THE BREEDING BIOLOGY OF THE EASTERN KINGBIRD IN NORTHCENTRAL OKLAHOMA

By

LAWRENCE EDWARD POWELL

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Northeastern State College

Tahlequah, Oklahoma

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IN NORTHCENTRAL OKLAHOMA

Thesis Approved:

Robert D. Smith
Thesis Adviser

Rudolph J. Miller

Roy W. Jones

D. D. Durham
Dean of the Graduate College

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CHAPTER I

INTRODUCTION

The original objective of this investigation was to obtain information on agonistic and territorial behavior of the Eastern Kingbird, (Tyrannus tyrannus). However, when I found that much of the behavior and breeding biology of the species was poorly known in the state, I decided on an investigation of wider scope.

The behavior investigated included reproductive, territorial, and agonistic activities of the adults. Specific behaviors studied included: nest-site selection, nest construction, territorial establishment and maintenance, intraspecific and interspecific aggression, feeding, and parental behavior. The various displays and vocalizations which accompany these activities were also described.

The life history of the Eastern Kingbird has been described in general form by both Davis (1941) and Bent (1942). The major emphasis of the work by Davis was on the belligerency of the Kingbird. Davis (1955) included nesting data from a study of Eastern Kingbirds in Montana in a discussion of a method for using miscellaneous nesting data quantitatively. Odum and Kuenzler (1955) also used data from observations of Eastern Kingbirds in their discussion of methods for measuring territory and home range size. Parental behavior of Eastern Kingbirds was studied by Morehouse (1965), and feeding behavior was discussed by Morehouse and Brewer (1968). Nest height preference of

Eastern Kingbirds was reported by Mayfield (1952). Dick and Rising (1965) compared food eaten by the Eastern Kingbird, Western Kingbird, (Tyrannus verticalis), and Scissor-tailed Flycatcher (Muscivora forficata) in western Kansas using stomach analysis techniques. The vocalizations of the Eastern Kingbird were discussed by Hausman (1925).

The seasonal occurrence of the Eastern Kingbird in Oklahoma has been reported by several authors. M. M. Nice (1931) listed the Eastern Kingbird as a summer resident throughout the entire state, while Sutton (1967) recorded the Kingbird as a transient and summer resident seen in Oklahoma from 10 April (earliest recorded sighting) to 22 September (latest recorded sighting). For Payne County the Eastern Kingbird is reported as "an abundant summer resident" (Moore, 1928), "a common spring and uncommon fall migrant and an uncommon summer resident seen from 17 April (1941) until 8 September (1939)" (Baumgartner and Howell, 1942), and as "a migrant and fairly common summer resident" (Baumgartner and Howell, 1948).

CHAPTER II

DESCRIPTION OF THE STUDY AREA

The site chosen for most of the observations was an area of approximately 9 square miles located in Payne County, Oklahoma. The study area included part of the north edge of the city of Stillwater as well as relatively open countryside to the north and west of the city. The location of the area offered abundant habitat suitable for the Eastern Kingbird, and was composed of large tracts of public land which were easily accessible; it was for these reasons that the particular location was chosen. The size of the area was limited to 9 square miles because coverage of a larger area would not have been feasible. The borders of the area were sections lines which were well defined by roads. The exact location of the study area was Sections 33,34, and 35, T. 20 N., R. 2 E., and Sections 2,3,4,9,10, and 11, T. 19 N., R. 2 E., Indian Meridian, Payne County, Oklahoma.

For ease of discussion, each square mile of the study area was allotted a plot number (Figure 1) starting with the upper left corner and ending with the lower right corner plot. Since section lines in all but a few cases were roads, the identification of plot numbers in the field presented no problems.

The general ecology of the study area was such that it could be divided into five habitat types although a sharp distinction between types did not always exist. The five habitat types, their character-

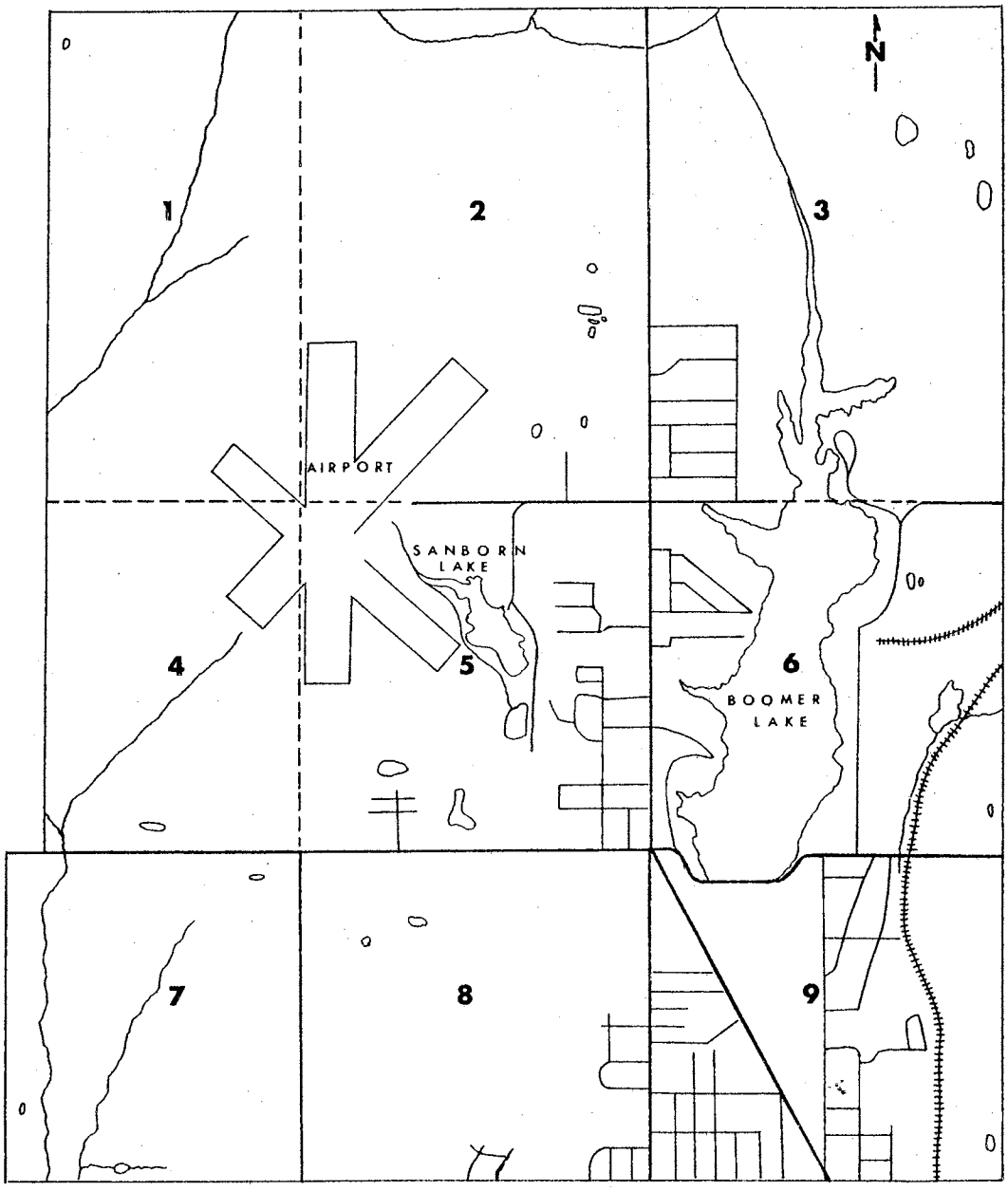

Figure 1. Map of the Study Area

istics, dominant vegetation, and locations in the study area are discussed below.

1. Residential habitat: This habitat type is characterized by houses and apartment buildings with well kept lawns, ornamental trees, and shrubs. The few park areas are also included in this habitat type. Undisturbed habitat was uncommon and human activity was high in this type. The lawns were mostly bermuda grass (Cynodon dactylon) with some crabgrass (Digitaria sanguinalis) and dandelion (Taraxacum officinale). The trees and shrubs tended to be scattered but abundant with the most common being Chinese elm (Ulmus pumila), American elm (U. Americana), mulberry (Morus alba), eastern red cedar (Juniperus virginiana), sycamore (Platanus occidentalis), pinoak (Quercus sp.), redbud (Cercis canadensis), privit hedge (Ligustrum vulgare), spirea (Spirea Van Houttei), and japonica (Chaenomeles Japonica).

Plot 9 consisted almost exclusively of the residential habitat type, but the residential habitat also extended into plots 8, 5, and 3 with a small area in plot 6.

2. Roadside-edge habitat: There was an extensive road system throughout the entire study area with characteristic habitat of unmowed grasses between the road and fences and scattered trees planted to serve as windbreaks. The common grass was Johnson grass (Sorghum halepense); various elms (Ulmus spp.) were the most common trees.

Although the roadside-edge habitat was found throughout the study area, it was most common in plots 1, 2, 3, 4, 7, and 8 which were areas of considerable farming activity. The roadside areas of plots 5, 6, and 9 tended to be either a part of the residential habitat type or of the open riparian habitat type.

3. Open field habitat: The areas of untended fields which were not used for pastures or farming are included in this habitat type. For the most part these were areas of public land in plots 2, 3, 4, and 5 which were part of an industrial park or the area surrounding the Stillwater Municipal Airport. The dominant grasses were the various bluestems (Andropogon spp.) and grama (Bouteloua spp.). The trees tended to be scattered in the fields or bunched along the edges but never occurred in dense stands. Elms (Ulmus spp.), mulberry (Morus alba), chinaberry (Sapindus drummondii), and hackberry (Celtis occidentalis) were the most common trees.

