Measurements of Adult and Hatch-year Reddish Egrets (*Egretta rufescens*)

Lianne M. Koczur[1,*], Gina M. Kent[2], Brock Geary[3], Bart M. Ballard[1], Kenneth D. Meyer[2] and M. Clay Green[3]

[1]Caesar Kleberg Wildlife Research Institute, MSC 218, 700 University Boulevard, Texas A&M University-Kingsville, Kingsville, Texas, 78363, USA

[2]Avian Research and Conservation Institute, 411 N.E. 7th Street, Gainesville, Florida, 32601, USA

[3]Department of Biology, 601 University Drive, Texas State University, San Marcos, Texas, 78666, USA

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

Abstract.—Measurements of live-captured adult and hatch-year Reddish Egrets (*Egretta rufescens*) from Texas (n = 29 and 25, respectively) and Florida (n = 7 and 3, respectively) are reported. Mass, tarsus length, and culmen length were used to compare sexes and ages of Reddish Egrets. Adult males (n = 17) were significantly larger than adult females (n = 19) in all parameters, and hatch-year Reddish Egrets were significantly smaller than adults in all parameters. Additionally, considerably larger measurements were recorded on average than those previously available for Reddish Egrets. These measurements provide updated information on the morphometry of Reddish Egrets that will be useful in understanding life history strategies and for planning future studies. *Received 20 January 2015, accepted 25 March 2015.*

Key words.—*Egretta rufescens*, measurements, morphometry, Reddish Egret, Texas.

Waterbirds 38(3): 308-311, 2015

The Reddish Egret (*Egretta rufescens*) is the rarest and least studied heron in North America and is listed as Near Threatened due to a low population size and reliance on a restricted range of coastal habitat (International Union for Conservation of Nature 2014). The global population is estimated at 5,000-7,000 individuals (Green 2006). There is still much to be learned about some of the species' basic life history strategies, which is essential for effective conservation planning. One such need is to identify and protect foraging and roosting habitat (Wilson *et al.* 2012). Furthermore, Reddish Egrets have been described as weakly migratory, and knowledge of migratory behavior is based on limited resightings of banded birds (Bent 1926; Paul 1991). The need to collect basic ecological data on Reddish Egrets, coupled with the difficulties of observational studies due to the extent of their range and the habitats they occupy, makes them an ideal species for satellite tracking. Satellite tracking is an effective monitoring tool, as transmitters provide accurate locations on a global scale and can be used to make inferences concerning habitat use. Knowledge of a species' morphometry is useful for planning such research, as well as obtaining a holistic understanding of life history strategies, such as migration and survival.

Previously available measurements for the Reddish Egret were based on a limited sample of museum specimens from Florida (Lowther and Paul 2002). The only published estimate of body mass of Reddish Egrets is pooled across an unknown age distribution. Measurements from a larger sample of birds that distinguish between the sexes and age groups would be useful in understanding Reddish Egret life history strategies. When developing monitoring protocols, these measurements will aid decisions regarding telemetry, including the optimal weight of the transmitter, which often influences the quantity and accuracy of the locations acquired. Consequently, this will affect the type of analytical methods that can be used and the inferences that can be made. We present measurements from live-captured adult and hatch-year Reddish Egrets. These data provide an update to currently reported body measurements and will be useful for planning future research.

Methods

In Texas, we trapped adult Reddish Egrets (egrets) during incubation (May-June) of 2010, 2011, 2012 and 2014. Adults (n = 29) were captured using a modified noose carpet placed at the nest. Fledgling egrets ($n = 25$) were hand-captured opportunistically on four islands at ~7 weeks of age during June-August 2010 (relatedness of fledglings is unknown). In Florida, we captured adult egrets during the nonbreeding season (October–February) of 2009-2010 ($n = 6$) and during the breeding season of July 2010 ($n = 1$). Hatch-year egrets (~5-10 months of age) were also captured ($n = 3$) in July and November. All egrets in Florida were captured at foraging areas using a flip trap (Herring *et al.* 2008) ($n = 8$) or net launcher ($n = 2$). We measured the central culmen (mm) from the intersection of skin and premaxilla to the tip of bill nail, tarsus length (mm) from proximal to lateral condyles of the metatarsus, and mass (g). We took blood or feather samples (Texas: $n = 33$; Florida: $n = 10$) to determine sex. We also collected carcasses of Reddish Egrets in Texas ($n = 6$) that had been marked and died during the study. We did not collect blood or feathers from these birds at the time of capture; therefore, we used toe pads and bone to determine sex.

