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Cover photo: Typical Reddish Egret (*Egretta rufescens*) nest in prickly-pear (*Opuntia spp.*) on Zigzag Island in the Laguna Madre, Texas. Photo by M. Clay Green

Frontispiece. All-white morph and dark-plumaged morph of Reddish Egret. "Pied" plumage (i.e. dark morph individual with varying amounts of white plumage) not shown. Art by Lynn Delvin.

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PLUMAGE DIMORPHISM AND NEST SITE SELECTION OF REDDISH EGRETS (*EGRETTA RUFESCENS*) IN THE LAGUNA MADRE, TEXAS.

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ABSTRACT.—The Reddish Egret (*Egretta rufescens*) is a rare waterbird that exhibits plumage polymorphism across its range. Differences in plumage coloration between individuals have been hypothesized to affect avian sociality and behavior. The objectives of this study were to determine if Reddish Egrets select specific nesting habitats within colony islands and if morphs spatially distribute themselves differently in relation to one another. Furthermore, we compared nesting habitats between islands and color morphs to detect possible differences in microhabitat site selection in Reddish Egrets. Reddish Egrets selected *Opuntia* spp. prickly-pear cacti, when available, for nest sites over other available sites. We found no differences in selection of nest site microhabitat between the two morphs. Although Reddish Egrets nested on a variety of substrates, they appear to select substrates that provide dense vegetation, presumably for thermal cover or protection from predators. Spatial analysis of nearest neighbor from each nest revealed that white morphs were closer to each other than would have been predicted by random chance; the density of each color morph at colony sites was included in our analysis. Dark morph individuals were not more closely associated with one another although on one island, dark morphs were closely associated with white morphs. Our research supports previous studies that found that white morphs in the Family Ardeidae oriented themselves more closely in proximity to one another than darker ardeids. Birds typically choose nest sites based on habitat characteristics that confer specific advantages including access to resources, thermal cover and protection from predators (Clark et al. 1983; Fasola and Alieri 1992). In theory, sites more favorable for reproductive success should be selected first; however intraspecific and interspecific competition for access to nesting sites may affect nest site selection (Minot and Perrins 1986, Loukola et al. 2012). In birds that nest in social aggregations (i.e. colonies), sites may be chosen for a variety of factors that facilitate coloniality in birds including protection from predators (Brown and Brown 1987), information center hypothesis (Ward and Zahavi 1973), and social attraction (Danchin and Wagner 1997, Danchin et al. 1998). Within given colonies, nest site selection by individuals also occurs, and individuals are often spatially or temporally separated from one another.

While coloniality in birds has been studied extensively (Wittenberger and Hunt 1985, Danchin and Wagner 1997, Danchin et al 1998), fewer studies have investigated nest site selection, both inter- and intra-specifically, within colonies. In gulls and terns, competition for nest sites can be

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intense and selection of a specific nest site may be a trade-off between benefits and costs associated with any given site (Coulson 1968). Within the family Ardeidae (herons and egrets), stratification of nesting substrate by different species has been observed (Bertolino and Gola 2008, Kim and Koo 2009) and nest site selection can directly affect reproductive success (Hilaluddin et al 2003).

Within Ardeidae, the Reddish Egret (*Egretta rufescens*) is a plumage-dimorphic species that generally nests in mixed-species colonies on a variety of sites and nesting substrates (Lowther and Paul 2002). Reddish Egrets are typically all-white morph or dark-plumaged morph, neither morph sex-specific with some individuals exhibiting "pied" plumage (i.e. dark morph individual with varying amounts of white plumage). Studies of nest site selection in Reddish Egrets are necessary to better understand the factors that potentially influence nest site selection by individuals within colonies. Furthermore, investigations into potential differences in nest site selection between color morphs of the Reddish Egrets may provide new insights into the adaptive significance of plumage dimorphism.

Nest site selection by Reddish Egrets may be influenced primarily by habitat variables that equally affect reproductive success, positively (or negatively), for both color morphs. However, studies on color polymorphism in birds suggest potential nest selection differences between color morphs (see review in Roulin 2004). Birds of the same-color morph would be expected to have similar advantages and disadvantages. Evidence suggests that white-plumaged birds are more conspicuous (Green and Leberg 2005) and therefore may be more readily detected by predators due to their conspicuous plumage (Caldwell 1986). If nest site selection is influenced by predation, less cryptic white morph Reddish Egrets should nest in close proximity to one another to enhance predator detection through shared vigilance (Pulliam 1973). If shared vigilance is occurring, the distance between white morph Reddish Egret nests within a colony should be closer to one another than dark morph Reddish Egret nests. Dark morph individuals, as the less conspicuous morph, would not expect to be closely associated with one another.

However other variables besides protection from predators may result in differential nest site selection between white and dark morph Reddish Egrets. White plumage may confer a thermal advantage in the warm sub-tropical climes that Reddish Egrets inhabit as thermal stress has been shown to affect nesting adult success and chick mortality (Ellis 1980). Dark plumage birds are presumably more prone to thermal stress and would therefore confer more of a disadvantage at nest sites without thermal cover (e.g. vegetative canopy) that do not minimize direct solar radiation during the hottest parts of the day. Conversely, white plumaged Reddish Egrets may be less constrained by thermal stress and can use open areas as nesting sites that have less cover and higher direct solar radiation.

Finally, if nest site selection in Reddish Egrets is most influenced by assortative mating, both color morphs would be expected to spatially or temporally segregate at colonies. A concurrent study on Reddish Egrets demonstrated no temporal isolation between color morphs; Reddish Egrets exhibited no difference in nest initiation between white and dark morphs (Holderby et al. 2012). If spatial segregation is occurring to maximize assortative mating, same-colored morphs individuals would be expected to nest closer to one another as courtship and mating in Ardeidae occurs at the nesting colony (Lowther and Paul 2002).

The objectives of this study were to determine if Reddish Egrets select nesting habitat non-randomly within colonies and if color morphs differentially distribute themselves in relation to one another at colonies. Furthermore, we examined nesting habitat between colonies and color morphs (compared with random points) to determine the occurrence of microhabitat differences in cover; Reddish Egret color morphs may select differing cover types within colonies based on environmental effects on plumage coloration and/or the social facilitation of plumage coloration. Conversely, Reddish Egrets may select cover types for nest site selection based on nesting substrate properties that are not related to plumage coloration differences (e.g. cover provides protection from predators). Based on the null model, we hypothesized that Reddish Egrets would randomly select nest sites across a given colony and that nearest-neighbor distances within and between color morphs would not be significantly different.

METHODS

We conducted our study on two nesting colonies, Zigzag Island and Rabbit Island, in the upper Laguna Madre of Texas near Corpus Christi (27°46' N, 97° 30' W) during 2007-2008 nesting seasons.

Dark and white morph Reddish Egret nests were monitored during the breeding season; brood coloration was determined by nestling plumage coloration within two weeks of hatching. We used handheld GPS units (Garmin Inc.) to mark coordinates (Universe Transverse Mercator-UTM) of nests and to circumscribe habitat patches on each nesting colony. We used Digital Orthoquads (DOQQs) maps (1 m resolution), downloaded from the Texas Natural Resources Information System website (www.tnris.state.tx.us), as baselayer imagery with GPS points of monitored nests and habitat patches overlaid on the DOQQ raster file. We compared infrared vegetation imagery with plotted habitat patches for ground-truthing. Hawth's Tools in ArcGIS (ESRI, Redlands, CA; Beyer 2004) was used to randomly generate points within island and habitat patch polygons. The frequency of random points that fell within patches was compared to the frequency of nest points that fell within patches. A chi-squared test (Zar 1996) was conducted to compare observed frequencies inside and outside of designated patches to frequencies of random points inside and outside of designated patches.

Microhabitat measurements were collected using line intercept to determine cover percentages. Vegetation classes were defined as 1) tall (> 40cm) prickly pear cactus *Opuntia sp.*, 2) low (< 40cm) prickly pear cactus *Opuntia sp.*, 3) sea-oxeye *Borrichia sp.*, 4) tall (> 20cm) grass, 5) low (< 20cm) grass, 6) bare ground, 7) low vegetation (evergreen, prostrate vegetation), 8) annuals, 9) shrubs, and 10) trees (generally honey mesquite *Prosopis glandulosa*). Each sample plot consisted of two perpendicular 10-m tapes that intersect at five meters at the location of the nest or random point. Orientation of sample plot was predetermined using bearings assigned by the random number generator in Microsoft Excel©. Percent of each cover type that intercepted the measuring tape was recorded for each meter along each axis of a sample plot. Nest number and morph was recorded for each sample plot as well. The Principle Components Analysis (PCA) function in R version 2.5.1© (R Development Core Team 2008) was used to discern general differences in cover composition between sites and morphs. The correlation matrix was used in conducting the PCA.

Because Reddish Egret color morphs nest in disproportionate numbers at each colony (i.e. more dark morph individuals than white morph individuals), comparisons of nearest-neighbor distances between morphs might be biased as based solely on random chance. A nest is more likely to be closest to a dark morph nest if dark morph nests are more numerous than white morph nests. To account for this bias, we used the Spatial Analyst extension in ArcGIS to generate expected null distances for each morph and patch. These nulls were based on randomized points equivalent to the number of birds within a patch or colony. Mean random distances were then generated between these points. A paired t-test was used to evaluate these mean distances to determine if spacing between a nest and nearest neighbor's nest were different than what would be predicted by chance alone (Zar 1996, Green and Leberg 2006).

RESULTS

We monitored 111 nests (Zigzag Island, n = 53, dark morph = 23, white morph = 30; Rabbit Island, n = 58, dark morph = 40, white morph = 18) during the breeding season with a total of 63 dark and 48 white morph nests. Due to logistical constraints, the vegetative analysis was conducted on a subset of 94 total nests. As Reddish Egrets appeared to nest disproportionately more in prickly-pear (*Opuntia engelmannii*) than in other vegetative cover, we compared the presence of observed nests inside versus outside prickly pear patches to that of randomly sampled points on each colony. Pearson's Chi-squared test with Yates' continuity correction revealed that a larger proportion of nests were found within cactus patches than what would be expected if Reddish Egret selected nest sites proportional to habitat availability within a colony (Nests within:outside cacti patches = 83:11; Randomly generated "nests" within:outside cacti patches = 13:81; $\chi^2 = 101.34$, df = 1, $P < 0.001$).

We considered cover < 1 m from Reddish Egret nests to be "nesting cover". Principal component analysis included ten vegetation variables (described above) as input data, and demonstrated differences between sites (Table 1, Fig. 1). Within one meter of nests, Tall Opuntia and Low Vegetation contributed the greatest to Principal Component 1 (PC 1). Short Opuntia, Shrubs and Borrichia were the important factors in PC 2. The first two components constitute 33% of the variance between sites. Rabbit Island nests seemed to have higher scores associated with low vegetation compared to random points along PC 1 (Fig 2a). On Zigzag Island, the

Table 1. Loadings of vegetation variables on the first two principal components and the proportion of variance explained by each component. Vegetation data collected from Zigzag and Rabbit Island in the Laguna Madre, Texas during 2007-2008. Bold-faced loadings >0.40 were used as axes labels in Figure 4 and Figure 5.

	NESTING COVER		PERIPHERAL COVER	
	PC 1	PC 2	PC 1	PC 2
Tall Opuntia	**0.552**	-0.154	-0.371	-0.131
Short Opuntia	0.359	**0.414**	**-0.548**	0.093
Borrichia	-0.16	-0.453	0.11	**-0.583**
Tall Grass	0.373	-0.166	-0.324	-0.036
Short Grass	-0.097	-0.31	0.091	**-0.563**
Bareground	-0.127	0.087	0.026	0.189
Low Vegetation	**-0.556**	0.226	**0.468**	**0.46**
Annuals	0.232	0.137	-0.225	0.045
Shrubs	-0.036	**0.598**	-0.294	0.212
Trees	0.113	0.201	-0.282	0.148
Variance Explained (%)	**0.18**	**0.15**	0.23	0.14

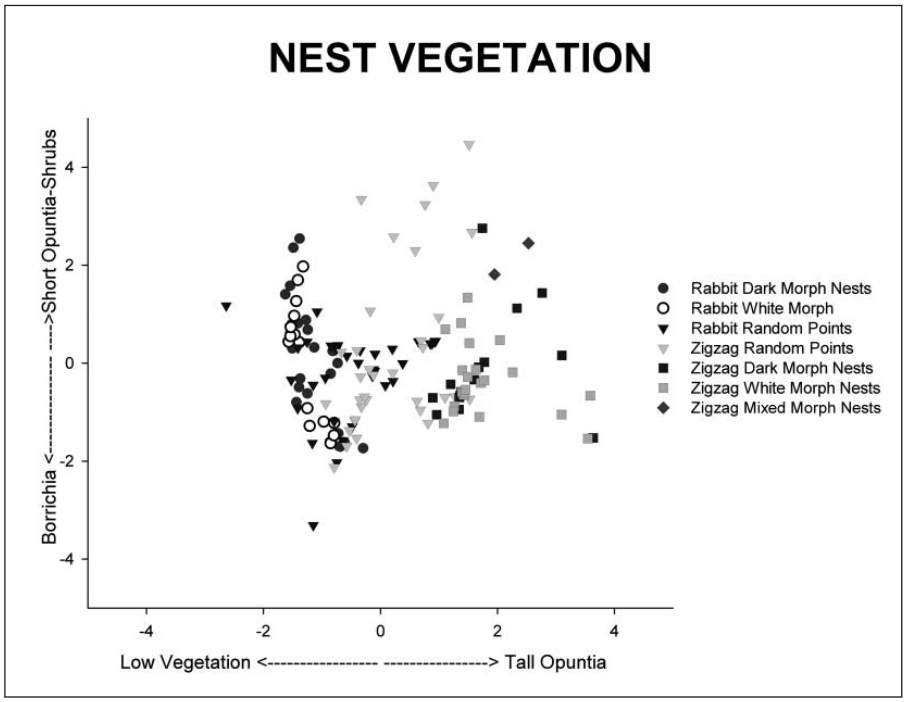

Figure 1. PCA scatter plot comparing nest vegetative characteristics from Zigzag and Rabbit Island in the Laguna Madre, Texas. Vegetative characteristics are within 1 m of nest between color morphs and colonies. Axes represent Eigenvalues with labels referring to highest loading scores.

Figure 2a. Typical Reddish Egret (*Egretta rufescens*) nest in Sea Oxeye (*Borrichia frutescens*) on Rabbit Island.

Figure 2b. Typical Reddish Egret (*Egretta rufescens*) nest in prickly-pear (*Opuntia* spp.) on Zigzag Island in the Laguna Madre, Texas.

selection of cactus patches was detected with nests having higher values in PC 1, which is associated with percent cover of *Opuntia englemannii*, than random points (Fig 2b). Variation in nesting habitat between morphs within each colony was not apparent from this analysis. Mixed morph nests (i.e. nests with dark and white morph chicks) may have separated from other nests in nest vegetation cover, however sample size was very low (n = 2). Cover between 1 – 10 m from Reddish Egret nests, termed "peripheral cover", was also measured and compared. Principal component analysis included the same ten vegetation variables used in the nesting cover analysis and correlated to differences between sites (Table 1, Fig. 3). Greater than 1 m from nests, Opuntia and Low Vegetation accounted for most of PC 1. Short Grass and Borrichia were the important factors in PC 2. The first two components constitute 37% of the variance between sites. Similar to

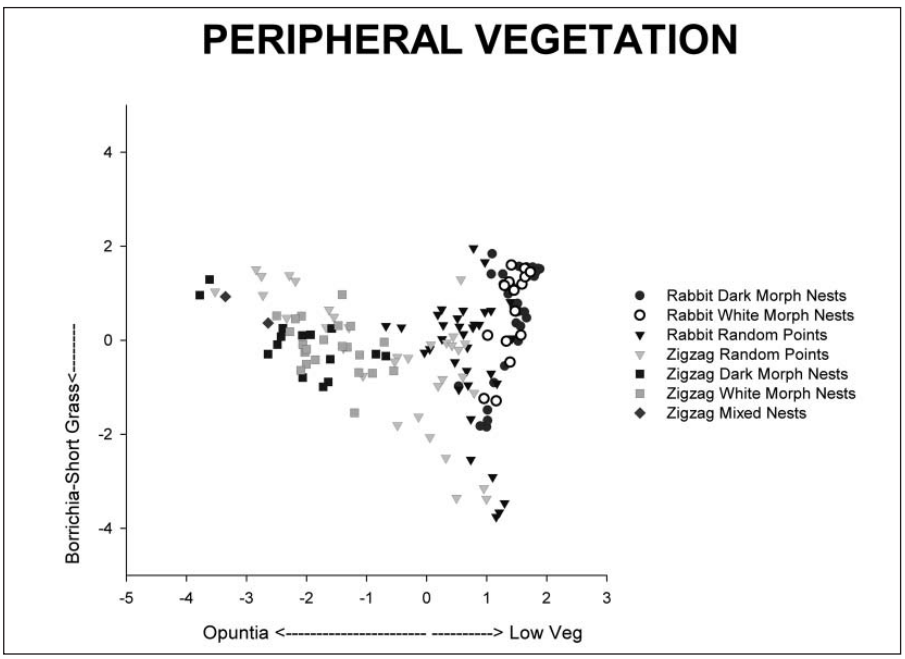

Figure 3. PCA scatter plot comparing peripheral vegetative characteristics from Zigzag and Rabbit Island in the Laguna Madre, Texas. Vegetative characteristics are within 10 m radius of nest between morph and colonies. Axes represent Eigenvalues with labels referring to highest loading scores.

nesting cover PCA, the selection of cactus patches was detected with nest scores having higher values for PC 1, which is associated with percent cover of *Opuntia englemannii*, than random points. Rabbit Island nests seemed to have higher scores associated with low vegetation in the nest periphery compared with random points.

We examined nearest neighbor distances differently between Zigzag Island and Rabbit Island as our results demonstrated disproportionate use of prickly-pear patches on Zigzag Island. For Zigzag Island, we analyzed nearest neighbor distances within defined prickly-pear patches whereas on Rabbit Island we analyzed nearest neighbor distances across the entire colony. At both colonies, spatial analysis revealed that white morphs were closer to other white morphs than what would be expected given their density at both sites (Zigzag: $t = -3.28$, $df = 51$, $P = 0.002$; Rabbit: $t = -2.06$, $df = 32$, $P = 0.047$; Fig. 4). For dark color morph spacing, our results revealed that there was not a significant difference in distance between observed dark morph nests and that which would be expected if the nests were randomly distributed (Zigzag: $t = 0.65$, $df = 36$, $P = 0.519$; Rabbit: $t = -0.85$, $df = 75$, $P = 0.400$). Examination of nearest neighbor distances between dissimilar morphs (e.g. dark morph nest to nearest white morph neighbor) revealed differing results with both white and dark morph Reddish Egrets more closely associated with each other than expected by random chance on Zigzag Island ($t = -1.75$, $df = 43$, $P = 0.008$; $t = -2.81$, $df = 50$, $P = 0.007$; Fig. 5). On Rabbit Island, dark and white morph Reddish Egrets were not more closely associated than expected ($t = -1.59$, $df = 77$, $P = 0.117$; $t = -0.64$, $df = 31$, $P = 0.527$).

DISCUSSION

Although Reddish Egrets nest on a variety of substrates (Lowther and Paul 2002, Green et al 2011, Holderby et al. 2012), Reddish Egrets disproportionately selected prickly-pear as nesting habitat when available (i.e. on Zigzag island),

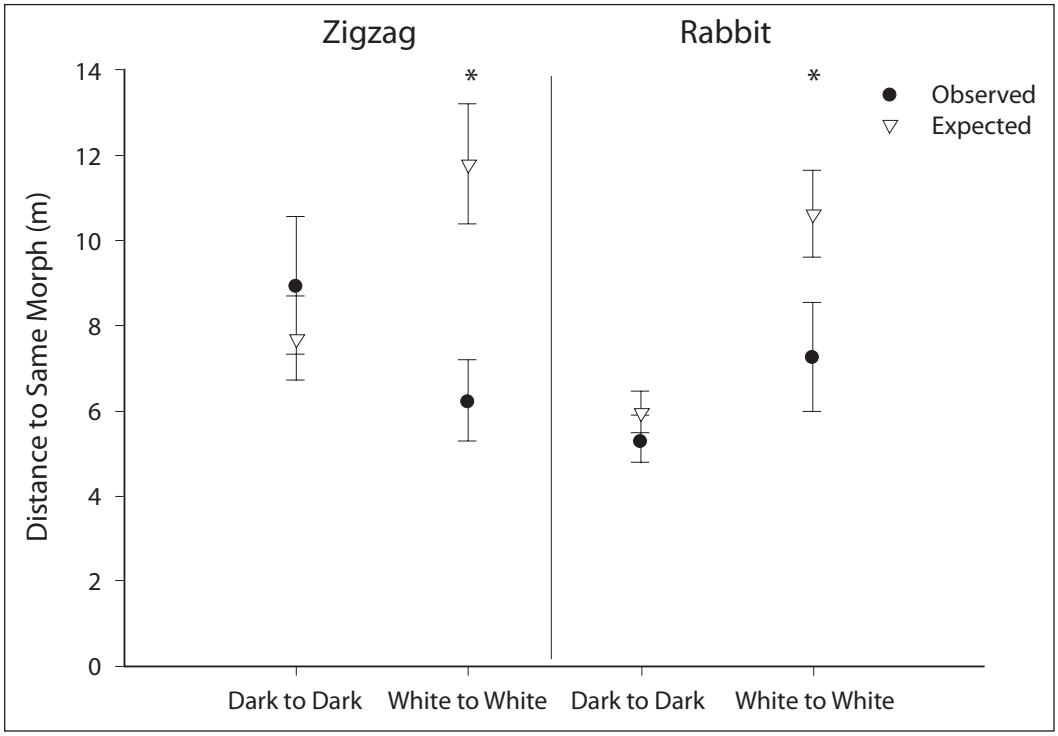

Figure 4. Comparison of observed same morph nest distances to random points within cactus patches at Zigzag Island and without cactus patches at Rabbit Island. Site 1: Zigzag Island, ($n = 23$, $n = 30$); Site 2: Rabbit Island ($n = 40$, $n = 18$). Black circles are observed mean distance and hollow triangles are randomly-generated distance between like-morphs; bars represent ± 1 SE.

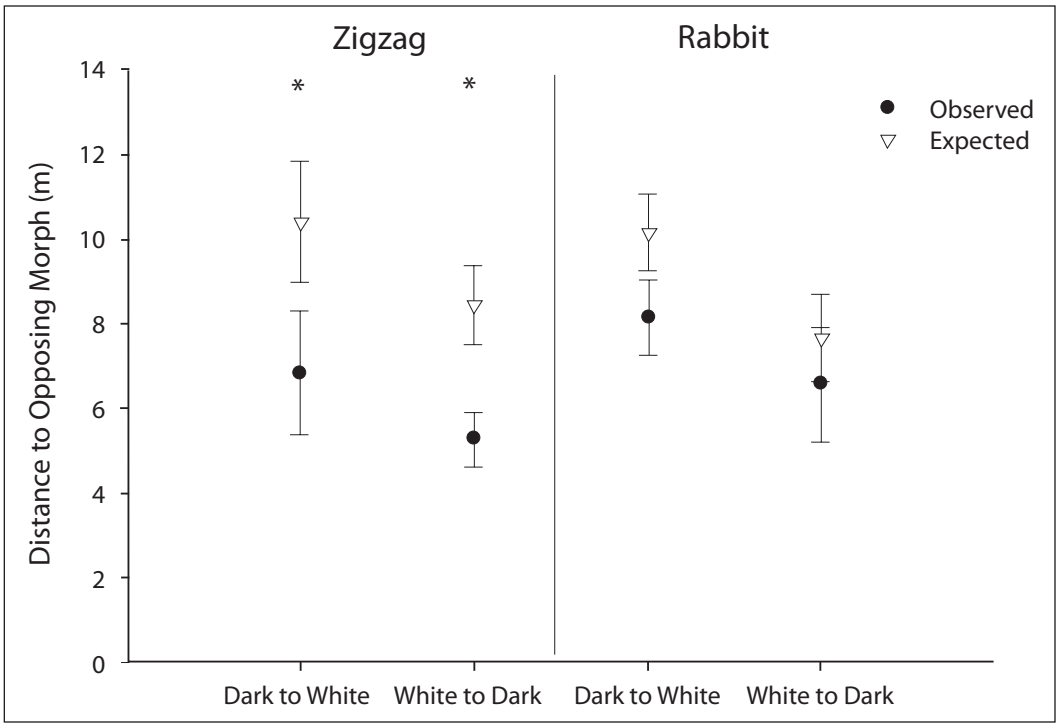

Figure 5. Comparison of observed opposing morph nest distances to random points within cactus patches at Zigzag Island and without cactus patches at Rabbit Island. Site 1: Zigzag Island, (n = 23, n = 30); Site 2: Rabbit Island (n = 40, n = 18). Black circles are observed mean distance and hollow triangles are randomly-generated distance between opposing morphs; bars represent ±1 SE.

presumably for benefits associated with dense cover. When prickly-pear was not available, Reddish Egrets still appeared to select nest sites with dense vegetative cover (e.g. *Borrichia*) but it is unclear if this vegetation provides the same cover benefits of prickly-pear cacti. Our PCA results also suggested factors influencing Reddish Egret nest site choice may be related to sites that have dense, spiny and thorny vegetation or vegetation that can conceal nests. Presumably, dense vegetative cover limits nest accessibility by predators (or human disturbance) and reduces thermal stress on the eggs and chicks. Zigzag Island is closer to urban areas (i.e. Corpus Christi, TX) and has been affected more frequently by mammalian predators than Rabbit Island (D. Newstead, pers. comm.); prickly-pear patches may provide some protection from mammalian predators although this has not been directly tested.

PCA analyses indicated that while differences in microhabitat selection were apparent between the two colonies and within each colony between random points and nest sites, there were no differences in microhabitat selection between morphs. Reddish Egrets are selecting certain cover types for nesting although the two morphs are not selecting these characteristics differently. Still, different plumaged individuals varied in nest site selection in relation to one another (i.e. their nearest neighbor). Our research demonstrated that within our study colonies, white morphs tended to nest near another white morph while dark morph Reddish Egrets did not exhibit preference towards nesting near same morph individual.

A comparison between colonies reveals that Reddish Egrets varied their distribution within a colony based on their nearest neighbor. On Zigzag Island, Reddish Egrets disproportionately selected prickly-pear cacti and within these patches, both dark and white morphs nested in closer association with white morph nests. In contrast on Rabbit Island, dark morphs tended to randomly distribute themselves in relation to one another while white morphs strongly associated with one another.

