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Author(s): Elizabeth M. Bates, Lianne M. Koczur and Bart M. Ballard

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# Post-fledging Survival and Dispersal of Juvenile Reddish Egrets (*Egretta rufescens*)

ELIZABETH M. BATES<sup>1,2</sup>, LIANNE M. KOCZUR<sup>1,\*</sup> AND BART M. BALLARD<sup>1</sup>

<sup>1</sup>Caesar Kleberg Wildlife Research Institute, MSC 218, 700 University Boulevard, Texas A&M University-Kingsville, Kingsville, Texas, 78363, USA

<sup>2</sup>Current address: Texas Parks and Wildlife Department, 1297 Church Hill Drive, Suite 213, New Braunfels, Texas, 78130, USA

\*Corresponding author; E-mail: LianneKoczur@gmail.com

**Abstract.**—The Reddish Egret (*Egretta rufescens*) is a species of conservation concern on an international scale, yet relatively little is known about its life history strategies and demographics. To estimate post-fledging survival and examine dispersal patterns/rates, Reddish Egrets ( $n = 30$  fledglings) were monitored and marked with VHF radio transmitters in the Laguna Madre, Texas, in 2006. Overall daily survival rate was 0.78 (SE = 0.11). Reddish Egrets dispersed from their natal colony at 12-15 weeks after hatching, and the average distance traveled in the Laguna Madre ranged from 0 to 488 km. These results help fill a knowledge gap during this little-known time period of the Reddish Egret. Furthermore, these results show that the Laguna Madre is an important system during this critical stage of development as many of the juveniles remained in this lagoon through the duration of our 6-month study. Received 2 April 2015, accepted 1 June 2015.

**Key words.**—dispersal, *Egretta rufescens*, juvenile, Reddish Egret, survival, Texas.

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Reddish Egrets (*Egretta rufescens*) are the rarest species of heron in North America (Lowther and Paul 2002). The species underwent a severe population decline in the early 1900s due to plume hunting (Paul 1991; Bates *et al.* 2009). Today, there are an estimated 2,000 pairs in the United States, primarily residing along the Gulf Coast (Lowther and Paul 2002; Green 2006). The majority of the breeding population occurs in Texas, where the species is designated as threatened. This species is facing habitat loss and degradation due to the growing human population throughout much of its range (Green 2006). Effective management for Reddish Egrets is critical for their conservation; however, little information exists concerning the life history and ecology of Reddish Egrets. There is a paucity of information on the juvenile stage of this species, potentially resulting in uninformed management decisions.

Juvenile survival is an important demographic parameter for developing models used to estimate population trends or to develop conservation plans (Servello 2000; Parker *et al.* 2003; Todd *et al.* 2003). Estimates of adult survival rates and reproductive success often are used as metrics to examine population trends, yet these estimates

may not provide an accurate picture if post-fledging survival is low. For example, first year survival rates of Little Egrets (*E. garzetta*) were relatively low and variable across years, whereas adult survival was relatively high and constant across years (Hafner *et al.* 1998). Furthermore, Wood Storks (*Mycteria americana*) exhibited relatively high, although variable, fledging success, yet survival during the first year was low (Hylton *et al.* 2006). Adult survival and reproductive success are relatively well known for Ciconiiforms, yet post-fledging survival is not. Understanding survival and the potential threats to survival during this stage are particularly important for species of conservation concern, such as the Reddish Egret (Green 2006).

Complementing survivorship estimates with knowledge of dispersal and movement patterns is important in understanding population dynamics and the conservation needs of species (Erwin *et al.* 1996; Ganey *et al.* 1998; Hafner *et al.* 1998). Determining juvenile dispersal destinations can have direct implications for conservation. Geary (2012) examined movements of juvenile Reddish Egrets and found that there was relatively high individual variation in dispersal distance and fidelity to the natal colony. Our objectives were to further our understand-

ing of juvenile survival (defined in our study as 6 months post-fledging) and dispersal of Reddish Egrets.

## METHODS

### Study Area

The Laguna Madre of Texas is ~185 km long, averages 7 km wide, and averages 1 m in depth (Tunnell 2002). The upper Laguna Madre is separated from the lower Laguna Madre by a land-bridge extending from Padre Island to the mainland. Whereas there are only a few natural islands in the Laguna Madre of Texas, dredge spoil islands are common and serve as rookeries for colonial nesting waterbirds (Tunnell 2002), including Reddish Egrets. We captured young Reddish Egrets in six breeding colonies in the Laguna Madre (Fig. 1).

