COLONIAL WATERBIRD SURVEY

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ABSTRACT—Texas Parks and Wildlife Department (TPWD) staff and volunteers conducted ground and air surveys of inland colonial waterbird nest sites at 584 locations in Texas from 1973 through 2004. There was an average of 472,466 nesting pairs sighted per year at all colonies. Cattle Egret (*Bubulcus ibis*), Little Blue Heron (*Egretta caerulea*), Snowy Egret (*Egretta thula*) and Great Egret (Ardea alba) were the most abundant species. The Oaks and Prairie Bird Conservation Region (BCR 21) had the most colonies with 171 and 269,210 nesting pairs. The total for the average densities for each colony from ground surveys from 1981-1990 in eastern Texas was 300,421 breeding pairs compared to 282,925 pairs observed from the air in 2002-2003. These totals were greater than the 164,720 pairs reported in coastal bays by the Texas Colonial Waterbird Society in 2003. Ground surveys in the 1980's documented some of the largest nesting populations of Little Blue Herons in the United States, but aerial surveys from 2002-04 found only 50% of the previously reported birds with few in northern counties. This population either shifted location or declined in northern counties before the aerial surveys. Great Blue Heron (*Ardea herodias*) and Neotropic Cormorant (*Phalacrocorax brasilianus*) occurred in greater numbers inland than elsewhere in Texas. The combined ground and the air surveys over 31 years provided a good characterization of the density and distribution of colonial waterbirds nesting inland in Texas. We recommend future aerial surveys be conducted at least once per decade to continue to monitor the distribution and size of colonies of each species in eastern Texas where the bulk of nesting occurs.

INTRODUCTION

Texas Parks and Wildlife Department (TPWD) personnel have participated in the annual Texas colonial waterbird nesting survey since 1973. This survey is coordinated by the Texas Colonial Waterbird Society (TCWS). The TCWS is a scientific group dedicated to monitoring colonial waterbirds in Texas. It is made up of staff members of TPWD, U.S. Fish & Wildlife Service, The Nature Conservancy of Texas, Texas Audubon Society, Texas General Land Office, Coastal Bend Bays and Estuaries Program, Welder Wildlife Foundation, Texas A&M University, and Caesar Kleberg Research Institute. Participation of conservation groups has varied annually depending on the interest of their staff and available funding. The main emphasis of the TCWS is on coastal surveys of nesting colonial waterbirds and the major contribution of TPWD has been conducting inland surveys and coordinating statewide surveys. This report will describe the participation and results from the TPWD surveys with the TCWS, and volunteer data gathered at inland colonies.

Texas Parks and Wildlife Department's role with TCWS has varied over the decades. From 1973 through 1984 the main contribution of TPWD was to conduct aerial surveys of known colonies near the Coast (<80 km) that TCWS ground/boat crews could not access (Fig. 1). In 1985 TPWD took over the responsibility of data from the annual survey and publication of the annual report. Texas Parks and Wildlife Department Wildlife Division personnel assumed primary responsibility in 1986 for coastal aerial surveys, inland ground

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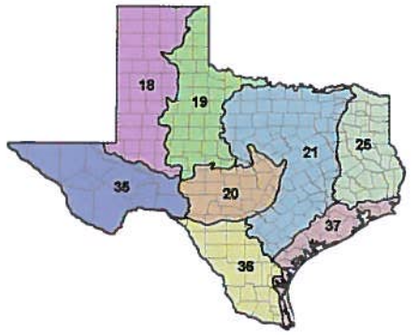

Figure 1. Bird Conservation Region Map of Texas

counts, data compilation, and report preparation through 1992. Afterwards, inland ground surveys were discontinued because of high labor demand and high variability of data between observers (Yantis 1990, Telfair 1993). Data compilation and report summary responsibility were transferred to cooperating agencies in 1993.

METHODS

All Texas colonial waterbird surveys were scheduled for the last week of May through the first week of June. A few were conducted at other times because of logistic issues.