We used a Puregene DNA Purification Kit (Qiagen) body fluid protocol to extract DNA from blood samples and solid tissue protocol to extract DNA from toe pads and bones. We conducted polymerase chain reactions (PCR) using the WZ-common, W-specific, and P8 primers for amplification (Wang *et al.* 2011). PCR was conducted using an Applied Biosystems 2720 Thermal Cycler following the protocol of Wang *et al.* (2011) with the first step of denaturation running for 10 min instead of 5 min. The PCR product was placed in an Applied Biosystems 3130xl Genetic Analyzer for genotyping. Feather samples used to determine sex were processed following the methods of Fridolfsson and Ellegren (1999), with sample volumes of 50 µl to accommodate the thermocycler used for DNA amplification (Hill 2009).

We were able to determine sex of all hatch-year egrets from Texas and of all Florida egrets. We were unable to determine sex of 15 adults captured in Texas due to the lack of DNA samples. Consequently, we used a discriminant analysis (PROC DISCRIM) in SAS (SAS Institute, Inc. 2008) to determine sex based on data for 10 known-sex egrets (the remaining five samples were used as controls) and to report the probability of correctly assigning sex for the unknown individuals. We used mass, tarsus length, and culmen length for comparisons between sexes and ages, as these parameters were recorded for all egrets captured. We tested mass, tarsus length, and culmen length for normality using the Shapiro-Wilk test. We tested for differences between sex and age classes using Welch's two sample *t*-tests in statistical program R (R Development Core Team 2014) and considered differences significant if $P \leq 0.05$.

RESULTS

The discriminant analysis correctly identified 90% of known-sex adult egrets from Texas ($n = 10$) using mass, tarsus length, and culmen length in the model. Of the 15 adults from Texas for which sex was unknown, the probability of correctly assigning sex was > 94% for nine birds; 88% for three birds; and 73%, 69%, and 53%, respectively, for the remaining three birds. The three lowest probabilities were assigned female.

All parameters were normally distributed for adult egrets (mass: W = 0.97, $P = 0.47$; tarsus length: W = 0.98, $P = 0.72$; culmen length: W = 0.98, $P = 0.59$). Adults (pooled across sex) were similar in all parameters when compared by location. Adult males had larger mean values for all three parameters compared to adult females (Table 1). On average, adult males were 17% heavier than adult females ($t_{31.9} = -6.14$, $P < 0.001$), had 8% longer tarsi than females ($t_{33.97}$ =

Table 1. Mean (± SD) and range of measurements of adult and hatch-year Reddish Egrets that were captured in Texas and Florida from 2010 to 2014. Additional data summarized based on individual measurements from the Florida Museum of Natural History (MNH; Lowther and Paul 2002); body mass was pooled across six males and one female of unreported ages.

	n	Mass (g)	Range	*n*	Tarsus (mm)	Range	*n*	Culmen (mm)	Range
Adult									
Male	17	924 (69)	782-1,025*	17	145.5 (6.0)	138.5-160.0	17	100.2 (4.0)	94.6-110.7
Female	19	790 (60)	680-910	19	134.8 (6.5)	118.4-145.4	19	94.2 (3.5)	86.6-98.8
Hatch-year									
Male	21	839 (118)	560-1,025*	21	140.9 (7.3)	125.0-150.6	21	86.6 (5.2)	73.5-95.1
Female	7	687 (165)	360-900	7	134.5 (8.0)	123.9-145.0	7	86.7 (5.4)	79.9-94.0
Florida MNH									
Male	6	614 (161)	364-869	21	137.3 (6.2)	127.3-147.4	21	94.7 (4.8)	77.2-92.0
Female	1	—	—	29	125.0 (4.5)	117.3-132.6	27	80.3 (3.2)	73.2-86.6

*One adult and two hatch-year birds were > 1,000 g and were recorded as 1,025 g for analysis.

-5.14, $P < 0.001$), and had 6% longer culmens than females ($t_{32.18} = -4.82$, $P < 0.001$).

All parameters were normally distributed for hatch-year egrets (mass: W = 0.94, P = 0.14; tarsus length: W = 0.94, P = 0.09; culmen length: W = 0.93, P = 0.07). Hatch-year egrets were similar to adults (pooled across sex) in mass ($t_{43.68} = 1.68$, $P = 0.10$) and tarsus length ($t_{59.33} = 0.28$, $P = 0.78$), but had 13% shorter culmens ($t_{56.06} = 8.30$, $P < 0.001$).