4. Pasture and cultivated cropland habitat: Included in this habitat type was a variety of plant communities each with its own characteristic vegetation. The cultivated land consisted of wheat or hay fields which were relatively devoid of trees. The pastures ranged from severely overgrazed to those which would fall into the open field category except for the fact that they were occasionally mowed or were actually used for grazing during the time of the study. Grazed pastures were composed of bluestem grasses (Andropogon spp.) with some grama (Bouteloua spp.) and lovegrass (Eragrostis sp.). Overgrazed pastures were composed of forbs which are characteristic of the overgrazed situation. The common forbs included western yarrow (Achillea lanulosa), hemp dogbane (Apocynum cannabinum), milkweed (Asclepias sp.), musk thistle (Carduus nutans), annual sunflower (Helianthus annuus), grooved flax (Linum sulcatum), plantain (Plantago sp.), dock (Rumex sp.), silverleaf nightshade (Solanum eleagnifolium), buffalobur (S. rostratum), Torrey nightshade (S. Torreyi), Baldwin's ironweed (Vernonia Baldwinii), and cocklebur (Xanthium strumarium).

Plots 1, 2, 4, 7, and 8 were composed almost entirely of the pasture and cultivated crop habitat with small areas also found in plots 3 and 5.

5. Open riparian cottonwood-willow habitat: This was the habitat type associated with the numerous water impoundments and creeks found in the study area. There were two lakes in the study area (Boomer and Sanborn), and each plot contained many small ponds. Every plot was crossed by creeks, most of which held water throughout the summer. The vegetation of this type was that commonly associated with lakes, ponds, and creeks in northcentral Oklahoma. Dominant trees were cottonwood (Populus deltoides), black willow (Salix nigra), pecan (Carya illinoensis), and elms (Ulmus spp.). Buttonbush (Cephalanthus occidentalis) and poison ivy (Rhus radicans) were also common in this habitat type. The most common grasses were cheat grass (Bromus secalinus), little bluestem (Andropogon scoparius), sideoats grama (Bouteloua curtipendula), blue grama (B. gracilis), Canada wildrye (Elymus canadensis), Indiangrass (Sorghastrum nutans), and mousetail (Manisurus cylindrica). Forbs included milkweed (Asclepias spp.), ragweed (Ambrosia trifida), American bluehearts (Buchnera americana), showy partridgepea (Cassia fasciculata), Illinois bundle flower (Desmanthus illinoensis), horsetail (Equisetum hyemale), yellow neptunia (Neptunia lutea), catclaw sensitivebrier (Schrankia uncinata), and cattail (Typha latifolia).

The Eastern Kingbirds were associated more closely with the open riparian cottonwood-willow habitat type than with any other. However, it was not uncommon to find them feeding in other habitat types, especially the open field habitat. All Kingbird nests found were over or near water, and once the nest site had been selected Kingbirds were

not found in the other habitat types unless they were in close proximity to the nest site itself.

The land in the study area was relatively flat, although there were slight elevation changes particularly in areas around the larger water impoundments.

CHAPTER III

MATERIALS AND METHODS

The collection of data was accomplished exclusively by direct personal observation aided by a pair of 7 x 50 binoculars. Field notes were recorded in 10" x 8" spiral notebooks attached to a clipboard for support. All times were determined by means of a wrist watch with a sweep second hand.

Observations were made by sitting quietly near the birds or nests. Considerable individual variation existed between different birds in their tolerance of an observer; some birds would be so disturbed by any attempt at close observation that observations had to be made several hundred feet from the nest, while other birds would settle down quickly and seemed to behave as if no one were there. It took only a few visits to each nest to determine the best vantage point from which to observe a particular pair and still be able to obtain the desired information.

General weather conditions were recorded at the beginning of each observation period and at any time that the conditions changed noticeably. The weather conditions recorded consisted of temperature, wind, and cloud cover. Temperature was determined by means of a Fahrenheit thermometer held 2 feet above the ground in the shade. The wind condition was described as slight, moderate, gusty, or strong; cloud cover was recorded as clear, partly cloudy, cloudy, overcast, or rain.

To facilitate observation into nests a 6-inch diameter mirror was attached to the end of a jointed pole. When fully extended the pole measured exactly 8 feet 6 inches. The pole was marked off in feet by means of strips of tape and this was used to measure tree height, height of nests from the ground or water, depth or water under the nests, and distance of nests from the main stem of the nest tree. Nest dimensions were measured by a centimeter rule. Distances from nest trees to the shore or from the nest tree to the nearest water were determined by pacing.

Two mist nets were used in attempts to capture and mark Eastern Kingbirds for future identification with only one instance of success. Marked animals were not necessary for the success of the study, although they would have made some aspects of the study more meaningful.

A stuffed specimen of an Eastern Kingbird was acquired from the museum of the Oklahoma State University and used both in attempts to lure Kingbirds into the mist nets and in the investigation of aggressive behavior.

Color photographs and movies were taken with a Kodak Model 35, 35 mm camera and a Cine-Kodak Model K-100, 16 mm movie camera. Pictures were taken of Kingbirds, their nests, habitat around the nests, nest construction, incubation, and feeding activities.

Field work began around the first of April, 1968, although the first Eastern Kingbird was not observed on the study area until 18 April 1968. The time spent in the field prior to the arrival of the Kingbirds was used to become familiar with the area, to map it, and to mark what appeared at the time to be favorable habitat for them. Observations began with the arrival of the Kingbirds and continued

until 12 August 1968 at which time the young of all known nests were feeding for themselves. For the most part, observations during this time were made daily. Less frequent observations were continued until 19 September 1968 after which no Eastern Kingbirds were found on the study area. The entire study was conducted during the spring and summer of 1968.

On 29 May a regular census of the study area was begun. Censuses were taken in the afternoons three or four times each week for two months to determine the density of breeding pairs of Eastern Kingbirds on the study area. Density was determined by plotting the location of pairs on a map during each census trip. The data from all census periods were then plotted on a large map of the entire study area. When a pair of Kingbirds was found at least five times in the same location on different census trips, a pair was assigned to that area. If time permitted, a search for nests was made in the areas where Kingbirds were repeatedly found. Notes concerning the ecology of the area and nest data (when nests were found) were recorded during each census period.

CHAPTER IV

REPRODUCTIVE CYCLE

In order to follow the events that took place during the 1968 reproductive season and to facilitate the discussion of the various reproductive activities, it is necessary to first describe the phases of the reproductive cycle that were examined.

Eastern Kingbirds were observed from the time of their arrival in the spring until their departure in the fall. It was found that two reproductive efforts occurred and two pairs were double brooded (Sanborn and Scott). The first reproductive effort extended from late April until late June; the second extended from late May until mid-August (Figure 2).

In the following discussions the activities of each reproductive effort are subdivided into five major phases and the activities common to both have been combined and discussed in the same section. The five major phases are as follows:

1. Prenesting Activity
2. Nest Construction
3. Incubation Activity
4. Prefledging Activity
5. Postfledging Activity

The activities associated with territorial establishment and maintenance are discussed in a separate section.