Aerial Surveys.—Traditional annual coastal aerial surveys along the lower reaches of rivers from the Guadalupe to the Sabine were conducted by TPWD as part of the TCWS from 1973 until 1992. After 1992, annual aerial surveys were discontinued in favor of biennial surveys through 2004 primarily as a cost saving measure. These aerial colony surveys covered all known colonies from Victoria south to the San Antonio Bay along the Guadalupe River floodplain, from Green Lake to Freeport within 16 km of the bays, from Freeport to Richmond along the Brazos River floodplain, from Anahuac to Lake Livingston along the Trinity River floodplain, and coastal marshes of Chambers and Jefferson counties. Aerial surveys also covered a few colonies in the bays that were too difficult for boat crews to access. These areas near the coast were selected for surveying because they were the only sites TPWD traditionally received reports of colonies and aerial coverage was within the capability of our team to survey within one calendar day.

Fig. 2. Typical mixed species colonial waterbird site surveyed from airplane.

Texas Parks and Wildlife Department expanded its role in 2002 to conduct aerial surveys over inland colonies formally surveyed by ground crews east of Interstate 35 and as far inland as Dallas and Texarkana. The aerial survey protocol of surveying colonies at 2-year intervals was maintained, but different portions of East Texas were flown on alternate years. Thus, most of the historic inland colonial waterbird sites in eastern Texas were surveyed in 2002 (west side) and 2003 (east side). The west side was surveyed again in 2004, but low budgets did not allow the survey of the east side in 2005. This expanded aerial coverage required 3-flight days each year.

Aerial surveys were generally conducted with a high-winged single-engine Cessna aircraft with a pilot and two observers. Aerial surveys entailed flying from one previously recorded colony site to another by flying predominantly over wetlands. When flying between colony sites, we continually looked for new colonies by searching suitable habitat in our flight path or observing characteristic flight lines of birds leaving or returning from colonies. Keller et al. (1984) estimated the effective census strip width during aerial surveys for wading bird colonies was at least 1 km on either side of the airplane and this approximated our ability to detect colonies along the flight path of the survey.

Depending on colony size and number and diversity of birds present, 1 to 5 passes were typically made over each colony. One observer counted each species of white birds and one observer counted each species of non-white birds. Each adult observed was considered one nesting pair, which for most species closely approximated the number of nesting pairs (Erwin 1980). Multiple passes 100 m outside of the periphery of the colony were made to estimate population size from an altitude of approximately 100 m at a flight speed of about 80 knots. If observers needed to more accurately determine the total number of birds and ratio of each species within the colony, additional passes were made at an altitude of approximately 50 m along the edge of the colony. We attempted to not flush birds during these passes.

Data from aerial surveys of nesting adult pairs provided estimates of the number of nesting pairs. Nests containing young and empty nests of Great Blue Heron (*Ardea herodias*) and Neotropic Cormorant (*Phalacrocorax brasilianus*), which typically finished nesting before the survey, were counted to help make an estimate of nesting pairs. We considered our nesting estimates as conservative since species do not all peak at the same time each season and we likely missed some nesting activity (Ortego 1976, Portnoy 1977).

Ground Surveys.—Inland ground survey methodologies were quite variable and were adapted to the conditions at the colony. Over 100 staff and volunteers conducted these surveys. Inland colony sites varied from a few nests in a large tree (Great Blue Heron) at isolated sites to a large number of nests on woody vegetation in wetlands, or a large number of nests in dense woodlands in suburbs. Water depth and safety concerns at many sites did not always allow entry into colonies in wetlands. Thus, all nests were counted from convenient vantage points where possible. In situations where nests were not visible, each adult identified was considered to be one nesting pair. However, large colonies required sampling because all nests/adults were not visible in the diverse woody vegetation found at these large sites (Fig. 2). Numbers from samples were extrapolated to derive a total estimate. The preferred method of sampling was for the observer to select one or more representative portions of the colony and count all nests or adults for each species within the sampled area. The sample area was then measured by pacing. The size of the colony was determined by measuring it on aerial photographs or topo maps. The sample was then extrapolated at the appropriate multiplier to arrive at an estimate of total pairs by species.

