to July 19 range reported in New Jersey (Bent, 1963). Average clutch size in the nine nests at White Oak was six eggs. "The Florida gallinule lays from 6 to 17 eggs with extremes unusual; probably 10 or a dozen would be aver-

age, the smaller sets are often incomplete." (Bent, 1963) Eggs exhibited the normal pale olive color with irregularly marked spots of various shades of brown and drab. The usual assumption is that Florida gallinule breed twice a year; the first egg dates documented are in late April and early May. It is highly possible that clutches representing an initial nesting effort were present but were not discovered due to early destruction by predators or failures to locate the nests during systematic searches.

The nest was a slightly hollowed heap of dead and shredded reeds placed in the center of a living cattail or needlerush clump. The 21 cm.-diameter and two to four cm.-deep nests were from one meter to a few centimeters above water, very exposed and obvious. Some nests had runways leading to them.

Predation losses were heavy, probably due to the exposed nature of the nest. Snakes, crows and raccoons are known predators of the Florida gallinule and take a heavy toll of both eggs and young (Bent, 1963). Water snakes and raccoons were particularly prevalent in the study area and probably played a role in the low nest success of ten per cent based on the successful fledging of one clutch out of nine observed.

The Florida gallinule cannot be described as a successful nester at White Oak Impoundment, due to the abundance of predators in that habitat. Obviously they do find the area attractive, probably because of the abundance of aquatic vegetation (Ruppia) and plentiful cover. The Florida gallinule is also known to consume frogs and small insects, food sources that are plentiful in the White Oak environment. (Burleigh, 1958.)

Purple gallinule: The purple gallinule (Porphyryla martinica (Linnaeus)) arrived at White Oak May 22. This bird is considered relatively common in South Carolina as a summer resident from April 10 to October. Its breeding range is almost entirely southern, being primarily in Florida, but extending into South Carolina. Orton Plantation near Wilmington, North Carolina, has been established as its northernmost breeding range. White Oak Impoundment lies approximately 100 miles north of Orton Plantation and can be considered a range extension for the purple gallinule. Bent (1963) describes Charleston, South Carolina, as being the northern limit on the east coast. Sprunt and Chamberlain (1970) verify this. This species remained for a period of approximately eight weeks (Figure 10), during which three to five nesting pairs were recorded. A total of six to ten individuals were