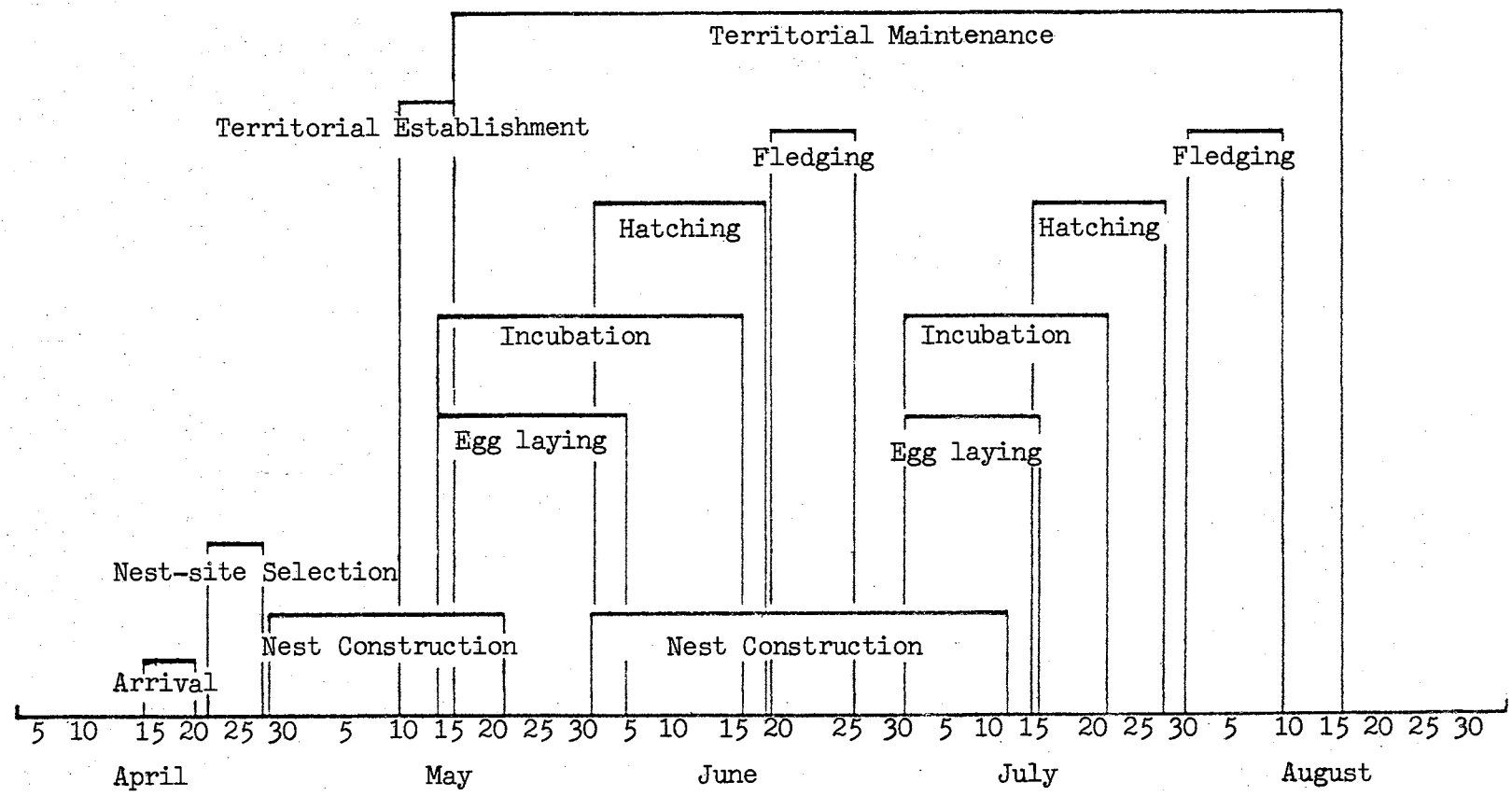

Figure 2. Reproductive Cycle of Eastern Kingbirds During the 1968 Reproductive Season

Figure 2 is an illustration of the temporal patterning of the various activities of each reproductive effort. The length of each solid line represents the number of days Kingbirds were actually engaged in a particular activity. No attempt has been made to indicate the intensity of activity during any of the phases of the two reproductive efforts.

Included in Table I is a list of the 14 Eastern Kingbird nests that were found on the study area, the name given to each pair, the date the pair was found, and the plot number in which the nest was located. The location of each of the 14 nests is plotted on the accompanying map (Figure 3).

TABLE I

PAIR NAME, DATE NEST WAS FOUND, AND LOCATION OF THE 14 EASTERN KINGBIRD NESTS FOUND ON THE STUDY AREA

Nest No.	Name of Pair	Date Found	Location (plot number)
1	Sanborn Lake	27 April	5
2	Boomer Lake #1	29 April	6
3	Scott Pond	30 April	2
4	Boomer Lake #2	1 May	6
5	Airport Pond	2 May	2
6	Lakeview-Western Pond	29 May	7
7	Perkins Road Pond #1	13 June	6
8	Hoke Pond	14 June	6
9	Perkins Road Pond #2	18 June	9
10	Sanborn Lake*	29 June	5
11	Boomer Lake Pond	2 July	6
12	Winter Pond	3 July	7
13	Corner Pond	3 July	1
14	Scott Pond*	13 July	2

*Represents the second nesting

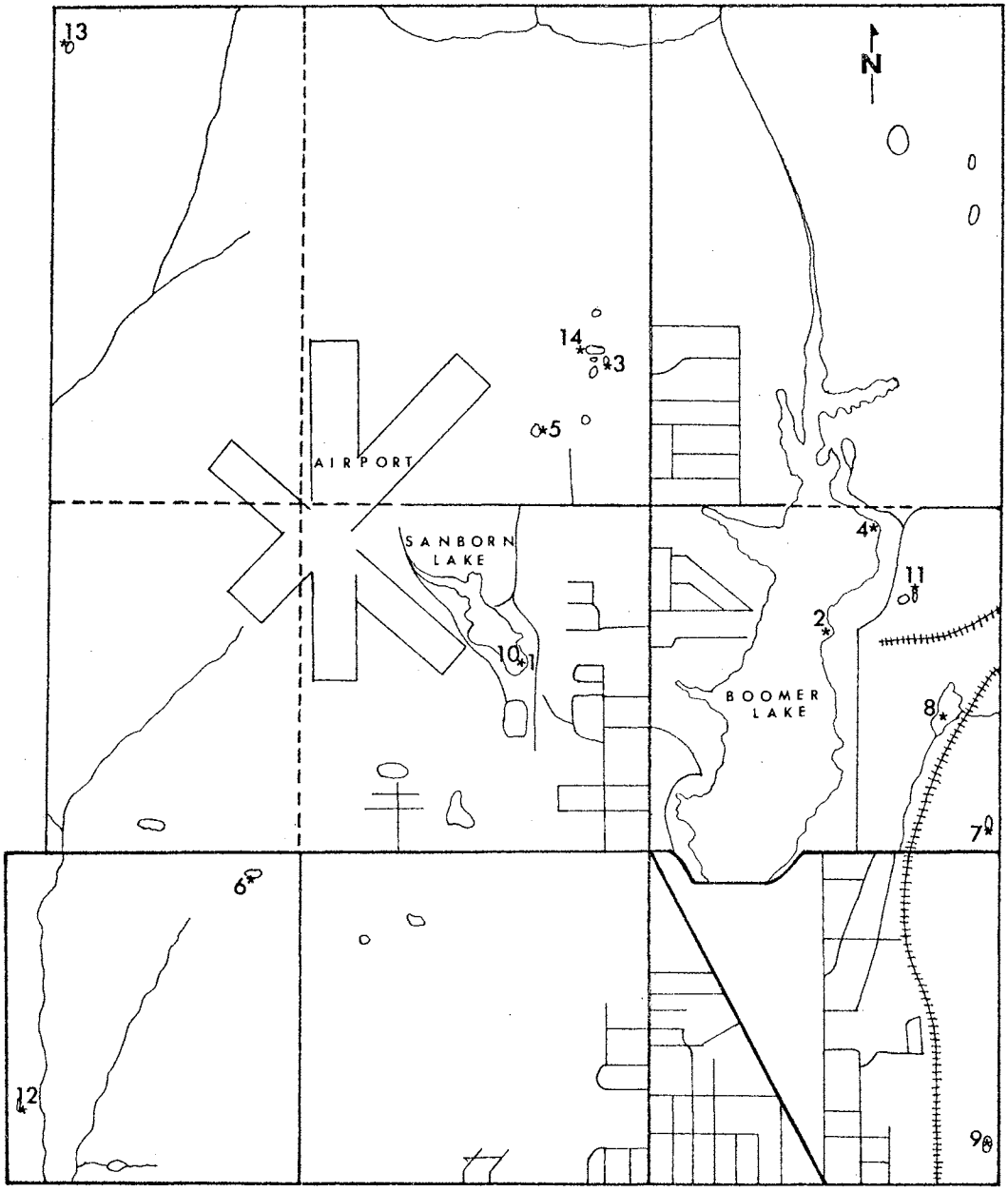

Figure 3. Location of the 14 Eastern Kingbird Nests Found on the Study Area

CHAPTER V

PRENESTING ACTIVITY

The first Eastern Kingbirds were seen on the study area on 18 April 1968 at Sanborn Lake. Daily observations in this location confirmed that these were resident birds which ultimately raised two broods there. Two other reports (personal communications) placed the arrival of Eastern Kingbirds in the Payne County area between 16 and 18 April 1968. Subsequent observations of the birds at Sanborn Lake, and observations elsewhere, indicated that by 22 April there were at least four pairs and several single, and presumably unpaired, Kingbirds on the study area.

Davis (1941) reported that following spring arrival single Kingbirds wander around until a mate is found, then pairing takes place. However, Welty (1962, p. 222) indicated that the Eastern Kingbird is already paired upon spring arrival. The pairing process was not observed during the study. However, the Kingbirds seen at Sanborn Lake appeared to have been already paired when they were first observed. One of the reports of the arrival of Kingbirds on the study area also indicated that the birds seen were already paired when they arrived.

One of the immediate problems in a study of this nature is the ability to identify individual birds or pairs of birds, and since the Eastern Kingbird is not sexually dimorphic, sex identification can also be a problem. Mist nets were used several times in an attempt to

capture and mark adult Kingbirds with only one success, and that rather late in the summer. However, with continued observation individual birds and their sex could be identified by behavioral and morphological differences. Paired Kingbirds observed during prenesting activity were almost immediately recognizable as such by their activity patterns. They could always be found in the same general area, although they were rather wide-ranging at times.

Members of a pair were quite vocal, especially when moving together from one feeding area to another, and exchanged call notes while on the wing. The vocalizations were either kitter or dzeek which are both sharp metallic notes given in rapid succession with the kitter often shortened to kit. Hausman (1925), Davis (1941), and Morehouse (1965) refer to the rapid repetition of kitter often interspersed with the kit component (kitter-kitter-kit-kit-kitter-kitter) or the repetition of the dzeek notes (dzeek-dzeek-dzeek) as flight notes, social notes, or greeting notes respectively. These vocalizations were given by pair members when flying from one location to another, when one member of the pair approached the other, and when they "greeted" each other at the nest tree later on in the season.

Single Kingbirds could be identified by their seemingly haphazard movements which covered such a large area that they could not be thought of as being localized, and thus were not found in the same areas day after day. Davis (1941) reported that unmated Kingbirds give a call (b-zee) which is different from that of mated birds, but this difference was not noticed during this study.

Single Kingbirds were attacked whenever and wherever they encountered a pair of Kingbirds with both members of the pair generally

cooperating to chase the lone Kingbird. This served to confirm the identification of paired versus unpaired Kingbirds during the time prenesting activity was occurring.