Having a like-morph neighbor close by may be important in communication of vital information within a colony (Ward and Zahavi 1973). However, we only found white morph individuals as likely neighbors for other individuals to nest near. White plumage, presumably conspicuous, has been shown to facilitate intraspecific and inter-specific communication (Kushlan 1977, Beauchamp and Heeb 2001, Green and Leberg 2005, 2006). Since there are no differences in nesting phenology between color morphs (Holderby et al. 2012), white plumage may serve as social cue that a specific colony or site is inhabited by Reddish Egrets (Green et al. 2011). If morphs are more different than just plumage color (e.g. vary in foraging behavior, Green 2005), information from a conspecific with similar plumage color would be more advantageous. While there are costs associated with coloniality (e.g. disease, cuckoldry), increased density of conspecifics at a colony may increase vigilance and dilute predation risks for each individual while also providing opportunities for information exchange (e.g. foraging areas) and courtship/mating (Wittenburger and Hunt 1985).

The differences in nearest neighbor distances between morphs and between colonies may also be a result of our study design. Since we determined that Reddish Egrets selected prickly-pear over other nesting substrates, our analysis confined to cacti patches on Zigzag Island may have influenced our results (versus nearest neighbor analysis across the entire colony). On Rabbit Island, our analysis was not confined to discrete habitat patches and yet we still found white morphs more closely associated with one another than dark morphs. Though our PCA indicated greater use of *Borrichia*, these features were not examined in our nearest neighbor analysis due to difficulty of clearly delineating a *Borrichia* patch versus delineating prickly-pear patches.

Our study was conducted where both color morphs frequently occur (Holderby et al. 2012). Future studies should be expanded to include additional colonies along the Texas/Mexico coast, especially where prickly-pear and other thorny vegetation (e.g. *Opuntia*, *Borrichia*, *Yucca*, and Taumalipan thorn-scrub) exists to determine if "preference" for cacti as a nesting substrate is consistent across the population. Additionally, this study should be expanded to examine nest site selection across its range, especially given the variation in dark to white morph individuals (Lowther and Paul 2002). Specifically, studies on the population in the Bahamas, which are roughly 80-90% white morph (Bolen and Cottam 1975, Green et al 2011), and in Baja California, where only dark morph individuals have been documented (Howell and Pyle 1997), would be worthwhile to assess whether Reddish Egret nearest neighbor distances vary in relation to variation in the proportion of color morphs. Information on nest densities at various colonies and between morphs, coupled with estimates of reproductive success, would be beneficial for continued management and protection of Reddish Egret colonies as well as provide new insights into the adaptive significance of plumage polymorphism in ardeids.

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ASSESSMENT OF LESSER PRAIRIE-CHICKEN USE OF WILDLIFE WATER GUZZLERS

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Abstract.—Man-made water sources have been used as a management tool for wildlife, especially in arid regions, but the value of these water sources for wildlife populations is not well understood. In particular, the value of water as a conservation tool for Lesser Prairie-Chickens (*Tympanuchus pallidicinctus*) is unknown. However, this is a relevant issue due to a heightened conservation concern for the species and its occupancy of an arid landscape anticipated to experience warmer, drier springs and winters. We assessed if Lesser Prairie-Chickens would use commercially available wildlife water guzzlers and if there was any apparent selection between two design types. We confirmed that Lesser Prairie-Chickens would use bird friendly designed wildlife water guzzlers. Use was primarily during the lekking-nesting period (March–May) and the brood rearing period (June–July) and primarily by males. Although both designs were used, we found significantly greater use of a design that had a wider water trough and ramp built into the tank cover compared to a design that had a longer, narrower trough extending from the tank.

Although we were unable to assess the physiological need of surface water by Lesser Prairie-Chickens, we were able to verify that they will use wildlife water guzzlers to access surface water. If it is found surface water is beneficial for Lesser Prairie-Chickens, game bird friendly designed guzzlers may be a useful conservation tool for the species.

The Lesser Prairie-Chicken (*Tympanuchus pallidicinctus*) is a prairie grouse species endemic to the central and southern Great Plains of North America. It has recently received substantive research and conservation attention due to estimated $>$ 90% decreases in distribution and population size since the 1800's (Taylor and Guthery 1980, Hagen et al. 2004). Primary factors contributing to these declines have been identified as habitat loss, degradation and fragmentation by conversion of native plant communities to cropland, overgrazing, and other factors such as energy development (see U.S. Fish and Wildlife Service 2011 for review). Currently, the species is being considered for federal protection under ESA (U.S. Fish and Wildlife Service 2011). Although the heightened conservation concern has led to substantive research of Lesser Prairie-Chickens, there is a paucity of data on the species' ecology, which has hampered implementation of published management guidelines (Hagen et al. 2004).

Water is an important component of habitat for terrestrial wildlife; when not available in adequate amounts, either freely or through food, water can be a limiting factor to wildlife populations (Leopold 1933). Thus, installation of water sources for wildlife has become a common wildlife management tool in arid regions (Broyles 1995, Krausman et al. 2006). However, the value of these water sources for wildlife populations is not well understood (Broyles 1995) and a review of evidence suggests equivocal results (Rosenstock et al. 1999). Although water availability can influence the distribution and or abundance of some game birds, such as Chukar partridge (*Alectoris chukar*), Mourning (*Zenaida macroura*) and White-winged (*Z. asiatica*) doves, and Wild Turkey (*Meleagris gallopavo*), it is generally thought that succulent vegetation meets the water needs for many game birds (Krausman et al. 2006). However, when available, it is not uncommon for game birds to use water sources (Krausman et al. 2006). Although surface water is not thought to

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be critical for survival of Lesser Prairie-Chickens (Hagen and Giesen 2005), it will be used when it is available (Copelin 1963, Jones 1964, Crawford and Bolen 1973, Crawford 1974). Opinions diverge on the importance of free water and whether man-made water sources may serve as a tool to improve habitat for the species (Hoffman 1963), or present risks such as drowning (Andrew et al. 2001) or increased predation. Regardless, free water use by Lesser Prairie-Chickens is a contemporarily relevant issue due to a lack of information on the subject in context of a heightened conservation concern for the species (U.S. Fish and Wildlife Service 2011). Water availability may become especially relevant due to the potential influences of a changing climate (Grisham et al. 2013). The Southern High Plains is expected to experience warmer, drier springs and winters and changes in spring phenology (IPCC 2007). Thus, Lesser Prairie-Chickens may be exposed to increased temperatures and decreased humidity that would result in a greater moisture need than can be obtained through preformed sources; severe drought can result in Lesser Prairie-Chickens forgoing reproduction or experiencing substantial reproductive failure (Grisham et al. in revision).

Wildlife water guzzlers are tanks designed to collect and store rain water so that it is available to wildlife. Wildlife water guzzlers are manufactured in a variety of configurations for different wildlife species, and can be used as part of state and federal wildlife habitat improvement programs. However, the suitability of wildlife water guzzlers for conservation of Lesser Prairie-Chickens has not been assessed. We investigated the utility of commercially available wildlife water guzzlers serving as a management tool for Lesser Prairie-Chicken conservation. Our goals were to determine if 1) Lesser Prairie-Chickens would use commercially available in-ground wildlife water guzzlers designed for game birds, and 2) if there would be a differential use between the two typical designs of wildlife water guzzlers designed for game birds.

STUDY AREA

Our study was located on a large private ranch in Cochran County, Texas. The area falls within the Southern High Plains, and is topographically flat terrain with intermixed sand dunes. Our study area was dominated by sand shinnery oak (*Quercus havardii*) and sand sagebrush (*Artimisia filifolia*) with grasses such as sand bluestem (*Andropogon gerardii* spp. *hallii*), little bluestem (*Schizachyrium scoparium*), sand dropseed (*Sporobolus cryptandrus*), purple three-awn (*Aristida purpurea*), blue grama (*Bouteloua gracilis*), buffalo grass (*Buchloe dactyloides*), and various forbs (Crawford and Bolen 1976). The dominant soil type was a Brownfield-Trivoli fine sand (Pettit 1979). Cattle grazing and crop production were the primary uses of the study area as well as substantial amounts of oil production. There were few active oil wells located in the study area, but anthropogenic features such as abandoned oil pads, cattle watering areas, and corrals were present. Between January 2010 and October 2013, temperatures in the study area ranged from 43.2° C to -19.4° C; June was the hottest month with a mean maximum temperature of 41.3° C and January was the coldest month with a mean minimum temperature of 12° C. Average annual precipitation for the study area from 2010 through 2013 was 32.47 cm (± 18.9 SD) but varied dramatically among months (Fig. 1). Temperature and precipitation data are from the mesonet station at Sundown, Texas (http://www.mesonet.ttu.edu; last accessed 12 December 2013).

METHODS

Water Guzzler Selection

We selected water guzzlers for this study based on the following criteria. First, we presumed that a guzzler requiring construction or complicated assembly and installation would be less attractive to landowners. Therefore, we considered only water guzzlers that were prefabricated, appeared to be easily installed, and were readily available from suppliers. Second, we wanted to assess water guzzlers that were designed for, but not necessarily exclusive to, upland game bird use. Third, given speculation that Lesser Prairie-Chickens may avoid vertical structures, we only considered units that could be installed below ground so that the top was at or near ($<$ 30 cm) level with the ground surface. Finally, we found among the commercially available wildlife water guzzlers that a primary difference was in the size and dimensions of the trough and ramp by which birds accessed water. Essentially, the reservoir feeds water into a trough with a sloped ramp bottom; birds access the water by walking down the ramp to the water edge. Therefore, our final criterion was to select guzzlers of different

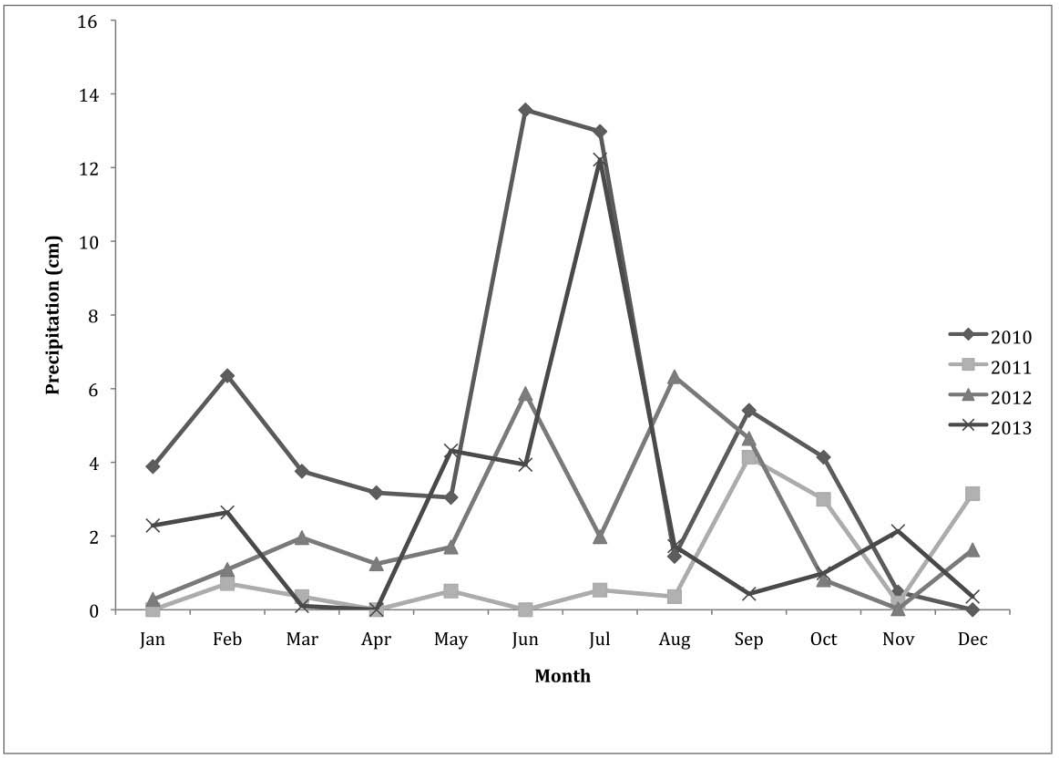

Figure 1. Monthly precipitation for the study area during 2010–2013, Cochran County, Texas.

trough design to assess differences in use by Lesser Prairie-Chickens.

We selected two wildlife water guzzler designs to test. The first was produced by Wildlife Water Guzzlers LCC in Canyon, TX (http://www.wildlife-waterguzzler.com/index.html). The manufacturer's design for upland game birds consists of a circular covered tank with a separate trough attached by a flexible hose (Fig. 2). The tank and trough are constructed of fiberglass and is a dark green color that is of a UV inhibiting pigment. The cover of this model functions as an, albeit small, water collection device in that rainwater is funneled into the reservoir. We selected the 200 gallon (757 liter) model which measures 1.22 m across and 0.61 m deep, with a total surface area of 2.33 m^2. The trough is 1.83 m long, 30.5 cm wide, and has a 19.5 degree slope. Hereafter, we refer to this model as the 'green guzzler'.

The second was produced by Rainmaker Wildlife in Bellingham, WA (http://rainmakerwildlife.com/). The manufacturer's design for upland game birds (i.e., the 'full ramp guzzler') consisted of two pieces; a rectangular 500 gallon (1893 liter) reservoir and a cover with a built in ramp (Fig. 3). The tank measures 2.34 m long, 1.66 m wide and 0.71 m deep. The ramp is 2.21 m long, 1.0 m wide at the ground level end and narrows to 0.74 m wide at the deep end. The ramp is at a 25 degree slope with the deep end being 0.68 m from the cover to the bottom of the trough. The guzzler was constructed of polyethylene and was gray in color using UV inhibitors. The cover of this guzzler does not function as a rain collection device; rather, construction of a rain collection apron would be required unless the tank is manually filled. Hereafter, we refer to this model as the 'gray guzzler'.

In both guzzler types, the ramps were textured to reduce slippage by birds, and the distance that birds walked into the ramped troughs depended on the water volume in the tank; when the tank was full, water reached almost to the end of the troughs.

Water Guzzler Placement

For this study, we selected three leks (hereafter Leks 1, 2, and 3) that did not have an available water source (e.g., spring, stock tank) within 1.5

Figure 2. Installed 757 liter (200 gallon) wildlife water guzzler produced by Wildlife Water Guzzlers LCC in Canyon, TX (http://www.wildlifewaterguzzler.com/index.html).

Figure 3. Installed 1893 liter (500 gallon) wildlife water guzzler produced by Rainmaker Wildlife in Bellingham, WA (http://rainmakerwildlife.com/).

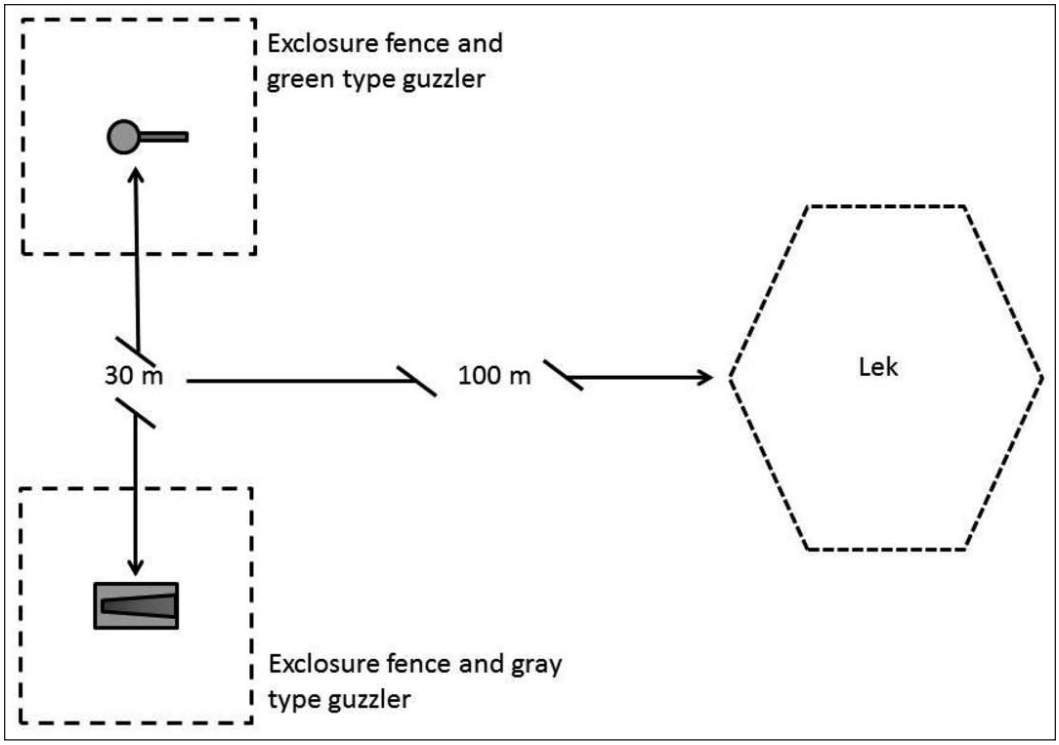

Figure 4. Example arrangement of wildlife water guzzler placement for a study of use by Lesser Prairie-Chickens. Green and Gray type guzzlers are placed within 9.7 m × 9.7 m exclosures and situated 30 m apart and 100 m from the edge of a Lesser Prairie-Chicken lek. Images not drawn to scale. Green Guzzler = manufactured by Wildlife Water Guzzlers LCC in Canyon, TX (http://www.wildlifewaterguzzler.com/index.html); design consists of a circular covered tank with a separate trough attached by a flexible hose; Gray Guzzler = manufactured by Rainmaker Wildlife (http://rainmakerwildlife.com/); the design consisted of a rectangular reservoir and with a ramp built into the cover.

km radius. All three leks were known to have been active display grounds for Lesser Prairie-Chickens in 2011. We installed pairs of each wildlife water guzzler type 30 m apart and at a distance of 100 m from the edge of each of the three leks (Fig. 4). Guzzlers were flush with the ground; this set-up allowed for guzzler types to be equally available to Lesser Prairie-Chickens. We placed fencing around each guzzler to exclude cattle, wild hogs (*Sus scrofa*), and deer (*Odocoileus* spp.); this was to protect guzzler integrity and to more easily maintain sufficient water levels (Fig. 5). All guzzler enclosures were constructed of 4.8 m cattle panels, 2.5 m t-posts, and chicken wire. Cattle panels were sunk 30 centimeters in the ground. The guzzler fence enclosure had one level of cattle panel that reached approximately 1 meter in height. We cut and evenly spaced 20 by 40 cm entrance holes in the cattle panels at ground level. We attached chicken wire fencing above the cattle panel to a height of 1.8 m. Thus, the fence enclosure dimensions were 9.75 m by 9.75 m square, with a height of 1.8 m. All guzzler installation, enclosure construction, and camera installation were completed by 21 December 2011.

We used a 125 gallon tank and gas motor powered water pump seated on a single axle trailer (approximately 1.2 m by 1.5 m) towed by a 450cc Honda Foreman ATV to refill guzzlers. We kept guzzlers filled to at least half capacity by refilling them at least once per month.

Trail Camera Monitoring

We used motion activated cameras with infrared nighttime flash to monitor Lesser Prairie-Chicken use of the guzzlers. Cameras were located inside each enclosure fence and oriented to face the trough of the guzzler. Each captured image was date and time stamped, and we replaced memory cards and batteries as needed. When analyzing the motion-

Figure 5. Exclosure fence constructed around a wildlife water guzzler to exclude large ungulates.

sensing camera pictures, we first wrote down the lek number and guzzler type, and the dates for which data were recorded on the data disk. We scanned through all pictures searching for images of Lesser Prairie-Chickens. To distinguish visits by different birds from continual presence and use during one visit by the same bird, we did not record a new visit unless there was a fifteen minute gap between sightings of the species. If a prairie-chicken was present for longer than fifteen minutes and a new prairie-chicken arrived, we counted it as the same visit but increased the total count of individuals using the guzzler. When a Lesser Prairie-Chicken was detected, we recorded the date and time, number of individuals, and sex (when discernible). All data were recorded into an excel file and photographic images were moved to an archive folder on a hard drive backup.

We allowed an acclimation period from December 2011 through February 2012 during which we kept guzzlers filled but were not collecting data. Starting March 2012, we collected data via the cameras continuously through July 2013. We decomposed the year into discrete units relevant to the ecology of Lesser Prairie-Chickens: March–May is the lekking and nesting period, June–August is the brood rearing period, September–February is the non-breeding season (Hagen and Giesen 2005). For analysis, we considered a trap-day as a 24 hr period in which the camera was present and collecting data at a guzzler. We calculated prairie-chicken use on basis of count of visits by birds per trap day. For example, 3 birds/ trap day could consist of one visit by a group of 3 prairie-chicken or 3 different visits (i.e., separated by $\geq$ 15 minutes) by single prairie-chickens.

Analyses

This is primarily an observational and descriptive exploration of Lesser Prairie-Chicken use, or lack-thereof, of commercially manufactured wildlife water guzzlers. We provide raw counts, means and standard errors where appropriate. To assess equitability in use of guzzler types, we used a Chi-square test for homogenous frequencies setting the expected values for each guzzler type as 50% of the total observed visits by prairie-chicken to the guzzlers (Fowler et al. 1998).

RESULTS

We collected data from March 2012 through July 2013, with 514 camera trap days at Lek 1, 510 camera trap days at Lek 2, and 478 camera trap days at Lek 3. We recorded 27,261 digital photographic images at the Lek 1 guzzlers, 61,753 images at the Lek 2 guzzlers, and 31,810 images at the Lek 3 guzzlers. We only detected Lesser Prairie-Chickens visiting guzzlers at Lek 1 and Lek 2. Although all three leks were active in 2011, we

subsequently confirmed that Lek 3 was inactive in 2012, which may explain the lack of any visits by prairie-chickens to the Lek 3 guzzlers. Therefore, we removed the Lek 3 guzzlers from all subsequent data analysis.

When considering only Leks 1 and 2, we conducted 1024 camera trap days and recorded 8,914 digital photographic images. Few of the images were of our target species, but we confirmed 43 visits by Lesser Prairie-Chickens to guzzlers with 1.34 (± 0.11 SE) prairie-chickens (n = 58) detected per visit. The majority of Lesser Prairie-Chicken visits occurred during the lekking and brood rearing periods of 2012 (Table 1). Only 3 visits were detected in the non-breeding period and no detections occurred during the lekking or brood rearing periods of 2013 (Table 1). We were able to identify 46 visiting prairie-chickens as male, 9 as female and 3 as unknown. Although male prairie-chickens were detected across several months, females were identified at guzzlers only during June 2012. There was a clear bimodal pattern of visits to guzzlers by prairie-chickens, with 74% of visits occurring between 0534 and 0919 hrs, and 26% of visits occurring between 1747 and 2033 hrs. Although Lesser Prairie-Chickens used both guzzler types, the majority of detections (81%) were at the gray guzzlers (Table 2). A test for homogenous frequencies indicated the difference in use was significant ($\chi^2_1 = 22.34$, $P < 0.001$).

DISCUSSION

It is reported that Lesser Prairie-Chickens will use surface water when it is available (Copelin 1963, Jones 1964, Crawford and Bolen 1973, Crawford 1974). We were able to expand on this and confirm that Lesser Prairie-Chickens will use wildlife water guzzlers designed for game bird use. Although Lesser Prairie-Chickens will use commercially manufactured guzzlers, we reject our second hypothesis that there would be no difference in use of game bird-friendly model types; indeed, we found substantial difference in use between the two models we examined.

If anthropogenic water sources are pursued as part of conservation efforts for Lesser Prairie-Chickens, the design of the wildlife water guzzlers we examined may be especially beneficial for hens with broods. We have evidence of hen prairie-chickens bringing their broods to areas were water has overflowed from above-ground stock tanks (unpublished data). We have observed chicks walking into the water to drink and, wading deep enough to wet their legs and possibly aid in thermoregulation by evaporative cooling (Costa et al. 2005). The guzzlers we tested may possibly allow access by prairie-chicken chicks with little risk of drowning. Although we never observed hens bringing broods to the guzzlers, this may have been due more to low reproduction during the study period. The study area had undergone severe drought in 2011 during which all radio-tagged hens in the study area experience nest failure (Grisham 2012); drought conditions persisted throughout 2012 and nesting success was poor (Boal unpub. data).

The primary purpose of the exclosures was to keep large mammals, such as deer, cattle, and feral hogs, away from the guzzlers so that water would be consistently available under our refill schedule. However, the exclosure did not prevent access by

Table 1. Detections of Lesser Prairie-Chickens at wildlife water guzzlers in Cochran County, Texas, March 2012–July 2013.

Perioda	Detections	Camera Trap Days	Detections/Day
Lekking-nesting 2012	35	180	0.194
Brood rearing 2012	20	184	0.109
Nonbreeding 2012-13	3	362	0.008
Lekking 2013	0	184	0.000
Brood rearing 2013	0	114	0.000
Total	58	1024	0.057

[a] Lekking-nesting = March – May; Brood rearing = June – August; Nonbreeding = September – February.

Table 2. Lesser Prairie-Chicken detection rates at two different guzzler types, Cochran County Texas, March 2012–July 2013.

Guzzler Type[a]	Detections	Camera Trap Days	Detections/Day
Green Guzzler	11	1024	0.011
Gray Guzzler	47	1024	0.046

[a]Green Guzzler = manufactured by Wildlife Water Guzzlers LCC in Canyon, TX (http://www.wildlifewaterguzzler.com/index.html); design consists of a circular covered tank with a separate trough attached by a flexible hose; Gray Guzzler = manufactured by Rainmaker Wildlife (http://rainmakerwildlife.com/); the design consisted of a rectangular reservoir and with a ramp built into the cover.

smaller animals and birds. Coyotes (*Canis latrans*), badgers (*Taxidea taxus*), and raptor species such as Swainson's Hawks (*Buteo swainsoni*) and Northern Harriers (*Circus cyaneus*), were able to enter the exclosures but no prairie-chicken were ever killed by predators within an exclosure. The fact that prairie-chicken readily visited guzzlers suggests that the exclosure fence did not deter them. If guzzlers were to be used as a conservation tool for Lesser Prairie-Chickens, or indeed, any other game bird species, similar exclosures could be beneficial in restricting access by large mammals. Large animals, especially aggregating domestic livestock, could quickly drain a guzzler and damage both the soil and vegetation around it. Exclosures could prevent this and insure water was available for game birds.