Hatch-year male egrets were significantly smaller than adult males in all parameters (mass: $t_{33.17} = 2.77$, $P = 0.009$; tarsus length: $t_{35.99} = 2.13$, $P = 0.04$; culmen length: $t_{35.91} = 9.18$, $P < 0.001$). Hatch-year female egrets were similar to adult females in mass and tarsus length, but had 9% shorter culmens than adults ($t_{7.96} = 3.43$, $P = 0.009$). Hatch-year males were similar to hatch-year females in culmen length and tarsus length (although tarsus length was approaching significance, $P = 0.09$), and were heavier than females ($t_{8.15} = -2.25$, $P = 0.05$).

DISCUSSION

Our results show that adult male Reddish Egrets are larger than adult females, which is common in other heron species; male Great Egrets (*Ardea alba*) have longer culmens and tarsi and are heavier than females (McCrimmon *et al.* 2011), and male Tricolored Herons (*E. tricolor*) are generally larger than females (Frederick 2013). Male Great Blue Herons (*A. herodias*) also have longer culmens and tarsi and are heavier than females, and adults are heavier than juveniles (Vennesland and Butler 2011). The average mass of hatch-year female Reddish Egrets indicated that they were lighter than hatch-year males, but individuals not yet fully grown could have skewed our mass estimates as evidenced by Erwin *et al.* (1996), who found relatively large daily increases in chick mass in other species. One hatch-year female in our study weighed 360 g, the lightest recorded, and may have been younger than the others. When this individual was excluded from the calculation, the average mass of hatch-year females was 817 g, which is only slightly lighter than hatch-year males and similar to adult females. There were no differences in size between Texas and Florida egrets; however, the sample of Florida birds was much smaller. This could potentially be seen as a similarity in body size between breeding and nonbreeding adults, although a larger sample of nonbreeding egrets would provide a better comparison of seasonal differences.

On average, our measurements of tarsus length and culmen length were greater than those reported by Lowther and Paul (2002) from museum specimens of Reddish Egrets. Average mass was 51% greater for adult males and 29% greater for adult females than reported by Lowther and Paul (2002). Additionally, the average mass reported by Lowther and Paul (2002) was > 10% lower than the lightest adult individual of either sex from our sample. The results from Lowther and Paul (2002) were pooled across age groups, which likely produced low-biased estimates since the sample included an unknown proportion of young birds. The measurements from Lowther and Paul (2002) were previously the only published body mass estimates for Reddish Egrets. We used this information to determine the appropriate satellite transmitter package to comply with the ≤ 3% of body mass rule, which states that the weight of the transmitter should not be > 3% of the body mass of the study species (White and Garrott 1990). Consequently, we could have chosen the same Solar-GPS PPT that we used on the adult Reddish Egrets for use on hatch-year egrets, which would have provided much more accurate location data over a longer time period.

Along with transmitter selection, having accurate measurements allowed us to use a discriminant analysis to determine sex fairly accurately. This methodology could reduce handling time and stress to birds, and also reduce the cost associated with conducting genetic analyses. The practical use of accurate body measurements is clear; however, these measurements also are useful for a holistic understanding of the natural history traits of the species. Body size underlies many ecological hypotheses and can aid in interpreting such things as behavior, survival, and migratory strategies. A study conducted by van der Winden *et al.* (2010) illustrates these points; the authors hypothesized that the large-bodied Purple Heron (*A. purpurea*) would make multiple stopovers during migration from the Netherlands to Africa, yet satellite telemetry revealed that very few stops were made. These results stressed the importance of quality habitat at departure sites in the Netherlands and arrival sites in Africa (van der Winden *et al.* 2010). Reddish Egrets are thought to be weakly migratory (Lowther and Paul 2002; B. M. Ballard, unpubl. data); knowledge of sex and body size will aid in interpreting the migratory strategy exhibited by Reddish Egrets and will be useful in examining survival throughout the annual cycle. Our results provide updated information on the body size of adult and hatch-year Reddish Egrets, thus contributing to the limited knowledge base for this species.

ACKNOWLEDGMENTS

Funding for this project was provided by the U.S. Fish and Wildlife Service Regions 2 and 4 Non-game Migratory Bird Programs, National Fish and Wildlife Foundation, and the Walter Fondren III Fellowship in Shorebird and Wading Bird Research at the Caesar Kleberg Wildlife Research Institute. In Florida, funding was provided by the U.S. Fish and Wildlife Service, the Florida Keys National Wildlife Refuges (FKNWR), The International Osprey Foundation, Sanibel-Captiva Audubon Society, Friends and Volunteers of the Florida Keys Refuges, and Florida Keys Audubon Society. Tom Wilmers (FKNWR) provided valuable logistic support; and Amanda Powell, Marjesca Brown, Brehan Furfey, Mark Westall, Marvin Friel, John Simon, and Andy Day assisted in the field. We also thank two anonymous reviewers for their constructive comments. Trapping was conducted under U.S. Geological Survey banding permits 21314, 23546, and 22689, and TAMUK IACUC #2013-05-23. This is manuscript #15-104 of the Caesar Kleberg Wildlife Research Institute.