The sex of individual Kingbirds was more difficult to determine in some pairs than in others, particularly prior to the beginning of nest construction. In two pairs (Sanborn and Scott) the female proved to be slightly smaller than the male, and the shade of white on the breast and cheek tended to be darker in the female than in the male. As the season progressed and more time was spent in the field the difficulty of sex identification ceased to be a problem since behavioral differences became more apparent. Morphological differences, such as the brood patch on the female, were especially helpful in sex identification.

Activity Patterns

The daily activities of four pairs of Kingbirds were observed while prenesting activities were in progress. The pairs that were observed and the number of days each pair was observed is given in Table II.

TABLE II

THE NUMBER OF DAYS EASTERN KINGBIRDS WERE OBSERVED DURING PRENESTING ACTIVITY

Pair	Date First Observed	Date Nest Construction Began	Number of Days Observed
Sanborn	18 April	27 April	9
Scott	19 April	30 April	11
Boomer Lake #1	22 April	29 April	7
Boomer Lake #2	22 April	1 May	9

The daily activity patterns of the four pairs were quite similar with most of their activity devoted to either feeding or resting. During feeding bouts the Kingbirds were generally quite active, hawking insects on the wing, and returning to a nearby perch to eat. Large insects were torn apart by placing the insect under the foot and pulling with the bill, although in some cases the insects were repeatedly batted across a branch and then eaten. Bill wiping, which consisted of drawing the bill across a branch several times, each time alternating sides of the bill, was observed to be a frequent activity after large insects were eaten, but was seldom observed when small insects were eaten. A feeding bout usually consisted of the hawking of three to five insects within a brief period of time, and was generally followed by a "rest" period. Preening was a common activity during the longer rest periods with both males and females preening at the same time on many occasions. Feeding bouts and rest periods were not always as distinct as just described, and in many cases the Kingbirds appeared to be feeding continually; instead of hawking several insects in rapid succession then resting, a rest period was interspersed between each insect caught. It was almost as if the Kingbird was a passive feeder during these times, i.e., not actively flying from perch to perch catching food, but waiting on a particular perch until an insect happened to pass nearby at which time it would be caught and eaten.

Five days during observations of prenesting activity (18, 20, 21, 22, and 26 April) had inclement weather with rain falling for the greater part of each day. For this reason it was impossible to determine a daily activity pattern, although during the days when the weather was good, the Kingbirds tended to be inactive during the early

afternoon. Movement during the morning hours tended to be restricted to the area around the water (the nest sites of all four pairs were situated close to water), while movements during the rest of the day did not tend to be so restricted. It was during this time that the pairs were generally found feeding in open fields as far as one-half mile from their respective lake or pond.

Nest-site Selection

The term nest-site selection as used in this paper refers to the activities of female Kingbirds at the nest tree prior to the beginning of nest construction. It is not known if all of the behavior involved is nest-site selection or if the nest-site is actually selected by a single visit or "inspection" and additional visits to the nest tree serve to reinforce or strengthen the site that was previously selected.

On 24 April the Sanborn female was observed in the inner branches of a dead willow tree which was located 10 feet out in the water. This was the first time she had been observed in the interior of this tree, although the tree had served as a perch many times before. On this occasion the female hopped from fork to fork while turning her head from side to side. She lingered in the interior of the tree for over 5 minutes. No evidence of nest building could be seen when the tree was inspected after her departure. About an hour later she returned to the same tree and repeated the process, however, this time she perched in the highest part of the tree and kittered several times before leaving. The tree was again inspected, and no indication of nest construction was found. This behavior is much like what Davis (1941) referred to as nest-site selection. On the afternoons of 25 and 26

April, and again in the early morning of 27 April, the Sanborn female repeated the "inspection" process in the dead willow tree. At 7:40 AM on 27 April she stripped a piece of bark from a small limb of the willow tree, carried to to one of the forks, and wound it around one of the smaller branches in the fork thus initiating nest construction. During the times that the Sanborn female was observed in the process of nest-site selection the Sanborn male was either feeding or perched in a small peach tree in an open field north of the lake.

Nest-site selection by the Scott female was also observed, and the process was basically the same, although the "inspection" process included hopping along a horizontal limb that extended out over the water of the pond. The nest was eventually built so that it straddled the horizontal limb, which would explain the inclusion of this part of the tree in the nest-site selection process. The Scott female was first observed "inspecting" the willow tree on 25 April, and again on 27 and 28 April. The Scott nest was begun sometime in the morning of 30 April, but the initial stages were not observed. As with the Sanborn male, the Scott male was not observed participating in the nest-site selection process.

On 11 and 12 July, the Scott female was again observed to be engaged in nest-site selection just prior to renesting, however, this time the "inspection" process took place in the upper branches of a cottonwood tree. Nest construction in this case began on 13 July.

Although the two Boomer Lake pairs were observed during the time of prenesting activity, neither of the two females was observed in the nest-site selection process.

The renesting of the Sanborn pair involved the repair of the same nest that was used for the first brood which, of course, did not necessitate additional nest-site selection or "inspection." All other nests were found either during construction or after they had been completed.

CHAPTER VI

TERRITORALITY

The Eastern Kingbird is regarded as a highly territorial species that defends all of its occupied space (Davis, 1941; Odum and Kuenzler, 1955; Sutton, 1967), so that territory as used in this paper can be defined as a topographically localized defended area (after Hinde, 1956, p. 342). Separate designations such as home range, utilized space, and territory are not necessary since once the territory is established all activities of the Eastern Kingbird tend to be restricted to the localized defended area.

Territorial Establishment

The behavior involved in territorial establishment and maintenance may have three major components according to Hinde (1956):

(a) Restriction of some or all types of behavior to a more or less clearly defined area.

(b) Defense of that area.

(c) Self-advertisement within the area.

Tinbergen (quoted by Crook, 1968) considered territorial defense to be the result of two tendencies (site attachment and hostility) which can occur independently of one another. He further proposed that the familiarity with an area resulting from site attachment may increase fighting potential (referred to as site dominance) and be a significant

consequence of territorial behavior.

Observations of four pairs of Kingbirds (Sanborn, Scott, and both Boomer Lake pairs) during the time territorial establishment was taking place indicated that the behaviors involved can best be described by considering the ideas of both Hinde and Tinbergen. Hinde (1966, p. 237) stated that only in the early stages of territory establishment is aggressiveness not tied to a particular locality. This appeared to be true of the Eastern Kingbirds observed. It was mentioned previously that paired Kingbirds were somewhat localized in their movements prior to the beginning of nest construction but they did move over considerable distances and were extremely aggressive when they encountered other Kingbirds. If Hinde is correct, then the behavior patterns of Kingbirds during the time prior to nesting could be considered to be a part of the process of territorial establishment.

Davis (1941) reported that nest-site selection is first accomplished by the female then the territory is acquired around the nest site. This implies that territorial establishment does not begin until after the nest site has been selected (site attachment). I decided to investigate the possibility of a change in movement patterns around the time of nest-site selection in order to determine if movement patterns did become restricted. Maps which crudely depicted the topography of the areas frequented by the four pairs of Kingbirds were prepared and taken into the field during each observation period. The locations of the pairs and individual sexes (when these could be determined) were plotted upon arrival in an area, and at each time a change in position took place. A survey of these maps indicated that the space covered by the Kingbirds decreased while the time spent within a particular

area increased once nest construction began and did not change noticeably after that. Not only did the pairs become more localized, but also they acquired what might be considered a site attachment to a particular location - the nest tree. From this time on until the young had fledged the pairs were not observed in the more distant areas that they had frequented earlier. The movements of the females became quite restricted once they began work on the nest. No decrease in activity was observed in the males, but the distances they covered decreased considerably. It seems, then, that not only were several different behavioral activities and/or processes taking place (restriction of movement, aggression, site attachment) that appeared to be independent of each other, but also this independence was related to the role of the sexes in the process of territorial establishment. In other words, one would not consider territorial establishment to be the role of the male or the female but a cooperative effort with each sex possibly involved in different activities that when taken together not only resulted in the desired end but also augmented and reinforced each other in the process.

The discrepancy between the observations of Davis (1941) and the observations in this study dealing with the role of the sexes in territorial defense can best be explained by considering that two tendencies which are expressed in different degrees by the sexes are functioning. Davis (1941) reported that both sexes cooperate to drive out an intruder with the female fighting as vigorously as the male. Of the 37 intraspecific aggressive encounters observed during the present study only 11 occurred at the time when territorial establishment was probably taking place, and only three of these involved the female to any extent.

In these three encounters, the female cooperated with the male to drive away an intruder, but was not more vigorous in doing so. In fact, only two intraspecific encounters were observed in which only the female was involved, and both of these were between the Sanborn female and an intruder during the second nesting of the Sanborn pair. At the time when these encounters took place the Sanborn male had not been seen for two days and was not seen again during the rest of the season. On most of the occasions when an intruder entered a Kingbird territory the female gave only a vocal protest while the male drove off the intruder. On two occasions the Sanborn female continued to feed or preen while the male engaged the intruder. Davis (1941) also used stuffed specimens of the Eastern Kingbird, Western Kingbird, and Gray Kingbird (Tyrannus dominicensis) to "determine the behavior involved in the defense of territory against intruders," and found that the reaction to the stuffed specimens was the same regardless of which species was used, and that the female Kingbird was far more aggressive, and actually hit the dummies while the male never struck the dummies. He further stated that the behavior involved in driving away intruders and attacking the stuffed specimens was so characteristic that similar behavior patterns could be used to identify the sexes. Observations of the four pairs of Kingbirds, and the use of a stuffed Eastern Kingbird specimen with the Sanborn pair did not agree with those of Davis.