Surface water is not considered critical for Lesser Prairie-Chickens (Hagen and Giesen 2005). However, in a rapidly change landscape and climate (IPCC 2007, Grisham et al. 2013), natural moisture may become more limited and the physiological needs of Prairie Chickens may become greater due to temperature increases and lessened humidity. The issue of water use by Lesser Prairie-Chickens, and the possibility of any ecological or conservation benefit, is a topic of research that warrants more attention. Until more information becomes available, however, we have 1) demonstrated that the species will use game bird friendly wildlife water guzzlers, and 2) suggest the ramped design may be beneficial for brood survival in that water is accessible by chicks with little or no risk of drowning. If actions are initiated to provide water for conservation of prairie-chicken, we suspect that game bird friendly water guzzlers may be useful.

MANAGEMENT IMPLICATIONS

We confirmed that Lesser Prairie-Chickens will use surface water provided by bird friendly wildlife water guzzlers, but we do not know the influences, if any, that providing water will have on the species survival, reproductive output, or brood survival. Additionally, different types of guzzlers may provide different benefits or be more or less attractive to the species. These questions may warrant investigation prior to using wildlife water guzzlers as a conservation tool for Lesser Prairie-Chickens.

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PRODUCTIVITY OF AN URBAN WHITE-WINGED DOVE POPULATION IN HARRIS, WALLER, AND FORT BEND COUNTIES, TEXAS

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ABSTRACT.—Over the past several decades, White-winged Doves have expanded their range northward throughout Texas with larger breeding populations found predominately in urban areas. We surveyed White-winged Dove nests at 10 randomly selected sites in Katy, Texas, to assess nesting success and examine relationships between nest success and micro-habitat variables such as nest tree species, tree height, nest height, mean canopy width, nest aspect ratio, nest distance from main tree trunk, and tree diameter at breast height. Nesting productivity (birds fledged) was estimated to be 63.5% from 26 active nests. Of the six micro-habitat variables measured, nest height was the best predictor of nest success accounting for 76% of the total variance. Nests placed at the middle third of tree height were most successful and might provide a good compromise between structural stability and protection from predation.

White-winged Doves (*Zenaida asiatica*) are migratory game birds that breed throughout most of Texas (Small et al. 2005, 2006, 2007). Historically, the majority of White-winged Doves in Texas nested in the Lower Rio Grande Valley (LRGV), with smaller populations occurring in the Big Bend Region, and wintered south of the U.S. in Southern Mexico and Central America (Cottam and Trefethen 1968, Swanson and Rappole 1992). Changes in White-winged Dove distribution and habitat use have been occurring in Texas since the 1950s (Texas Parks & Wildlife Department (TPWD 2007). Over the past several decades, White-winged Doves gradually have been expanding their range northward with large populations now throughout the state (TPWD 2007). White-winged Doves are now found in some regions of East Texas and as far north as Amarillo (TPWD 2007).

Although breeding populations were originally restricted to rural environments along the Rio Grande, breeding populations outside this region are predominantly urban (Schaefer et al. 2004, Breeden et al. 2007, Small et al. 2007). Also, a portion of White-winged Doves in urban areas have become resident and no longer migrate, resulting in an extended breeding season (Hayslette and Hayslette 1999, Schaefer et al. 2004). Yet, even as White-winged Doves become more dependent on urban areas for nesting sites, they still continue to aggregate in large flocks for fall feeding flights (Small et al. 2005).

MATERIALS AND METHODS

Study area

Surveys were conducted in Katy, Texas within Harris, Waller, and Fort-bend Counties. Katy is located at 29.79 ° N, 95.82 ° W, and encompasses 2,771.29 ha with a human population of about 13,833 (City-data 2007). Until the late 1960s, rice production was the dominant industry in Katy. It is possible that White-winged Doves were able to extend their distribution further east from South-Central Texas because rice fields around Katy provided a reliable food supply. Currently, Katy is a growing suburb west of Houston with many residential subdivisions. The most common trees and shrubs found in residential areas were loblolly pine (*Pinus taeda*), crepe myrtle (*Lagerstroemia indica*), Texas live oak (*Quercus virginiana*), red

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maple (*Acer rubrum*), river birch (*Betula nigra*), pecan (*Carya illinoinensis*), green ash (*Fraxinus pennsylvanica*), sweet-gum (*Liquidambar styraciflua*), shumard oak (*Quercus shumardii*), bald cypress (*Taxodium distichum*), eastern redbud (*Cercis canadensis*), Mexican plum (*Prunus mexicana*) and yaupon (*Ilex vomitoria*).

Sampling

We used the 2001 National Land Cover Database (NLCD) (US Geological Survey 2003) imported into Geographic Information Systems (GIS) software (ArcGIS) to delineate urban residential areas for Katy. We then randomly placed 10 points within the designated area. We used the area around each point out to one ha as our sample areas. We obtained landowner permission to access property within each ha to conduct White-winged Dove nest searches.

We conducted White-winged Dove nest searches weekly at each of the 10 sample sites from June through August 2009. We used only nests which were active at the time of detection. We designated nests as active if an adult was present on two consecutive visits and monitored these nests for the duration of their use. We used a mirror on a pole device to monitor nests less than 10 feet high and a wireless camera on an extendable pole with an LCD monitor (TreeTop Peeper 4, Sandpiper Technologies, Inc., Manteca, CA) for higher nests. We assumed an incubation period of 14 days and a hatching to fledging time of 14 days (Boydstun and DeYoung 1987, Hayslette et al. 2000).

Rather than using an index to calculate productivity, which would require us to categorize nests as successful (at least one young fledged) or unsuccessful (no young fledged), we calculated overall empirical productivity as the percent of fledglings produced from all eggs laid and mean number of fledglings produced per active nest observed. However, we did use the categorical classes of successful and unsuccessful nests for purposes of examining relationships between nest success and micro-habitat variables using principal component analysis (PCA). Micro-habitat measures recorded for each active nest were nest tree species, tree height, nest height, mean canopy width, nest aspect ratio, nest distance from main tree trunk, and tree diameter at breast height (DBH). Also, for unsuccessful nests (those that failed to produce any fledglings), we categorized cause of failure as abandoned, predated, destroyed, or unknown, by examining the nest site and adjacent area for causal evidence.

RESULTS

We located 26 active nests in 10 tree species with 42.3% (11) of nests occurring in live oak trees and 19.2% (5) in loblolly pine trees. The remaining 38.5% (10) of nests occurred in 8 additional tree species: white ash (*Fraxinus americana*), cedar elm (*Ulmus crassifolia*), bluejack oak (*Quercus incana*), crepe myrtle (*Lagerstroemia indica*), yaupon, brazil (*Condalia hookeri*), and short-leaf pine (*Pinus echinata*). Average nest aspect ratio (nest distance to nearest branch/nest distance to trunk) was 0.094 in live oak trees, 0.039 in loblolly pine trees, and 0.048 in the 8 remaining tree species.

Thirty-three hatchlings successfully fledged from 52 eggs layed in 26 nests; each active nest contained two eggs. Thus, productivity is estimated as 63.5%, or 1.27 fledglings per active nest. For micro-habitat variables, PCA showed that nest height was the best predictor of nest success accounting for 76% of the total variance of all six variables measured. Tree height and mean canopy width ranked second and third, accounting for 13 and 5% of overall variance, respectively.

DISCUSSION

White-winged Doves are very successful breeders and have adapted to a variety of different environments outside their historic range. Despite occurring in new habitats, primarily urban areas with an increased level of anthropogenic disturbance, including physical factors and non-physical factors such as increased noise, over half of the observed nests fledged at least one young. This may in part be attributed to their ability to conserve energy while incubating and brooding multiple pairs of young (Schacht et al. 1995).

Interestingly, although not necessarily surprising, nest height was the best predictor of nest success. Our observations showed that nests located in the middle third of the nest tree (vertically) and mid-limb (horizontally) were more likely to fledge young. We suggest that this is likely because mid-tree nest positioning provides the greatest overall combination of tree stability and predation protection. White-winged Doves build poorly constructed nests (Small 2006) and some stability in the mid-tree would alleviate the potential for nest destruction during

unfavorable weather. White-winged Dove eggs and nests are also prone to predation from house cats (*Felis catus*), raccoons (*Procyon lotor*), grackles (*Quiscalus mexicanus*), and opossums (*Didelphis virginiana*). Thus, nest location potentially may alleviate predation pressure.

Because White-winged Doves are highly adaptable to urban environments and appear to have high fecundity there is a concern that they could, at least partially, displace Mourning Doves (*Zenaida macroura*) as urbanization continues to increase. WWDs are now more widely distributed in Texas than they were in the 1980s and appear to have displaced Mourning doves as a nesting bird in some cities (George 2004). According to the U.S. Fish and Wildlife Service, Mourning Doves populations are already believed to have decreased significantly in the Central Management Unit (CMU), including Texas, with an overall significant downward trend in from 10 year and 43 year call-count periods (Dolton et al. 2008). Thus, continued monitoring of White-winged Dove range expansion is warranted.

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OVERWINTER SURVIVAL OF NORTHERN BOBWHITES ON NON-HUNTED AREAS IN THE ROLLING PLAINS AND SOUTH TEXAS PLAINS OF TEXAS

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ABSTRACT.—Northern Bobwhite (*Colinus virginianus*) harvest regulations are usually implemented at large (e.g., state-wide) spatial scales. However, this may not be appropriate in situations where local or regional populations experience different vital rates and population trajectories. Estimating overwinter survival (November–February) in the absence of hunting is an important component in developing a sustained–yield harvest strategy for Northern Bobwhites. We estimated overwinter survival of radiomarked Northern Bobwhites using Program MARK for the winter seasons (16 November–28 February) of 2007–2008 and 2008–2009 in two Texas ecoregions, the Rolling Plains and the South Texas Plains. We calculated survival using 2 different estimators (Kaplan-Meier staggered entry and Program MARK) and compared these survival estimates. There were no differences in survival estimates between the 2 estimators. Based on estimates derived from Program MARK Northern Bobwhites in the Rolling Plains exhibited similar survival over both winters: 0.332 (95% CI = 0.216 − 0.473, n = 53) and 0.375 (95% CI = 0.257 − 0.511, n = 55). In the South Texas Plains survival varied drastically between winters: 0.181 (95% CI = 0.116 − 0.272, n = 92) and 0.762 (95% CI = 0.592 − 0.876, n = 41). These data illustrate the variation in Northern Bobwhite population dynamics across different ecoregions of Texas and provide a background for making harvest management decisions on localized scales.

Northern Bobwhites seem to exhibit lower and more variable survival during winter months than during other time periods (Cox et al. 2004). This makes winter an important time period with respect to understanding the annual demographic cycle of Northern Bobwhites.

Estimating overwinter mortality rates of Northern Bobwhites in the absence of hunting also is a crucial component for testing whether sustained-yield harvest theory can be applied to Northern Bobwhites. Estimates of overwinter survival (Sw) are needed to estimate winter mortality (Mw). Since Mw is the complement of Sw, Mw can be calculated as Mw = 1 − Sw.

Harvest strategies for Northern Bobwhites are usually implemented on statewide scales with little biological justification (Williams et al. 2004). Setting harvest strategies at smaller scales requires knowledge of population parameters that account for demographic variation the population of interest. It is important to quantify overwinter survival of non-hunted Northern Bobwhites to examine the viability of using sustained-yield harvest strategies to manage Northern Bobwhite hunting. When Northern

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Bobwhite populations exhibit different survival, it is essential to adjust annual harvest strategies accordingly so each harvest prescription is scaled to mortality. If different ecoregions experience different survival then it may be beneficial to adjust harvest prescriptions to fit each region. To calculate the desired harvest rate one would use the equation:

$$H = (T - [1 - Sw]) / (Sw),$$

where H is the harvest rate, T is total overwinter mortality ([fall density – spring density goal] / [fall density]), and *Sw* is overwinter survival in the absence of hunting (Brennan et al. 2008). Therefore 2 hypothetical populations with the same fall density (1 bird/ha) and same spring population goal (0.5 birds/ha) may require a drastically different harvest strategy. If population (*a*) experiences natural overwinter survival of 0.6 and population (*b*) experiences natural overwinter survival of 0.8 then

$$T = (1 - 0.5) / 1 = 0.5$$
$$(a)\ H = (0.5 - [1 - 0.6]) / (0.6) = 0.17$$
$$(b)\ H = (0.5 - [1 - 0.8]) / (0.8) = 0.38.$$

Population (a) would allow a harvest rate of 17% where population (b) would allow a harvest of 38%. A 20% increase in survival would more than double the amount of harvestable Northern Bobwhites in a given population. This basic example demonstrates the importance of quantifying overwinter survival because such variation can drastically influence harvest rate.

Our objectives were to 1) estimate Northern Bobwhite overwinter survival (Nov–Feb) in 2 ecoregions of Texas over 2 winter periods, 2) determine if survival differed between winter periods within ecoregions and between ecoregions, and 3) compare radiotelemetry survival estimates derived from Kaplan-Meier staggered entry (Pollock et al. 1989) to those derived from Program MARK (White and Burnham 1999) to test for potential differences in estimates of survival from these methods.

METHODS

Study Area

We conducted this study in 2 ecoregions of Texas: Rolling Plains and South Texas Plains (Gould 1975). These ecoregions experience high annual and seasonal variability in rainfall (Correl and Johnston 1979) and Northern Bobwhite populations in these regions exhibit irruptive behavior as a result (Jackson 1969, Lehmann 1984:8).

Rolling Plains.—The Rolling Plains study area was located in Fisher County near Roby, Texas. Land uses were primarily cattle production and lease hunting. Soils in the area are Paducah loam (55.0%) and Woodward loam (32.0%) (NRCS Web Soil Survey 2008). Average annual precipitation for this region is 55.9 cm with an average snowfall of 25.4 cm (National Climate Data Center 2007). Average winter temperature (Nov-Mar) is 7.7°C and summer temperature (Apr-Aug) is 23.3°C (National Climate Data Center 2007). The study pasture was approximately 400 ha in size. The vegetation community was predominantly honey mesquite (*Prosopis glandulosa*), lotebush (*Ziziphus obtusifolia*), netleaf hackberry (*Celtis reticulata*), prickly pear (*Opuntia* spp.), silver bluestem (*Bothriochloa saccharoides*), threeawns (*Aristida* spp.), sideoats grama (*Bouteloua curtipendula*), and buffalo grass (*Buchloe dactyloides*) (Rollins 2007).

South Texas Plains.—The South Texas Plains study area was located in Brooks County south of Falfurrias, Texas on the Encino Division of the King Ranch. Also known as the coastal sand plain of the Tamaulipan Biotic Province, this region is characteristic of semi-arid, sub-tropical climate. Land uses on the study area include commercial hunting, ecotourism, and cattle production (Hernández et al. 2007). Soils in the area are Falfurrias fine sand (84.5%), Sauz fine sand (13.2%), and Sarita fine sand (2.3%) (NRCS Web Soil Survey 2008). Rainfall varies considerably from year to year making this region's climate and habitat very dynamic. Average annual rainfall is 63.5 cm, mean winter (November–March) temperature is 16.6°C, and summer (April–August) temperature is 30°C (National Climate Data Center 2007). This site was approximately 400 ha in size. The vegetation community was dominated by honey mesquite, oaks (*Quercus* spp.), huisache (*Acacia minuata*), granjeno (*Celtis pallida*), brazil (*Condalia hookeri*), prickly pear (*Opuntia lindheimeri*), doveweed (*Croton* spp.), sunflower (*Helianthus* spp.), gulf cordgrass (*Spartina spartinae*), sandbur (*Cenchrus incertus*), and purple threeawn (*Aristida purpurea*).

Trapping

Trapping occurred from 20 October 2007–29 February 2008 and 20 October 2008–1 March 2009 and was performed continuously throughout this

period. This period coincided with the Northern Bobwhite hunting season. The number of trapping occasions was not consistent between sites and years due to logistical constraints; therefore, we analyzed each site and year separately. To properly sample a defined population, we used funnel-type traps (Stoddard 1931:442) baited with milo and sampled evenly across each study site placing traps, > 250 meters apart, on selected random grid points (grid created using ARC GIS 9.2, ESRI, Inc., Redlands, California, USA).

Captured individuals were classified by sex and age (Rosene 1969:44–54) and mass was measured in grams. Female and male Northern Bobwhites weighing ≥ 150 g were fitted with a 5-6 g neck-loop radio transmitter (Shields et al. 1982) (American Wildlife Enterprises, Tallahassee, Florida, USA) until the sample size reached ≥ 30 Northern Bobwhites (Guthery and Lusk 2004). We radiomarked additional individuals periodically throughout the study period to replace bobwhites that were lost or died.

Radiotelemetry

Radiomarked Northern Bobwhites were tracked 2-4 times a week during the study period with a hand-held receiver (Communication Specialties, Orange, California, USA or Advanced Telemetry Solutions, Inc., Isanti, Minnesota, USA) and a 3-element Yagi antenna. We recorded date, location, status (e.g., alive or dead) and suspected cause of mortality (if applicable) each time a radiomarked Northern Bobwhite was relocated. We followed these basic assumptions when adding a Northern Bobwhite to the radiomarked sample: individuals were sampled randomly, survival is independent for each individual, left-censored (staggered entry) individuals had the same fate as previously marked individuals, and censoring (radio failure) was independent of fate. We only included Northern Bobwhites that survived > 7 days from initial radiomarking (Pollock et al. 1989).

Data Analysis

We calculated survival using 2 methods, Kaplan-Meier staggered entry (Pollock et al. 1989) and Program MARK. We used Kaplan-Meier staggered entry to calculate survival for all Northern Bobwhites based on the initial capture date and last recorded date and status. Individuals were classified according to the status at the last encounter.

In addition to Kaplan-Meier, we used the "known fates" platform in MARK to generate survival estimates for the same time period. This platform is commonly used with telemetry data and has 1 basic assumption: the resighting probability is equal to 1. In other words, telemetry allows the researcher to "recapture" the Northern Bobwhite every time they attempt to do so. We built encounter histories for each radiomarked Northern Bobwhite from the trapping data based on the LDLDLDLD format (White and Burnham 1999). Whereas, at each tracking occasion each Northern Bobwhite was classified in one of three categories: 10 = the Northern Bobwhites survived the interval, given it was alive at the start of the interval, 11 = the Northern Bobwhite died during the interval, given it was alive at the start of the interval, and 00 = the animal was censored for the interval. Encounter histories included an identification number and capture history. For example, the encounter history for an individual looked like this: (/*7035*/0010101010101011000 00000 1;) where (/*7035*/) was the identification number, (00101010101010110000000) capture history, (1) group membership. We built the model "survival is constant over time or S (.)" for each site and year because it is the simplest model and does not account for any additional parameters.

RESULTS

In South Texas during the 2007–08 trapping season we captured 240 Northern Bobwhites over 30 days of trapping effort. We captured more than 8 times as many juveniles as adults and the ratio of males to females was 1 (Table 1). In the 2008–09 trapping season we captured 73 Northern Bobwhites over 55 days of trapping effort. We captured 2.6 times as many juveniles and 1.1 times as many males (Table 1). During the 2007–08 trapping season, in the Rolling Plains we captured 126 Northern Bobwhites over 36 days of trapping effort. We captured 3.0 times as many juveniles as adults and 1.3 times more males than females (Table 1). In the 2008-09 trapping season we captured 126 Northern Bobwhites during 30 days of trapping effort. We captured 1.7 times more juveniles than adults and 1.2 times more males than females (Table 1).

Kaplan-Meier survival estimates for the Rolling Plains were similar between years, ranging from 0.321in 2008 to 0.401in 2009 (Table 2). Program MARK estimates were similar between years in the

Table 1. Sample size (n), age ratio (juveniles:adults) , and sex ratio (males:females) of Northern Bobwhites, estimated by trapping from 20 October 2007 to 29 February 2008, and 20 October 2008 to 1 March 2009 in Fisher (Rolling Plains) and Brooks Counties (South Texas Plains), Texas, USA.

Year	Ecoregion	n	Age ratio (J:A)	Sex Ratio (M:F)
2007-2008	Rolling Plains	118	3.0:1	1.3:1
	South Texas Plains	166	>8.0:1	1.0:1
2008-2009	Rolling Plains	126	1.7:1	1.2:1
	South Texas Plains	73	2.6:1	1.1:1

Rolling Plains ranging from 0.332 in 2008 to 0.375 in 2009 (Table 2, Figures 1 and 2) Kaplan-Meier survival estimates in South Texas differed between years, ranging from 0.177 in 2008 to 0.832 in 2009 (Table 2). Program MARK estimates also differed, ranging from 0.181 in 2008 to 0.762 in 2009 (Table 2, Figures 3 and 4). Survival estimates from Kaplan-Meier and Program MARK were similar for both years (Table 2). Estimates from Kaplan-Meier varied 0.4% to 7.0% from program Mark estimates (Table 2).

DISCUSSION

Survival estimates from Kaplan-Meier were similar to all estimates from program MARK showing that both methods produced analogous estimates of overwinter survival. The survival estimate for South Texas in the 2007-08 winter was lower than most estimates reported by Lehmann (1984:135) (23–94%), Roseberry and Klimstra (1984) (54–94%), and Williams et al. (2004) (48%). During the 2007-08 winter period Schnupp et al. (2009) estimated fall and spring Northern Bobwhite densities on an adjacent property showed 16–87% variation in population retention. Our overwinter survival estimates for this period are similar to those from Burger et al. (1995; 16% from 1 October to 31 March) and Parry et al. (1997; 19%). Throughout the 2007 nesting season, the South Texas study site experienced higher than average rainfall resulting in high Northern Bobwhite production. This successful breeding period was followed by intense drought conditions in the fall and winter months that only produced 6.7 cm of precipitation (National Climate Data Center 2008). The excessively dry weather conditions may have caused increased stress and mortality among Northern Bobwhites. This decrease in survival is supported by Guthery (1997) showing that populations having juvenile:adult ratios $\geq$ 8:1 potentially have low annual survival (typically less than 20%). This result is consistent with previous work that supports "boom and

Table 2. Comparison of estimated winter survival (Sw) of radiomarked Northern Bobwhites estimated using the known fates module in Program Mark and the Kaplan-Meier methods from 16 November 2007 to 29 February 2008 and 16 November 2008 to 1 March 2009 in Fisher (i.e., Rolling Plains) and Brooks Counties (i.e., South Texas), Texas, USA.

		MARK					Kaplan-Meier				
County	Year	n^b	Sw	SE	Lower 95% CI	Upper 95% CI	*n*	Sw	SE	Lower 95% CI	Upper 95% CI
Brooks											
	2007-08	92	0.181	0.040	0.116	0.272	91	0.177	0.031	0.117	0.237
	2008-09a	41	0.762	0.073	0.592	0.876	40	0.832	0.060	0.714	0.950
Fisher											
	2007-08	53	0.332	0.067	0.216	0.473	57	0.321	0.055	0.213	0.429
	2008-09	55	0.375	0.066	0.257	0.511	55	0.401	0.062	0.279	0.522

[a]Survival estimates for South Texas 2008-2009 were estimated from 12 December 2008 to 1 March 2009.
[b]Number of radiomarked Northern Bobwhites used in survival analysis.

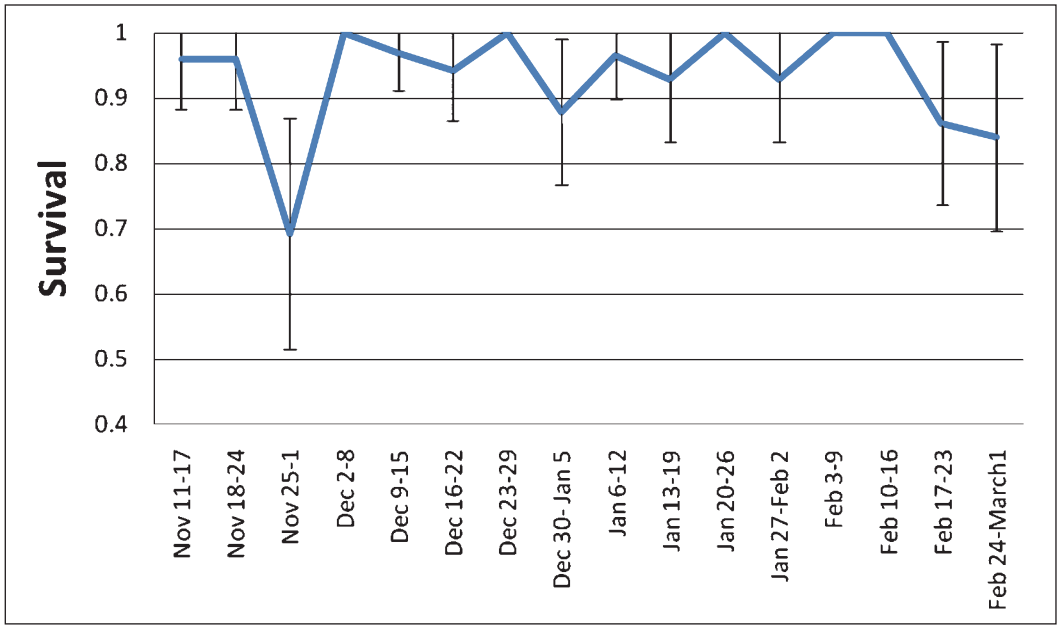

Figure 1. Northern Bobwhite weekly survival during the 2007-08 winter (Nov 16–Mar 1) based on Program MARK estimates from radiotelemetry data from the Rolling Plains (Fisher County), Texas, USA.

bust" dynamics (Lehmann 1984:8, and DeMaso 2008) and cycles (Lusk et al. 2007) in South Texas Northern Bobwhite populations. Survival in South Texas increased ~63% from the winter of 2007–08 to the 2008–09 winter. These estimates were higher than most reported literature but are similar to those reported by Roseberry and Klimstra (1984:50,53) (54–94%) and Lehmann (1984:135) (23–94%) who

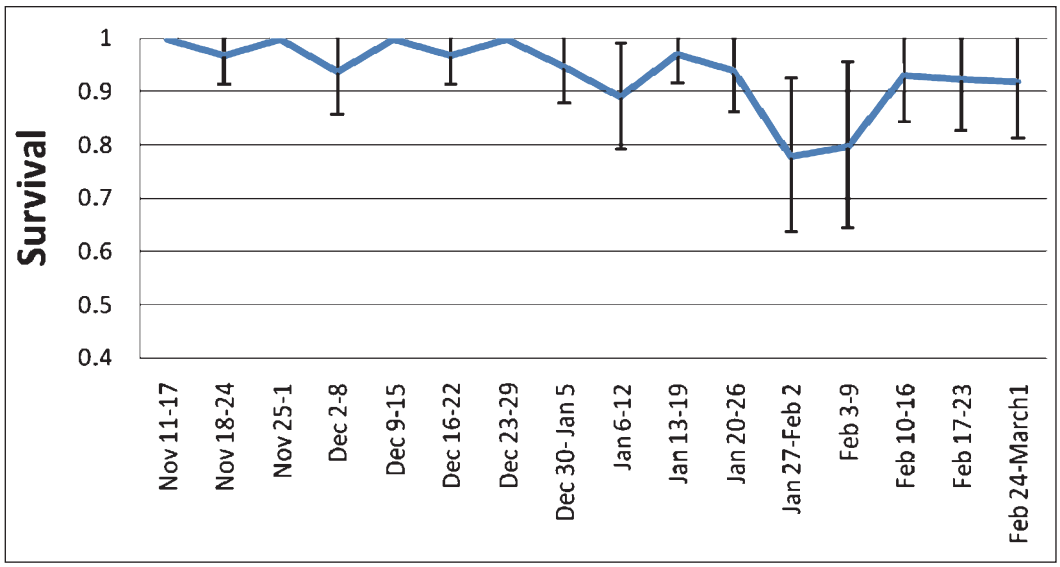

Figure 2. Northern Bobwhite weekly survival during the 2008-09 winter (Nov 16–Feb 29) based on Program MARK estimates from radiotelemetry data from the Rolling Plains (Fisher County), Texas, USA.