Averaging data.—The average for each colony was determined by dividing the total nesting pairs surveyed by species and dividing it by the number of years surveyed. For species in which only occupation was known, this data was only used for history of the colony, but not the average. Data were sorted by county and Bird Conservation Region (Fig. 3).

Bay Island Surveys.—Texas Colonial Waterbird Society members surveyed virtually all nesting colonies in the bays annually. Most of these occurred on islands. Small colonies were generally surveyed from convenient vantage points on boats and a total count was attempted by using multiple positions of the boat. Larger colonies were typically surveyed on foot and similar to the small islands multiple vantage points were used to try to count all birds while creating minimal disturbance to nesters.

Figure 3. Dense nesting of multiple species at an inland forested wetland site in Texas.

Conducting transects or sample plots which have been commonly used on inland colonies were typically avoided because nesting birds on coastal islands were much more visible and observers wanted to minimize disturbance (Fig 4).

RESULTS

Texas Parks and Wildlife Department staff and volunteers surveyed 584 colonial waterbird nesting colonies from 1973 through 2004 at inland sites. The average for all colonies was 472,466 nesting pairs (Table 1). This nearly doubled the number of colonies and the estimate of nesting pairs of the original Texas survey from 1973-1980 (TCWS 1982). This is even more impressive when you consider the earlier survey included 130 colonies in bays and estuaries, which were mostly not covered by this summary.

Cattle Egret (*Bubulcus ibis*), Little Blue Heron (*Egretta caerulea*), Snowy Egret (*Egretta thula*) and Great Egret (*Ardea alba*) were the most abundant species during our study. The most common nester was the Great Blue Heron, which was found at 282 sites and was followed by the Cattle Egret at 212 sites, Little Blue Heron 163 sites, Great Egret 159 sites and Snowy Egret 135 sites. Inactive colony sites were somewhat common over the years. Many inactive sites resulted from the transitory nature of Great Blue Heron colonies and some wetland shrub communities being seasonally dry and exposed to mammalian predators.

The Oaks and Prairies BCR had the most colonies (171) and total nesting pairs (269,010). Colony density generally followed the rainfall gradient with fewer colonies to the west (TCWS 1982). However, density was greatest in wetlands in non-forested settings. Thus, the heavily forested West Gulf Coastal Plain BCR (#25 in Fig. 3) of East Texas had less suitable habitat for colonial waterbird nesters than the adjoining Oaks and Prairie BCR even though it had greater average annual rainfall and a greater surface area of lakes.

Hunt County had the largest number of nesting birds for a county with 39,086 largely due to high numbers of one species, Cattle Egret. This species represented 80% of the nesting birds. Species other

Figure 4. Diverse array of species are more visible at colonies on Texas bay islands because of the lower height of vegetation.

than Cattle Egret totaled 95,475 nesting pairs. The Gulf Coastal Prairie BCR (#37 in Fig. 3) had the most pairs with 43,211 followed by the Oaks and Prairies BCR with 31,129. Henderson County had the largest number for a county with 10,329 pairs. This was largely due to large numbers of Little Blue Herons and Snowy Egrets. Liberty County had the second most birds with 9,322 pairs with a good mixture of long legged waders. Jefferson County was third with 6,013 pairs of a diverse mix of species in the coastal marshes.

Density per season varied within colonies and river basins. Many variables contribute to density (McNicholl 1975, Erwin et al. 1981), but the most obvious one was water depth at colonies. Waterbirds in most inland colonies situate nests onto bushes or trees over water to avoid predation from mammals; whereas, most nests in coastal colonies were on the ground on islands. Islands with nests in the bays are usually too far from the mainland and too small to support mammal predators, and birds can safely nest on the ground. Whenever inland colonies did not have water under the nest sites, the birds generally did not build nests. Exceptions to this were upland egret colonies near suburbs (Parkes 2007).

During 6 years of aerial surveys near the coast from 1994 – 2004 (Table 2), we tracked the presence of water at nest colony sites in swamp settings. Years in which water occurred under <50% of nest trees were rated as dry years, and wet years had water under all nest sites. We located an average of 25 active colonies during wet years and 17 during dry years. This resulted in 70,233 nesting pairs during wet years and 34,887 nesting pairs in dry years. Sizeable dry year numbers of nesting birds were maintained by 8 colonies situated on reservoirs and lakes in the Brazos River watershed. These colony sites always had water under nest sites.