On 26 April the stuffed specimen was wired to a dead branch 120 yards from the nest tree of the Sanborn pair while both Kingbirds were away. Twenty-four minutes later both Kingbirds returned and the male dove at the dummy while kittering and bill clicking (vigorous closing of the mandibles which produces a clicking sound). The male dove at

the dummy three times then perched on its back and tore feathers from its neck. So vigorous was this attack that the dummy was upended with the male perched on its breast while continuing the attack. During the $2\frac{1}{2}$ minutes of the attack the Sanborn female preened and gave no indication of joining in the attack.

Later on the same day the dummy was again used, but this time it was placed about 50 feet from the nest tree. Within 5 minutes the Kingbirds returned and both flew directly to the dummy. The male dove at the dummy before perching on it and tearing feathers from its head. The female perched about one foot from the dummy and kittered loudly, but did not strike it.

The dummy was used several more times during the summer, but on most occasions it was ignored by both Kingbirds. On 24 May the Sanborn female dove at the dummy on three separate occasions as she returned to the nest to incubate, but she did not strike it.

If the response to a stuffed specimen is any indication of the degree of involvement of the sexes in territorial defense, then the Sanborn female showed an almost total lack of involvement. Davis reported the exact opposite in his use of stuffed specimens, however, he always presented the dummy at the edge of the nest, or at least very close to it, so it is difficult to attribute the response of the female to territorial defense and not to defense of the nest or nest contents.

Territorial Maintenance

Once the activities of the Kingbirds became localized and restricted to fairly well defined areas, one can assume that the

territory has been established and what follows is defense of the area and perhaps a better definition of the area involved. The impression was not obtained in any of the pairs observed that the territories of the Eastern Kingbird had strict boundaries except perhaps those imposed by the habitat and especially the availability of feeding areas. The nature of the available habitats on the study area were such that in 13 pairs of Kingbirds that were observed enough to get an idea of their defended areas only two pairs (Boomer Lake #1 and #2) nested close enough together that they presumably shared a common territorial boundary. Even in this case the areas utilized by these pairs was such that there was no indication of the location of the common boundary by way of intraspecific aggressive encounters or mutual displays.

Defense of the territory against conspecifics was observed 37 times during the study with 26 encounters occurring after the territories had been established. No instance of resident Kingbirds being defeated by an intruder was observed. The impression was not obtained that the male (or any Kingbird for that matter) actively sought out other birds to attack or "looked for" intruders by patrolling the territorial boundary. On several occasions, however, a resident male Kingbird would fly to investigate the call notes of a distant Kingbird. The outcome of these investigations gave the best indication of the territorial boundary of the resident Kingbird. If the territorial boundary had been violated the intruder was attacked and chased away, but if the boundary had not been crossed the resident Kingbird would perform what Davis (1941) referred to as the tumbling display. In this display the male would fly high into the air and summersault several times, then repeat the process while kittering continuously. If the

intruder advanced the displaying Kingbird would attack the intruder. Davis considered the tumbling display to be a substitute for the territorial song-display of many passerine birds, and as such, it would be considered to be self-advertisement within the territory which is one of the major components of territorial maintenance according to Hinde (1956). The tumbling display performed by a resident male was observed on four occasions and always with the stimulus of another Kingbird.

It was expected that since territorial Kingbirds restricted almost all of their activity to the territory the opportunity for intraspecific aggressive encounters would decrease as the season progressed, therefore, the number of encounters would also decrease. It was also expected that as the young began to move about more at the end of the summer the number of intraspecific encounters would increase. Unfortunately, the number of encounters observed was so small that it was not possible to determine the seasonal frequencies. Of the 37 intraspecific encounters that were observed, 3 occurred prior to nest construction, 9 occurred while nest construction activity was in progress, 4 occurred during the time females were incubating, 7 occurred while young were still in the nests, and 15 occurred after the young had fledged. The increase in the number of encounters after the young had fledged is misleading for 12 of the 15 encounters involved the Sanborn pair and either a persistent intruder or a female that attempted to nest within the territorial boundary of the Sanborn pair. The lone intruder remains a mystery. Its sex could not be determined, but it definitely was an unmated Kingbird, and there was no suitable nesting habitat for over a half mile in the direction from which it kept reappearing. The female that attempted to nest in the Sanborn territory was found on

18 June at the time the first Sanborn brood was fledging. This female succeeded in constructing a partial nest before being driven away by the Sanborn male. A possible mate for this Kingbird was not observed.

Interspecific Aggression

Although interspecific aggression is usually not included in a discussion of territorial defense, the Eastern Kingbird is considered by Davis (1966) to possess an interspecific territory and is noted for its belligerency in attacking other species. During all observation periods the number of interspecific encounters was recorded as well as the number of opportunities for encounters. An aggressive encounter in most cases involved the Kingbird chasing another bird although in some instances the other bird was not only chased but also physically attacked. An opportunity for an encounter was subjectively judged or determined to occur when a Kingbird and another bird were within approximately 10 feet of each other, or when a Kingbird appeared to take notice of the flight of another bird which caused it to pass closeby, or when another bird perched in the nest tree while a Kingbird was either in the nest tree or nearby. Attacks against predators were included as interspecific encounters although Davis (1941) listed them separately because he felt that a different motivation was involved.

A total of 277 opportunities for interspecific aggressive encounters was recorded, 75 of which involved the presence of the other species in the Kingbird nest tree. A total of 89 actual encounters (chases and/or attacks) was recorded. Data for opportunities and encounters are given in Table III, and are separated according to the phase of the reproductive effort in which they occurred, and

according to the sex of the Kingbird involved. These same data are represented in Figure 4. It should be noted that the fewest number of opportunities and actual encounters was observed during the two phases of the reproductive effort when the territory had not yet been established (prenesting) or was breaking down following the nesting season (postfledging), while the greatest number of opportunities and encounters occurred during phases when the territory was in existence. These data reflect to some extent the observation time spent in the field during each phase of the reproductive efforts, but they do lend some support to the idea that the Eastern Kingbird possesses an interspecific territory.

Davis (1941) reported that the important characteristic of interspecific fighting was that only the male fights. Morehouse (1965) observed the female fighting other species, and 12 such encounters were observed in the present study. To be sure, the female was not involved in these encounters as frequently as the male, but she would chase and/or attack other species.

Miller (quoted by Davis, 1941) reported an instance in which the female joined the male to attack an intruder, but Davis discredited the report. Ten such cooperative encounters were observed in this study which indicated that the male and female Kingbirds do in fact cooperate to fight other species of birds.

The Eastern Kingbirds in this study were observed to have an opportunity for interspecific aggressive encounters with 35 different species (see Appendix), with 21 of these species being involved in actual aggressive encounters. As expected, the greatest numbers of opportunities and encounters were recorded for those species which

TABLE III

THE NUMBER OF OPPORTUNITIES FOR AND ACTUAL INTERSPECIFIC AGGRESSIVE ENCOUNTERS FOR EACH PHASE OF THE REPRODUCTIVE EFFORTS AND SEX OF THE EASTERN KINGBIRDS INVOLVED

	Phase of the Reproductive Effort											
Sex	Prenesting		Nest Const.		Incubation		Prefledging		Postfledging		Total	
	opp.*	enc**	opp.	enc.	opp.	enc.	opp.	enc.	opp.	enc.	opp.	enc.
Unknown	21	1	56	4	0	0	0	0	0	0	77	5
Male	9	1	16	13	31	14	46	32	3	2	105	62
Female	3	0	8	0	26	7	17	5	2	0	56	12
Both	1	1	19	6	11	1	6	2	2	0	39	10
Total	34	3	99	23	68	22	69	39	7	2	277	89

*Opportunity for an interspecific aggressive encounter
**Actual interspecific aggressive encounter