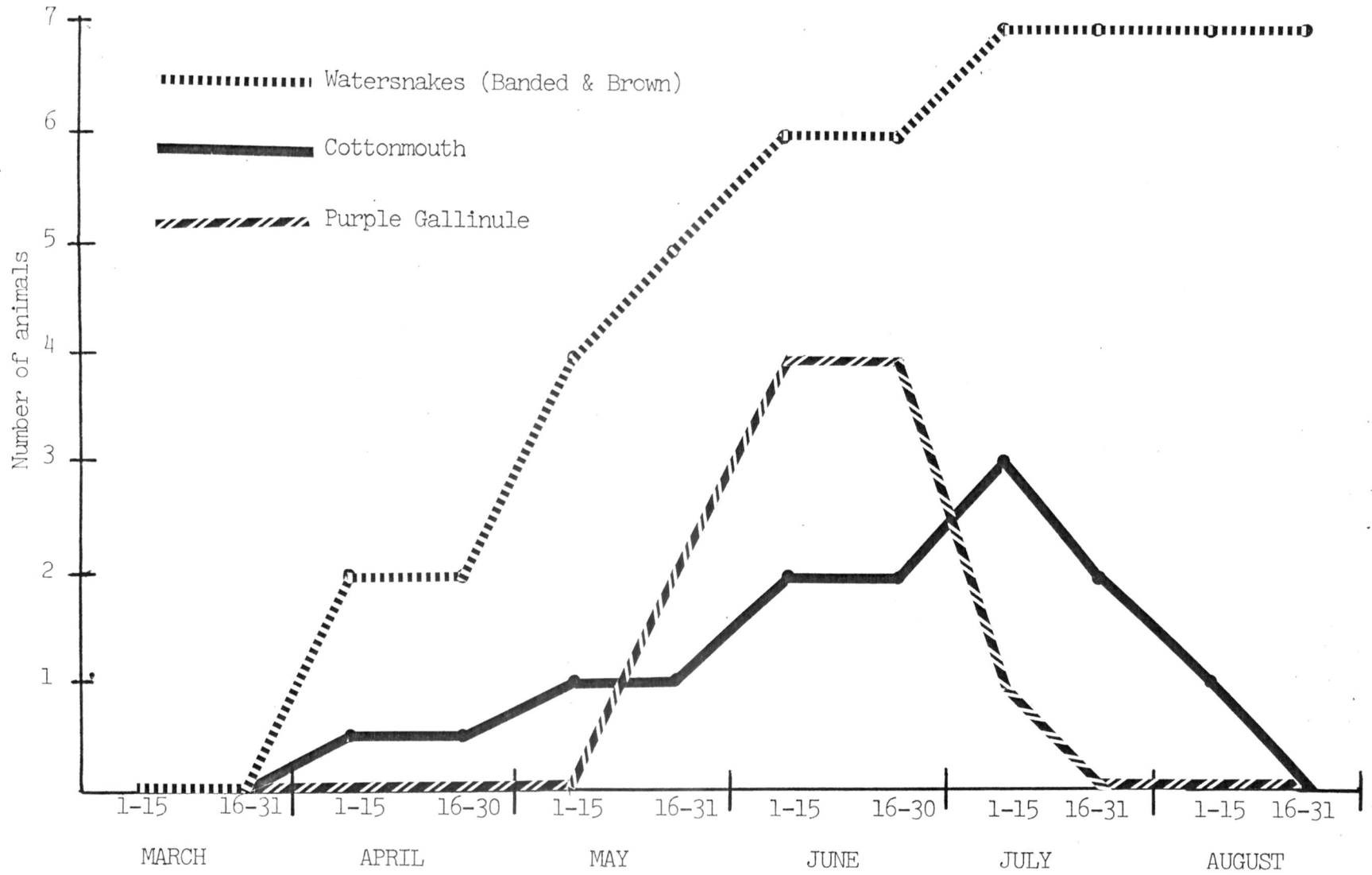


Figure 10. Average number of individuals recorded per day/two week period

resident during the month of June.

Nest building took place in June, with the first clutch of eggs sighted on June 18. In Florida egg dates vary from April 10 to June 26, and in South Carolina recorded dates extend from May 28 to June 1. Thus the nesting dates in North Carolina may be rather late for a northern area.

The nest of the purple gallinule is similar to that of the Florida gallinule, except more often it is lower and more exposed. The nest is a modified platform with a shallow 3 cm. depression over its 26 cm. diameter. In most cases these nests were composed of cattail and sedges and were positioned in a clump of needlerush. "Dummy nests," or partially finished nests surrounded the active one holding the eggs. The function of these half-completed nests is not known, but it is common as a behavioral trait in nesting purple gallinules.

As far as could be determined, nesting efforts of this gallinule met with complete failure. All active nests were destroyed or predated before fledging. This total predation loss (Table II) was based on the absence of hatchlings and disappearance of eggs from the four gallinule nests monitored. Even more than the Florida gallinule, purple gallinules suffer in habitats that are heavily populated with water-borne predators. The nest of this species is, in some cases,

directly exposed to the sun. This has caused some speculation that incubation is partially carried out by decomposition and insolation. Whether or not this is true, eggs and young pay the consequence to predacious water snakes, cottonmouths and raccoons.

The mean clutch size was six from the four nests. The purple gallinule normally lays from five to ten eggs (six to eight are considered average; larger sets are rare (Bent, 1963)). The eggs are ovate in shape and are pale pinkish in color, with small spots of brown and pale drab.

Departure date for the purple gallinule was July 16, somewhat earlier than the August and September dates recorded in South Carolina. This early departure was due either to their nesting failure or more northern occurrence.