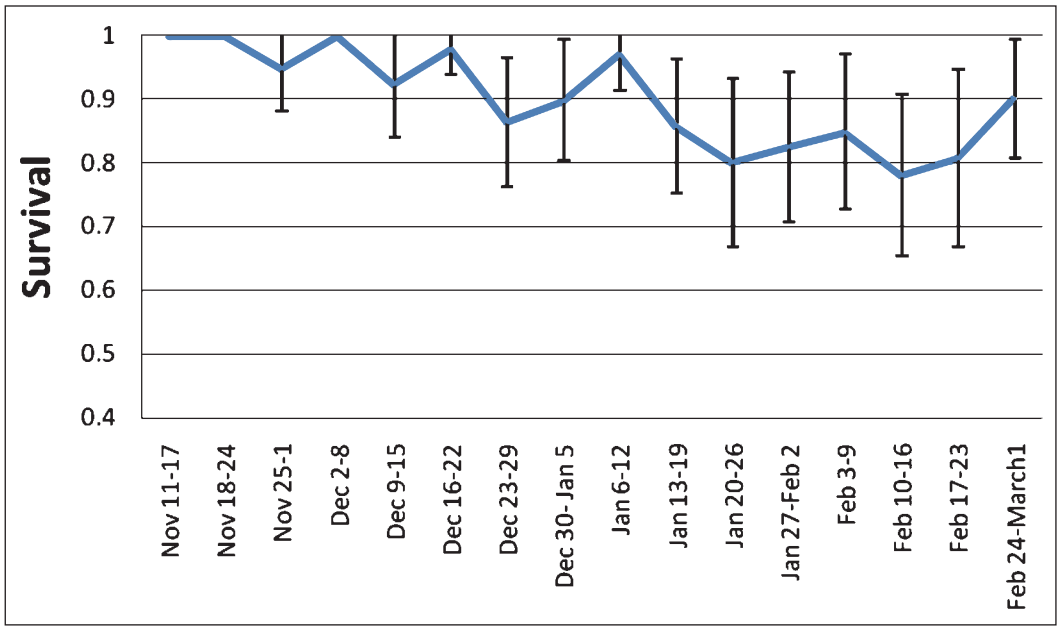

Figure 3. Northern Bobwhite weekly survival during the 2007-08 winter (Nov 16–Mar 1) based on Program MARK estimates from radiotelemetry data from the South Texas Plains (Brooks County), Texas, USA.

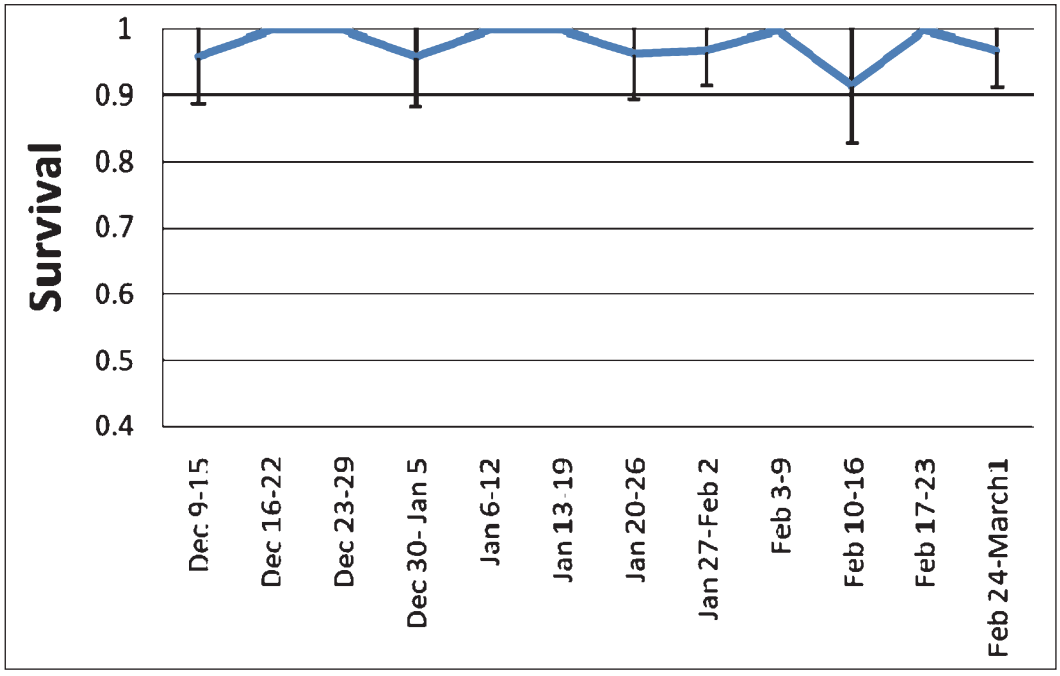

Figure 4. Northern Bobwhite weekly survival during the 2008-09 winter (Nov 16–Feb 29) based on Program MARK estimates from radiotelemetry data from the South Texas Plains (Brooks County), Texas, USA.

reported a wide range of survival estimates. In Mississippi Holt et al. (2012) observed Northern Bobwhite survival ranged from 3 to 36% during the winters of 2000–2001 and 2001–2002 respectively.

During the 2007–08 winter in the Rolling Plains Northern Bobwhites experienced a 16% decrease in survival coinciding with a winter storm. Survival estimates in the Rolling Plains were consistent between the two winter seasons and similar to those from Williams et al. (2004) (21 and 48%), Dixon et al. (1996) (20 and 56%), Seckinger et al. (2006) (34–43%), and Lehmann (1984:135) (23–94%). These estimates were also similar to survival reflected by density estimates produced by Schnupp (2009) showing 46–50% population retention in 2007-08 and 30–49% in 2008-09, from properties adjacent to this site. When survival estimates are consistent it provides a predictable platform for developing sustained-yield harvest strategy. These two regions of Texas exhibited different overwinter survival, which supports the case for implementation of localized harvest regulations in each region of Texas.

Conservation Implications

Survival varied widely between the ecological regions used for this study. Although we have demonstrated that there is great variation in overwinter Northern Bobwhite survival between regions and years, the tremendous amount of effort required to quantify overwinter survival makes it impractical for a state agency to quantify at a large scale. In South Texas it would be thus be wise for Northern Bobwhite managers to set harvest quotas designed to withstand fluctuations in overwinter survival. Although this study points to differences in survival between regions it only represents a snapshot of 2 years which may or may not be representative of other Northern Bobwhite populations in Texas.

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HARRY CHURCH OBERHOLSER AND *THE BIRD LIFE OF TEXAS*

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ABSTRACT.—Harry Church Oberholser (1870-1963) published extensively on the birds of the Americas, as well as those of the West and East Indies, Africa, Europe, Australia and the Pacific Islands. However, the work for which he is best known in the Lone Star State is his book *The Bird Life of Texas*, a project on which he worked from 1900 until his death in 1963. The text continued to expand over the years as Oberholser gathered additional information from the literature, as well as from his own fieldwork and that of others. With continuing revisions, the manuscript eventually grew to such a length that the cost of publishing it became prohibitive. As the years passed without the finances necessary for publication, frustration and disappointment became evident. One prominent supporter, naturalist Roy Bedichek, remarked that publication of *The Bird Life of Texas* was "perhaps an undertaking too big even for the state of Texas" (Aldrich 1974).

How the information for *The Bird Life of Texas* was gathered and the events leading up to its publication is a remarkable story. Many influential Texans knew of Oberholser's manuscript and, at various times, strongly advocated its publication. Each time, however, that publication seemed imminent obstacles arose that led to additional delays. This paper presents a brief summary of Oberholser's early life and traces the history of *The Bird Life of Texas* from its inception in 1900 until 1946 when the manuscript first attracted the attention of officials at the University of Texas.

EARLY LIFE AND EDUCATION

Harry Church Oberholser, son of Jacob and Lavera Church Oberholser, was born 25 June 1870 in the Brooklyn Heights section of New York City. At the age of three, he entered a kindergarten operated by the daughters of the associate pastor of Plymouth Church. His later education was obtained at private schools in Akron, Ohio, Red Bank, New Jersey, and during 1886-1888 at Pratt's Preparatory School in Shelburne Falls, Massachusetts. Oberholser's first ornithological work, a note describing the killing of a House Sparrow by a Northern Shrike, was published while living in Shelburne (Oberholser 1887). In the fall of 1888 he enrolled in Columbia University but because of poor health could not continue his education at that time (Oberholser 1954).

The Oberholser family continued to live in Brooklyn Heights until 1877 when Harry's father purchased a 19-acre farm near Red Bank, New Jersey. It was on this farm, when he was about nine years old, that Harry first became interested in nature. At every opportunity he "roamed the fields, woodlands, and shores of river and ocean, collecting insects, shells, plants, birds, their nests and eggs, minerals, fossils [and] other miscellaneous objects, together with books on natural history." His mother encouraged him in these activities and provided him with a "good-sized room" on the third floor of the family home to furnish as a museum. His geological collection of nearly 2000 specimens was largest of all, and he became so intrigued by the subject that he began to think of making mineralogy or geology his life's work (Oberholser 1954). However, this early enthusiasm for geology was soon to be re-directed to the discipline of ornithology.

While attending Pratt's Preparatory School, Oberholser made the acquaintance of a classmate who opened his mind to the world of birds. In his autobiography written nearly 75 years later, Oberholser recalled that this individual "so completely captivated my imagination and interest that I began to think of nature in terms of birds, so that thenceforth I desired to be only an ornithologist" (Oberholser 1954). Strangely, even though this fellow student exerted such a powerful and lasting influence in his life, Oberholser either did not remember his name or chose not to make it known.

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Although Harry strongly desired a career in ornithology, his father did not think highly of birds and, instead, obtained for him a position in a well-known grocery firm in New York City where he spent 1889 learning the "business and psychology of salesmanship." However, because of continuing health problems, his father decided in January 1890 to send him to the more healthful climate of Wooster, Ohio to look after his interests in a store, which he owned in that town. In Wooster, Harry learned the finer points of business as he worked as a bookkeeper, part-time cashier and eventually as manager of the establishment (Oberholser 1954).

Oberholser later remembered Wooster, Ohio, and its people as a "cultural inspiration" that remained with him for the rest of his life. Upon learning that he liked to sing, he was invited to join a local amateur society for the performance of light operas. He also joined the Wooster University Oratorio Society, as well as becoming the youngest member ever elected to the Century Club, a small group of professional townsmen and professors of the University who met to discuss scientific, literary and other cultural subjects (Oberholser 1954). A photograph of Oberholser presumably taken around this time shows him smartly dressed and wearing what appear to be pince-nez eyeglasses (Fig. 1).

Figure 1. Photograph of "Mr. Harry C. Oberholser" published in The Condor, 1904, vol. 6, page 98.

Ornithology was not neglected during Oberholser's stay in Wooster. He began to gather a library of books and journals pertaining to birds and at every opportunity to collect birds and their eggs in the surrounding countryside. The result of these collecting expeditions was the publication in 1896 of a list of the birds of Wayne County, Ohio. It was also at Wooster that Oberholser determined that, if at all possible, he would follow ornithology as his life's work (Oberholser 1954).

Oberholser left Wooster in April 1894 and returned to Brooklyn where he obtained a position as a salesman in a store in New York City. That autumn, he learned of an examination in Washington, D.C., to fill a bird position in the Division of Economic Ornithology and Mammalogy, United States Department of Agriculture. He took the exam during January 1895 and within ten days was offered an appointment as 'Ornithological Clerk'. On 1 February 1895 he reported for duty to begin what would be a career or 46 years and 5 months in government service. Upon his arrival in Washington, Oberholser began a long friendship with Robert Ridgway, curator of the bird collection, who mentored him in the technical aspects of ornithology (Oberholser 1954).

FIELDWORK IN TEXAS, 1900-1902

In early 1900 Oberholser was directed to prepare a comprehensive report on the birds of Texas. Field agents of the Bureau of Biological Survey had sporadically worked in Texas for over a decade, and Oberholser's task was to expand this work to all areas of the State through field observations and collections, and to supplement these data with information obtained from local naturalists and the published literature. With this objective in mind and most certainly unaware that the writing of a "comprehensive report" would occupy the remainder of his life Oberholser, then 30 years old, departed Washington, D. C. for his great adventure in Texas.

Travel between widely separated collecting sites in Texas was by train or stagecoach. Upon arrival, a horse and buggy or other means of conveyance might be rented to facilitate exploration of the surrounding area sometimes to a distance of as much as 30 miles. A report, generally consisting of an annotated list of birds, would be mailed to the headquarters in Washington following completion

of the fieldwork in a particular area. Occasionally, a lengthy description of the topography and vegetation of an area would be included. In contrast to the handwritten communiqués of other agents, Oberholser's reports are typed, thus suggesting that he carried with him a portable typewriter while working in the field. He also carried a camera and is known to have taken numerous photographs of landscapes and habitats to document his descriptions of the topography and vegetation (Schmidly 2002). The dates and locations visited by Oberholser during his work in Texas can be determined by consulting his itinerary in the typescript of *The Bird Life of Texas* (Oberholser 1900-1939).

Oberholser first touched the soil of Texas at Port Lavaca on 18 March 1900. From Port Lavaca he moved to Matagorda Island and Port O'Connor and then on to Beeville, San Diego, Laredo and Cotulla. During the first three weeks in June he was in Uvalde, Rock Springs and San Antonio before going to Henrietta where, in addition to making observations on birds, he tried out a recently invented formula for poisoning rodents. These experiments, conducted on prairie dogs and mice, were completed by mid-August at which time Oberholser returned to Washington (Oberholser 1954).

San Angelo was Oberholser's first stop during 1901. Three days were spent at this location during the first week in April before moving to Fort Lancaster and then on to Langtry where, on 25 April, he joined Louis Agassiz Fuertes who was the artist for the biological survey of Trans-Pecos Texas (Casto and Burke 2007). The meeting of these two men had long-range consequences since the illustrations prepared by Fuertes during the next few months would later be used to illustrate *The Bird Life of Texas*.

Oberholser and Fuertes collected in the vicinity of the Pecos High Bridge and Painted Caves during the first three days of May. Oberholser then departed for Del Rio and Comstock where he worked for several days before joining Fuertes and Vernon Bailey in their camp at Peña Colorado south of Marathon. Over the next several days, the three collectors and the camp assistant, McClure Surber, made their way into the Big Bend (Fig. 2). Their camp was eventually made at the mouth of Tornillo Creek from which location Oberholser and Fuertes departed for a hunt on 27 May. Fuertes soon spotted the Zone-tailed Hawk that he had seen on previous hunts in the area. The hawk was shot and by chance fell onto a ledge protruding from the canyon of the Rio Grande. While attempting to retrieve this prized specimen Fuertes became trapped and could neither ascend nor descend from the ledge. Oberholser who was hunting nearby heard Fuertes' cries for help. Upon arriving at the scene and evaluating the perilous situation, Oberholser returned to camp to inform Vernon Bailey of Fuertes' predicament. The two men quickly gathered a sufficient length of rope and rushed to the canyon's edge where the rope was lowered and Fuertes and his specimen were pulled to safety (Casto and Burke 2007). This event was apparently indelibly imprinted in Oberholser's memory and the story would later be included in *The Bird Life of Texas* (Oberholser 1974).

On the evening of 31 May, Oberholser, Bailey and Fuertes arrived at Pine Canyon and on the following morning began their ascent into the Chisos Mountains. Their work in the Chisos Basin continued until near the end of June at which time they moved to Terlingua and then on to Alpine and Fort Davis. A wagon was obtained in Fort Davis and on 6 July the expedition moved up Limpia Canyon into the Davis Mountains. On 15 July the group arrived back in Fort Davis where they disbanded. Oberholser and Fuertes took the stage to Marfa while Bailey and the camp assistant, Surber, remained in Alpine before going on to New Mexico. Oberholser went from Marfa to Hereford where he remained until 25 July before going on to Mobeetie where he worked until 2 August before returning to Washington.

Oberholser's work during 1902 was dull as compared with the adventures of the preceding year. His schedule was also somewhat different. He arrived in Texas on 18 June 1902, almost 2-l/2 months later than in 1901. His first stop was at Texarkana where he remained until 3 July before making a brief trip to Boston and then returning for an additional three days at Texarkana. The remainder of July was spent at Waskom, Long Lake and Conroe before moving during August to Beaumont, Jasper and Sabine. During September visits were made to Sabine, Hempstead, Brenham, Elgin and Austin. On 4 October Oberholser left Austin for Waco where he remained until 19 October at which time he returned to Washington.

Oberholser compiled an impressive work record during his three seasons in Texas. During this time, a total of 397 days was spent collecting,

Figure 2. Photograph taken in 1901 of the members of the Biological Survey of Trans-Pecos Texas. L to R: Harry Oberholser, Vernon Bailey, Louis Agassiz Fuertes and McClure Surber (in back). Courtesy National Archives, 22-WB-B5502.

writing reports, traveling between sites or engaged in other activities. In addition, he contributed 118 survey reports, 276 mammal specimens, and 710 photographs of landscapes, wildlife and habitats (Schmidly 2002). There has apparently been no tally made of the large number of ornithological specimens that he collected during his work in Texas.

THE BIOLOGICAL SURVEY REPORT

The Biological Survey of Texas was published in October 1905. However, the section on birds, which Oberholser had completed in 1903, was not included. Oberholser later contended that his report was not included because of a lack of funds (Oberholser 1954). However, the official explanation offered by Vernon Bailey was that the bird report had grown to such proportions that it would be published separately (Bailey 1905, Schmidly 2002). Years later, it was claimed that it was Oberholser's decision to delay publication in order that he might gather additional information (Aldrich 1971, Anon. 1974). Perhaps all of these statements contain an element of truth. The bird manuscript was long, and its inclusion would have dwarfed the other sections of the report. Bailey's statement that the report would be published separately was undoubtedly made in good faith. However, as is often the case where funding is limited, other projects perhaps received priority and the money never became available. Whatever the cause may have been, the failure to publish

the report during 1905 seems to have been the beginning of the difficulties and frustration that would follow before the often revised and heavily edited typescript was eventually published in 1974.

THE SLAYDEN PROPOSAL OF 1917

No serious effort to publish Oberholser's bird report was made until early 1917. In January of that year, United States Representative James L. Slayden of the Brownwood district informed his hometown newspaper that he would like to see the report published by the State of Texas (Anon. 1917). Slayden believed that if the manuscript could be examined by the governor and legislature, it might be quickly arranged to have it issued by Texas A&M or the University of Texas. The title of the manuscript was given at this time as *The Birds of Texas: Their Value to Farmers and Orchardists* and it was described as being 3,500 pages in length including the illustrations prepared by Louis Agassiz Fuertes. The cost of publishing the manuscript was estimated by the Government Printing Office to be about $7,500 for 2,500 copies or $9,000 for 5,000 copies. Slayden shrewdly pointed out that the information in the manuscript had been gathered by scientists working for the federal government at a cost of thousands of dollars. All of this would be freely given to the State of Texas if the legislature would pay the cost of publication. Since the content of the book pertained only to Texas, Slayden considered it improbable that publication would ever occur if not financed by funds obtained in Texas. Apparently nothing came of Slayden's efforts to promote publication

THE RELATIONS OF VEGETATION TO BIRD LIFE IN TEXAS.

HARRY C. OBERHOLSER.

INTRODUCTORY.

The present paper was originally intended as a part of the author's still unpublished treatise on the birds of Texas. It has, however, outgrown its place in the introduction of that report. The data set forth in the following pages were gathered by the various naturalists of the Biological Survey in the course of many years of zoological exploration in all parts of Texas. No one more than the writer regrets the limitations of treatment, which are for various reasons necessary. We have tried, however, with the information at our disposal, to prepare an outline of the ecological areas in various parts of this State, leaving the details to be gathered by future investigators. Since the probabilities of our returning to this field are slight, it seems worth while, with this explanation, to place on record what information we now possess.

Figure 3. Title page and introduction of Oberholser's paper "The Relations of Vegetation to Bird Life in Texas" published in the *American Midland Naturalist*, 1925, vol. 9, pp. 564-594, 595-661.

and, once again, Oberholser faced the possibility that his work would never be made available to the public. Over a decade would pass before another attempt was made to promote the publication of Oberholser's manuscript.

Oberholser often insisted that everything discovered in connection with his research on Texas birds must go into his book (Aldrich 1974). There was, however, one early exception made to this rule. In 1925, he published a 96-page paper on vegetation and the birds of Texas in The American Midland Naturalist (Fig. 3). It was his original intent to include this information in the bird report but, considering the already excessive length of the manuscript (3,500 pages), it was decided to publish the vegetation data separately (Oberholser 1925).

SUPPORT FROM ORGANIZATIONS IN TEXAS, 1928-1929

In August 1927 Oberholser was placed in charge of organizing a continent-wide census of the ducks, geese, swans and coots of the United States, Canada, Alaska and Mexico. Hundreds of volunteers were needed, and it became Oberholser's responsibility to recruit these individuals and to explain the census program to the general public (Anon. 1928a). In January 1928 Oberholser returned to Texas, his first visit to the State since completing his fieldwork with the biological survey in 1902. During January and February, he toured the Gulf Coast with side trips to San Antonio and El Paso. At each stop he undoubtedly received many questions regarding his book on Texas birds. When would it be published? How much would it cost? Who would be interested in buying it? What would be its practical value? Having had considerable experience as a salesman during his early life, one can only imagine that Oberholser patiently answered these questions while emphasizing the practical value of the book to a diverse audience of sportsmen, conservationists, educators and agriculturists.

By late 1928 the movement for publication of Oberholser's book had gained widespread support. The science and nature study teachers of Texas were of the opinion that the monograph should be published as a textbook for use in the public schools. Underlying their position was the premise that education was more powerful than the law in protecting the rapidly disappearing bird life of the Texas. Their resolution supporting publication read as follows:

> "Therefore be it resolved: That we go on record as being in favor of this movement and that we pledge the full support of the Science Section of the Texas State Teacher's Association as an organization and ourselves as individuals to support this movement and to use our influence to bring about the passage of a measure in the State Legislature that will make possible the publication of this most needed book"(Anon. 1928b).

The Texas Academy of Science and the Texas Science Club also passed similar resolutions, and the movement was said to have the approval of William J. Tucker, State Game, Fish, and Oyster Commissioner, as well as that of the Chief of the Bureau of Biological Survey in Washington (Anon. 1928b). The announcement of the teacher's support for publication was given by Ellen Schulz Quillin, director of science and nature study in the San Antonio public schools, and, perhaps more significantly, the wife of Roy Quillin, an egg collector who was a friend and correspondent of Harry Oberholser.

Support of the science teachers for publication of Oberholser's book seems to have faded following passage of their original resolution, and the leadership of the movement passed to the Texas Academy of Science and the San Antonio chapter of the Izaak Walton League. In early February 1929 naturalist Charles Bowman Hutchens and his wife, Helen, presented a program of talks, nature songs and music on WOAI radio in San Antonio. This program, sponsored by the Texas Academy and the Walton League, was intended to be educational and to promote the publication of Oberholser's book. The official position of the Academy was that the book was "a needed publication and an educational necessity in Texas" (Anon. 1929a).

The *San Antonio Express* strongly supported publication of Oberholser's book at State expense. It was further noted that the book would provide the school children of Texas with "a comprehensive guide to the birds, whether in a museum or in the fields and woods". It was also believed that the book would effectively "promote the conservation cause" (Anon. 1929b).

In early October 1929 the San Antonio chapter of the Izaak Walton League and the Texas Academy of Sciences hosted a banquet to honor Oberholser who was then in Texas to inspect potential sites for new

game refuges. As the keynote speaker, Oberholser related his adventures while working on his book whereas the naturalist Roy Bedichek offered comments on the manuscript that Oberholser had prepared. Other prominent individuals on the program or in attendance included William J. Tucker, secretary of the state game commission, Harris Braley Parks, secretary of the Texas Academy of Science and A. E. Wood, chairman of the board of fish and game commissions. In a follow-up commentary to the banquet, the *San Antonio Express* again declared that Oberholser's book should be published at State expense since "the cost would be small" and the book "would give the rising generation in Texas a far better acquaintance with the State's birds" (Anon. 1929d).

EFFORTS OF THE TEXAS ACADEMY OF SCIENCE

By 1930 the Texas Academy of Science seems to have taken the lead in promoting publication of Oberholser's book. In early January the Academy requested that the Texas Game, Fish and Oyster Commission publish Oberholser's book. This request was taken under advisement but no action was taken. The position of the Academy was that the book should be published at State expense, distributed free to schools and public libraries, and sold at cost to individuals. In a surge of almost religious idealism, it was declared that the book would "convert the schoolboy—who, with slingshot or air-gun, is the songster's deadly enemy—into a friend to the birds." Given that Texas was still an agrarian State in 1930, it was further declared, "Sportsmen, gardeners and farmers also could read the book with profit" (Anon. 1930a,b).

The inaction of the Game, Fish and Oyster Commission with regard to the Oberholser manuscript is not surprising. Given its length and abundance of technical detail, it was not suitable, unless seriously edited, as either a textbook for the public schools or a reference manual for the general public. The commissioners were obviously cognizant of the need for a book on birds since only six years later they approved the publication and distribution to the public schools of an 82-page booklet titled *Brief Studies in Texas Bird Life* (Burr 1936).

Oberholser did not visit Texas during 1930, and the movement to publish his book received little attention. However, when he arrived in San Antonio in early July 1931, it was announced in the local newspaper that his manuscript was to be offered to the Texas Academy of Science for publication (Anon. 1931a). Oberholser did not own the manuscript since it had been researched and prepared while he was on the federal payroll. The fact that this issue was not raised suggests that there had been a behind-the-scenes agreement between the authorities in Washington and the officers of the Texas Academy. Interestingly, the president of the Academy at this time was the well-known naturalist John Kern Strecker of Baylor University who was, himself, the author of a checklist of the birds of Texas.