### Field Protocols

We hand-captured 30 Reddish Egret fledglings that had left the nest but were not yet able to fly (5-6 weeks of age based on known hatch-dates) and attached VHF radio transmitters to a plastic leg band placed on the left leg of each individual. Radios had an expected battery life of 200 days and contained a mortality sensor that became activated after 8 hr of inactivity. We surveyed the Laguna Madre approximately every 2 weeks from capture to 6 months post-capture. We conducted 10 aerial surveys and one boat survey from 20 June to 1 November 2006. In October 2006, we also made an exploratory flight outside of the Laguna Madre, extending north to Matagorda Bay, to potentially locate missing birds. During aerial surveys, we maintained altitudes between 152 and 330 m, and used Yagi antennae mounted to the fixed-wing aircraft to scan for tagged egrets. Once a signal was detected, we determined status (dead or alive) and circled the area to estimate and record the location using a GPS. We did not observe any Reddish Egrets flushing during surveys; therefore, we do not believe disturbance affected movements. Distance traveled was measured as the straight-line distance between successive locations. Survival was estimated in SAS (SAS Institute, Inc. 2008) using the Kaplan-Meier estimator with staggered entry design. Individuals whose signals were lost during the study were included in the analysis, but were censored after the last day they were located.

## RESULTS

We were able to detect 29 of the 30 individuals at least once during the survey period (June-November). One individual was never detected, perhaps due to a radio transmitter malfunction. By November, five individuals were still emitting detectable signals within the survey area. Three

of the 25 censored birds were reported by bird watchers outside of our study area following our study. We confirmed five mortalities, three of which occurred before the fledglings dispersed from the colonies. We estimated an overall survival rate of 0.78 (SE = 0.11) (Fig. 2). Age at dispersal from natal colonies ranged from 7 to 15 weeks. One individual dispersed from its natal colony at 7 weeks of age, but the remainder of our tagged egrets remained near their natal colony until 12 weeks of age. The majority of movements throughout the first 6 months of age occurred between 12 and 19 weeks. Juvenile Reddish Egrets appeared to settle on wintering areas during week 20, at which time movements decreased substantially. The mean weekly distance traveled (straight-line distance between locations) in the Laguna Madre ranged from 0 to 488 km across age classes (Table 1). Eight (32%) of the Reddish Egrets that lived to 10 weeks of age dispersed to Nine-Mile Hole, an area south of Baffin Bay and east of the Land-Cut, where they remained until surveys ceased in mid-November. Three egrets were last located south of the Land-Cut in the Lower Laguna, one in Baffin Bay, one east of Baffin Bay and one northwest of Zig-Zag Island.

One of our radio-marked Reddish Egrets made a particularly interesting movement. It was last located in the Laguna Madre on 17 October 2006, but was next detected on 3 November 2006 in Colombia, South America, approximately 10 km south of the city of Andes, Antioquia Department, at an altitude of 2,600 m. This observation may be the most southerly known location of a Reddish Egret (but see Sprunt 1976), and is particularly interesting for an individual known to have originated from Texas. The roughly 3,800-km trip (3,220-km straight-line distance) from the Laguna Madre was made in < 16 days and terminated in an atypical location and habitat for a Reddish Egret, a small pond in a cattle pasture 280 km inland in mountainous terrain. It survived for at least 3 days at this site and was found dead on 6 November 2006; it was emaciated and appeared to have starved to death.