The significance of the data on purple gallinule is that of range extension. Most sources consider the species a rare but regular summer resident of wetlands in the southeastern United States. Their nesting range is definitely southern, although Burleigh (1958) says it is found "casually to southern Virginia." In Florida it is an inhabitant of cypress swampland, and throughout South Carolina and southern North Carolina it is found in old rice field plantations. Although plant food and insects are abundant, the White Oak Impoundment

represents an environmental variation from the Floridian type of environment typical for the species.

Redwing blackbird: The redwing blackbird (Agelaius phoeniceus (Linnaeus)), a permanent resident along the North Carolina coast, breeds in large numbers in suitable marsh areas. Nesting of this species is preferred in areas near water. Populations of nesting redwings at White Oak Impoundment were so large that an attempt to accurately estimate the numbers present was abandoned. The number of nests observed per day is represented in Figure 11.

The cup-shaped nest of the redwing was extremely sturdy and was interwoven with strands of living sawgrass and needlerush. Occasional nests were in cattail. The typical bowl or cup shaped nest was anchored securely to the supporting vegetation. Bent (1958) reported that this nest will support up to four pounds before starting to slide downward. Nests measured about 10 cm. in diameter and 10-12 cm. in depth. The nest itself was composed almost totally of needlerush with a small amount of cattail. The inside of the nest is lined with smaller material, sedges and grasses. All nests were found at a relatively uniform height, one to 1.5 m. above the water level.