Oberholser was humble and reflective while describing his ornithological work to the news media in San Antonio. He first noted that even with his many years of research and the "splendid support" received from the leading authorities, he had only partially covered the field of ornithology in Texas. Then, in a moment of personal reflection, he declared that working on the book had provided him with "the greatest pleasure" and many "delightful friendships." Additional praise was given San Antonio following his visit to the new aviary in Brackenridge Zoo, which he declared to be one of the most modern he had seen and that the city was to be congratulated on its variety of rare birds (Anon. 1931b,c).

A FAILED ATTEMPT TO PUBLISH

Arrangements were made during 1932 to publish the Oberholser manuscript and an attractive 4-page prospectus (Figs. 4-5) was printed and distributed throughout the state. The book, now titled *The Bird Life of Texas*, was to be published by the Texas Academy of Science in cooperation with the Bureau of Biological Survey and was to be made available at a prepaid price of $10.00. Members of the Texas Academy, American Ornithologists' Union, Cooper Ornithological Club, Wilson Ornithological Club, libraries, educational institutions and teachers were eligible for a special rate of $8.00 prepaid. The promotional blurb (Fig. 5) accompanying the prospectus confidently boasted that those individuals "accustomed to magnitude in everything pertaining to Texas…will find it in *THE BIRD LIFE OF TEXAS*." With 375 illustrations and 344 distribution maps the two-volume set was indeed a bargain when compared with today's prices.

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By

HARRY C. OBERHOLSER

Senior Biologist, Bureau of Biological Survey, United States Department of Agriculture

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The Illustrations comprise—

344 distribution maps of breeding and winter birds.
10 color plates of birds.
20 black-and-white plates of birds and Texas country.
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Published by the
Texas Academy of Science, San Antonio, Texas,
in co-operation with the
Bureau of Biological Survey, U. S. Department of Agriculture
The Southwest Press, Publisher's Agent
Dallas, Texas

Figure 4. Title page of the prospectus prepared by the Texas Academy of Science to solicit subscriptions for *The Bird Life of Texas*. From the Roy and Ellen Schulz Quillin Collection courtesy of Roy Kendall and Horace Burke.

The subscription period for the book was apparently kept open through 1935. In early April of that year the bird book committee of the Texas Academy met with Oberholser to discuss strategy for obtaining publication. The result of this meeting was that the manuscript, now re-titled *Birds of Texas and Their Habits,* would be published in 1936 as a centennial volume commemorating the independence of Texas (Anon. 1935a).

Although the book was advertised widely and priced to sell, subscriptions were slow in coming and the project ultimately failed. The adverse

A Texas Book *for* Bird Lovers

Americans are accustomed to magnitude in everything pertaining to Texas, and they will find it in THE BIRD LIFE OF TEXAS—the first comprehensive, authoritative book on the birds of this State. Over 600 species and subspecies are here described—*more birds than have been recorded for any other State*. Naturalists of all parts of the United States will find the book useful and interesting, for in Texas there are found not only most of the common birds of this country but also many species, the road-runner, for example, which in the United States are to be seen only in the Southwest.

The authoritativeness of THE BIRD LIFE OF TEXAS is assured by the reputation of the author. Doctor Oberholser has been studying the birds of Texas *for more than 30 years*, and during parts of six years has conducted field expeditions for the United States Biological Survey in all regions of the State, and at all seasons. To this first-hand knowledge he has added the advantages of laboratory studies and the contributions of *more than 250 Texas collaborators*. The result is this comprehensive work.

The book contains 375 illustrations, including *28 plates* (10 in colors) illustrating 32 species of birds, reproduced *from paintings by the late Louis Agassiz Fuertes*. All but one of the color plates and many of the others were prepared by Fuertes especially for this work, and *all but 4 of the 28 are here published for the first time*. Distribution maps—344, a greater number than in any other bird book—add greatly to the value of the work, by showing the winter ranges of many species of State and the summer ranges of practically all the birds that breed in Texas.

The book will be published in two *octavo* volumes—easily held in the hand. This feature, together with the typography selected (shown on pages 2 and 3 of this prospectus), will make it easily read. With its gold-lettered imperial blue fabrikoid binding, it will be *an attractive addition to shelf or table*.

PRICES and TERMS

Published by the Texas Academy of Science with the coöperation of the United States Biological Survey, THE BIRD LIFE OF TEXAS will be available at a *non-profit price of* $10.00, prepaid, from the publisher (Route 1, Box 368, San Antonio, Texas), or from the publisher's agent, The Southwest Press, Post Office Box 746, Dallas, Texas.

A Special Discount of 25 per cent (charges not prepaid) will be allowed libraries, educational institutions, and teachers. *Until publication* date the same discount—25 per cent—will be allowed members of the Texas Academy of Science and of the three largest scientific ornithological societies of North America—The American Ornithologists' Union, the Cooper Ornithological Club, and the Wilson Ornithological Club—*if remittance of $8.00 accompanies the order* (50 cents of this to cover carriage and packing charges). The blank below may be used.

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Figure 5. The back page of the prospectus prepared by the Texas Academy of Science to solicit subscriptions for *The Bird Life of Texas*. From the Roy and Ellen Schulz Quillin Collection courtesy of Roy Kendall and Horace Burke.

economic conditions of the time were undoubtedly a contributing factor. The country was in a major depression and many areas of the State were also suffering from drought. Many Texans would have undoubtedly liked to purchase the book but there were more urgent priorities on which to spend their limited income.

Failure to have the manuscript published in 1936 was obviously a disappointment to Oberholser, as well as to the Texas Academy and his many supporters throughout the State. His response to this failure was, however, not disillusionment, but instead a revision of the manuscript to include even more information. Efforts to secure funds for publication were also continued by the Academy. Roy Bedichek was asked to write a 2,000-word article on the birds of the Austin area for the Dallas News. The money received for this paid article would be used to defray the cost of the Oberholser book, which was scheduled to appear in 1938 (Bedichek 1937).

ADDITIONAL DELAYS IN PUBLICATION

Although the planned revisions of the manuscript were extensive, it was originally believed they would be complete sometime in 1938 (Anon. 1937a). However, in July 1938 Oberholser informed the San Antonio Light that completion would require "about two more years". As evidence of the enlargement of the text, it was reported that the book, now with its earlier title *The Bird Life of Texas*, would be published in three rather than two volumes (Anon. 1938). In November 1939 Oberholser again declared that his book, for which he was still gathering information, would be published "next year" (Anon. 1939).

"Next year" came and went with no progress toward publication. In 1940 Oberholser reached the mandatory retirement age for retirement but was given a one-year extension by President Roosevelt so that he could finish his work on the birds of Texas (Anon. 1941). In December 1941, Roy Quillin was informed "the book is now completed and I am marking time by trying to improve the manuscript as much as possible while the money for its publication is being obtained (Oberholser 1941). The group working to obtain the money was the "Oberholser Book Committee" of the Texas Academy. In their report for 1941 the committee, whose membership consisted of Oscar Alvin Ullrich, Samuel Wood Geiser, Ellen Shulz Quillin and Walter Penn Taylor, reported that that it was still working on plans to finance publication (Ullrich 1942).

Oberholser moved to Ohio following his retirement to become curator of ornithology at the Cleveland Museum of Natural History. He continued to work on the manuscript but hope began to fade as the years passed and the manuscript remained unpublished. Oberholser's frustration with the situation was conveyed a letter of April 1945 to Roy Quillin—"I had hoped to be able to get this book published long ago, but so many things have worked against its appearance that it has not been even near publication…I am hoping, however, that something will develop some day that will put the project over" (Oberholser 1945). An editorial in the Abilene Reporter-News for 23 May 1946 succinctly described the sad state of affairs:

> "What is probably the greatest work on the birds of Texas ever compiled may turn out to be a waste of effort for all concerned –unless some Texan, or group of Texans, who realize the value of such a work come forward with the necessary guarantee to have it published" (Anon. 1946).

It seemed in 1946 that the manuscript would never be published. However, it was rumored that the University of Texas was interested, although it did not presently have the necessary finances with which to proceed (Anon. 1946). For the next seventeen years the fate of the manuscript remained in limbo, and it was not until late 1961 that the University obtained a private bequest from Verna Hooks McLean that finally brought publication of the manuscript to fruition (Anon. 1961).

THE OBERHOLSER MANUSCRIPT AS HISTORY

The manuscript of *The Bird Life of Texas* is an extraordinary document produced by a man with a broad range of interests. Oberholser was a member of the Metropolitan Memorial Methodist Episcopal Church in Washington, D. C., and from 1899 until 1913 the leader of the adult bible class (Oberholser 1954). Because of his strict prohibitionist views his colleagues often referred him to as "H2O", a clever play on his manner of initialing specimen tags with

the letters "HCO". Oberholser enjoyed singing and collecting stamps, coins and ornithological literature. He was also a baseball fan and always attended, when possible, the opening games of the Washington Senators (Aldrich 1968). He belonged to 40 scientific and conservation societies, including the Texas Ornithological Society of which he was both a charter and honorary member.

First and foremost, Oberholser was a dedicated ornithologist. However, some aspects of his life suggest that he had a strong interest in history. In his autobiography, he notes with some pride the distinguished ancestry of his mother and wife and his membership in the Sons of the American Revolution. His membership in the Cosmos Club, a private social club for men distinguished in science, literature and the arts, further demonstrates that he was a man of broad vision. His personal library, considered one of the best in the country, consisted of a wide variety of classical ornithology literature (Oberholser 1954) thus suggesting that he viewed the history of ornithology as a worthy topic of study. Oberholser's interest in history, however, is most evident in the manuscript of *The Bird Life of Texas*.

Those people who have had the opportunity to examine the 12,000-page manuscript of *The Bird Life of Texas* are astounded by the enormous detail that it contains. Four sections of the manuscript deal mainly with the history of ornithology in Texas rather than its scientific aspects: (1) history of Texas ornithology, (2) species accounts, (3) gazetteer of Texas, and (4) the bibliography. The reduction of the manuscript by nearly two-thirds during its preparation for publication brought about significant changes in these four sections. The section on the history of Texas ornithology survived the editing process with only minor alterations whereas the species accounts and the bibliography were greatly modified. The gazetteer section was completely removed.

History of Texas Ornithology—This section of the manuscript describes the work of those early investigators that Oberholser considered to have made major contributions to the study of Texas birds. Included as a subsection was a list of all of the field naturalists of the Bureau of Biological Survey and the Texas Cooperative Wildlife Unit who worked in Texas from 1890 to 1940. Appended to each name were the dates and localities where that naturalist worked thus allowing the reader to place the work done by that individual in time and space. During the editing process the localities and specific dates were eliminated leaving only the names of the naturalists and the range of years that they worked in Texas. As a result, for example, we learn that Oberholser worked in Texas from 1900 to 1939 but are not told that from 1903 through 1927 he did no fieldwork in Texas. Neither do we learn the locations and dates where he did fieldwork during the years that he was in Texas.

Another subsection provides the names of 'Other Collectors' and the general locations where they worked in Texas from 1828 to 1940. This extensive list was obtained from published sources, as well as from the names appearing on the tags of the thousands of Texas specimens examined. With the exception of a few dozen prominent individuals, most of the people named in the list are unknown to present-day ornithologists. The inclusion of these obscure individuals suggests that Oberholser considered their contributions as important. In addition, it also highlights his obsession that the manuscript had to contain everything known about the birds of Texas, including the names of all of the people who had studied them.

Species Accounts—The manuscript contains detailed distribution records for each species and subspecies—who observed or collected them, where they were seen or collected and on what date. To compile this record, Oberholser searched obscure ornithological journals both domestic and foreign, as well as books, newsletters and hunting magazines. The only print source that he did not systematically examine was newsprint, most likely because there was no central collection of Texas newspapers and the immense effort required to gather and examine individual copies would have yielded little in return. The numerous records from Forest and Stream, American Field and Chicago Field testify to Oberholser's belief that hunters were competent in the identification of game birds, and that their observations and specimens, i.e., the birds they shot, were worthy of becoming a part of the ornithological record. During the editing process, the distribution entries were reduced to a symbol recorded on a county map of Texas. Lost from the historical record were the names of the observers or collectors, the specific locations where the species was seen or collected and the specific dates of observation or collection.

Gazetteer of Texas—This 353-page section includes the names of all places in Texas from which there were records of birds observed or collected. In addition, the gazetteer also included localities from which there were no present records of birds, it being reasoned by Oberholser that these places were so little known that it was advisable to include them for "possible future reference." The editor of the manuscript did not agree and the gazetteer was deleted as the manuscript was prepared for publication. Thus disappeared a multitude of place names that would excite the interest of any historian or geographer. What indeed might be the stories, ornithological or otherwise, behind locations with such intriguing names as Patterson Pot Hole, Bill Mutt Bayou, Bitch Creek Tank, Buzzard Mill, Democrat Crossing, Hell's Half Acre, Illusion Lake, Lucky Patch, Mud Dump, Nipple Hill, Poverty Reef, Wet Weather Lake, and Zulch? Some locations, such as Lake Surprise in Chambers County, which was once considered the best goose and duck lake in Texas, ceased to exist early in the 20th Century (Casto 2006). Other sites have disappeared due to development and the ravages of time. Changes in ownership have resulted in many of the original names of the ranches in the gazetteer being lost to memory. In retrospect, it can be said that Oberholser had a strong sense of place and the historical role that it played in the distribution of the birds of Texas.

The Bibliography—It was Oberholser's intent to include in his 572-page bibliography all publications from earliest times through 31 December 1945 that "furnish definite Texas information regarding some bird or birds." This objective was not fully realized since no attempt was made to gather all of the notices of Texas birds in newspapers and lesser-known sportsmen's magazines. Articles from major sports magazines such as American Field, Chicago Field and Forest and Stream were, however, cited since Oberholser considered information from these sources to be of "considerable value." Also cited were articles from ephemeral journals such as Bay State Oologist, The Curlew, The Naturalist, Nidologist, The Osprey, The Oologist, Random Notes on Natural History, Science News and Sunny South Oologist. Much of the information from the sports magazines and ephemeral journals was trivial, but it provides a contemporary view of Texas bird life as seen by observers of the 19th and early 20th centuries (Casto 2001).

The bibliography was purposely arranged by Oberholser to reflect the historical development of ornithology in Texas. Listing entries by year of publication and providing a brief annotation of their content accomplished this objective. As originally designed the bibliography represented the most comprehensive guide to the literature and conceptual development of ornithology in Texas ever assembled.

Major alterations were made to the bibliography during editing of the manuscript for publication. The citations were arranged alphabetically by author and, in order to reduce the length of the bibliography, 83% of the pre-1900 citations, as well as most of the annotations, were deleted (Casto 2001). The consequence of these alterations was the negation of the original purpose of the bibliography to serve as a guide to the historical development of ornithology in Texas.

A special effort was made to fully identify the authors whose articles were cited in the bibliography. Many sportsmen of the late 19th Century signed their reports using a moniker. By diligent inquiry Oberholser was able to determine the identities of such interesting characters as "Fusil"[George W. Baines], "Jacob Staff"[Amory R. Starr], "Archer"[G. A. Stockwell], "Elanoides" [Charles Durand Oldright], "Scolopax" [Robert Morris Gibbs], "Gaucho" [Arthur W. Dubray], "Arrow" [Junius P. Leach], "Bob White" [George Underwood] and "Bushwacker" [F. E. Phelps]. Many sportsmen writing under monikers could not be identified, a prime example being "Almo" who between 1878 and 1898 submitted 70 reports on the game birds of Texas in Forest and Stream, American Field and Chicago Field.

Complete names were also provided for well-known ornithologists who commonly used only initials for their given and middle names. For example, W. E. D. Scott [William Earle Dodge Scott], F. E. L. Beal [Foster Ellenborough Lasceiles Beal] and W. E. C. Todd [Walter Edmond Clyde Todd]. There were, of course, many authors whose complete names could not be determined.

NOT BY HIS EFFORTS ALONE

The final manuscript version of *The Bird Life of Texas* was the result of over six decades of dedicated work by Harry Oberholser. This monumental work of nearly 12,000 pages and

three million words could not, however, have been achieved without the assistance of over 250 individuals who, over the years, gave freely of their time and expertise. Oberholser was aware of this indebtedness, and he provided Edgar Kincaid, Jr. with a select list of those individuals who he regarded as having supplied particularly valuable information and encouragement (Kincaid 1974). An examination of the names in this list reveals the scope of Oberholser's contacts with a variety of Texans ranging from naturalists, educators and bird enthusiasts, as well as to practitioners of geology, law and taxidermy.

Individuals on the list who might be characterized as 'naturalists' were George Henry Ragsdale, Henry Philemon Attwater, Roy Bedichek, James Judson Carroll, Albert Joseph Bernard Kirn, Robert Lee More, Harris Braley Parks, Jerry E. Stillwell, Walter Penn Taylor and Roy William Quillin. Each of these men had an interest in natural history and, in some cases, a strong commitment to the study and conservation of birds. The inclusion of Ragsdale's name is somewhat puzzling since he died in 1895, five years before Oberholser first came to Texas. Ragsdale's notes and unpublished records are cited dozens of times in the unedited typescript of *The Bird Life of Texas*, and these data were presumably obtained from the Ragsdale family.

The naturalists on the list represent a broad spectrum of pursuits. H. P. Attwater was the most renowned naturalist in Texas with interests in all aspects of nature and conservation. Bedichek was a writer on nature topics whose books are still popular today. J. J. Carroll was a lumberman and amateur ornithologist with a strong commitment to conservation. A. J. B. Kirn was a general collector whereas R. L. More and Roy Quillin were noted oologists, each of which assembled a large collection of birds' eggs. Parks, an apiculturist, entomologist, and botanist, was active in the Texas Academy of Science, as well as being the senior author of a publication on the birds of the Big Thicket. J. E. Stillwell was an oil company engineer from Dallas who later specialized in recording birds' songs whereas W. P. Taylor was a professional biologist who worked with the Texas Wildlife Cooperative Research Station at Texas A&M University.

Educators named in the list included Ellen Schulz Quillin, director of nature study and science in the San Antonio public schools and later director of the Witte Museum; John Campbell Godbey, professor of chemistry at Southwestern University in Georgetown; Donald O. Baird, professor of biology at Sam Houston State Teachers College; George Guion Williams, professor of English at Rice University and publisher of Gulf Coast Migrant; Frederick A. Burt, professor of geology at Texas Agricultural and Mechical College; Harry Yandell Benedict, contributor of bird records from Young County and president of the University of Texas from 1927 until his death in 1937, and Oscar Alvin Ullrich, dean of the college of arts and sciences at Southwestern University. It seems evident that several of these educators were acknowledged, not for their technical contributions, but rather for their encouragement and efforts to secure publication of the manuscript This seems particularly true for Quillin, Godbey, Baird, Burt and Ullrich, all of whom were, at one time or another, officers in the Texas Academy of Science.

Martha Conger 'Connie' Hagar, Elizabeth 'Bessie' McCulloch Reid and Cora 'Corrie' Herring Hooks were bird enthusiasts who provided data to Oberholser. Connie Hagar grew up in Corsicana but moved during the mid-1930s to Rockport where her observations of resident and migrant birds established several new distribution records. Oberholser became aware of her work by reading the observations she submitted to the Gulf Coast Migrant. He was at first skeptical of some of her sightings but eventually came to regard her as a local expert and used many of her records in his book.

Bessie Reid, a self-taught naturalist, lived in Port Arthur before moving to Silsbee around 1950. Her skill in raising abandoned young birds and in rehabilitating those that had been injured was legendary. During the 1930s, she was considered to be "the best informed student of bird life in southeast Texas" (Parks and Cory 1938). Bessie often went on field trips with her friend Corrie Hooks who was also a dedicated student of nature. Corrie had been inspired to study birds after hearing Oberholser lecture in Beaumont and, in later years, provided him with records for his book. The relationship between Corrie Hooks and Oberholser would years later bear unexpected fruit in the form of a gift from Corrie's daughter, Verna Hooks McLean, that provided the money to finance publication of Oberholser's manuscript by the University of Texas Press.

Three individuals on the list represent the areas of law, geology and taxidermy. Royall Richard Watkins was a judge and former head of the State Board of Education from Dallas who assisted Oberholser in reconstructing the history of the Passenger Pigeon in Henderson County. William Armstrong Price was a consulting geologist from Corpus Christi known for his pioneering work on the geology of the Gulf Coast, and, who during 1936 was president of the Texas Academy of Science. Anton Mirales McLellan was a taxidermist and furrier from El Paso. The extent and nature of his contribution to Oberholser's book are unknown.

A LOOK BACK

The manuscript of *The Bird Life of Texas* as it appeared in 1946 was a treatise worthy of the great State of Texas. The 11,754 typewritten pages laid end-to-end would extend for slightly over two miles! Complementing the exhaustive text were the paintings and sketches of the artist Louis Agassiz Fuertes and a large number of black-and-white photographs of birds and their habitats.

Great accomplishments invite comparisons, and Oberholser's work was soon compared to that of John James Audubon and Alexander Wilson. As one writer declared "a treatise wrought with such pains, taking care and covering so wide a range will deserve a place among the great ornithologies (sic)" (Anon. 1938c). Another commentator described Oberholser's manuscript as being the work of a "great ornithologist who did for Texas what Audubon did for Louisiana" (Anon. 1946). Echoing these sentiments, Pat Ireland Nixon, historian of medicine in early Texas, voiced the opinion that the Oberholser volumes "may well be among the most important ornithological publications since Audubon" (Nixon 1961). These flattering comparisons undoubtedly stimulated Oberholser to continue working toward publication of his manuscript. However, he would not live to see this happen. He died in Cleveland, Ohio, on Christmas Day, 1963 and an additional 11 years would pass before his majestic work was finally published.

The manuscript of *The Bird Life of Texas* can be viewed in several different ways. The editorial staff that prepared the manuscript for publication perhaps saw it as overloaded with excessive detail, most of which had to be condensed or deleted in order to reduce the text to one-third its original size. Ornithologists valued the technical parts of the manuscript but viewed sections such as the 353-page gazetteer as having little to do with the study of Texas birds. On the other hand, academicians interested in the 'who, what and where' of ornithology in Texas would find a wealth of information of historical value. It is this latter group of scholars that the manuscript is of perhaps the greatest value. Those wishing to draw their own conclusions can examine an unedited copy of this historic document at the Briscoe Center For American History at the University of Texas in Austin. Microfilm copies of the manuscript (6 rolls) may also be purchased from the Briscoe Center.

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DARK-MORPH BROAD-WINGED HAWKS IN TEXAS AND AN UNPRECEDENTED FLIGHT AT SMITH POINT, CHAMBERS COUNTY

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ABSTRACT.—Dark-morph Broad-winged Hawks (*Buteo platypterus*) are rare in Texas, with the vast majority of individuals being noted at the state's four established hawk counts. Data on the occurrence of this form are recorded individually at two of those hawk counts, Hazel Bazemore Park, Nueces County, and Smith Point, Chambers County. Data from Hazel Bazemore Park indicate that dark morphs account for more than four of every 10,000 Broad-winged Hawks counted, averaging 25/year among 564,858 tallied Broad-winged Hawks; the actual number of dark morphs is probably somewhat higher due to detection difficulties at that site. The date span for dark-morphs at Hazel Bazemore Park is 19 September–5 November, with the peak of abundance being 26-30 September, coincident with that of Broad-winged Hawk numbers in general. Conversely, dark morphs are much rarer at Smith Point, which has a pre-2013 average of 3/year, but account for a larger percentage of tallied Broad-winged Hawks (at least 7 of every 10,000), due to the much smaller Broad-winged Hawk flight counted there (average of $<$ 40,000/year). The fall 2013 season at Smith Point saw an unprecedented flight of dark-morph Broad-winged Hawks, both for Texas and for North America north of Mexico, and that flight is detailed here.

Broad-winged Hawk is a small member of the widespread and varied genus *Buteo*, breeding in deciduous and mixed forest in Canada from northeastern British Columbia east through Nova Scotia and in the United States from northeastern North Dakota south (patchily) to eastern Texas, east through the panhandle of Florida, and north through Maine, though not on the coastal plain from Georgia to North Carolina (National Geographic Society 2008, Wheeler 2003). While the vast majority of that range is occupied solely by light-morph individuals, the rare dark morph is thought to be restricted as a breeder to the northwest corner of the range – "western and central Canada" (National Geographic Society 2008), with the only known breeders in the U. S. being in the Turtle Mountains, North Dakota (B. Sullivan pers. comm.) (Fig. 1).

Figure 1. Light-morph and dark-morph juvenile Broad-winged Hawks at Smith Point Hawk Watch on October 22, 2014. Photo taken by Tony Leukering.

The dark morph of Broad-winged Hawk is rare and poorly known, with few hard data defining its range during breeding or winter seasons. Hawk-count data from across the West and the Great Lakes region define rough boundaries of the area that migrants regularly traverse, but little in the way of details or of relative abundance has been published. Two of the four annual hawk counts conducted in Texas provide most of what we know about the occurrence of the form in the state, and those data are summarized here. Finally, details of an unprecedented late-season push of Broad-winged

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Hawks at Smith Point, one that included a large number of dark-morph individuals, are presented.

Below, unless otherwise attributed, data cited are taken from the Hawk Migration Association of North America (HMANA) website (www.hawkcount.org; accessed January 2014).

CURRENT KNOWLEDGE ABOUT MIGRATION OF DARK-MORPH BROAD-WINGED HAWK

Hawk-count data made available by HMANA and discussions with numerous raptor-migration experts indicate that dark-morph Broad-winged Hawks are tallied annually from the Pacific Coast (Golden Gate hawk count, San Francisco) east through the Great Basin (Goshute Mountains hawk count, Nevada) and the Rocky Mountains (various sites from Montana to New Mexico) to the western Great Lakes (Hawk Ridge hawk count, MN, and Whitefish Point hawk count, MI); there are exceedingly few verifiable records in eastern North America east or due south of the Great Lakes. A more thorough analysis of timing and abundance of migrant dark-morph Broad-winged Hawks outside of Texas will be published elsewhere.

TEXAS

Despite the immense size of the state of Texas, it supports just four annual hawk counts; by comparison, Massachusetts hosts at least seven. A spring count is conducted at Santa Ana National Wildlife Refuge, Hidalgo County, while spring and fall counts are conducted at nearby Bentsen-Rio Grande Valley State Park. Fall counts are run at Hazel Bazemore Park (or HBP) near Corpus Christi, Nueces County, and Candy Abshier Wildlife Management Area at Smith Point (or SP), Chambers County. Unfortunately, the two Hidalgo County counts apparently do not report the specific occurrence of dark-morphs separate from typical Broad-winged Hawks, so all data analyzed here are from HBP and SP.