Population Trends. Surveys throughout the study were too sporadic to make many comparisons. Most inland colonies were only surveyed 4 of 10 years during the 1980s. The inland surveys on ground and by air covered a much larger area and indicated a much more dispersed breeding density with an unknown reliability of the percent of actual colonies present. We believe we surveyed the

Table 1. Average number of nesting pairs per colony visit by county, Bird Conservation Region (BCR), and total colonial waterbirds observed in Texas from 1973 through 2004. Gulls and Terns are not included in species totals..

County	BCR	Colonies	TOTAL	DCCO*	NECO	ANHI	GBHE	GREG	SNEG	LBHE	TRHE	REDE	CAEG	BCNH	YCNH	WHIB	WFIB	ROSP
Anderson	21	8	22,040		62	52	71	197	890	2,247			18,120			400	1	
Angelina	25	12	4,676		76	2	108	151	100	4			4,135			100		
Aransas	37	2	299															
Archer	21	3	56				56											
Armstrong	18	1	35											35				
Atascosa	21	1	225					75					150					
Atascosa	36	1	225					75					150					
Bandera	20	5	0															
Bastrop	21	1	7,573					8	5	60			7,500					
Baylor	19	8	691				86			130	1		465	7		2		
Bee	36	2	470		15								455					
Bell	21	2	373						8	15			350					
Bexar	36	5	2,074		28	4	3	55	33	24	2		1,842		83			
Blanco	20	1	0															
Bowie	25	3	711				14	1	1	5			690					
Brazoria	37	13	15,140		10	53	48	267	213	390	9		13,811	2	2	289		46
Brazos	21	4	8,070				10		20	40			8,000					
Brown	21	2	0															
Burleson	21	2	0															
Burnet	20	2	23				23											
Caldwell	21	1	401							1			400					
Calhoun	37	6	6,897		136	28	174	477	728	226	17		4,610	4	1	71	32	279
Callahan	21	2	14				14											
Camp	25	2	80				50	30										

Table 1. *(continued).*

County	BCR	Colonies	TOTAL	DCCO*	NECO	ANHI	GBHE	GREG	SNEG	LBHE	TRHE	REDE	CAEG	BCNH	YCNH	WHIB	WFIB	ROSP
Cass	25	3	2,105			4	36	23	2	40			2,000					
Chambers	37	12	8,035		169	83	174	488	756	965	20		4,042	14		915	69	244
Cherokee	25	1	0															
Childress	19	1	8															
Clay	21	4	202		17		184	1										
Coke	21	1	0															
Coleman	19	6	16				23											
Collin	21	2	1,156	1	53	3	103	154	30	50			763					
Colorado	21	2	4,021		8	2		40	223	108			3,610	13				17
Comal	20	1	0															
Comanche	21	2	16				16											
Concho	19	5	4				4											
Dallas	21	10	8,786			1		647	225	2,064	1		5,821	21	1	4	1	
Deaf Smith	18	3	57				7							50				
Delta	21	3	118				68										43	
Denton	21	1	1,400					100	100	200			1,000					
Donley	19	3	9				5						3					
Eastland	21	2	15				15											
El Paso	35	2	140		10				30				100					
Ellis	21	3	21,598			1		86	89	4,572			16,826	15	8		1	
Erath	21	1	40				40											
Fannin	21	3	4,736				10	101		475			4,150					
Fayette	21	1	0															
Fort Bend	37	8	12,124		21	32	3	923	303	501	1		9,264	3		973	36	64