There were approximately 26 to 40 nesting pairs of

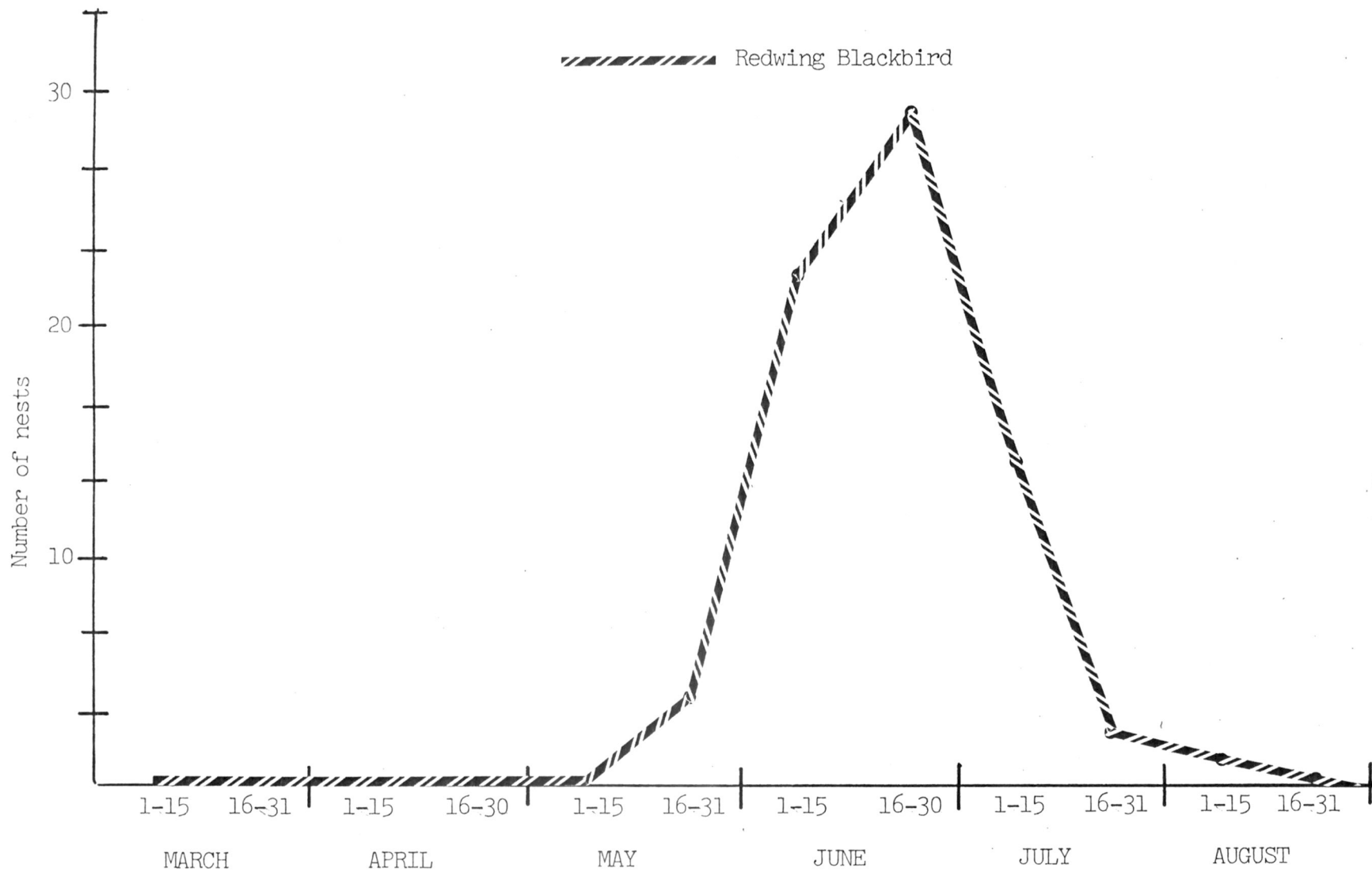


Figure 11. Average number of active nests recorded (eggs or young) per day/two week period

redwings among the large resident population. During the peak nesting month of June, 22 to 28 active nests were observed per day. Nesting began on May 11 at the study area; April 25 to May 18 was reported in Ithaca, New York (Bent, 1958). Eggs first appeared on May 18 and last June 19 in White Oak marsh. Comparable egg dates include Florida, May 16 to May 20; and Massachusetts, May 27 to June 6. The average clutch size in 27 nests was 4 eggs. Eggs were oval and glossy; the background color was bluish green with gray, with spots and streaks of brown and drab mostly on the broader end.

Nesting success was approximately 70%, based on 22 verified nest successes. The defensive behavior of the redwing and the number of nests present may have contributed to this success. Raids on nests were mostly by raccoons, with evidence of long-billed marsh wren (Telmatodytes palustris (Wilson)) predation on two clutches. In the latter cases small holes were punctured through the egg shells and much of the liquid interior extracted. Bent (1958) substantiates this type of predation, explaining that this happens in part because the two species nest in such close proximity.

Least bittern: The least bittern (Ixobrychus exilis (Gmelin)), the smallest heron inhabiting White Oak Impoundment,

is a summer resident in most of the eastern United States and southern Canada. It winters as far north as Texas and occasionally South Carolina and south as far as Brazil. Arrival date for the least bittern was April 2, in keeping with previously reported spring arrival dates of April 20 at Manteo, North Carolina, and April 5 at Frogmore, South Carolina (Bent, 1963). Arrival was dramatic, with three or four individuals appearing on that date. During the six-month study period the population fluctuated but steadily increased to a maximum of 20 to 30 residents (Figure 9). As shown, these birds became considerably less obvious during the later half of June, probably due to nest incubation. Eight to 15 breeding pairs were noted, with a peak during early June.

Eggs were recorded June 14 in a typical flimsy platform nest structured with portions of reeds and cattail placed in the center of a large cattail stand. The nests were constructed on a foundation of cattail blades bent down and interlaced. Runways were provided in two instances, making the nests obvious; most were fairly well concealed. Nests were 17 to 20 cm. across, 8 cm. deep, and 1.75 m. above the water. Comparable egg dates are from Florida on March 25 to June 26; and southern New York, May 20 to June 23. An average of three eggs in ten nests were found; the least bittern ordinarily

lays four or five eggs (Bent, 1963). The eggs were oval, greenish-white in color, with a smooth but non-glossy texture. The incubation period extended from 14 to 16 days. Exact figures were not available, because clutches were discovered at all stages of incubation. Least bittern nests were most easily located during periods of slight rain. These weather conditions required the female to remain brooding at the nest and allowed the investigator to approach cattail stands closely before the adult was flushed from the nest, betraying its location. This same technique worked successfully in locating gallinule nests in large expanses of marsh vegetation.