Hazel Bazemore Park

The HBP hawk count has been covered annually in fall since 1997 and is the premier, high-volume hawk count in the United States, averaging 622,471 counted raptors per year (Table 1). Broad-winged Hawk accounts for 90.7% of all counted raptors (average 564,858), so it is no surprise that the site also records a relatively large number of dark-morph Broad-winged Hawks (24.7/year, range 0-73; Table 1); among U. S. hawk counts, only the Lucky Peak, ID, count averages more per season (26.3; 1995-2013). However, most passing raptors are very high and/or quite distant. Additionally, the sheer number of raptors passing can make it difficult to focus on determining the color of individual Broad-winged Hawks, particularly as the vast majority of birds travel rapidly past the count site. Thus, the number of dark morphs counted is almost certainly lower than the number actually passing the site. The only other hawk count that potentially sees more dark morphs is the Cardel/Chichicaxtle count conducted in the state of Veracruz, Mexico. That site, though, records four million or more raptors each fall and the counters certainly do not have the time to deal with determining the color morph of even a small percentage of the passing Broad-winged Hawks.

Due to the HBP count's location, and Broad-winged Hawk's predilection for avoiding substantial water crossings (Kerlinger 1989), this count lies on the primary southbound route for a large percentage of the world's Broad-winged Hawks (Alderfer 2006, pg. 144). However, because the primary southbound route of dark-morph Broad-winged Hawks seems to be in the montane West (Leukering et al. unpubl. ms.), even this site probably counts only a small percentage of this morph, as they undoubtedly slip by well to the west of the Park.

Broad-winged Hawk numbers peak at the site in late September, with the temporal occurrence of dark morphs matching that of Broad-winged Hawks in general. Of the 420 dark-morphs tallied during the count's history (19 September–5 November), 294 of them were noted passing in September, with 235 of those occurring 26-30 September. Interestingly, as the annual count of migrating Broad-winged Hawks has fallen over the course of the count's history, the absolute number and percentage of dark morphs has climbed (Table 2). This seeming discrepancy might be caused by one or both of two possibilities: 1) overall population of Broad-winged Hawk is declining while that of the area supporting dark morphs is increasing and 2) the lower number of Broad-winged Hawks passing Hazel Bazemore Park allows for the determination of color morph of a higher percentage of individuals. There is some suggestion that the species' breeding range is expanding to the north and west (Carlisle

Table 1. Comparison of numbers of dark-morph Broad-winged Hawks (BWHA) at two Texas fall hawk counts, with percentage of total Broad-winged Hawk tallies accounted for by dark-morphs.

	Hazel Bazemore Park			Smith Point		
Year	Total BWHA	# dark BWHA[1]	% dark BWHA	Total BWHA[2]	# dark BWHA[1]	% dark BWHA
1997	823602	12	0.001%	30417	2	0.007%
1998	970025	28	0.003%	16137	1	0.006%
1999	640258	6	0.001%	34243	0	0.000%
2000	396774	13	0.003%	29956	1	0.003%
2001	864355	0	0.000%	103612	18	0.017%
2002	464772	3	0.001%	65255	2	0.003%
2003	684815	4	0.001%	21799	0	0.000%
2004	989957	22	0.002%	26013	1	0.004%
2005	263101	73	0.028%	20380	5	0.025%
2006	767730	11	0.001%	49575	0	0.000%
2007	569839	18	0.003%	18828	1	0.005%
2008	370088	55	0.015%			
2009	403192	27	0.007%	85209	1	0.001%
2010	328730	70	0.021%	16707	5	0.030%
2011	445112	24	0.005%	48498	3	0.006%
2012	283755	11	0.004%	39452	3	0.008%
2013	336474	43	0.013%	28936	112	0.387%
Totals	9602579	420		635017	154	
Average	564858	25	0.004%	39689	10	0.024%
Avg w/o 2013	579132	24	0.004%	40405	3	0.007%

[1]Numbers of dark morph Broad-winged Hawks should be considered low estimates (see text).
[2] In 2008, Hurricane Ike caused cancellation of the Smith Point count after 11 September, so those data are excluded.

et al. 2007). Because this corner of the range is the apparent source of dark morphs, this range expansion is potentially increasing the absolute number of dark morphs, but there is no published, well-documented suggestion of a general Broad-winged Hawk population decline.

Smith Point

The Smith Point hawk count, like the HBP, has been conducted on a full-time basis annually since 1997, though most of the 2008 season was cancelled after September 11 due to the passage and effects of Hurricane Ike. From 1991 to 1996, the count was staffed by volunteers on a more-limited diel basis; we here use just the data obtained 1997-2013. While the count period at Smith Point was expanded from a start date of August 15 to August 1 in 2011, this has essentially no impact on Broad-winged Hawk numbers, as very few are recorded prior to early September.

The flight past SP is usually more complex than that past HBP, as is typical for peninsular hawk counts (Leukering pers. obs.). Because individual raptors, particularly those of soaring species like Broad-winged Hawk, are often present for numerous passes past the count site, SP counters generally have more chances to note dark-morph Broad-winged Hawks than do those at inland sites, such as HBP. Unlike at HBP, the absolute numbers and percentage of identified dark morphs has not changed appreciably during the course of the count's history (Table 3), excepting the unprecedented 2013 tally (Table 1).

Table 2. History of counts of Broad-winged Hawk (BWHA) and total raptors at Hazel Bazemore Park, 1997-2013 with six-year averages.

				Multi-year averages			
Year	Total BWHA	Total raptors	% of BWHA	# dark BWHAs	# BWHAs	# Total raptors	BWHA % of total
1997	823602	841138	0.979				
1998	970025	992950	0.977		1997-2002 (six years)		
1999	640258	687014	0.932	10.3	693298	731941	93.7%
2000	396774	444484	0.893				
2001	864355	897519	0.963				
2002	464772	528539	0.879				
2003	684815	727899	0.941				
2004	989957	1030849	0.960		2003-2008 (six years)		
2005	263101	297374	0.885	30.5	607588	663975	90.2%
2006	767730	825916	0.930				
2007	569839	649622	0.877				
2008	370088	452191	0.818				
2009	403192	457477	0.881				
2010	328730	381302	0.862		2009-2013 (five years)		
2011	445112	536353	0.830	35	359453	441301	81.3%
2012	283755	389366	0.729				
2013	336474	442009	0.761				
Average	564858	622471	0.907				

As at HBP, the peak of Broad-winged Hawk migration past SP occurs in late September, typically in the period 18-27 September. With the exception of one flight on 2 October 2012, this period has seen all of the $>$ 10,000-bird flights. Unlike at HBP, the occurrence of dark morphs at Smith Point does not match the temporal occurrence of Broad-winged Hawks in general. Instead, 33 of the 43 pre-2013

Table 3. History of counts of Broad-winged Hawk (BWHA) and total raptors at Smith Point, 1997-2013 with six-year averages.

				Multi-year averages			
Year	Total BWHA	Total raptors	% of BWHA	# dark BWHAs	# BWHAs	# Total raptors	BWHA % of total
1997	30417	42993	0.979				
1998	16137	25824	0.977		1997-2002 (six years)		
1999	34243	47337	0.932	4.0	46603	59237	78.7%
2000	29956	40766	0.893				
2001	103612	117517	0.963				
2002	65255	80984	0.879				
2003	21799	31885	0.941				
2004	26013	39658	0.960		2003-2008 (five years)		
2005	20380	35568	0.885	1.2	27319	39728	68.8%
2006	49575	58010	0.930				
2007	18828	33520	0.877				
2008							
2009	85209	94553	0.881				
2010	16707	24916	0.862		2009-2013 (five years)		
2011	48498	62163	0.830	24.8	43760	58383	75.0%
2012	39452	67369	0.729				
2013	28936	42915	0.761				
Average	39689	52874	0.907				

dark morphs were noted 12-20 October; the full range of dates being 9 September – 10 November.

UNPRECEDENTED NUMBERS OF DARK-MORPH BROAD-WINGED HAWKS AT SMITH POINT IN FALL 2013

Fall 2013 saw a very poor early-season raptor flight, with a relative dearth of Broad-winged Hawks. By 30 September, just 5925 had been tallied, which was the primary cause of low overall raptor numbers. However, on 19 October an immense and unprecedented late-season push of Broad-winged Hawks began. Though no Broad-winged Hawks were tallied on the rainy day of 21 October, this push resulted in a combined count of 14,012 for the period 19-23 October, with a peak of 5477 on 19 October, and four daily counts of $>$ 2000. These were the only post-15 October tallies of this magnitude in the count's history.

Not surprisingly given the date span, dark-morph Broad-winged Hawks were noted during this push (Fig. 2), but the incredible numbers were unprecedented: 112 in the period 19 October–10 November, with single-day counts of 28 (19

Table 4. Numbers of Broad-winged Hawks counted during late fall (16 October – 15 November) 2013 at two Texas hawk counts.

Date	Hazel Bazemore Park	Smith Point
	October	
16	652	344
17	1147	1178
18	199	250
19	1442	5477
20	1245	2758
21	23	
22	12	3657
23	22	2120
24	56	345
25	2	168
26	1	172
27	18	
28		57
29		1
30		
31	2	
October total	4821	16527
	November	
1	2	94
2	7	202
3	16	46
4	1	
5		
6	3	48
7	2	151
8	38	42
9	4	3
10		31
11	13	9
12		7
13	9	26
14	2	1
15	3	
November total	100	660
Late-fall 2013 total	4921	17187
Percent of 2013 total	1.5%	59.4%

Figure 2. Dark-morph adult and juvenile Broad-winged Hawk at Smith Point Hawk Watch on October 24, 2014. Photo taken by Tony Leukering.

October), 29 (20 October), and 25 (23 October) and with the highest single-view count of six dark morphs (19 October). Unfortunately, the volunteer counter on 22 October did not record the occurrence of the dark morphs seen that day, but Leukering photographed eight identifiably different individuals. Leukering photographed nearly half of the dark morphs noted during fall 2013 at SP and was able to determine that most individuals counted were identifiably different individuals, and that there was little in the way of multi-day occurrence of individuals (details to be published in a forthcoming paper by Leukering in the journal North American Birds.)

It seems logical to assume that a particular weather system or set of weather systems was the proximal cause for this anomalous flight. Fall 2013 did see a consistent upper-level high-pressure ridge stationed over the West Coast, while a low-pressure trough was centered over the northern Great Plains and Great Lakes region. This combination of features produced "a fairly strong and wide-ranging upper-level flow from the north and northwest during the Broad-winged Hawk push down the Intermountain Rockies, which then curved to a westerly and southwesterly direction across the border states and southern Great Plains" (P. Lehman in lit.). While a major flight down the spine of the western U. S. encouraged by favorable flight conditions may have then been pushed east by the westerly and southwesterly flow in the southwestern U. S., this in no way explains why Broad-winged Hawks were still present in such large numbers so late in the season.

Unfortunately, neither Commissary Ridge, WY, nor Manzano Mountains, NM—the two easterly montane hawk counts—reported 2013, thus eliminating any useful comparison between the relative abundances of dark-morph Broad-winged Hawks on the eastern and western southbound montane migration routes. However, the Bridger Mountains, MT, count recorded three dark morphs (singles on 21 & 22 Sep and 12 Oct) and the Goshutes Mountains, NV, count tallied seven (20 Sep–2 Oct), with four on 2 Oct. The 46 during fall 2013 at Lucky Peak, ID, accounted for the site's third-highest fall total (84 in 2009, 53 in 2011). The most westerly of the Great Lakes hawk counts, at Duluth, MN, did not see a late-season Broad-winged Hawk push, tallying just 36 after 5 October.

Where the large number of late-season Broad-winged Hawks went after passing SP is unknown. While 59.4% of SP's fall Broad-winged Hawk count (17,187) was tallied in the period 16 October–15 November, just 1.5% (4921) of HBP's 2013 count was notched in the same time period (Table 4). Since Broad-winged Hawks generally pass SP heading west and most Broad-winged Hawks travel to winter grounds by passing south through eastern Mexico, these late-season birds should be expected to pass by or near HBP. Table 4 shows that they were not detected from HBP, though may certainly have passed by close to the shore of the Gulf of Mexico, thus avoiding detection from HBP, which is 51 km inland. Interestingly, three dark-morph Broad-winged Hawks were noted in Florida in fall 2013, all on 28 October. One was among ten other Broad-winged Hawks at Alligator Point, Franklin County, during an abnormally robust late-season flight past that location (J. Murphy, fide R. Galvez) and two among a flock of 157 Broad-winged Hawks that passed the Florida Keys hawk count at Curry Hammock State Park, Monroe County,—that site's first-ever—on the same date (K. Ross pers. comm.). These data suggest another route by which these late-season individuals continued their fall migration. However, the Florida Keys hawk count recorded a relatively poor late-season (16 October

–15 November) tally of Broad-winged Hawks in 2013: 938 vs. the previous 13-year average of 1805 (R. Galvez, pers. comm.). This poor showing suggests that only a very small percentage of the late-season surge of Broad-winged Hawks passing SP continued clockwise around the Gulf of Mexico rather than the expected counter-clockwise path. Finally, a juvenile dark-morph Broad-winged Hawk was found 15 February 2014 in Plaquemines Parish, Louisiana (C. Rutt pers. comm.; http://www.flickr.com/photos/chrysoptera/12579803785/), suggesting a third option for these late Broad-winged Hawks: wintering in the U.S.

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TEXAS BIRD RECORDS COMMITTEE REPORT FOR 2012

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The Texas Bird Records Committee (hereafter "TBRC" or "committee") of the Texas Ornithological Society requests and reviews documentation on any record of a TBRC Review List species (see TBRC web page at http://texasbirds.org/tbrc/). Annual reports of the committee's activities have appeared in the Bulletin of the Texas Ornithological Society since 1984. For more information about the Texas Ornithological Society or the TBRC, please visit www.texasbirds.org. The committee reached a final decision on 84 records during 2012: 74 records of 39 species were accepted and 10 records of 9 species were not accepted, an acceptance rate of 88.10% for this report. In addition, there was 1 record which was withdrawn by the submitter (Connecticut Warbler, 2012-40). A total of 119 observers submitted documentation (to the TBRC or to other entities) that was reviewed by the committee during 2012.

The TBRC accepted two first state records in 2012. The additions of Double-toothed Kite and Nutting's Flycatcher bring the official Texas State List to 638 species in good standing. This total does not include the four species on the Presumptive Species List.

In addition to the review of previously undocumented species, any committee member may request that a record of any species be reviewed. The committee requests written descriptions as well as photographs, video, and audio recordings if available. Information concerning a Review List species may be submitted to the committee secretary, Eric Carpenter, 4710 Canyonwood Drive, Austin, Texas 78735 (email: ecarpe@gmail.com). Guidelines for preparing rare bird documentation can be found in Dittmann and Lasley (1992) or at http://www.greglasley.net/document.html.

The records in this report are arranged taxonomically following the AOU Check-list of North American Birds (AOU 1998) through the 53th supplement (Chesser et al. 2012). A number in parentheses after the species name represents the total number of accepted records in Texas for that species at the end of 2012. Species added to the Review List because of population declines or dwindling occurrence in recent years do not have the total number of accepted records denoted as there are many documented records that were not subjected to review (e.g. Brown Jay, Pinyon Jay, Tamaulipas Crow, and Evening Grosbeak). All observers who submitted written documentation or photographs/recordings of accepted records are acknowledged by initials. If known, the initials of those who discovered a particular bird are in boldface but only if the discoverer(s) submitted supporting documentation. The TBRC file number of each accepted record will follow the observers' initials. If photographs or video recordings are on file with the TBRC, the Texas Photo Record File (TPRF) (Texas A&M University) number is also given. If an audio recording of the bird is on file with the TBRC, the Texas Bird Sounds Library (TBSL) (Sam Houston State University) number is also given. Specimen records are denoted with an asterisk (*) followed by the institution where the specimen is housed and the catalog number. The information in each account is usually based on the information provided in the original submitted documentation; however, in some cases this information has been supplemented with a full range of dates the bird was present if that information was made available to the TBRC. All locations in italics are counties. Please note that the county designations of offshore records are used only as a reference to the nearest point of land.

TBRC Membership—Members of the TBRC during 2012 who participated in decisions listed in this report were: Randy Pinkston, Chair; Keith Arnold, Academician; Eric Carpenter, Secretary; Greg Cook, Tim Fennell, Mary Gustafson, Mark Lockwood, Jim Paton, Martin Reid, Byron Stone, and Ron Weeks. During 2012, Carpenter resigned his voting membership (but retained his Secretary position) and Ron Weeks' second term expired. Greg Cook and Mark Lockwood were elected to

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fill the two open positions. Both Mary Gustafson and Tim Fennell were re-elected as voting members after their first term expired. The Academician and Secretary were also re-elected.

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Additional Abbreviations—AOU = American Ornithologists' Union; NP = National Park; NS = National Seashore; NWR = National Wildlife Refuge; SHS = State Historic Site; SNA = State Natural Area; SP = State Park; TBSL = Texas Bird Sounds Library (Sam Houston State University); TCWC = Texas Cooperative Wildlife Collection (Texas A&M University); WMA = Wildlife Management Area.

ACCEPTED RECORDS

Brant (*Branta bernicla*) (29). One at Canyon, Randall, from 1 February–31 March 2012 (**ST**, BBr, BPi; 2012-14; TPRF 3011).

Masked Duck (*Nomonyx dominicus*) (94). One nw. of Zionville, Washington, from 16 August–3 September 2011 (NMG, JMc, AB,HK; 2011-79; TPRF 2975). One at Santa Ana NWR, Hidalgo, on 23 November 2011 (**LM**; 2011-92; TPRF 2989). One sw. of Port Lavaca, Calhoun, on 16 January 2012 (KK; 2012-08; TPRF 3007). One at Sabal Palm Sanctuary, Cameron, from 5 June–2 July 2012 (**SP**, ME, HH; 2012-44; TPRF 3030).

Red-necked Grebe (*Podiceps grisegena*) (24). One at Lake O'The Pines, Marion, on 27 December 2011 (**TiF**; 2011-105; TPRF 2999).

Manx Shearwater (*Puffinus puffinus*) (8). One off the pier/jetties, Matagorda Bay Nature Park, Matagorda, on 19 December 2011 (**PH**; 2011-102).

Brown Booby (*Sula leucogaster*) (32). One at Lake Sam Rayburn, San Augustine, on 7 July 2012 (**RB**; 2012-51; TPRF 3033).

Double-toothed Kite (*Harpagus bidentatus*) (1). One at High Island, Galveston, on 4 May 2011 (**DH**; 2011-67; TPRF 2970). This unexpected sighting represents the first record for Texas.

Short-tailed Hawk (*Buteo brachyurus*) (40). One at Rio Grande Village, Big Bend NP, Brewster, on 7 May 2011 (**JW**; 2011-54; TPRF 2977). One at Utopia Park, Uvalde, on 14 April 2012 (**MH**; 2012-47).

Surfbird (*Aphriza virgata*) (11). One at Packery Channel jetties, Nueces, from 22 March–1 April

2012 (**JiH**, **CDo**, JoM, RS, RP, MC, ByS; 2012-30; TPRF 3022).

Purple Sandpiper (*Calidris maritima*) (25). One at East Beach, Galveston, from 3–5 December 2011 (**BTa**, **EBa**; 2011-98; TPRF 2993). One ne. of Surfside, Brazoria, on 4 January 2012 (**JB**; 2012-02; TPRF 3002). One at Port Mansfield, Willacy, from 23 January–5 February 2012 (**CDe**, ME, DB, LBr; 2012-09; TPRF 3008). One at Packery Channel jetties, Nueces, on 28 March 2012 (**MC**, DMu; 2012-31; TPRF 3023).

Ruff (*Philomachus pugnax*) (34). One at El Franco Lee Park, Houston, Harris, from 31 October–16 December 2011 (**JO**, RP, ToF, PF, AW, SL, MRe; 2011-87; TPRF 2985).

Red Phalarope (*Phalaropus fulicarius*) (39). One at Packery Channel jetties area, Nueces, on 1 April 2012 (**GH**, MG; 2012-32; TPRF 3024).

Black-legged Kittiwake (*Rissa tridactyla*) (89). One at South Padre Island, Cameron, from 9–24 January 2012 (BiS, RS, ME, DB; 2012-05; TPRF 3005).

Little Gull (*Hydrocoloeus minutus*) (74). One at San Jacinto Battleground SHS, Harris, from 19–23 November 2011 (**CTL**, SL, MLi, ToF, PF; 2011-89; TPRF 2986). One at Lake Ray Hubbard, Dallas, on 12 December 2011 (**CR**; 2012-07). One at Lake Arlington, Tarrant, from 23 December 2011–14 January 2012 (**GC**, DDC, BTo; 2012-23; TPRF 3017). One at Lake O'The Pines, Marion, from 7–15 January 2012 (**DB**, **LBr**; 2012-03; TPRF 3003). One at Port Aransas jetty area, Nueces, from 13–15 February 2012 (**JoM**, CoM; 2012-15; TPRF 3012). Up to four at White Rock Lake, Dallas, from 13 February–19 March 2012 (**CR**, RP, BBa; 2012-19; TPRF 3034). Up to two at Port Aransas jetty area, Nueces, from 18 February–9 March 2012 (**CrM**, LK, JKr; 2012-18; TPRF 3015). One at Village Creek Drying Beds, Tarrant, from 28 February 2012–1 March 2012 (BTo; 2012-48; TPRF 3031). One at Lynchberg Ferry, Harris, on 14 April 2012 (**GP**; 2012-34; TPRF 3026). Little Gull was removed from the TBRC Review List at the TBRC annual meeting on 22 September 2012.

Mew Gull (*Larus canus*) (36). One at Mae Simmons Park, Lubbock, Lubbock, on 22 November 2011 (**SC**; 2011-94; TPRF 2991).

Great Black-backed Gull (*Larus marinus*) (49). One at Follett's Island, Brazoria, on 21 January 2012 (**RW**, TaF; 2012-27; TPRF 3019).

Brown Noddy (*Anous stolidus*) (20). One at mile 38, Padre Island NS, Kleberg, on 18 June 2008 (**BSa**; 2012-50; TPRF 3032). Two offshore, 26 miles e. of Port Aransas, Nueces, from 17 June–23 July 2011 (**JoM**, **NF**; 2011-71; TPRF 2978).

Arctic Tern (*Sterna paradisaea*) (9). One at Rollover Pass, Galveston, on 26 May 2011 (**DF**; 2011-59).

Snowy Owl (*Bubo scandiacus*) (7). One at Lake Ray Hubbard, Rockwall, from 11–19 February 2012 (BSt, BSm, SSm, RP, BTo, JP; 2012-16; TPRF 3013). One at Dallas, Dallas, on 26 February 2012 (**AC**; 2012-25; TPRF 3018).

Green Violetear (*Colibri thalassinus*) (73). One at sw. Austin, Travis, on 12 May 2012 (**MB**, KA; 2012-42).

Violet-crowned Hummingbird (*Amazilia violiceps*) (19). One at Christmas Mts., Brewster, from 1–6 December 2011 (**COJ**, MRe; 2011-96; TPRF 2992).

White-eared Hummingbird (*Hylocharis leucotis*) (33). One at Davis Mts. Resort, near Fort Davis, Jeff Davis, from 10–15 August 2011 (**BH**; 2011-77; TPRF 2979).

Buff-breasted Flycatcher (*Empidonax fulvifrons*) (26). Two at Madera Canyon, Davis Mts. Preserve, Jeff Davis, from 6 May–7 August 2011 (**MLo**, CR; 2011-52; TPRF 2976).

(Lawrence's) Dusky-capped Flycatcher (*Myiarchus tuberculifer lawrencei*) (14). One at Sabal Palm Sanctuary, Cameron, from 18 December 2011–6 March 2012 (**DJ**, BiS, MBS; 2011-103; TPRF 2997). One at Estero Llano Grande SP, Hidalgo, from 23–24 February 2012 (RS, TJ; 2012-28; TPRF 3020).

Nutting's Flycatcher (*Myiarchus nuttingi*) (1). One at Santa Elena Canyon area, Big Bend NP, Brewster, from 31 December 2011–11 January 2012 (**BPe**, KB, MY, EC, MRe, MLo; 2012-01; TPRF 2971). This sighting represents the first record for Texas.

Sulphur-bellied Flycatcher (*Myiodynastes luteiventris*) (20). One at Sabine Woods, Jefferson, on 15 September 2011 (**LBa**; 2011-82; TPRF 2981).

Sulphur-bellied/Streaked Flycatcher (*Myiodynastes luteiventris/Myiodynastes maculates*) (1). One at Paradise Pond, Port Aransas, Nueces, on 12 October 2011 (**ND**; 2011-85).

Rose-throated Becard (*Pachyramphus aglaiae*) (47). One at Santa Ana NWR, Hidalgo, from 16–21

September 2011 (MRi; 2011-81; TPRF 2980). One at Salineno, Starr, on 7 January & 5 February 2012 (**RA**, **PA**, MG, FC; 2012-04; TPRF 3004).

Black-whiskered Vireo (*Vireo altiloquus*) (36). One at Paradise Pond, Port Aransas, Nueces, on 16 May 2011 (**JoM**; 2011-63). One at Sabine Woods, Jefferson, from 17–24 April 2012 (**KS**, ThF, RP, EC, MLo, BPi, JKe; 2012-35; TPRF 3027). One at Quintana Neotropic Bird Sanctuary, Brazoria, on 11 May 2012 (**MSc**; 2012-39; TPRF 3029). One at Matagorda Island, Calhoun, on 14 May 2012 (**PH**; 2012-43).

Brown Jay (*Psilorhinus morio*) (5). Up to two at Salineno/Chapeno, Starr, from 3 December 2011–15 April 2012 (TD, MBS, BiS, RS, DMo, GE, JoM, FD, JoH, MRe; 2011-99; TPRF 2994).

Varied Thrush (*Ixoreus naevius*) (41). One at Buffalo Lake NWR, Randall, on 5 November 2011 (**BPi**; 2011-86; TPRF 2984).

Connecticut Warbler (*Oporornis agilis*) (11). One at Terlingua, Brewster, on 8 May 2011 (**MF**; 2011-50).

Golden-crowned Warbler (*Basileuterus culicivorus*) (21). One at the National Butterfly Center, Hidalgo, from 20 November–22 December 2011 (BiS, MG, JoM, MRe, CL; 2011-91; TPRF 2988). One at Frontera Audubon Thicket, Hidalgo, from 17 December 2011–4 March 2012 (ME, DMo; 2011-106; TPRF 3000).