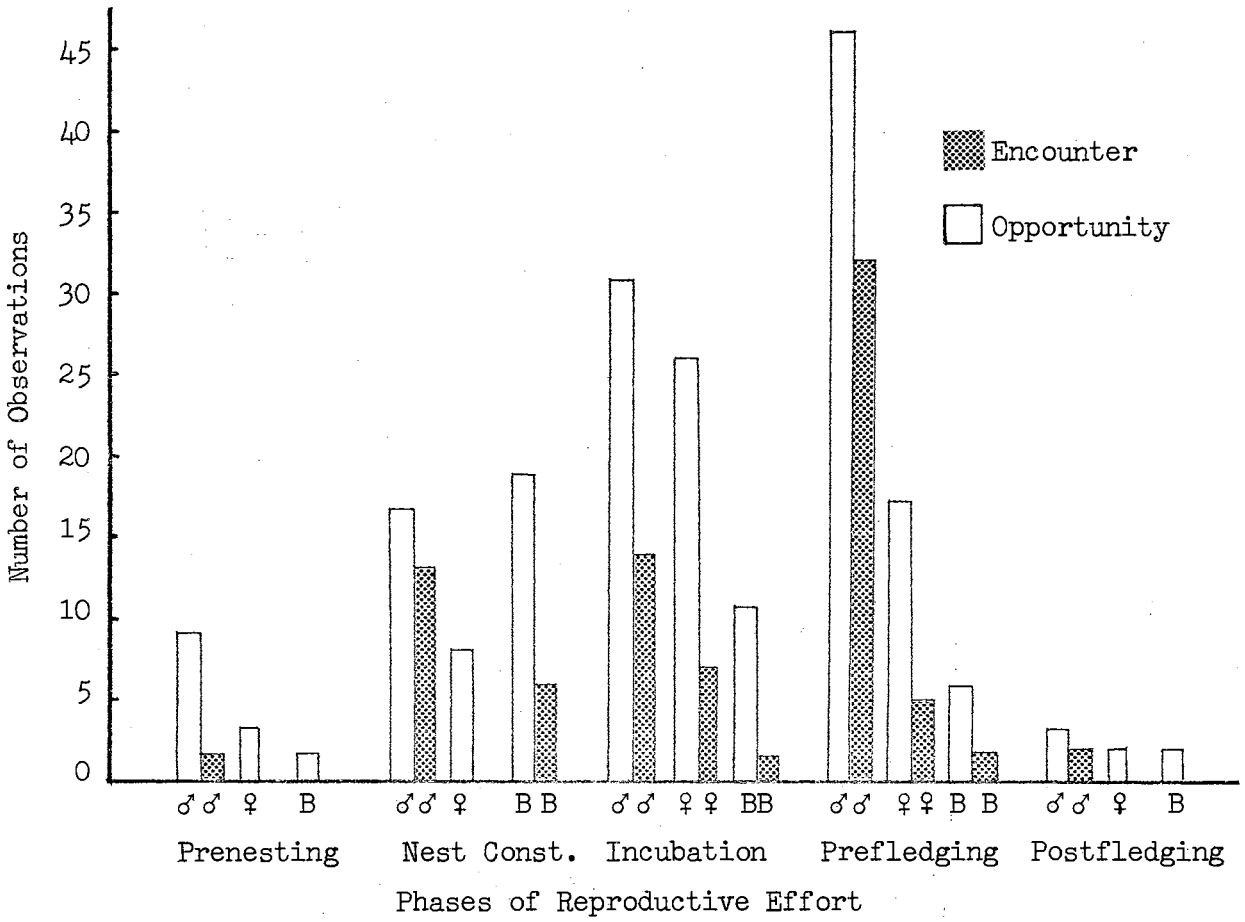

Figure 4. Opportunities for Interspecific Aggressive Encounters and Number of Actual Interspecific Aggressive Encounters Involving Males Only, Females Only, and Both Sexes

utilized the same area as the Kingbirds or which actually nested within the territory of the Kingbirds. Both Redwinged Blackbirds (Agelaius phoeniceus) and Scissor-tailed Flycatchers (Muscivora forficata) nested close to Eastern Kingbird nests while House Sparrows (Passer domesticus), Field Sparrows (Spizella pusilla), Bell's Vireos (Vireo bellii), Eastern Meadowlarks (Sturnella magna), Orchard Orioles (Icterus spurius), Baltimore Orioles (Icterus galbula), and Mourning Doves (Zenaidura macroura) nested within the territorial boundaries of Eastern Kingbirds. Five species, three of which are predators, were observed to be attacked on every opportunity although the opportunities were infrequent. These included the Common Crow (Corvus brachyrhynchos), Loggerhead Shrike (Lanius ludovicianus), an owl (sp.), Crested Flycatcher (Myiarchus crinitus), and Blue Grosbeak (Guiraca caerulea). The attack on the owl was unusual in that it involved the mobbing of the owl by a male Eastern Kingbird, a Western Kingbird, and two Scissor-tailed Flycatchers.

The number of opportunities and encounters for Redwinged Blackbirds and Scissor-tailed Flycatchers was recorded by the sex of the birds involved since there appeared to be a considerable difference in the degree of tolerance to these species according to their sex. The females of these two species were attacked much more frequently in relation to the number of opportunities than were the males. This indicated that the stimulus they present by their presence is in some way different than that presented by the males.

Not all encounters with other species were won by the Kingbirds. On one occasion the Sanborn male was chased by two Western Kingbirds and on another by a male Redwinged Blackbird. The female Kingbird was

chased by a male Redwing on two occasions. The single encounter between a Yellow-shafted Flicker (Colaptes auratus) and the Sanborn male resulted in a standoff. The Flicker perched in the nest tree and the male Kingbird dove at it several times before perching nearby. The Flicker was not driven from the nest tree and it did not chase or attack the Kingbird. Eventually the Flicker left the nest tree, but it was not chased when it did so.

The most vigorous encounters were those between male Kingbirds and Common Grackles (Quiscalus quiscula). The five encounters were all the result of the Grackles entering the nest tree. On one occasion both the male and female Kingbirds drove a Grackle from the nest tree. The Sanborn male attacked three Grackles at one time and managed to dislodge several feathers from two of the Grackles before driving them from the nest tree.

The response to Mockingbirds (Mimus polyglottos) closely resembled intraspecific encounters. On three occasions the call of a Mockingbird resulted in the male Kingbird flying a considerable distance to chase or attack it. Once a Mockingbird repeated the call notes of the Eastern Kingbird which resulted in a vigorous attack by the male of the Boomer Lake #2 nest.

CHAPTER VII

NEST CONSTRUCTION

Fourteen Eastern Kingbird nests were located during the summer of 1968, seven of which were found during the initial stages of nest construction. No mention of the length of time it takes Eastern Kingbirds to build a nest could be found in the literature. However, Pettingill (1942) indicated that tyrant flycatchers may take from 3 to 13 days to complete the nest. Data on the length of nest construction for the Eastern Kingbird nests that were under observation are given in Table IV. The length of the period for the first four pairs is somewhat misleading since all of these were characterized by intermittent nest construction. The shorter nest construction periods occurred later in the summer and involved the renesting of two pairs (Sanborn and Scott). The Sanborn female used the same nest as before so actually only nest repair was involved.

Only the female engaged in nest construction although on many occasions she was accompanied by the male as she gathered nest materials or the male waited in the nest tree and "greeted" her as she returned. There appeared to be no preference for a particular time of day for working on the nest, and on days of intense nesting activity the female tended to work all day with only brief interruptions for feeding and preening. On one occasion 3 days passed during which time the Sanborn female was not observed engaging in nest construction or even

going to the nest tree. During this time a Scissor-tailed Flycatcher removed some of the nest materials and generally disrupted the nest. The opinion was held at this time that the Sanborn nest was an abortive one, however, 3 days before the first egg was laid intensive nest construction (and repair) resumed.

TABLE IV

LENGTH OF NEST CONSTRUCTION FOR SEVEN PAIRS OF EASTERN KINGBIRDS

Pair	Construction Began	Construction Completed	Length of Period (days)	First Egg
Sanborn	27 April	13 May	17	14 May
Scott	30 April	17 May	18	18 May
Boomer Lake #1	29 April	19 May	21	20 May
Boomer Lake #2	1 May	23 May	23	24 May
Boomer Lake Pond	2 July	10 July	9	11 July
Sanborn	29 June	2 July	4	3 July
Scott	13 July	17 July	5	18 July

The materials used for the nest and the appearance of the nest when completed seemed to depend upon two factors:

1. The materials available.
2. The situation of the nest in the nest tree.

For the most part, the outer part of the nest was composed of bark, stems of various forbs, twigs, and grape vines. The Sanborn female was the only one observed using thin strips of bark torn from the smaller limbs of the nest tree although bark was found in other nests. In a few cases the entire plant (including the roots) was included in the rough outer part of the nest, but after a few days these plants

were removed from the nest and discarded. Pieces of string, cloth, and paper were incorporated into the outer parts of most nests. The nest cup was more tightly arranged and smaller than the outer part, and finer materials were used in its construction. Grasses, plant inflorescences, paper, and thin forb stems were used for the cup. An enormous amount of seeds of various kinds were matted together and woven into the cup of all nests. The lining consisted of fine cottony plant fibers, grasses, cattail seeds, and horsehair. Four of the 14 nests were constructed in situations in which only the nest cup and inner lining were required. Three of these nests were inside willow stumps and one was built inside an old Orchard Oriole nest. The other ten nests were very similar in overall appearance and differed only in the way they were placed in the nest tree. One of these nests (Scott) straddled a limb much like a saddle while another (Winter) was built between two upright splinters of wood that projected from a broken willow limb. The rest of the nests were built in the forks of the willow or cottonwood trees in a manner typical of Eastern Kingbird nests (Davis, 1941).

The preference of the Eastern Kingbird for nesting near water (Davis, 1941, 1955 Sutton, 1967) was obvious in this study. All but three of the 14 nests were built over water with the remaining three located near water. Only two species of trees, black willow (Salix nigra) and cottonwood (Poplar deltoides), (both common along streams, ponds, and lakes in northcentral Oklahoma) were used as nest trees. Data concerning nest heights, location of the nests in the trees, tree heights, and proximity of the nest trees to water are given in Table V. Mayfield (1952) found that the nest height preference of Eastern

Kingbirds in northern Michigan was approximately 6 feet and suggested that nest height was related to the visibility around the nest. Davis (1955) found that over 50% of 70 Eastern Kingbird nests found in western Montana were less than 9 feet above the ground or water. Although eight of the nests found in this study were at or below the 9 foot level, it is difficult to interpret this as a preference for nesting at this level. Rather, the nests in this study appeared to be situated so that an unobstructed view was possible. The Eastern Kingbird typically builds an exposed nest with little or no vegetation shading the nest (Sutton, 1967) and such was the case with the nests found on the study area. It is interesting to note that the nests located in the three cottonwood trees were much higher than those in the willow trees (mean nest height of 30.6 feet as opposed to 8.5 feet), and again this appeared to be due to the lack of visibility at the lower levels of the cottonwood trees.