Fall departure was on August 15. An unusually late date of fall departure (September 11) at Raleigh, North Carolina, was recorded by Bent (1963).

Least bitterns are known to have many natural enemies: birds of prey (mostly the marsh hawk), crow, muskrat, raccoon, and snakes are the most noted. Young escape by climbing among reeds. The long-billed marsh wren is known to destroy eggs by puncturing, but no incidence of this was found in this study. Water snakes were the most numerous known predator; reproductive success was reduced to approximately 20% (Table II). In two cases the runways leading to the nest site

were obviously used by the predators.

Long-billed marsh wren: The long-billed marsh wren (Telmatodytes palustris (Wilson)) is a permanent resident at White Oak Marsh Impoundment. Its normal breeding range extends north to Rhode Island and south to Virginia (Burleigh, 1958). This bird is scarce in Georgia throughout the year and common in South Carolina only in the winter from September 29 to May 19 (Sprunt and Chamberlain, 1970). Arrival date was March 2 (Table II). Typical breeding environment for the long-billed marsh wren is overgrown marshes with cattails, reeds and other aquatic vegetation. This is an accurate description of the study area.

Sixteen to 20 pairs nested, with most peaking during the months of July and August (Figure 5). Unlike during the winter months, when the bird is extremely tame and fearless, during its breeding phase it is impossible to approach closely enough to photograph or observe. Eggs were first discovered on July 16. The nests, located about one meter above the water in needlerush clumps (rarely in cattail), were coconut-shaped or spherical and composed of grasses and reed stalks intertwined. The nests were completely enclosed, allowing for entrance at the side by way of a small hole. Nest material was pulled over this hole when the adult left

the nest, making the entrance difficult to locate. The insides were lined with finer grasses, body feathers from the adult bird, and large numbers of dragonfly wings. The long-billed marsh wren, being almost wholly insectivorous, consumes water bugs, click beetles, wasps, damsel flies, dragon flies and spiders. The eggs, about the size of a corn kernel, measured 1.5 cm. in length. They were variable in color from light to darker brown and smooth in texture. The broader end tended to be the darker color. The average clutch size of two nest inspections was 3 eggs. Inspection required destruction of the nest because of its enclosed construction.

Predation pressure was minimal, probably due to the manner of nest construction and concealment; estimated nesting success was 75% (12 of 16 nests). Destruction of nests may have been by weather in addition to the reptilian and mammalian predators. No departure from the study area occurred by September 1.

Snakes: The eastern cottonmouth (Agkistrodon piscivorus (Lacépède)) and water snakes (Natrix spp.) inhabit White Oak in moderate to large numbers. Although some sources report that the Canebrake rattlesnake (Crotalus horridus atricaudatus (Latreille)) is present in the study area (Conant, 1958), none were seen. Figure 10 demonstrates the densities of water

snakes and cottonmouths from March to September. The banded water snake (Natrix sipedon fasciata (Linnaeus)) and the brown water snake (Natrix taxispilota (Holbrook)) were the most abundant species present.

Water snakes were seen mostly in the impoundment waters, whereas the poisonous cottonmouth was primarily on land (dike). However, cottonmouths entered the water often and could be expected in flattened beds of Juncus roemerianus. The gut of a cottonmouth that was killed in June contained a recently eaten mouse. Reproductive productivity of the snakes was not noted.

It is a reasonable assumption that water snakes are active at White Oak Impoundment on warm days the entire year. A banded water snake was seen in the area on January 1. The banded water snake usually darkens with age, and in cases of extreme age the dorsal banding is obscured by a total black coloration (Conant, 1958). This very dark coloration was common in banded water snakes in the study area, indicating a well-established and ecologically stable water snake population.

Brown water snakes are known to be accomplished climbers (Conant, 1958); with this knowledge and the previously noted evidence, it seems they may have been the primary reptilian

predator of wood duck eggs. Natrix taxispilota is the geographical representative of Natrix rhombifera (diamond-backed water snake) in the southeastern United States, and these two should probably be considered conspecific (Fitch, 1970).