LITERATURE CITED

Bent, A. C. 1926. Life histories of North American marsh birds. U.S. National Museum Bulletin 135, Smithsonian Institute, Washington, D.C.

Erwin, R. M., J. G. Haig, D. B. Scotts and J. S. Hatfield. 1996. Reproductive success, growth and survival of Black-Crowned Night Heron (*Nycticorax nycticorax*) and Snowy Egret (*Egretta thula*) chicks in coastal Virginia. Auk 113: 119-130.

Frederick, P. C. 2013. Tricolored Heron (*Egretta tricolor*). No. 306 *in* The Birds of North America Online (A. Poole, Ed.). Cornell Lab of Ornithology, Ithaca, New York. http://bna.birds.cornell.edu/bna/species/306, accessed 31 March 2015.

Fridolfsson, A. and H. Ellegren. 1999. A simple and universal method for molecular sexing of non-ratite birds. Journal of Avian Biology 30: 116-121.

Green, M. C. 2006. Status report and survey recommendations on the Reddish Egret (*Egretta rufescens*). Unpublished report, U.S. Department of the Interior, Fish and Wildlife Service, Atlanta, Georgia.

Herring, G., D. E. Gawlik and J. M. Beerens. 2008. Evaluating two new methods for capturing large wetland birds. Journal of Field Ornithology 79: 102-110.

Hill, A. H. 2009. Molecular genetic assessment of population structure, paternity, and sex ratios for the reddish egret. M.S. Thesis, Texas State University, San Marcos.

International Union for Conservation of Nature (IUCN). 2014. The IUCN red list of threatened species, v. 2014.3. BirdLife International, Gland, Switzerland. http://www.iucnredlist.org, accessed 31 March 2015.

Lowther, P. E. and R. T. Paul. 2002. Reddish Egret (*Egretta rufescens*). No. 633 *in* The Birds of North America Online (A. Poole, Ed.). Cornell Lab of Ornithology, Ithaca, New York. http://bna.birds.cornell.edu/bna/species/633, accessed 31 March 2015.

McCrimmon, D. A., Jr., J. C. Ogden and G. T. Bancroft. 2011. Great Egret (*Ardea alba*). No. 570 *in* The Birds of North America Online (A. Poole, Ed.). Cornell Lab of Ornithology, Ithaca, New York. http://bna.birds.cornell.edu/bna/species/570, accessed 31 March 2015.

Paul, R. T. 1991. Status report: *Egretta rufescens* (GMELIN) Reddish Egret. Unpublished report, U.S. Department of the Interior, Fish and Wildlife Service, Houston, Texas.

R Development Core Team. 2014. R: a language and environment for statistical computing v. 3.1.2. R Foundation for Statistical Computing, Vienna, Austria. http://www.R-project.org, accessed 5 December 2014.

SAS Institute, Inc. 2008. SAS statistical software v. 9.2. SAS Institute, Inc., Cary, North Carolina.

van der Winden, J., M. J. M. Poot and P. W. van Horssen. 2010. Large birds can migrate fast: the post-breeding flight of the Purple Heron *Ardea purpurea* to the Sahel. Ardea 98: 395-402.

Vennesland, R. G. and R. W. Butler. 2011. Great Blue Heron (*Ardea herodias*). No. 025 *in* The Birds of North America Online (A. Poole, Ed.). Cornell Lab of Ornithology, Ithaca, New York. http://bna.birds.cornell.edu/bna/species/025, accessed 31 March 2015.

Wang, Z., X. Zhou, Q. Lin, W. Fang and X. Chen. 2011. New primers for sex identification in the Chinese Egret and other ardeid species. Molecular Ecology Resources 11: 176-179.

White, G. and R. Garrott. 1990. Analysis of wildlife radio-tracking data. Academic Press, San Diego, California.

Wilson, T. E., J. Wheeler, M. C. Green and E. Palacios (Eds.). 2012. Reddish Egret conservation action plan. Unpublished report, Reddish Egret Conservation Planning Workshop, Corpus Christi, Texas.