The size of each nest appeared to be dictated by its situation in the nest tree. Nests built in the sturdy forks of trees tended to be shallower and wider, while those higher in the trees tended to be deeper. The mean internal depth of the three nests in cottonwoods was 61 mm as opposed to 42.6 mm for those in willow stumps (mean nest height of 9 feet). Dr. G. M. Sutton (personal communication) suggested that perhaps the stimulus of the nest swaying in the wind in the taller trees induced the females to build deeper nests. Data on the nest dimensions are given in Table VI.

TABLE V

TYPE, HEIGHT, AND LOCATION OF NEST TREES, HEIGHT OF NESTS, AND LOCATION OF NESTS IN NEST TREES FOR 14 EASTERN KINGBIRD NESTS

Nest No.	Type of Tree	Height (ft) Tree	Height (ft) Nest	Comments
1	Dead Willow	14	5	In water, 9 ft from shore, nest on main stem.
2	Willow	17	9	In water, 28 ft from shore, nest on main stem.
3	Willow	27	12	At edge of water, nest 12 ft from main stem.
4	Cottonwood	44	37	In water, 7 ft from shore, nest on main stem.
5	Willow	16	4	On edge of pond dam, nest 5 ft from main stem.
6	Willow stump	12	12	In water, 8 ft from shore, nest on main stem.
7	Willow stump	7	7	In water, 2 ft from shore, nest on main stem.
8	Willow stump	8	8	In water, 30 ft from shore, nest on main stem.
9	Willow	19	7	On edge of pond dam, nest 6 ft from main stem.
10	Dead willow	14	5	In water, 6 ft from shore, nest on main stem.
11	Cottonwood	30	25	On land, 30 ft to edge of water, nest on main stem.
12	Willow	17	9	At edge of water, nest 6 ft from main stem.
13	Willow	21	18	On edge of pond dam, nest on main stem.
14	Cottonwood	30	30	On land, 28 ft to edge of water, nest on main stem.
TOTAL		276	188	
RANGE		7-44	4-37	
MEAN		19.7	13.4	
STANDARD DEVIATION		10.0	10.3	

TABLE VI

DIMENSIONS OF 14 EASTERN KINGBIRD NESTS
FOUND ON THE STUDY AREA

Pair	Ext. Diam. (mm)	Int. Diam. (mm)	Ext. Depth (mm)	Int. Depth (mm)
Sanborn Lake	110	74	80	45
Boomer Lake #1	130	85	96	30
Scott Pond	110	80	65	34
Boomer Lake #2	115	78	90	63
Airport Pond	115	70	80	30
Lakeview-Western Pond	115	80	90	35
Perkins Road Pond #1	120	90	87	43
Hoke Pond	120	85	85	40
Perkins Road Pond #2	100	80	85	45
Sanborn Lake	110	74	79	43
Boomer Lake Pond	120	80	90	55
Winter Pond	120	75	96	48
Corner Pond	110	75	60	38
Scott Pond	95	70	110	65
TOTAL	1590	1096	1194	614
RANGE	95-130	70-90	60-110	30-65
MEAN	113.5	78.3	85.3	43.8
STANDARD DEVIATION	8.9	5.8	12.6	10.9

CHAPTER VIII

INCUBATION ACTIVITY

Observations of the time of egg laying indicated that the eggs were laid at one day intervals and usually in the morning, although the exact time of egg laying was not determined for most eggs.

The average clutch-size for 13 nests was 3.5 eggs per nest. Only one nest contained five eggs, while five nests had four eggs each, and seven nests had three eggs each. A total of 46 eggs were laid in the 13 nests.

Nine of the 13 nestings occurred during the first reproductive effort with a total of 34 eggs and a mean clutch-size of 3.7 eggs per nest. Only four nests were found during the second reproductive effort and each of these nests contained three eggs. Davis (1955) reported that the clutch-size of Eastern Kingbirds declined during the breeding season in Western Montana; a similar decline in average clutch-size was indicated in this study.

Davis (1941) stated that the female begins to incubate when the penultimate egg is laid, and only incubates regularly after the last egg is laid, but none of the females observed followed this pattern. All females began incubation with the first egg, although the time spent on the nest tended to be fairly short during the first few days. The first 4 to 5 days of incubation were characterized by short periods of incubation and short periods of feeding and preening. As incubation

continued more time was spent on the nest and less time feeding. The last few days of incubation prior to hatching were characterized by almost continuous incubation.

The length of time from the laying of the first egg until that egg hatched was determined for ten nests. The mean incubation length for all ten nests was 14.9 days and varied from 13 days to 17 days. The mean for six nests that were observed during the first reproductive effort was 15 days; the mean for four nests observed during the second reproductive effort was 14.7 days.

CHAPTER IX

PREFLEDGING ACTIVITY

The activities of both male and female Kingbirds changed drastically once the eggs had hatched. The males had not participated in nest-site selection, nest construction, or incubation, but once the eggs had hatched they became as attentive as the females. Male Kingbirds were observed feeding the young and removing fecal sacs but were not observed brooding the young, removing egg shells, or shading the young.

Since the eggs were not hatched on the same day, it is difficult to attribute the time spent on the nest by the female to only brooding or incubation. Once the first egg in a nest had hatched the female tended to spend longer periods away from the nest than before, and tended to brood (or incubate) for shorter periods. Periods of brooding after all eggs of a nest had hatched were seldom as long as periods of incubation during the last few days before the first egg hatched. As mentioned previously, all Kingbird nests were fairly exposed and this probably eliminated the need for extensive brooding. Generally by the ninth or tenth day after the last egg of a nest hatched brooding had ceased during the daylight hours. In some of the more exposed nests the females were frequently seen standing on the edge of the nest shading the young. The females usually engaged in some preening during the time they were shading the young.

Both male and female Kingbirds were observed feeding the young, and although data were not taken in such a way that feeding rates could be determined, the Sanborn and Scott males (during the first nesting) fed the young more frequently during the first 4 days after hatching than did the females. Morehouse (1965) found that the feeding rates of male Kingbirds remained fairly constant throughout the prefledging period while the feeding rates of the females was rather low during the first 6 to 8 days then increased considerably. It should be mentioned that the female Kingbirds hawked insects in the immediate vicinity of the nest only after several days following hatching, but once this practice began they seldom flew far from the nest to feed.

On four separate occasions the Sanborn male was observed passing an insect to the female who then fed it to the young. Both Davis (1941) and Morehouse (1965) reported similar activity. On one occasion the Sanborn male removed an insect from the mouth of one of the young and ate it himself.

Both male and female Kingbirds were observed removing fecal sacs from the nest. In most cases the fecal sac was carried some distance from the nest before it was dropped either in the weeds or into the water. The Sanborn female had an unusual method of disposing of the fecal sacs. On eight occasions she was observed to fly to a hollow pipe 120 feet from the nest tree and drop the fecal sac into the pipe.

The length of time from hatching to fledging was determined for ten nests. The mean length for all nests was 15.9 days and varied from 14 to 19 days. The mean length for six nests during the first reproductive effort was 16.6 days; for four nests during the second reproductive effort 14.7 days. Thus, although the length of incubation for

the first and second reproductive efforts were very similar, the length of prefledging was shortened during the second reproductive effort.

CHAPTER X

POSTFLEDGING ACTIVITY

Fledging

All of the young of the same nest did not fledge on the same day. Since the eggs were laid on consecutive days and incubation began with the first egg, the young of a particular nest were in various stages of development at the time the first young bird fledged. For several days after all of the young of a nest had fledged it was possible to recognize individual fledglings by their size and feather development.

When the young left the nest they were guided by the female Kingbird to cover in a clump of trees that was located near the nest tree. The presence of this clump of trees proved to be a common ingredient in the nesting habitats of all of the Kingbirds found on the study area. This would possibly explain why Eastern Kingbirds were not found nesting around ponds that had what appeared to be an adequate nest tree and other favorable habitat except for a clump of trees in which the young could hide after fledging.

The young were extremely vocal during the first few days after fledging. They continuously repeated the dzeek notes, and were able to increase the intensity and rapidity when alarmed so that it served as an effective alarm signal.

Reproductive Success

M. M. Nice (1957) indicated that the success of nesting with passerines is influenced by the safety of the nest site, and that the percentage of young that are fledged typically is around 60%. The data on reproductive success of 13 Kingbird nests are included in Table VII.

TABLE VII

REPRODUCTIVE SUCCESS OF 13 EASTERN KINGBIRDS NESTS

Nest No.	No. of Eggs Laid	No. of Eggs Hatched	Per cent Hatched	No. of Young Fledged	Per cent Fledged
1	5	5	100	5	100
2	4	4	100	4	100
3	4	3	75	3	75
4	3	3	100	3	100
5	3	3	100	3	100
6	4	4	100	4	100
7	3	3	100	3	100
8	4	4	100	4	100
9	4	4	100	4	100
10	3	3	100	3	100
11	3	3	100	3	100
12	3	3	100	3	100
13	3	3	100	3	100
TOTAL	46	45		45	

In order to determine the degree of reproductive success three calculations were made:

1. Hatching success = $\frac{\text{no. of eggs hatched}}{\text{no. of eggs laid}} \times 100$

2. Fledging success = $\frac{\text{no. of eggs hatched}}{\text{no. of young fledged}} \times 100$

3. Survival success = $\frac{\text{no. of young found at fledging + 3 days}}{\text{no. of young fledged}} \times 100$

Of 46 eggs that were laid in 13 nests only one egg failed to hatch resulting in a hatching success of 98%. All of the eggs that hatched resulted in young that fledged so the fledging success was 100%. Only 24 young could be found on the third day after fledging so the survival success was only 53.3%. This figure is based on the ability to find the fledglings and not on known deaths; but there were no instances where more young were found at a particular nest than were found on the third day after fledging.