Snakes resembling the diamond-backed water snake were seen, but collection for identification was not attempted, due to possible concurrent environmental disruption. Water snake as well as cottonmouth young were seen from June 18 to June 28. Fitch notes that brown and banded water snakes can be born as early as June and as late as September.

Two eastern indigo snakes (Drymarchon corais couperi (Holbrook)) were recorded in early May. Their range is south of North Carolina, mostly in Georgia and Florida. This snake, one chiefly of large unsettled areas, consumes small mammals, frogs and snakes that include the cottonmouth (Conant, 1958).

Other species: The following wildlife species use White Oak Impoundment for food and/or refuge purposes. Small breeding populations of some may exist.

The harrier (Circus cyaneus hudsonius) or marsh hawk is a dominant resident in the marsh ecosystem. This species is a permanent resident at the study area except at the height of its June breeding period. In Michigan average hatching dates are around June 11 (Craighead, 1956). One harrier

nest was located in the woodland adjacent to the impoundment with activity indicating others along the White Oak River. Ranges of nesting harriers average about 2.3 linear miles. The harassment by a large nesting population of redwing blackbirds in the marsh area may have contributed to the absence of these hawks during June. Sightings increased in August to previous levels of April and May. Evidence of harrier kills, as indicated from remains left atop nest boxes and earthen islands, include a number of wood duck young. Coot remains were commonly found until their departure in May. Shoveler remains were found on March 28. Field mice, small and medium sized birds, rabbit, muskrat and frogs are the primary foods of the harrier. During the nesting period the marsh hawk consumes 5.9% rabbit, 3.9% rat, 54.9% mice, and 31.4% small birds (Craighead, 1956). The remaining 3.9% is unidentifiable.

The American alligator (Alligator mississippiensis (Daudin)) resides at White Oak Impoundment, although no nests were found on the impoundment dike. There is suitable nesting habitat for the alligator bordering the White Oak River, and it is believed by Wildlife Management personnel that small alligators often travel from the nest site by way of the White Oak River to the impoundment. This theory was

basically confirmed by the study showing a total population of six to eight alligators residing in the impoundment, ranging in size from one to two m. in length. Nest location was not attempted. The American alligator ranges from the Texas (Corpus Christi) Gulf coast to North Carolina (Tyrell County) (Nobile and Deedy, 1972). The status of this species is nationally classified as critically endangered (Nobile and Deedy, 1972). According to Oliver (1955), an alligator of four feet total length is approximately two years old, and a five-foot alligator is about three years of age. Age and size are not proportional in larger individuals. The alligators almost always remained in the deep canal zone on the inside of the dike. They swam into the more shallow vegetative interior when alarmed or pursued. Alligators congregated around waterfowl traps even during banding activities in mid-August.

The river otter (Lutra canadensis (Schreber)) was found periodically spending varying amounts of time in the White Oak River and usually frequented the impoundment in groups of three or four. An abundance of otter droppings (mostly fish scales and unidentified waste materials that dries to a whitish, scaly mass) on the dike indicates a large and variable otter population, although the otters themselves are infrequently seen. The otter, like the alligator, always

inhabited the deep canal area and seemed to prefer open water to cover. Worn paths leading from the river indicated their crossing places into the impoundment. The population was an estimated 10 to 12 individuals. Muskrats (Ondatra zibethicus (Linnaeus)) inhabited White Oak just as they do most of the other marsh impoundments in the state (Donnelly, 1974). In some cases they did considerable harm to the dike by digging. Because of their obscurity no attempt was made at accurately estimating the population size.

The Osprey (Pandion haliaetus carolinensis (Gmelin)) fished in the impoundment daily but did not spend an extended amount of time there. They were usually seen in soaring flight in search of food in the morning and early afternoon. Individuals never spent more than one hour at a time in the study area before moving on. Territorial conflicts were observed in the woodland area adjacent to the impoundment, indicating the possibility of a nesting pair nearby. No nests were located.