Slate-throated Redstart (*Myioborus miniatus*) (10). One at Boot Canyon, Big Bend NP, Brewster, on 16 April 2011 (**CA**; 2011-42).

Flame-colored Tanager (*Piranga bidentata*) (10). One at Davis Mts. Preserve, Jeff Davis, on 30 July 2011 (**JKa**; 2011-80).

Crimson-collared Grosbeak (*Rhodothraupis celaeno*) (33). Two at Frontera Audubon Thicket, Hidalgo, from 21–22 November 2011 (**DJ**; 2011-93; TPRF 2990). One at Estero Llano Grande SP, Hidalgo, on 25 November 2011 (GP; 2012-17; TPRF 3014). One at Pharr, Hidalgo, from 7 December 2011–14 April 2012 (MSh, JoM, DMo, MG; 2011-100; TPRF 2995). One at Sabal Palm Sanctuary, Cameron, from 15 December 2011–16 January 2012 (DJ; 2011-104; TPRF 2998). One at Slaughter Park, Laredo, Webb, on 16 December 2011 (**ED**; 2011-101; TPRF 2996). One at Frontera Audubon Thicket, Hidalgo, from 17 December 2011–22 April 2012 (JC, BBe, JaM; 2012-29; TPRF 3021). One at the National Butterfly Center, Hidalgo, from 18–23 December 2011 (ME; 2011-107; TPRF 3001). One at Valley Nature Center, Weslaco, Hidalgo, on 1 May 2012 (BF, MBS; 2012-38; TPRF 3028).

Blue Bunting (*Cyanocompsa parellina*) (45). One at Sheepshead Lot, South Padre Island, Cameron, on 14 October 2011 (**LL**; 2011-84; TPRF 2983). One at Casa Santa Ana, Hidalgo, from 17–22 November 2011 (EBr, DJ; 2011-90; TPRF 2987). One near Bentsen SP, Hidalgo, from 4–5 January 2012 (MG; 2012-13).

Black-vented Oriole (*Icterus wagleri*) (9). One at & near Bentsen SP, Hidalgo, from 13 October 2011–10 January 2012 (**SSh**, JR, LF, MG, DMo, MBS; 2011-83; TPRF 2982).

White-winged Crossbill (*Loxia leucoptera*) (9). One nw. of Tarpley, Bandera, from 4–5 November 2011 (**RH**; 2012-10; TPRF 3009).

Common Redpoll (*Acanthis flammea*) (13). One at Southlake, Tarrant, from 7–10 January 2012 (**SW**; 2012-06; TPRF 3006). One nw. of Nacogdoches, Nacogdoches, from 27 January–21 February 2012 (**DW**, LS; 2012-20; TPRF 3016). One at Colleyville, Tarrant, from 29 January–1 February 2012 (**BTo**, DMo, JJ; 2012-11; TPRF 3010). One at Lake Bridgeport, Wise, from 10–19 February 2012 (**MSm**; 2012-33; TPRF 3025).

NOT ACCEPTED

A number of factors may contribute to a record being denied acceptance. It is quite uncommon for a record to not be accepted due to a bird being obviously misidentified. More commonly, a record is not accepted because the material submitted was incomplete, insufficient, superficial, or just too vague to properly document the reported occurrence while eliminating all other similar species. Also, written documentation or descriptions prepared entirely from memory weeks, months, or years after a sighting are seldom voted on favorably. It is important that the simple act of not accepting a particular record should by no means indicate that the TBRC or any of its members feel the record did not occur as reported. The non-acceptance of any record simply reflects the opinion of the TBRC that the documentation, as submitted, did not meet the rigorous standards appropriate for adding data to the formal historical record. The TBRC makes every effort to be as fair and objective as possible regarding each record. If the committee is unsure about any particular record, it prefers to err on the conservative side and not accept a good record

rather than validate a bad one. All records, whether accepted or not, remain on file and can be re-submitted to the committee if additional substantive material is presented.

Buller's Shearwater (*Puffinus bulleri*). One offshore, 145 miles east of Port Isabel, Cameron, on 1 December 2011 (2011-97).

Northern Goshawk (*Accipiter gentilis*). One at Palo Duro Canyon S.P., Randall, on 18 November 2011 (2011-95).

Little Gull (*Hydrocoloeus minutus*). One at Lake Iowa Park, Wichita, on 26 February 2012 (2012-24).

Great Black-backed Gull (*Larus marinus*). One at Boca Chica, Cameron, on 27 January 2012 (2012-12). One at Anahuac NWR, Chambers, on 24 February 2012 (2012-26).

Greater Pewee (*Contopus pertinax*). One at Boot Canyon, Big Bend NP, Brewster, on 15 August 2011 (2011-78).

Social Flycatcher (*Myiozetetes similis*). One at Brownsville, Cameron, in February 1887 (2010-85).

Black-capped Chickadee (*Poecile atricapillus*). Up to two at Mount Vernon, Franklin, from 17–20 February 2012 (2012-22).

Connecticut Warbler (*Oporornis agilis*). One at Muenster, Cooke, on 25 April 2012 (2012-37).

Golden-crowned Warbler (*Basileuterus culicivorus*). One at Packery Channel, Nueces, on 1 April 2011 (2011-65).

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IS THE TAMAULIPAS CROW (*CORVUS IMPARATUS*) AN "AT RISK" SPECIES?

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ABSTRACT.—The Tamaulipas Crow occurs from the Texas and Mexico border south into the northern portions of the state of Veracruz. Sightings of this species have steadily declined since the large invasion into Texas in the early 1970s. From an analysis of sightings from 1968 through 2013 based on the author's field notes, published records, communications with ornithologists conducting studies within the species range, e-bird records, and notes from experienced birders who have visited northeast Mexico, it was concluded that numbers have precipitously declined and that the species should be considered an "at risk" species.

Inhabiting the Texas-Mexico border near Brownsville, Texas and the Mexican states of Tamaulipas, Nuevo Leon, San Luis Potosi, Veracruz, Hidalgo and possibly Querétaro (Fig. 1) the Tamaulipas Crow *Corvus imparatus* was previously considered one of two races of the Mexican Crow (Howell and Webb 1995). In 1998 the Mexican Crow was split into two species with the northeast Mexican race becoming the Tamaulipas Crow *C. imparatus* (Fig. 2) and the west Mexican race becoming the Sinaloan Crow *C. sinaloae* (AOU 1998, Hardy 1990). Considered commensal with man the Tamaulipas Crow is a Mexican endemic with a historic distribution of 161 km (east- west) x 202 km (north-south) from Brownsville, Texas to near Tampico. Its distribution extends to the Gulf of Mexico on the east and the Sierra Madre Mountains on the west. The species is patchily distributed on ranchlands, agricultural farms, rubbish dumps, and sanitary landfills. In response to a perceived decline in numbers its distribution and numerical status was investigated.

METHODS

The population status and distribution of the Tamaulipas Crow was analyzed from 1968 through 2013 using observations sourced from published records, author's field notes, the literature, communications with ornithologists conducting studies within the species range, e-bird records, and notes from experienced birders who have visited northeastern Mexico. Multiple sightings from the same location, within the same month, were considered as a single sighting with the largest number recorded included in the analysis. While the sightings are biased towards locations accessible by automobile, we assume that this bias applies throughout the study period and that the numbers observed from year to year are valid indicators of the species' total population changes.

RESULTS

Figure 3 depicts crow numbers, from 1968 through 2013 from pooling all sources (n = 156).

Figure 1. Range and Distribution of Tamaulipas Crow using eBird Data. Source: eBird.org (2014) downloaded 16 January 2014.

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Figure 2. Tamaulipas Crow photographed by the author near the Rio Guayalejo Bridge in Tamaulipas, Mexico. Photo from Eitniear (1987).

Three periods of population change are apparent, the first being 1968-1972 during which large flocks were observed in Texas. From 1973 through 2000 the population appears to have declined by 50%.

Finally, from 2001 to the present, there is another 50% decline in the population. Possible explanations for such changes will be explored in the discussion section. Details on the species status follows. A gazetteer of locations where *C. impartus* has recently been observed is included in Table 1.

TEXAS

The crow's historical presence in Texas is well documented in Brush (2005) and Oberholser (1974). In summary, the species was first recorded in Texas in 1968 with the observation of 200 birds feeding at a ranch west of Brownsville. Principally winter residents, their numbers increased with the largest flock noted being 2,300 at the Laguna Atascosa National Wildlife Refuge during January of 1970 (Arvin et al.1975). The first evidence of breeding was four nests at the Port of Brownsville in 1989. Numbers and nesting attempts began to decline in the 1990s (single nest sighted irregularly from 1998–2002) with the species being added to the Texas Bird Record Committee (TBRC) "review list" in 2000. Since that time small numbers of Tamaulipas Crows have been documented (Table 2) in Cameron County from 2001 to 2010 (except 2009). No observations have been accepted by the TBRC from 2011-2013 (E. Carpenter pers. com).

MEXICO

Tamaulipas

Since a 2001 sighting of 50 birds roosting at the Matamoros landfill (Brush 2005) the crow's numbers have significantly declined in the border region. Often only an occasional individual generally observed until (Fig. 1) reaching the Mexican coastal city of La Pesca where numbers increase.

Further inland near the Rio Corona Dave Krueper and Tim Brush spent 5 days in 2003 with

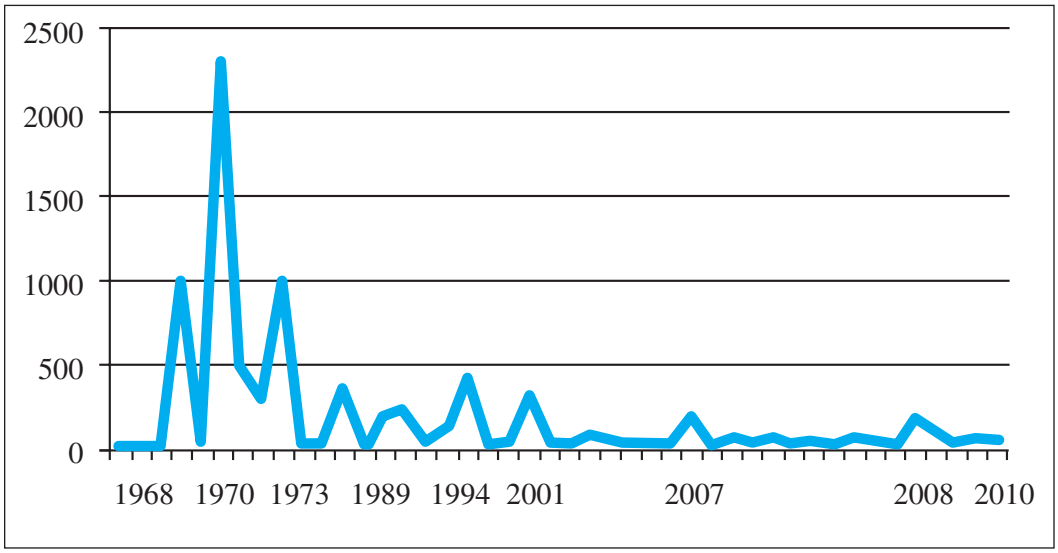

Figure 3. Numbers of Tamaulipas Crows observed from 1968-2010. n=156.

Table 1. Gazetteer of Localities where Tamaulipas Crows have been sighted (2000-present).

Site[1] (Year crows observed)	Coordinates								Source
Brownsville, Texas (2010)	26°	00’	17.35"	N,	96°	07’	17.32”	W	E. Carpenter pers comm.
Ciudad Victoria, Tamps (2008)	23°	07'	31.73"	N,	99°	01’	1.13"	W	B. Frenz pers comm.
Sota la Marina,Tamps (2005)	23°	46'	14.12"	N,	98°	12'	6.19"	W	R. Behrstock pers. comm.
Rancho Los Colorados,Tamps (2000)	22°	54'	12.17"	N,	97°	50'	3.72"	W	E. Enkerlin pers comm.
Aldama, Tamps (2007)	22°	55'	12.72"	N,	98°	04'	6.09"	W	R. Valdez pers comm.
La Pesca, Tamps (2007)	23°	46'	53.80"	N,	97°	44'	8.45"	W	D. Krueper pers. comm.
Cd. Mante, Tamps (2007)	22°	44'	39.74"	N,	98°	58'	0.27"	W	T. Ludwick pers comm
Llera, Tamps (2007)	23°	22'	02.38"	N,	93°	17'	3.46"	W	D. Benn pers comm.
Rio Corona, Tamps (2002)	23°	55'		N,	99°	00'		W	D. Kreuper pers. comm.
Gomez Farias,Tamps (2010)	22°	59’	59.62"	N,	99°	06'	35.23"	W	R. Hoyer pers comm. A. Gahem pers comm.
Tampico,Tamps (2008)	22°	17'	35.30"	N,	97°	53'	04.79"	W	B. Frenz pers comm.
Loma Alta,Tamps (2010)	18°	24'	50.85"	N,	96°	18'	50.28"	W	T. Ludwick pers comm.
Monterrey, N.L.(2014)	25°	40'	23.56"	N,	100°	18'	33.12"	W	Ebird.org
Linares, N.L.(2014)	24°	51'	35.00"	N,	99°	34'	00.00"	W	Ebird.org
Montemorellos, N.L.(2014)	22°	40'	11.53"	N,	82°	51'	31.71"	W	Ebird.org
Cuidad del Maiz, S.L.P. (2011)	22°	23'	37.30"	N,	87°	24'	17.64"	W	Ebird.org
El Naranjo, S.L.P. (2003)	22°	31'	36.80"	N,	99°	19'	32.36"	W	J. Booker pers comm.
Tamazunchale, S.L.P (2003)	21°	15'	33.81"	N,	98°	47'	17.34"	W	J. Booker pers comm.
Cd. Valles, S.L.P (2008)	21°	59'	40.79"	N,	99°	00'	38.66"	W	R. White pers comm.
Palmiro Nuevo,S.L.P (2008)	21°	41.0'		N,	98°	57.8'		W	C. Harrison pers comm.
El Pujal,S.L.P. (2008)	21°	50.9'		N,	98°	56.4'		W	C. Harrison pers comm.
Rio Tecolutla,Ver (2008)	20°	28'	11.10"	N,	97°	00'	41.59"	W	J. Arvin pers comm.
Cucharas ,Ver (2007-08)	21°	37'	4"	N,	97°	39'	21"	W	G. Dominguez pers comm.
Tempoal, Ver (2003)	21°	31'	0'	N,	98°	23"	0'	W	S. Bailey pers comm.
La Guadalupe, Ver (2008)	17°	22'	12.23"	N,	92°	35'	51.78"	W	Ebird.org
Orizatlan, Hgo (2007	21°	9'	16"	N,	98°	37'	43"	W	Valenca-Herverth et al 2009
Jaltocan, Hgo (2007)	21°	07'	59"	N,	98°	32'	17"	W	Valenca-Herverth et al 2009
Huejutla, Hgo (2007)	21°	10'	31"	N,	98°	17'	41"	W	Valenca-Herverth et al 2009
Tlanchinol, Hgo (2007)	21°	07'	52"	N,	98°	41'	26"	W	Valenca-Herverth et al 2009
Huazalingo, Hgo (2006)	20°	59'	19"	N,	98°	30'	16"	W	Valenca-Herverth et al 2009
Atlapexco, Hgo (2007)	21°	04'	22"	N,	98°	22'	25"	W	Valenca-Herverth et al 2009
Huautla, Hgo (2005)	21°	01'	30"	N,	98°	30'	16"	W	Valenca-Herverth et al 2009

[1]Mexico State Abbreviations- ISO 3166-2, International Organization for Standardization. (accessed 21 January 2014).

no sightings; additional visits in 1996 and 1998 also resulted in no sightings (D. Krueper pers. com.). This is consistent with the observations of Gehlbach et al. (1976). Robert Behrstock (pers. com.) reported as many as 10 near La Pesca and enroute to the beach near Sota La Marina during the second week of November 2006 and 2007. However, James Booker (pers. com.) commented that during a full morning and afternoon of birding at La Pesca on 19 December 2008 “we missed them entirely.” This contrasts with Michael Retter (pers. com.) who, during 28-30 April 2008, recorded flocks of 20-40 in various locations near La Pesca. Booker also mentioned that during a trip on 20 December 2008 from McAllen, Texas down the Gulf Coast to Catemaco, Veracruz the only crows he observed were a flock of 40 at Tecolutla. During 19-28 June and 10-19 July 1996 Earthwatch (1996) sponsored research on *Amazona* parrots at Rancho Los Colorados, near Aldama, where up to 30 crows were observed daily. A visit in 2013 to the ranch indicated that the population remains unchanged (Rene Valdez pers. com.)

Nuevo Leon and San Luis Potosi

These two states are principally mountainous and therefore outside the species preferred habitat. Numerous incidental observations of small numbers, or single birds, have been recorded on *eBird.org* from the following cities: (NL) Monterrey, Linares, Montemorellos, Cuidad del Maiz, (SLP) El Naranjo, Tamazunchale, Cd. Valles (eBird.org 2014).

Table 2. Records of Tamaulipas Crow in Texas since it was listed as a TBRC review Species.

Date observed	# crows	City	County	Source[1]
18 Mar-22 May 2001	(4)	Brownsville,	Cameron Co.	(TBRC 2001-65)
13 Mar-11 Jul 2002	(6)	Brownsville,	Cameron Co.	(TBRC 2002-47;TBSL 235)
15 Mar 2003	(2)	Brownsville,	Cameron Co.	(TBRC 2003-18; TPRF 2161)
02 May-26 July 2004	(4)	Brownsville,	Cameron Co.	(TBRC 2004-35; TPRF 2206)
26 Mar-Jul 2005	(6)	Brownsville,	Cameron Co.	(TBRC 2005-74; TPRF 2314)
06 Mar-3 July 2006	(7)	Brownsville,	Cameron Co.	(TBRC 2006-48; TPRF 2415)
08 Apr-15 Jul 2007	(2-4)	Brownsville,	Cameron Co.	(TBRC 2007-26; TPRF 2481)
31 Mar 2008	(?)	Brownsville,	Cameron Co.	(TBRC 2008-23; TPRF 2575)
26 Mar-5 May 2010	(1-2)	Brownsville,	Cameron Co.	(TBRC 2010-25; TPRF 2805)

[1]TBRC=Texas bird record file, TPRF=Texas photo reference file.

Table 3. Highest Numbers in a single flock (by decade) 1960-2010.

Year	Number	Source
1960-1970	1000	Arvin et al. 1970
1971-1980	2300	Arvin et al. 1970
1981-1990	355	Audubon Christmas Count 1988-89
1991-2000	438	Audubon Christmas Count 1994-95
2001-2010	480	Brush 2005
2010-present	50	R. Valdez pers. Comm.

Hidalgo and Querétaro

Valencia-Herverth et al. 2009 reported on Tamaulipas Crows in seven municipalities in northeastern Hidalgo including 5 active nests in one location. Roberto Pedraza (pers com.) stated that the species was found in the northeastern portions of the Biosphera de Sierra Gorda, Querétaro but was not common.

The species is not included in avian checklists for Querétaro by Lepage (2014) or Pineda-Lopez (2010).

Veracruz

During 11 monthly visits to Tamiahua Lagoon near Cucharas between Feb 2007 and March 2008 the species was always present in groups of 5-10 birds (Garcia Dominquez pers. com). Additionally, Cliff Shackelford and John Arvin saw scattered pairs from Tecolutla to Nautla during July 2000 (J. Arvin pers com.). In contrast Roberto Straub travelled from Xalapa to Tamaulipas in January 2011 and saw no crows (R. Straub pers. com.). eBird.org indicates small numbers at La Guadalupe and Loma Alta.

DISCUSSION

Estimating the size of the crow's population is problematic. It has a patchy distribution and its gregarious nature results in flocks continually traveling in search of food resources. As was illustrated by the researchers at La Pesca, the crow not only displays seasonal shifts but also daily movements which may permit a flock to be observed one day but not the next.

Three periods of population change are apparent. The first,was 1968-1972, during which large flocks were observed in Texas originating from further south in Mexico. Oberholser (1974) attributes this population spike to the impact of a 1968 farming decline in northeast Mexico and the accelerated use of DDT. Presumably the reduction in farming and the use of agrochemicals resulted in a decline in insect populations, which was the principle food of the crow. From 1973 through 2000 the population appears to have declined by 50%. Agrarian reform in Mexico may have contributed to this change in the face of a possible peasant revolt in 1970 when President Luis Echeverria legalized the takeover of foreign-owned farms, turning them into collective ejidos. Then in 1991, President Carlos Salinas de Gortari amended Article 27 of the Mexican Constitution, making it legal to sell ejido land or put it up as a collateral for loans. These land ownership changes may have altered population centers from small ejidos to larger villages and cities, effectively reducing food resource availability for crows. Another possible factor influencing the population is West Nile virus. In the five years since West Nile virus was first detected in the Western Hemisphere (New York City in 1999), it has spread west to the Pacific Coast of the United States, north and west through seven Canadian provinces, and south to the Caribbean and Central America (Caffrey et al 2005) check font size. In Mexico, West Nile virus (WNV; family Flaviviridae, genus *Flavivirus*) was first

isolated in 2003 from a Common Raven (*Corvus corax*) carcass in Tabasco (southeast Mexico) (Estrada-Franco et al. 2003). During this time West Nile virus was ravaging the American Crow (*Corvus brachyrhynchos*) population. Field and laboratory evidence suggests that most if not all members of the genus *Corvus* are at great risk of infection, and that survivorship of infected individuals is close to zero. Unlike 24 other species of birds tested, American Crows have become infected through every route examined—getting bitten by infected mosquitoes, eating infected prey, drinking water containing viral particles, and being in physical contact with infected conspecifics (Komar et al. 2003). Although no studies have been conducted on the Tamaulipas Crow, it seems plausible that the virus equally affects this species. Carcasses of deceased crows would be rapidly disposed of by a variety of scavengers, making discovery by the occasional birder or biologist unlikely. Finally, from 2001 to the present, another significant decline in the population occurred, perhaps due to the synergistic effect of agricultural shifts to large monocultures, drought, improved sanitary landfill practices that rapidly bury garbage, and possibly low reproduction due to losses of adults by West Nile virus.

As shown in Table 3, the population of Tamaulipas Crows has suffered severe population reductions since 1968. Although the largest flock size increased from 1991-2010 it remains significantly smaller than pre-1980 numbers and has recently reclined. While currently placed in the risk category of *Least Concern* by Birdlife International (2012), it would appear to warrant uplisting to *Vulnerable*. With additional monitoring further uplisting to *Near Threatened* may well also be justified. The following quote summarizes the current situation *"Where one used to see 100s, you're lucky to find 5-10 birds, which is what we found near Ciudad Victoria"* (Janet M Ruth, USFWS pers. com.). Such an observation when supplemented with others supports the conclusion that the Tamaulipas Crow is an "at risk" species.

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SHORT COMMUNICATIONS

DEFINITIVE NESTING OF SEASIDE SPARROWS AT LAGUNA ATASCOSA NATIONAL WILDLIFE REFUGE, CAMERON COUNTY, TEXAS.

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The breeding range of the Seaside Sparrow (*Ammodramus maritimus*) extends from the southern tip of Maine to the central Gulf Coast of Texas. Previously, the southern limit of breeding populations of Texas Seaside Sparrows (*A.m. senetti*) was documented as Copano and Nueces bays (Post and Greenlaw 1994) near Corpus Christi, Texas. Typical habitat reported for Seaside Sparrows includes salty-to-brackish marshes dominated by cordgrass (*Spartina* spp.), a variety of rushes (*Juncus* spp.), marsh elder (*Iva frutescens*), and seashore dropseed grass (*Sporobolus virginicus*) (Marshall and Reinert 1990, Post and Greenlaw 1994).

Seaside Sparrows were reported breeding in the Rio Grande delta in May and June, 1999 (Phillips and Einmen 2003), well south of the historic breeding range. However, this report was based on circumstantial evidence which included nest fragments that were assumed to be from Seaside Sparrows.

We photographed active Seaside Sparrow nests and observed numerous juvenile Seaside Sparrows on the Laguna Atascosa National Wildlife Refuge (LANWR), Cameron County, Texas during their typical breeding season, well south of their historic breeding range. In April, 2012, we observed abundant Seaside Sparrows along the Cayo Atascoso in the northern portion of LANWR. Male sparrows were observed singing and numerous aggressive interactions between adults suggested the establishment of nesting territories. We returned in July, 2012 and observed Seaside Sparrows regularly demonstrating behavior consistent with territoriality. We also observed Seaside Sparrow adults carrying food items to a specific location and leaving with the food item absent. Subsequently, we searched the area and located a nest containing three Seaside Sparrow nestlings about 32 m from the shore of Cayo Atascoso (Fig. 1). The nest was constructed in a stand of saltwort and sea oxeye daisy measuring 67 cm high. The top of the nest was 49 cm above the ground, and the nest cup was 5 cm wide and 6 cm high. We located a second nest in the same manner.

Figure 1. Seaside Sparrow nest in saltwort and sea oxeye daisy with three nestlings.

Again, three nestlings were present and the nest was about 25 m from shore and 450 m from the first nest (Fig. 2). This nest was also constructed in a stand of saltwort surrounded by sea oxeye daisy measuring 65 cm high. This nest was 45 cm above the ground with a nest cup 5 cm wide and 7 cm high.

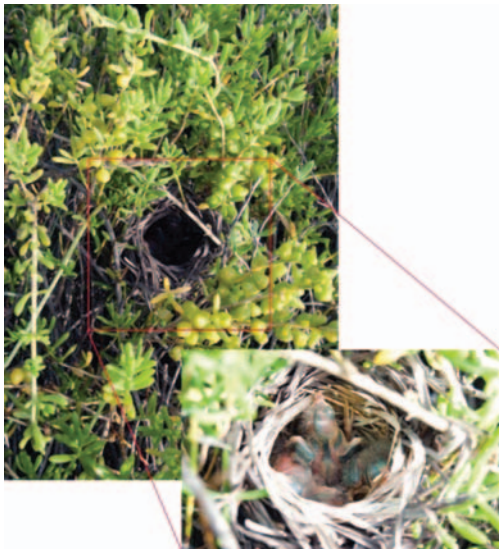

Figure 2. Second Seaside Sparrow nest in saltwort and sea oxeye daisy with three nestlings.

In addition to the two active Seaside Sparrow nests, we observed numerous juvenile Seaside Sparrows along the Cayo Atascoso during July and October, 2012. Juveniles were distinguishable from the adults by their faint plumage, often larger eyes, and grouped behavior. Adults were rarely seen in groups of more than 3 unless during an altercation whereas juveniles were observed in groups averaging five members, but as large as 10. This site was visited each season during 2012 and Seaside Sparrows were observed during each visit. We would like to thank the staff of LANWR for their assistance.