The high level of both hatching and fledging success speaks well of the ability of the adult Kingbirds to protect the nest and provide for the young while they are still in the nest. The young, however, appear to be especially vulnerable after fledging.

CHAPTER XI

CONCLUSIONS

Observations of the activities of Eastern Kingbirds on a 9 square mile area in northcentral Oklahoma were made during the spring and summer of 1968 in order to add to the understanding of the reproductive status of the bird in the state. Certain activities observed during the present study did not agree with those recorded in the literature. It should be mentioned that not only is the existing literature on the Eastern Kingbird meager, but also that studies of any depth are restricted to the northcentral and northeastern United States. Most of the discrepancies between the observations in this study and those found in the literature could be explained by the fact that the climate in the areas where Kingbirds have previously been studied tends to shorten the length of the reproductive season, especially for flycatchers.

The conclusions drawn from the present study are as follows:

1. Sutton (1967) indicated that Eastern Kingbirds in Oklahoma are probably one-brooded as a rule. Two pairs of Kingbirds in this study raised two broods during the summer of 1968. None of the studies found in the literature indicated that Kingbirds raised two broods, however, one would expect them to be one brooded in the areas where they have previously been studied.

2. Eastern Kingbirds appeared to have been already paired upon spring arrival, which does not agree with the pattern reported by Davis (1941) in New York. It was possible to identify some unpaired Kingbirds on the study area following spring arrival, and it is conceivable that even if the general rule is for Kingbirds to pair during migration (Welty, 1962) some would be unable to do so. It is possible that young Kingbirds in their first reproductive season do not pair during migration but no data are available to support this idea.

3. The role of the sexes in parental care conformed with that recorded in other studies. The males observed in the present study did not participate in nest-site selection, nest construction, incubation, removal of egg shells, or shading the young, although they tended to be quite active in feeding the young and removal of fecal sacs.

4. Several components appeared to be involved in the establishment of territories by the Eastern Kingbirds in this study. These components include the restriction of movement of both members of the pair, site attachment (nest tree), hostility or aggressiveness, self-advertisement within the territory, and site dominance. Instances of intraspecific aggressive encounters observed in this study can best be understood by considering that two tendencies (site attachment and hostility) were operating independently of each other and as such were expressed differently by the sexes. Davis (1941) considered intraspecific aggressive encounters involving the female Kingbird to be an expression of defense of the territory, however, it is believed that the behavior he observed can best be described as defense of the nest or nest contents. The differences between the aggressive response of female Kingbirds as described by Davis and those observed in this study

seem to be more apparent than real if two independent tendencies are considered.

5. The available nesting habitat on the study area appeared to space Eastern Kingbirds so that intraspecific contacts were infrequent. Only two pairs of Kingbirds nested close enough to each other so that they possibly had a common territorial boundary. No indication of the shared boundary was demonstrated by intraspecific encounters or displays.

It would seem that the distribution of Eastern Kingbirds in northcentral Oklahoma is regulated by available nesting habitat whereas density is regulated by their highly territorial behavior.

No studies of the behavior or habitat requirements of Eastern Kingbirds in areas of high breeding densities could be found in the literature.

6. Eastern Kingbirds are not only highly territorial but also possess an interspecific as well as an intraspecific territory. Both male and female Kingbirds engaged in interspecific aggressive encounters either individually or together although the number of interspecific encounters observed involving either females or both sexes were not as frequent as those involving only the male. Davis (1941) reported that only the male Kingbird engaged in interspecific encounters which was not true for the Kingbirds observed in the present study.

7. Nest construction was intermittent in those nests observed during the first reproductive effort. No instances of intermittent nest construction were observed during the second reproductive effort. It is not known if intermittent nest construction was due to bad weather during the first reproductive effort or if the females

involved in nest construction were inexperienced. Davis (1941) reported several cases of females building nests only to abandon them and build others. No abandoned nests were found in this study. It is possible that the abortive nesting attempts observed by Davis and the intermittent nest construction observed in the present study could both be due to a learning process exhibited by inexperienced females.

8. Incubation by female Kingbirds was begun with the first egg in all nests observed in this study. Davis (1941) reported that incubation began with the penultimate egg. Since eggs were laid on succeeding days and incubation began with the first egg, the young hatched on different days and even fledged on different days.

9. All nesting habitats were characterized by the presence of a clump of trees near the nest site. The fledglings were guided to cover in the clump of trees by the female Kingbird and remained there several days after fledging.

10. The hatching success and fledging success of the Eastern Kingbirds observed in this study were both high (98% and 100% respectively). The survival success at three days after fledging was 53.3% although this figure is based on the ability to find fledglings and not on known deaths.

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APPENDIX

APPENDIX

NUMBERS OF OPPORTUNITIES AND ACTUAL INTERSPECIFIC AGGRESSIVE ENCOUNTERS FOR EACH PHASE OF A REPRODUCTIVE EFFORT

Species	Phase of a Reproductive Effort										Total	
	Prenesting		Nest Const.		Incubation		Prefledging		Postfledging			
	opp.	enc.	opp.	enc.	opp.	enc.	opp.	enc.	opp.	enc.	opp.	enc.
Pied-billed Grebe (*Podilymbus podiceps*)	1										1	
Green Heron (*Butorides virescens*)					2		3				5	
American Bittern (*Botaurus lentiginosus*)							1				1	
Swainson's Hawk (*Buteo swainsoni*)			2	1							2	1
Hawk (sp.)	1										1	
Killdeer (*Charadrius vociferus*)			2	1	1						3	1
Franklin's Gull (*Larus pipixcan*)					6						6	
Mourning Dove (*Zenaidura macroura*)	1										1	
Owl (sp.)									1	1	1	1
Belted Kingfisher (*Megaceryle alcyon*)	1										1	
Yellow-shafted Flicker (*Colaples auratus*)	3		1		1	1					5	1
Western Kingbird (*Tyrannus verticalis*)			1		5	4	3	2	1	1	10	7

APPENDIX (continued)

Species	Phase of a Reproductive Effort											
	Prenesting		Nest Const.		Incubation		Prefledging		Postfledging		Total	
	opp.	enc.	opp.	enc.	opp.	enc.	opp.	enc.	opp.	enc.	opp.	enc.
Scissor-tailed Flycatcher (♂) (*Muscivora forficata*)	4		9	3	3		2	1	2		20	4
Scissor-tailed Flycatcher (♀)		1	2	1							2	2
Crested Flycatcher (*Myiarchus crinitus*)					1	1					1	1
Purple Martin (*Progne subis*)					3		2	2			5	2
Crow (*Corvus brachyrhynchos*)					2	2	1	1			3	3
Mockingbird (*Mimus ployglottos*)	2	1		1	1	4	3	1			9	4
Robin (*Turdus migratorius*)	1										1	
Eastern Bluebird (*Sialia sialis*)	1										1	
Cedar Waxwing (*Bombycilla cedrorum*)	1										1	
Loggerhead Shrike (*Lanius ludovicianus*)							1	1			1	
Starling (*Sturnus vulgaris*)	4	1	3								7	1
Bell's Vireo (*Vireo bellii*)			1		1	1	1	1			3	2

APPENDIX (continued)

Species	Phase of a Reproductive Effort											
	Prenesting		Nest Const.		Incubation		Prefledging		Postfledging		Total	
	opp.	enc.	opp.	enc.	opp.	enc.	opp.	enc.	opp.	enc.	opp.	enc.
House Sparrow (Passer domesticus)	3	1	8	4							11	5
Eastern Meadowlark (Sturnella magna)	2		4								6	
Redwinged Blackbird (♂) (Agelaius phoeniceus)	6		36	7	29	6	31	13			102	26
Redwinged Blackbird (♀)			8	3	6	4	4	4			18	11
Orchard Oriole (Icterus spurius)			12		2		3	1			17	1
Baltimore Oriole (Icterus galbula)	2	1					1		1		5	
Common Grackle (Quiscalus quiscula)			1		3	2	5	3	1		10	5
Cowbird (Molothurs ater)			1				4	4			5	4
Blue Grosbeak (Guiraca caerulea)							1	1			1	1
Painted Bunting (Passerina ciris)					1						1	
Field Sparrow (Spizella pusilla)	1		2		1						4	
Sparrow (sp.)			2	1							2	1
Unknown			2	2			2	2			4	4
Total	34	3	99	23	68	22	69	39	7	2	277	89

VITA

Lawrence Edward Powell

Candidate for the Degree of

Master of Science

Thesis: THE BREEDING BIOLOGY OF THE EASTERN KINGBIRD IN NORTHCENTRAL OKLAHOMA

Major Field: Zoology

Biographical:

Personal Data: Born in Muskogee, Oklahoma, September 22, 1940, the son of Mr. and Mrs. A. O. Powell.

Education: Graduated from Muskogee Central High School, Muskogee, Oklahoma, in May 1958; received the Associate of Arts degree from Muskogee Junior College in 1960; received the Bachelor of Science degree in Biology from Northeastern State College, Tahlequah, Oklahoma, in May 1962; completed requirements for the Master of Science degree in August 1969.

Professional Experience: January 1964 to May 1967, Instructor, Tascosa High School, Amarillo, Texas; September 1968 to present, graduate teaching assistant, Oklahoma State University.

Professional Organizations: Member of the Animal Behavior Society, Oklahoma Ornithological Society, and Wilson Ornithological Society. Associate member of the Society of Sigma Xi.