Cattle egrets (Bubulcus ibis (Linnaeus)) that usually remain on surrounding farmland frequent the impoundment in times of changing weather. Their arrival to these pastures was on April 23, and their gradual departure began August 27. These and other cattle egrets roosted each evening (6:30-7:00

p.m. EDT) in a woodland fringe south-southeast of the impoundment.

The pied-billed grebe (Podilymbus podiceps (Linnaeus)), a native grebe of the southeast, inhabited the impoundment exclusively in the canal or deep portion. They were secretive and it was difficult to establish their numbers; the total population was estimated at 30. No evidence of nests was found.

The yellow-bellied turtle (Pseudemys scripta scripta (Schoepff)) existed in large numbers at White Oak Impoundment and buried eggs adjacent to the impoundment by the hundreds. The first eggs were noted April 9. Predation losses to raccoons were heavy. Eggs were found only in the dark soil of the south dike.

The common five-lined skink (Eumeces fasciatus (Linnaeus)) and the glass snake lizard (Ophisaurus ventralis (Linnaeus)) were abundant in the vicinity of the storage houses used by management personnel. Bobwhite quail (Colinus virginianus (Linnaeus)) fed on wild seeds on the impoundment dike during the months of June, July and August. No nests were located. The mourning dove (Zenaidura macroura carolinensis (Linnaeus)) likewise used the dike for food and grit. Various species of birds inhabited the brush habitat on the dike at different

times during the six-month period from March to August. They were: magnolia warbler (Dendroica magnolia (Wilson)), April 15 to July 2; yellow throat (Geothlypis trichas (Linnaeus)), April 15 to July 2; myrtle warbler (Dendroica coronata (Linnaeus)), March 28 to August 13; downy woodpecker (Dendrocopus pubescens (Linnaeus)), occasional; eastern kingbird (Tyrannus tyrannus (Linnaeus)), April 30 to July 30.

The great blue heron (Ardea herodias (Linnaeus)) should be considered a permanent resident in the impoundment interior. Representatives were present at all times during the research period. Past records indicate that it also remains during the fall and winter months throughout eastern North Carolina (Sprunt and Chamberlain, 1970).

Louisiana herons (Hydranassa tricolor ruficollis (Gosse)) were seen regularly from February 1 to May 22. No shore birds were recorded at White Oak.

Single sight occurrences include: herring gull (Larus argentatus (Pontoppidan)), June 14; least tern (Sterna albifrons (Pallas)), May 9; royal tern (Thalasseus maximus (Boddaert)), May 9; double crested cormorant (Phalacrocorax auritus (Lesson)), May 30; and laughing gull (Larus atricilla (Linnaeus)), May 7.

Insects were collected by sweep net over the impoundment

dike and water to determine types present. Odonatens (dragonflies and damselflies) were by far the most abundant group associated with the aquatic environment. The dike contained at least ten families of insects, the dipteran mosquitoes and deerflies being the most noticeable. Hymenopteran wasps and bulblebes were accompanied by smaller numbers of their dipteran mimics (Bombyliidae). Numbers of the pest species declined sharply over water, possibly due to carnivorous habits of dragonflies or to wind.

Summary and conclusions: Traditionally the practice of marsh impoundment has been undertaken primarily for mosquito control and to supplement migratory waterfowl refuge on the North Carolina coast. Until now its major importance has lain in game management. These data demonstrate that a variety of species other than waterfowl utilized White Oak Marsh Impoundment for biological processes that include reproduction, feeding and refuge. River otter, muskrat, at least six species of herons, the pied-billed grebe, osprey, marsh hawk and the endangered alligator inhabit the area for food and refuge on a regular basis. Wood ducks, Florida gallinules, purple gallinules, long-billed marsh wrens, least bitterns and redwing blackbirds utilize the impoundment for nesting and brood rearing. Numbers of individuals of these species

are increased as a result of the available habitat. Purple gallinules nest farther north in this man-made habitat than in natural areas. At least five species of songbirds are associated with the impoundment, as well as an abundance of water snakes and cottonmouths.

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