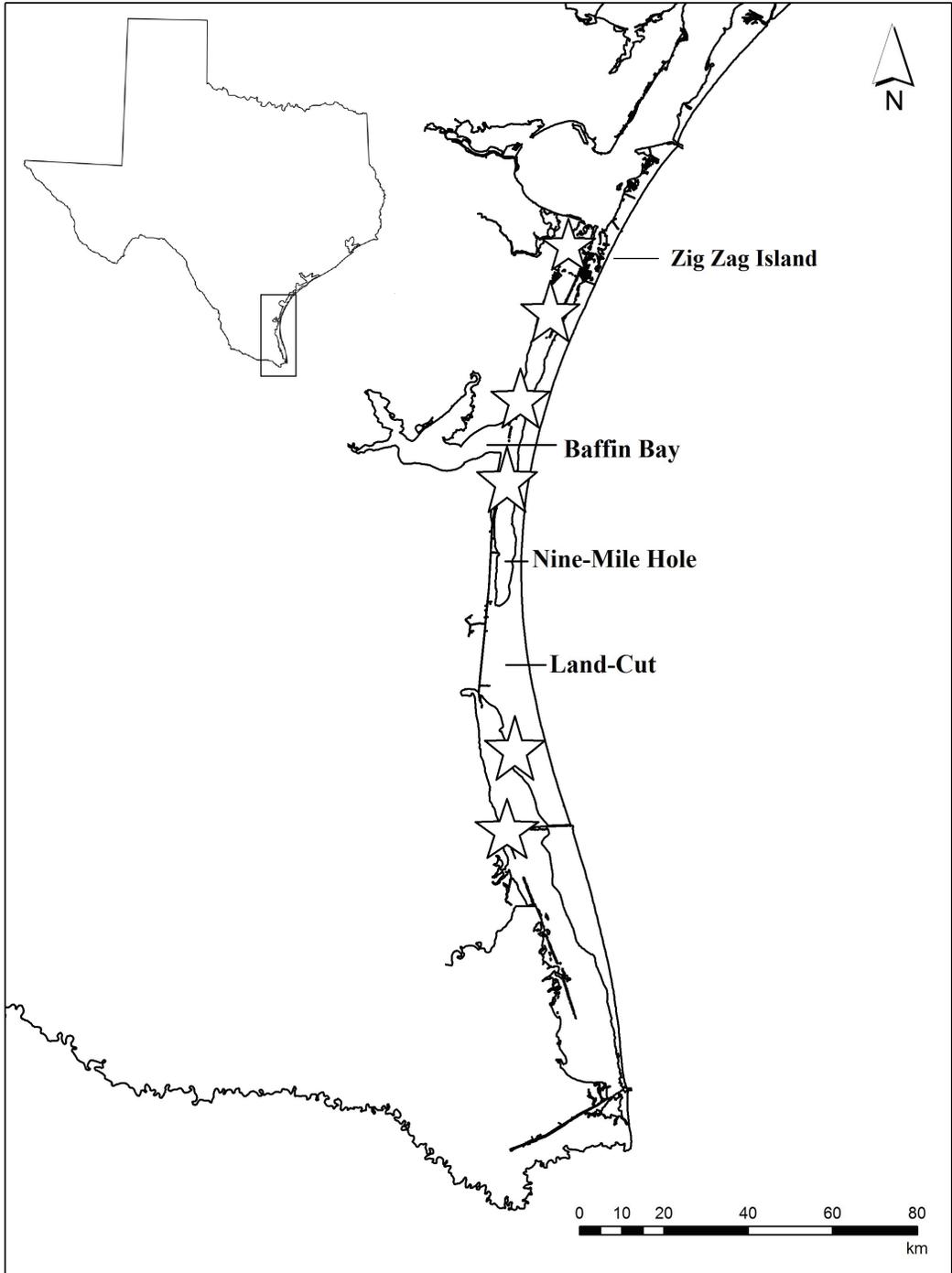


Figure 1. Study area of the Laguna Madre, Texas, showing colonies (stars) where we captured fledgling Reddish Egrets and conducted surveys during June–November 2006.

#### DISCUSSION

We found that survival of Reddish Egrets was relatively high in the Laguna Madre in

the first 6 months after hatching. Post-fledgling survival in several Ciconiiformes has been found to be relatively high while young are in the colony compared with lower rates