Table 1. *(continued).*

County	BCR	Colonies	TOTAL	DCCO*	NECO	ANHI	GBHE	GREG	SNEG	LBHE	TRHE	REDE	CAEG	BCNH	YCNH	WHIB	WFIB	ROSP
Franklin	25	2	63		13		50											
Freestone	21	1	0															
Galveston	37	1	25															
Goliad	37	2	900			13	5	5	1	131			740					5
Gregg	25	4	7,129			98	39	79	51	310			6,548		1	3		
Grimes	21	2	323			5	1	3	8	5			300				1	
Hall	19	1	1															
Hamilton	21	1	0															
Hansford	18	2	34										10	22			2	
Hardeman	19	1	2															
Hardin	25	1	0															
Harris	37	10	6,827		178	22	60	476	650	224	22		4,597		34	167		50
Harrison	25	5	3,361				16	11		667			2,667					
Hartley	18	1	2				2											
Hemphill	19	7	131				124											
Henderson	21	18	32,975		265	34	33	967	2,592	6,393	29		22,646	15		1		
Hidalgo	36	1	49					5	26	3	5		10					
Hill	21	2	649				50		10	22			567					
Hood	21	1	13				13											
Hopkins	21	1	2,543				10			200			2,333					
Houston	25	1	61				1			15			45					
Hudspeth	35	3	?		x				x				x	x				
Hunt	21	6	39,086				105	8	1	3,777			35,195					
Irion	19	10	32				32											

Table 1. *(continued).*

County	BCR	Colonies	TOTAL	DCCO*	NECO	ANHI	GBHE	GREG	SNEG	LBHE	TRHE	REDE	CAEG	BCNH	YCNH	WHIB	WFIB	ROSP
Jack	21	4	51				51											
Jackson	37	2	3,580			10	1	20	11	196	1		3,341					
Jasper	25	7	3,602			20	21	2	19	560	18		2,950			12		
Jefferson	37	8	9,036		1,599	21	15	1,209	499	360	237	2	3,023	64		1,633		355
Johnson	21	2	28				28											
Kinney	36	1	0															
Kleberg	36	3	600		100												500	
Lamar	21	1	277				25			252								
Lamb	18	1	50										40	10				
Lampassas	20	1	6				6											
Lee	21	2	?															
Leon	21	2	3,680					50	30	100			3,500					
Liberty	37	30	23,009		152	130	171	1,430	1,156	2,621	47		13,687	10	12	3,466	22	105
Limestone	21	7	18,056		6		27	110	30	400			17,483					
Lipscomb	19	1	11				11											
Live Oak	21	1	3,750		200			50					3,500					
Liveoak	36	4	4,856		120			1,034	1				3,700					1
Llano	20	8	47				47											
Lubbock	18	1	120										100	20				
Madison	21	2	5,000										5,000					
Marion	25	5	416			23	120	273										
Mason	20	1	0															
Matagorda	37	13	13,938		129	10	65	616	2,020	815	109	1	8,237	17	23	287	29	219
McLennan	21	5	18,057					30	496	1,522			16,009					

Table 1. *(continued).*

County	BCR	Colonies	TOTAL	DCCO*	NECO	ANHI	GBHE	GREG	SNEG	LBHE	TRHE	REDE	CAEG	BCNH	YCNH	WHIB	WFIB	ROSP
McMullen	36	5	1,832		840	104		535	10	1	1		340					1
Milam	21	2	12,555					30	25	250			12,250					
Mills	21	1	0															
Montague	21	2	26				26											
Montgomery	25	6	904			12	25	11		31			825					
Moore	18	1	46										1	45				
Morris	25	3	20				2	18										
Nacogdoches	25	5	155			3			1	1			150					
Navarro	21	6	3,249				34						3,215					
Newton	25	8	1,257			11	58	367	22	97			615			7		80
Nolan	19	1	33				33											
Ochiltree	18	1	3				3											
Orange	37	5	8,434		249	14	1	845	4,123	83	604		2,040	140		82	41	198
Palo Pinto	21	9	158				158											
Panola	25	5	45				45											
Parker	21	2	22,797				17	205	175	3,100			19,300					
Parmer	18	2	44										14	30				
Polk	25	5	2,963			29	96	361	205	244			1,788	1	5	233		1
Potter	18	4	104				11							93				
Rains	21	1	200				200											
Randall	18	1	49				1		1				13	31		3		
Red River	25	1	0															
Refugio	37	4	306		10		8	61	10	3			213					1
Roberts	19	2	8				4											