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A CASE OF HERMAPHRODITISM IN A WOOD DUCK (*AIX SPONSA*)

Janelle E. Mikulas[1] and Daniel M. Brooks[1, 2]

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The Wood Duck (*Aix sponsa*) is a North American duck that exhibits the characteristics of typical dichromatic species, with male breeding plumage brighter in color compared to the drab brownish female counterpart (Hepp and Bellrose 1995).

Several studies have focused on the costs and benefits of brightly colored plumage in male birds, such as conspicuousness to predators and potential mates (Dale and Slagsvold 1996), the mating advantage in males expressing delayed plumage maturation (Hakkarainen et al. 1993; Karubian et al. 2008), and the advantage of crypsis in females to decrease predation (Brooks et al. 1999; Amundsen 2000). Further investigations have examined the driving force behind female preference for brightly colored males (Lozano 1994). However, a keen interest has focused on the expression of male plumage coloration in females. Modified female coloration patterns have been naturally and artificially examined in several species of poultry (Cole and Lippincott 1919; Parkes and Brambell 1926; Fitzgerald and Cardona 1993). Herein we

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describe an apparent case of hermaphrodism in a Wood Duck (Fig. 1).

The Wood Duck specimen was collected along the Trinity River, east of Cleveland and north of Liberty (Liberty County, TX) on 21 January 2012 by Jason Overall, along with two male Wood Ducks from a flock of five individuals flying by. The ducks were feeding on acorns submerged in 10-15 cm of rain water from rain showers on 20 January 2012. The unusual specimen was prepared as a taxidermy mount by Lowell Shapley after it was collected, and had characteristics of both female (distinctive white eye ring, face lacking iridescent green or extensive striping pattern) and male (typical breast pattern, iridescent patches on top of head and parts of wing and tail coverts) (Fig. 1). These unusual features prompted Shapley to save the carcass for gross examination and donate the mounted specimen to HMNS (HMNS VO 3447).

JEM dissected the reproductive tract on 8 February 2012 and found the presence of both an ovary and testes, with the ovary and left testes forming an ovotestis (11 x 5 mm, contained no oocytes ≥ 1 mm in diameter) and the right testes normal in appearance (5 x 3 mm), confirming the individual was a true hermaphrodite. Further histological analysis would be necessary to determine if the ovarian and/or testicular tissue was fully functional.

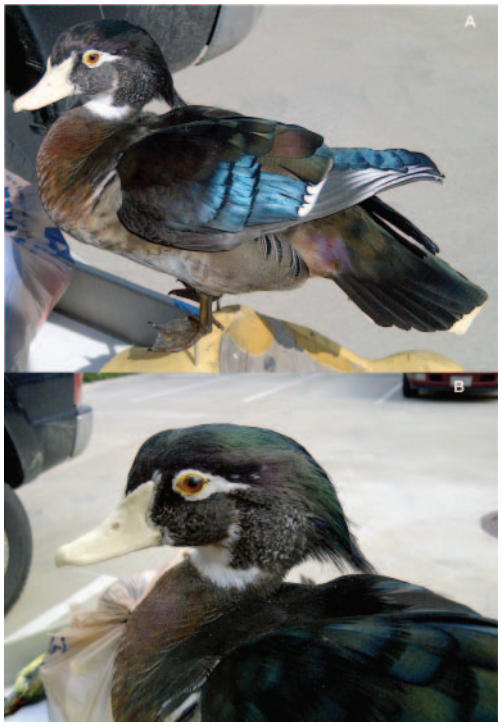

Figure 1. Wood duck (*Aix sponsa*) taxidermy mount which presents an intermediate plumage appearance between genders. (A) Full body mount. (B) Left side of mounted head.

Research has shown that shifts in plumage coloration is hormone-dependant (Lank et al. 1999; Kimball 2006). Specifically, male coloration patterns can develop due to estrogen breakdown in aging females (Kimball and Ligon 1999; Doucet et al. 2007) or degeneration of ovaries caused by a pathologic condition (Parkes and Brambell 1926) or abnormalities during fertilization (Fitzgerald and Cardona 1993). The specimen appeared to be a healthy individual, in behavior and morphology. The reproductive tract showed no signs of disease, suggesting this observed change in secondary sexual characteristics is due to an embryonic abnormality, not a degeneration of ovarian tissue, or estrogen breakdown due to age.

In addition to morphological shifts, such females may also exhibit male behavior, including courting, mating, and occasionally successful fertilization of other females (Cole and Lippincott 1919). Future studies examining long-term behavior of such individuals as we have described would provide a unique perspective on the behavioral implications of such an anomaly.

ACKNOWLEDGMENTS

We are grateful to Jason Overall and Lowell Shapley (Gulf Coast Waterfowl) for providing the specimen described herein. Thanks to Stephanie Jones and Jim Dubovsky for their comments on the ms.

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GOLDEN-FRONTED WOODPECKER EATING CARRION

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The Golden-fronted Woodpecker *Melanerpes aurifrons* occurs from southwestern Oklahoma through Texas and Mexico as far south as northern Nicaragua. Golden-fronted Woodpeckers are omnivorous, foraging at all levels in trees and on the ground where they search for insects. Acorns, pecans, wild fruits, citrus, whole corn and cornmeal, and even dog food are eaten (Bent 1939, Casto 1973). At 18:30 hr on April 26, 2013 at the Santa Clara Ranch located in Starr County, Texas. 26° 33" 02.59' N, 98° 32" 29.34' W a dead mouse (*Peromyscus* sp.) was discovered in a hunting blind placed in Tamaulipan thorn brush. The mouse appeared freshly killed of an unknown cause. After discovered the mouse was placed in front of the blind in hopes of luring a Greater Roadrunner (*Geococcyx californianus*). Within a short period of time a Golden-fronted Woodpecker landed and walked up to the mouse. The woodpecker prodded the mouse a few times then picked it up and flew off with it. While woodpeckers have been documented to feed on a variety of items in addition to this account of the Golden-fronted Woodpecker only the Red-headed Woodpecker (*Melanerpes erythrocephalus*) has been documented to eat small mammals (Smith et al. 2000; Beal 1911).

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ACKNOWLEDGMENT

I thank Kimberly Smith for commenting on the manuscript.

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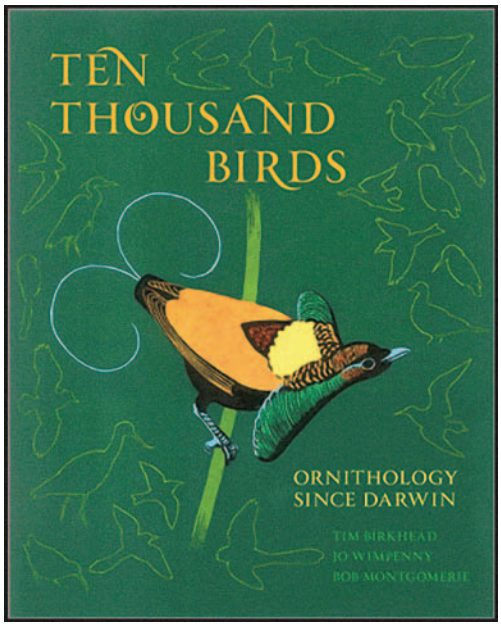
BOOK REVIEWS

TEN THOUSAND BIRDS: ORNITHOLOGY SINCE DARWIN

Tim Birkhead, Jo Wimpenny and Bob Montgomerie

Princeton University Press. 2014. 524 pp. $45 Hardcover.



Ten Thousand Birds: Ornithology Since Darwin is an authoritative and meticulously documented history of ornithology. It is organized by topic, with separate chapters for Form and Function, The Study of Instinct, Ecological Adaptations for Breeding, Behavior as Adaptation, and other major topics of interest.

These authors do what good historians do so well: tell a good story while being faithful to the historical record, interpret the historical events honestly and thoughtfully, and reveal misinformation that has been accepted as true. Rothschild, for example, sold his enormous bird collection to the American Museum of Natural History for personal financial reasons that probably relate to being blackmailed by his mistress. "Rothschild…..without his dalliance gone wrong and his pending bankruptcy, his collections would probably have stayed in Europe, and the development of both systematics and evolutionary biology in the twentieth century would no doubt have taken a very different course." (p. 78)

We also learn from this book that some basic ideas and concepts commonly assumed to be original with famous men, such as Konrad Lorenz, can be traced back to earlier, less well-known scientists.

The "Timelines" are attractive charts that depict the chronology of events and include photographs of prominent historical figures. The book also contains photographs of numerous ornithologists, some of whom made extremely important contributions to the field of ornithology.

The authors have included in this quite scholarly work a number of rather long autobiographical sketches written by contemporary ornithologists. Perhaps this is in keeping with our current culture's focus on celebrities, as well as the public's apparent interest in magazines and TV talk shows that celebrate the mundane details of people's lives. These successful ornithologists are, after all, human, and maybe we should be reminded of that. Yet many of these personal details add very little substance to the history of ornithology: "My mother is a biologist who later specialized in environmental education for primary schools" (Arie J. van Noordwijk); "My father was a GP, and I had intended to be a doctor, but it seemed like an awfully long course to start when I was already incredibly old at twenty-three!" (Robert Hinde); and "In 1957 I went with a group of friends to Fair Isle. Peter Davis had just become warden of the Bird Observatory." (Peter O'Donald)

Considering the incredible amount of detailed information in this book, anyone with even a passing interest in the history of ornithology will find it an invaluable reference work. It is also an enjoyable and well-written book that summarizes how many ornithologists, past and present, have contributed to our understanding of birds.

—Kent Rylander, *Texas Tech University: Junction Campus*

BULLETIN OF THE TEXAS ORNITHOLOGICAL SOCIETY
GUIDELINES FOR AUTHORS

SUBMISSION

For initial submission, e-mail one copy of the manuscript and photographs/illustrations1 to editor@texasbirds.org (alternate e-mail jackeitniear@yahoo.com) or mail to Jack C. Eitniear, 218 Conway Drive, San Antonio, Texas 78209-1716. If you do not have access to the internet mail a DVD or CD containing a word processor version (MS WORD 1997-2003 preferred or OpenOffice 3.0) of the manuscript with all figures and tables, as separate documents

Submission Categories.—Manuscripts may be submitted as a Major Article or Short Communication. Major Articles generally are longer papers that are >5,000 character count including literature cited and figure captions, and excluding tables, figures, and spaces between characters. Manuscripts <5,000 characters in length including literature cited and figure captions, and excluding tables, figures, and spaces between characters will be considered Short Communications. Major articles must include an Abstract. The Editor may move a paper from one category to another at his discretion.

Multi-authored Submissions.—All authors should have contributed in a significant manner to designing and performing the research, writing the manuscript, and reading and approving the manuscript prior to submission.

Non-U.S. Submissions.—Authors whose native language is not English should ensure that colleagues fluent in English have critically reviewed their manuscript before submission.

GENERAL INSTRUCTIONS

(Carefully read and follow these instructions before submitting your manuscript. Papers that do not conform to these guidelines will be returned.)

Prepare manuscripts on 8.5 X 11 inch format with 1-inch margins. Double-space all text, including literature cited, figure captions, and tables. Insert page numbers top right beginning on the second page. Use a font size of at least 11 point. Consult a recent issue of the journal for correct format and style as you prepare your manuscript.

Write in the active voice whenever possible. Use U.S. English and spelling. Use *italics* instead of underlining (i. e., scientific names, third-level headings, and standard statistical symbols). Use Roman typeface (**not boldface**) throughout the manuscript.

Common and scientific names of bird species that occur in North and Middle America should follow the AOU *Check-list of North American Birds* (1998, 7th ed., and its supplements in *The Auk*; http://aou.org.whsites.net/ checklist/index). Names for other bird species should follow an appropriate standard (cite standard used). Use subspecific identification and list taxonomic authorities only when relevant. Give the scientific name at first mention of a species in the abstract and in the body of the paper. Capitalize common names of birds except when referred to as a group (i. e., Northern Cardinal, Golden-cheeked and Yellow warblers, vireos). Do not italicize family names.

The common names of other organisms are lower case except for proper names (i. e., yellow pine, Ashe juniper, Texas kangaroo rat).

Cite each figure and table in the text. Sequence tables and figures in the order cited. Use "figure" only outside of parentheses; otherwise, use "Fig." if singular, "Figs." if plural (i. e., Fig. 1, Figs. 2–3). To cite figures or tables from another work, write figure, fig., or table in lowercase (i. e., figure 2 in Jones 1980; Jones 1980:fig. 2; Jones 1987: table 5).

Use the following abbreviations: d (day), wk (week), mon (month), yr (year), sec (second), min (minute), h (hour); report temperature as °C (i. e., 15° C). In text months should be abbreviated (Jan, Feb, Mar, Apr, etc.) in figures and tables. Define and write out acronyms and abbreviations the first time they appear in text; abbreviate thereafter: "Second-year (SY) birds . . . We found SY birds in large numbers."

Present all measurements in metric units. Use continental dating (i. e., 15 August 2007), the 24-hour clock (i. e., 0500, 1230), and local standard time. Specify time as Standard Time (i. e., CST for Central

[1]Due to file restrictions by most e-mail systems we ask that you contact the editor regarding the best means to provide graphic support.

Standard Time) at first reference to time of day. **Study site location(s) should be identified by latitude and longitude.** Present latitude and longitude with one space between each element (i. e., 28° 07' N, 114° 31'W). If latitude and longitude are not available indicate the distance and direction from the nearest permanent location. Abbreviate and capitalize direction (i. e., north = N, southwest = SW, or 5 km W Abilene, Taylor County [but Taylor and Bexar counties]). Also capitalize regions such as South Texas or Southwest United States.

Numbers.—The conventions presented here revise what has often been called the "Scientific Number Style (SNS)". The SNS generally used words for 1-digit whole numbers (i.e., 9 = nine) and numerals for larger numbers (i.e., ten =10), a distinction that may be confusing and arbitrary. The revised SNS treats numbers more consistently by extending the use of numerals to most single-digit whole numbers that were previously expressed as words. This style allows all quantities to be expressed in a single manner, and because numerals have greater visual distinctiveness than words, it increases the profile of quantities in running text. The objective of emphasizing quantity with numerals is further facilitated by the use of words for numbers appearing in a context that is only secondarily quantitative, i.e., when a number's quantitative function has been subordinated to an essentially nonquantitative meaning or the number is used idiomatically. In these cases, use words to express numbers (i.e., the sixty-four-dollar question). However, the numbers zero and one present additional challenges. For these numbers, applying consistent logic (numerals for quantities and words otherwise) often increases tedium in making decisions about correct usage and creates an inconsistent appearance, primarily because "one" has a variety of functions and readers might not quickly grasp the logic. For example, "one" can be used in ways in which quantity is irrelevant: as a personal pronoun or synonym for "you" (i.e., "one must never forget that") or as an indefinite pronoun ("this one is preferred"). The usage of the numeral in these cases would possibly be confusing to a reader. "Zero" and "one" are also used in ways that are more like figures of speech than precise quantifications (i.e., "in one or both of the ….", "in any one year", "a zero-tolerance policy"). In addition the numeral"1" can be easily confused with the letters "l" and "I", particularly in running text, and the value"0" can be confused with the letter "O" or "o" used to designate a variable. Therefore simplicity and consistent appearance have been given priority for these 2 numbers.

Cardinal Numbers.—quantitative elements in scientific writing are of paramount importance because they lead the way to the findings. Use numerals rather than words to express whole and decimal numbers in text tables and figures. This practice increases their visibility and distinctiveness and emphasizes their enumerative function.

2 hypotheses 5 birds 65 trees 0.5 mm 5 times 8 samples

Also use numerals to designate mathematical relationships.

6:1 at 200X magnification 5-fold not five-fold

Use words in to represent numbers in 4 categories of exceptions:

(1) If a number begins a sentence, title, or heading, spell out the number or reword the sentence so the number appears elsewhere in the sentence.

Five eggs were in the nest, but the typical clutch size is 12. The nest contained 5 eggs, but the typical clutch size is 12.

(2) When 2 numbers are adjacent, spell out the first number and leave the second as a numeral or reword the sentence.

The sample area was divided into four 5 ha plots.

I divided my sample area into 4 plots containing 5 ha.

(3) For most general uses, spell out zero and one.

one of the species was one of the most important on the one hand

values approaching zero one peak at 12-14 m, the other at 25-28 m.

However, express the whole numbers zero and one as numerals when they are directly connected to a unit of measure or a calculated value.

1 week 1 m a mean of 0 1-digit numbers when $z = 0$

Similarly, express zero and one as numerals when part of a series or closely linked to other numbers.

1 of 4 species between 0 and 5 of these, 4 samples were…1 sample was… and 8 samples

(4) When a number is used idiomatically or within a figure of speech.

the one and only reason a thousand and one possibilities comparing one to the other

the two of them one or two of these an extra week or two of growth.

Ordinal Numbers

Ordinal numbers usually convey rank order, not quantity. Rather than expressing how many, ordinals often describe what, which, or sequence. Ordinals are more prose oriented than quantitative within the text and it is less important to express ordinal numbers as numerals.

1) Spell out single-digit ordinals used as adjectives or adverbs.
   the third chick hatched first discovered a third washings for the seventh time
2) The numeric form of 2-digit ordinals is less confusing, so express larger ordinals as numerals.
   the 20th century for a 15th time the 10th replication the 50th flock
3) Express single digit ordinals numerically if in a series linked with double-digit ordinals.
   The 5th, 6th, 10th, and 20th hypotheses were tested or We tested hypotheses 5, 6, 10, and 20

Zeros before Decimals.

For numbers less than 1.0, always use an initial zero before the decimal point.
0.05 not .05 P = 0.05 not P = .05

Numbers Combined with Units of Measure

1) Use a single space to separate a number and a subsequent alphabetic symbol
   235 g 1240 h 8 mm
2) Generally close up a number and a non alphabetic symbol whether it precedes or follows the number.
   45° for angles 45 °C for temperature ±9 35± <5 but P < 0.001
3) Geographic coordinate designation for latitude and longitude have a space between each unit.
   35º 44' 77" N
4) If the number and associated symbol or unit start a sentence, spell out the number and associated factor.
   Twenty-five percent of nests

Numeric Ranges, Dimensions, Series, and Placement of Units

1) When expressing a range of numbers in text, use the word to or through to connect the numbers. Alternatively, an en dash, which means to may be us3ed but only between 2 numbers that are not interrupted by words, mathematical operators, or symbols.
   Yielded −0.3 to +1.2 differences not −0.3−+1.2 differences 5 July to 20 July or 5-20 July not 5 July-20 July 1-12 m not 1 m – 12 m
2) When the word from precedes a range, do not substitute the en dash for to.
   From 3 to 4 nests not from 3-4 nests
3) The en dash represents only the word “to”, when between precedes a range, use “and” between the numbers.
   between 5 and 18 March not between 5-18 March
4) When the range includes numbers of several digits, do not omit the leading digits from the second number in the range.
   between 2001 and 2012 not between 2001 and 12 nor 2001-12 1587-1612 m not 1587-12 m
5) A range of numbers and the accompanying unit can be expressed with a single unit symbol after the second number of the range, except when the symbol must be closed up to the number (i.e., percent symbol) or the unit symbol may be presented with both numbers of the range.
   5 to 12 cm or 5 cm to 12 cm 5 to 10 °C or 5 °C to 10 °C 20% to 30% or 20-30% not 20 to 30%
6) If a range begins a sentence, spell out the first number and present the second as a numeral; however if a nonalphabetic symbol (%), write out both units.
   Twelve to 15 ha not twelve to fifteen ha Ten percent to 20 percent of samples not Ten percent to 20% of samples
7) To prevent misunderstanding, avoid using “by” before a range; this may imply an amount change from an original value, rather than a range of values. growth increased 0.5 to 0.8 g/d (a range) or growth increased 0.5-0.8 g/d not growth increased by 0.5-0.8 g/d
8) To prevent a wrong conclusion by a reader, do not express 2 numbers preceded by words like “increase”, “decrease”, or “change”. A range may be intended but the reader may conclude the first value as an initial value and the second as a new value.

increased from 2 cm/wk to 5 cm/ wk (Was the increase 2-5 cm or was the increase 3 cm?)
When changes are from one range to a new range, en dashes within each range is a better statement.
increased from 10-20 m to 15-30 m

9) For dimensions, use a mathematical symbol (not a lower case "x") or the word "by" to separate the measurements.
5 X 10 X 20 cm 5 cm X 10 cm X 20 cm 5 by 10 by 20 cm

10) For a series of numbers, present the unit after the last numeral only, except if the unit symbol must be set close to the number.
5, 8, 12, and 20 m diameters of 6 and 8 mm 12%, 15%, and 25% categories of <2, 2-4, and > 6 km

Descriptive Statistics

Variables are often reported in the text: the units and variability term should be unambiguous.
mean (SD) = 20% (2) or Mean of 20% (SD 2) mean of 32 m (SD 5.3) not mean of 32 ± 5.3 m
mean of 5 g (SD ± 0.33) mean (SE) = 25 m (0.24)

MANUSCRIPT

Assemble a manuscript for Major Articles in this sequence: title page, abstract, text (introduction, methods, results, and discussion), acknowledgments, literature cited, tables, figure captions, and figures. Short Communications need not be subdivided into sections (optional).

Title Page.—At top of page place running head for Major Article: author(s) name(s) in upper- and lowercase italics followed by shortened version of title (=45 characters) in caps and Roman type. The running head for Short Communications is RRH: SHORT COMMUNICATIONS.

Put title in all caps for a Major Article and a Short Communication. Follow with author name(s) with the first letter of the first name, middle initial and last name as a cap and all other letters in lower case.

Addresses of author(s) should be in italics and arranged from first to last at the time of the study. The current address (if different from above) of each author (first to last), any special essential information (i. e., deceased), and the corresponding author and e-mail address should be in a footnote. Use two-letter postal codes (i. e., TX) for U.S. states and Canadian provinces. Spell out countries except USA. Consult a recent issue if in doubt.

Abstract.—Heading should be caps, indented, and followed by a period, three dashes, and the first sentence of the abstract (ABSTRACT.—Text . . .). Only Major Articles have an abstract.

Text.—Text, except for headings, should be left justified. Indent each paragraph with a 0.5-inch tab. Text should began immediately after the abstract.

Up to three levels of headings may be used. First level: centered, all caps (includes METHODS, RESULTS, DISCUSSION, ACKNOWLEDGMENTS, and LITERATURE CITED). There is no heading for the Introduction. Second level: flush left, indent, capitalize initial letter of significant words and italicize all words. Third level: flush left, indent, capitalize the initial letter of each word, followed by a period, three dashes, and then the text. In Major Articles, use headers in this sequence: First level, third level, and then second level (if needed). *Keep headings to a minimum.* Major Articles typically contain all first-level headings. Short Communications may or may not have these headings, depending on the topic and length of paper. Typical headings under Methods may include "Study Area" and "Statistical Analyses." Consult a recent issue for examples.

METHOD

Study Species, Locations, and Recordings

Study Species, Locations, and Recordings.---

Each reference cited in text must be listed in Literature Cited section and vice versa. The exception is unpublished materials, which occur only in the text. Cite literature in text as follows:

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- Two authors: Jones and Smith (1989) or (Jones and Smith 1989)
- Three or more authors: Smith et al. (1989) or (Smith et al. 1989)

- Manuscripts accepted for publication but not published: Smith (in press), (Jones in press) or Jones (1998) if date known. "In Press" citations must be accepted for publication, with the name of journal or publisher included.
- Unpublished materials, including those in preparation, submitted, and in review:
  (1) By submitting author(s) use initials: (JTB unpubl. data), JTB (pers. obs.),
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- When citing a direct quote, insert the page number of the quote after the year: (Beck 1983:77).

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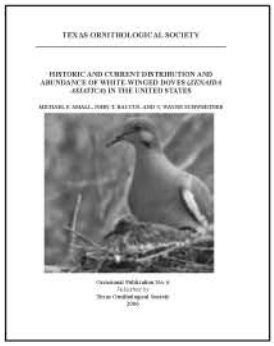

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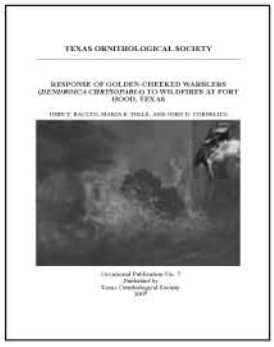

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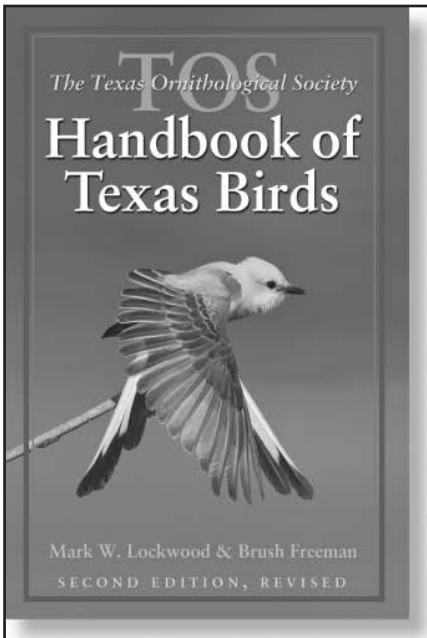

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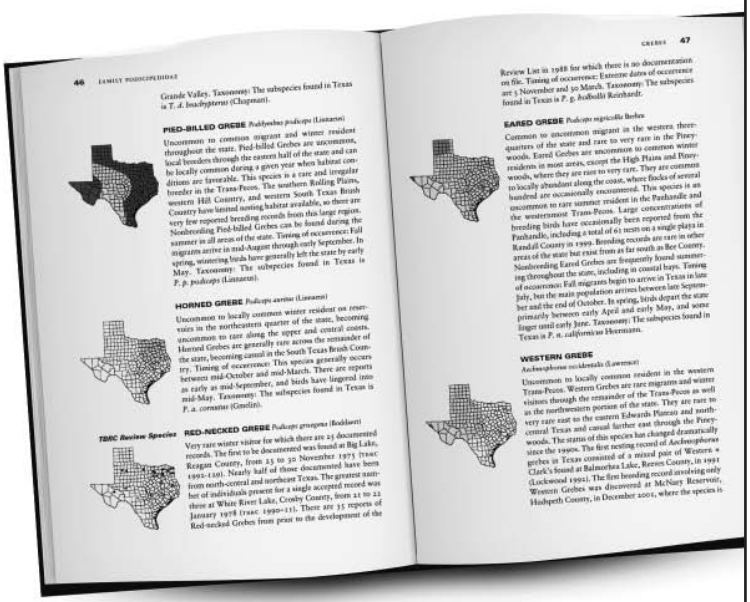

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