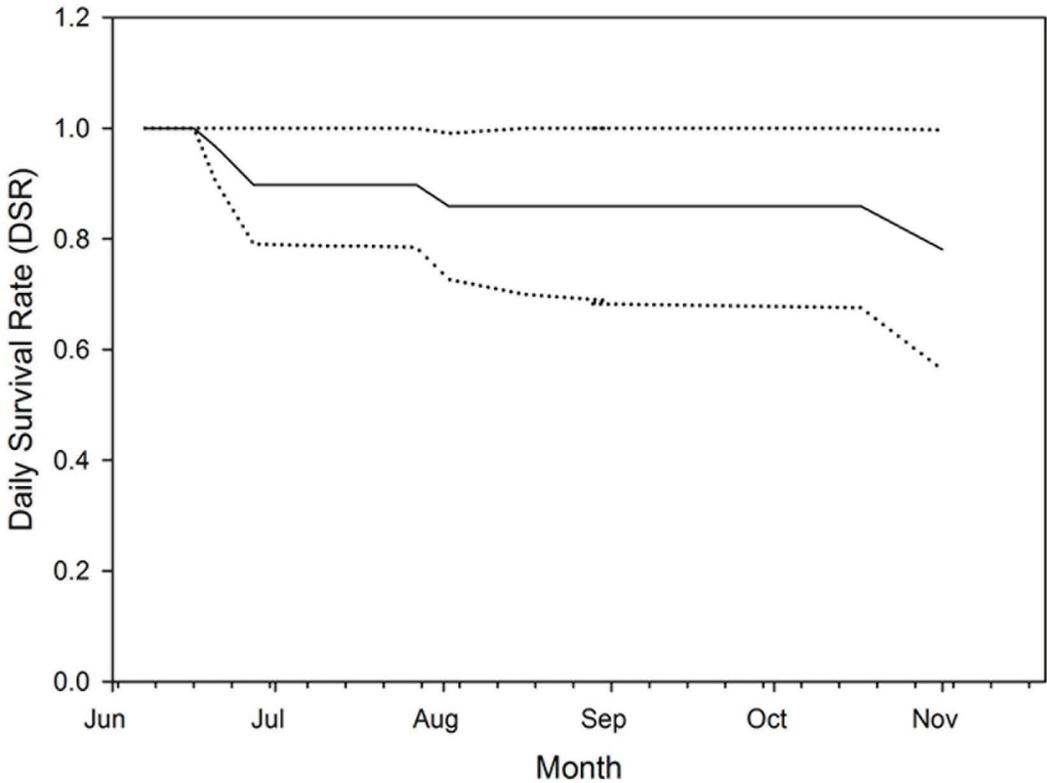


Figure 2. Daily survival rate (solid line) with 95% confidence interval (dotted lines) during June–October 2006 of juvenile Reddish Egrets tracked with VHF radio telemetry in the Laguna Madre, Texas.

Table 1. Mean distances (SE) traveled by post-fledging Reddish Egrets that dispersed from the nesting colony in the Laguna Madre of Texas during June–November 2006. Distance was measured in km, and means were calculated only for birds that dispersed from the natal colony.

Age (weeks)	Mean Distance	<i>n</i>
5	0.0	0
6	0.0	0
7	6.0	1
8	0.0	0
9	0.0	0
10	19.9 (7.7)	2
11	51.8 (16.6)	3
12	488.0 (453.5)	6
13	205.5 (200.2)	3
14	10.9	1
15	22.2 (11.5)	4
16	58.5	1
19	313.3 (296.2)	9
20	5.4	1
22	4.8 (1.8)	7
23	3.2	1
24	8.8 (4.5)	3

following dispersal from the colony (Erwin *et al.* 1996; Hylton *et al.* 2006). Our estimate of survival is comparable to that found by Geary (2012), who monitored 25 juvenile Reddish Egrets (captured at a similar age) using satellite telemetry. Geary (2012) estimated survival at 83% over the first 6 months after hatching; however, at ~17 months after hatching, survival decreased to 53%. Bates (2011) found that the amount of foraging habitat in the Laguna Madre, Texas, decreases during winter months. Furthermore, juvenile Reddish Egrets are not as efficient at foraging as adults (Bates and Ballard 2014). This suggests that the first overwinter period may be critical for juvenile survival.

Survival estimates of other waterbird species during the first year are relatively low. First year survival of Little Egrets ranged between 6.5% and 55.2% (Hafner *et al.* 1998). First-year survival of two cohorts of Wood Storks was 44% in 2002 and 6% in 2003

(Hylton *et al.* 2006). Although our estimate of survival was relatively high, there is evidence to suggest it may have declined following our 6-month study period (Geary 2012). Investigating juvenile survival of Reddish Egrets over multiple years and with a larger sample size would provide information on annual variation and provide a clearer picture of survival.

Several Reddish Egrets in our study were relatively old at the time of dispersal (84 days) compared to other heron species; Erwin *et al.* (1996) found that Snowy Egrets (*E. thula*) dispersed at 53-55 days after hatch and Black-crowned Night Herons (*Nycticorax nycticorax*) at 55-60 days. Our results of mean distances traveled within the Laguna Madre are similar to Geary (2012), who found that many of the Reddish Egrets dispersed to areas along the Texas coast or in Tamaulipas, Mexico, at a mean distance of 122.94 km from their natal colony.

Reddish Egrets are thought to be only weakly migratory with post-breeding migration involving mostly immature birds (Lowther and Paul 2002). Geary (2012) reported a small proportion of juvenile Reddish Egrets dispersing to the Gulf Coast of Louisiana, Florida, or Tamaulipas, Mexico. Furthermore, Geary (2012) found that the majority of movements occurred within the first 6 months after fledging, which was the extent of our study. Individual Reddish Egrets from Texas have been found as far south as El Salvador and Guatemala (Lowther and Paul 2002), but our study is the first report of an individual migrating as far as Colombia. These results, coupled with those of Geary (2012), show that there is considerable individual variation in dispersal and movements among hatch-year Reddish Egrets from the Laguna Madre, Texas. Our results highlight the need to protect habitat within the Laguna Madre, as it is known to be important for Reddish Egrets throughout the annual cycle. In particular, Nine-Mile Hole appears to be an important foraging area for Reddish Egrets and other wading birds following the breeding season, as evidenced by the results from this study and our frequent observations of hundreds

of wading birds using this area during our survey period. Nine-Mile Hole is a contiguous, shallow area that is well within the range of water depth used by foraging Reddish Egrets (Bates 2011), is relatively free from disturbance due to the shallow water, and most of the area is within the boundaries of Padre Island National Seashore.

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