Table 1. *(continued).*

County	BCR	Colonies	TOTAL	DCCO*	NECO	ANHI	GBHE	GREG	SNEG	LBHE	TRHE	REDE	CAEG	BCNH	YCNH	WHIB	WFIB	ROSP
Robertson	21	2	2,500										2,500					
Rockwall	21	1	82		44		38											
Runnels	19	1	1				1											
Rusk	25	5	7,090			13	10			400			6,667					
Sabine	25	10	799		430	21	110	100					138					
San Augustine	25	4	1,504			8	6	3	7	28	2		1,450					
San Jacinto	25	4	10							10								
San Patricio	36	1	0															
San Saba	20	1	8				8											
Shackelford	21	3	57				57											
Shelby	25	7	484		150	27	146	161										
Sherman	18	1	10											10				
Smith	25	1	11				11											
Stephens	21	1	8				8											
Sterling	19	2	3				3											
Tarrant	21	5	3,819				26	127	6	667			2,990	3				
Throckmorton	21	2	12				12											
Tom Green	19	11	581				26	5	25	25			500					
Travis	21	4	10,216				45	15	6	150			10,000					
Trinity	25	12	2,686		175	11	81	470	10	46			1,883			8		2
Tyler	25	2	509					3		3			500		3			
Upshur	25	3	0															
Uvlade	36	1	0															
Val Verde	35	6	42				11											

Table 1. *(continued).*

County	BCR	Colonies	TOTAL	DCCO*	NECO	ANHI	GBHE	GREG	SNEG	LBHE	TRHE	REDE	CAEG	BCNH	YCNH	WHIB	WFIB	ROSP
VanZandt	21	1	5			1	4											
Victoria	37	10	16,113		162	54	80	121	167	769	25		14,098	7	68	421		138
Walker	25	4	79				78	1										
Waller	37	2	3,426						15	125			3,175	9			100	2
Webb	36	1	39		7		2	3					12		3			
Wheeler	19	6	61				45							16				
Wichita	19	2	416				12	2	2	200			200					
Wilbarger	19	1	2				2											
Williamson	21	3	7,893					2	185	293			7,413					
Wise	21	2	0															
Wood	25	5	21,566		90	75	275	190	9	711			20,216					
Young	21	3	54				53	1										
Zapata	36	12	157															
Summary by BCR																		
Shortgrass Prairie BCR 18		8	554	0	0	0	24	0	1	0	0	0	178	346	0	3	2	0
Central Mixed-grass Prairie BCR 19		69	2,010	0	0	0	411	7	27	355	1	0	1,168	23	0	2	0	0
Edwards Plateau BCR 20		20	84	0	0	0	84	0	0	0	0	0	0	0	0	0	0	0

Table 1. *(continued).*

County	BCR	Colonies	TOTAL	DCCO*	NECO	ANHI	GBHE	GREG	SNEG	LBHE	TRHE	REDE	CAEG	BCNH	YCNH	WHIB	WFIB	ROSP
Oaks and Prairies BCR 21		171	26,9010	1	655	99	1,608	3,007	5,154	26,963	30	0	230,891	67	60	405	47	17
West Gulf Coastal Plain BCR 25		136	62,286	0	934	357	1,398	2,255	427	3,172	20	0	53,267	1	9	363	0	83
Chihuahuan Desert BCR 35		11	182	0	10	0	11	0	30	0	0	0	100	0	0	0	0	0
Tamaulipan Brushlands BCR 36		43	10,251	0	1,110	108	5	1,707	70	28	8	0	6,509	0	35	0	500	2
Gulf Coastal Prairie BCR 37		126	128,089	2	2,815	470	805	6,938	10,652	7,409	1,092	3	84,878	270	140	8,304	329	1,706
TEXAS		584	472,466	3	5,524	1,034	4,346	13,914	16,361	37,927	1,151	3	376,991	707	244	9,077	878	1,808

* DCCO = Double-crested Cormorant (*Phalacrocorax auritus*), NECO = Neotropic Cormorant, ANHI = Anhinga, GBHE = Great Blue Heron, SNEG = Snowy Egret, LBHE = Little Blue Heron, TRHE = Tricolored Heron (*Egretta tricolor*), REDE = Reddish Egret (*Egretta rufescens*), CAEG = Cattle Egret, BCNH = Black-crowned Night-Heron (*Nycticorax nycticorax*), YCNH = Yellow-crowned Night Heron (*Nyctanassa violacea*), WHIB = White Ibis, WFIB = White-faced Ibis, ROSP = Roseate Spoonbill; 0 = no active nest present; X = species present; ? = unknown quantity

CAEG = Cattle Egret, BCNH = Black-crowned Night-Heron (*Nycticorax nycticorax*), YCNH = Yellow-crowned Night Heron (*Nyctanassa violacea*), WHIB = White Ibis, WFIB = White-faced Ibis, ROSP = Roseate Spoonbill.

Table 2. Number of colonial waterbird breeding pairs observed by species, by year and number of active colonies during wet and dry years during aerial surveys near the Texas Coast.

	wet	dry	wet	dry	wet	wet
Year	1994	1996	1998	2000	2002	2004
ACTIVE COLONIES	20	15	23	19	28	27
Neotropic Cormorant	225	284	3,410	290	954	873
Anhinga	398	46	107	28	94	203
Great Blue Heron	114	40	1,211	343	782	165
Great Egret	4,240	1,335	8,315	1,943	2,810	3,092
Snowy Egret	8,173	4,780	8,865	1,900	4,735	12,815
Little Blue Heron	12,355	2,900	4,075	834	5,855	6,106
Tricolored Heron	750	130	268	35	99	95
Reddish Egret	4	0	0	0	0	0
Cattle Egret	27,358	17,095	29,205	31,340	44,500	53,830
Black-crowned Night-Heron	0	0	45	0	4	70
Yellow-crowned Night-Heron	0	0	23	0	6	3
White Ibis	13,280	316	6,325	810	976	4,100
White-faced Ibis	0	2	0	0		0
Roseate Spoonbill	1,350	1,173	2,660	189	1,179	1,316
Laughing Gull	2,450	3,775	0	0	25	0
Least Tern					6	0
Forster's Tern					153	70
Black Skimmer	0	0	105	150	275	250
TOTAL	70,777	31,876	64,614	37,897	62,453	82,988

vast majority of colonies over wetlands in eastern Texas because most of our surveys occurred over floodplains, but we do not have an estimate of the number of unfound inland upland colonies.

Because of the large area we could cover and the greater visibility obtained from aircraft, we thought more colonies and nesting birds could be found by aerial surveys than previously reported on the ground. However, when you look at the different methodologies and time interval between surveys, there was not a remarkable difference in total numbers. The average density for all colonies from 1981-1990 was 300,421 breeding pairs versus 282,925 pairs observed from the air in 2002-2003 and 164,720 pairs on bay islands in 2003 (Table 3).

We observed twice as many Neotropic Cormorants during the inland aerial survey versus inland ground counts and on bay islands. These higher counts over inland ground survey were expected since most cormorants were dispersed nesters on snags on major reservoirs. These sites were difficult to access from the ground. We did not know at the time of the survey of the larger numbers of this species nesting inland because previous reports (Telfair and Morrison 1995) indicated this species was primarily a tidal marsh nesting species. The 3551 estimated breeding pairs in 2003 was similar to the 4334 reported in 1990 (Telfair and Morrison 1995). However, we showed 80% nested inland in 2003; whereas, Telfair and Morrison (1995) indicated 87% nested on the coast. We don't think this was a shift in nesting birds between the years because most birds from our survey were from locations that were not previously surveyed.

Ground crews reported twice as many Anhingas (*Anhinga anhinga*) during the 1980s than the aerial survey. These differences might be attributed to methodology with many Anhingas nesting within tree crowns rather than on top and not being visible from an airplane (Frederick and Siegel-Causey 2000). Low numbers within the bays were expected because this species prefers freshwater sites.

The most important areas for nesting Great Blue Herons are inland wetlands and reservoirs. The

Table 3. Comparison of averaged ground surveys for nesting colonial waterbirds from 1981-1990 to aerial surveys from 2002-2003 in eastern Texas, and to ground/boat surveys in Texas bays.

	INLAND		COASTAL
Year	1981-1990	2002-2003	2003
Species	Ground	Airplane	Ground
Neotropic Cormorant	949	2,907	644
Anhinga	2,075	1,183	78
Great Blue Heron	1,381	7,219	1,185
Great Egret	6,709	10,411	3,824
Snowy Egret	6,250	8,557	4,162
Little Blue Heron	21,278	9,191	1,027
Reddish Egret	0	0	1,276
Tricolored Heron	416	234	5,147
Cattle Egret	255,637	238,206	10,381
Black-crowned Night Heron	149	102	699
Yellow-crowned Night Heron	38	28	3
White Ibis	5,037	3,752	18,470
White-faced Ibis	19	0	620
Roseate Spoonbill	483	1,135	2,454
Laughing Gull	0	25	83,701
Gull-billed Tern	0	0	1,292
Forster's Tern	0	113	1,102
Caspian Tern	0	0	1,341
Royal Tern (*Sterna maxima*)	0	65	22,342
Sandwich Tern (*Sterna sandvicensis*)	0	0	288
Least Tern	319	22	769
Black Skimmer	0	535	4,203
TOTAL	300,740	283,685	165,008

aerial survey reported 7,219 nesting pairs that were mostly located on snags dispersed over East Texas reservoirs. This was 5 times greater than what was found on inland ground and bay surveys.

Great Egrets and Snowy Egrets were twice as abundant inland than in the bays with aerial surveys reporting at least 30% more than ground surveys.

Average densities of Little Blue Herons were twice as high on inland ground counts during the 1980s than on aerial surveys. Bay surveys only found 10% of the state estimate during 2003. This species used to be abundant in counties near Dallas during the 1980's, but these populations have disappeared as area reservoirs have aged and the vicinity urbanized. There has been an increase in Little Blue Herons in the lower reaches of coastal rivers following this decline, but this increase is lower than former populations further north. Telfair (1993) showed Little Blue Heron populations declined at a rate of 3% per year from 1972-1990 using TCWS data. However, Texas breeding bird surveys from roads show Little Blue Heron populations are stable (Breeding Bird Survey Lab 2011).

As expected, almost all Tricolored Herons (*Egretta tricolor*) and Reddish Egrets (*Egretta rufescens*) were found nesting on bay islands.

Both inland ground and aerial surveys showed there were about 250,000 breeding pairs of Cattle Egrets. Bay colonies only support about 4% of this population. Even though the numbers between the 1980s and 2002-03 appear very similar, we were surprised to observe large expanses of pasture land in some counties without any Cattle Egrets.

This was particular evident in Ellis County which averaged 16,000 pairs during the 1980's and no presence during the aerial survey. Cattle Egrets nested on upland sites in this county until humans started removing upland colonies from near residences where they were creating disturbance and health issues (Telfair et al. 2000).

No survey methods estimate night-heron (*Nycticorax/Nyctanassa*) populations very well in Texas. These species tend to nest under shrubbery or tree canopies, only forage at night and are only exposed at colonies when flushed. Most surveyors in Texas try to avoid disturbing nesting birds, and thus, counts greatly underestimate populations of these species.

Ibises nest on bay islands in much greater density than elsewhere in Texas. Ground and aerial surveys had similar numbers but were only 1/3 of the numbers nesting on the bays. White Ibises (*Eudocimus albus*) primarily forage in brackish water habitats and nests in close proximity (TCWS 1982). In contrast, White-faced Ibises (*Plegadis chihi*) are primarily freshwater feeders and are frequently associated with rice fields. They are extremely difficult to survey since this species frequently nests by itself in tall marsh vegetation and are not visible to ground and aerial surveyors. Few were found during our survey.

The Roseate Spoonbill (*Platalea ajaja*) is a very colorful marsh bird that once was nearly extirpated from Texas (Allen 1942). There were twice as many on bay islands than inland colonies, and aerial surveys reported twice as many as inland ground surveys.

Gulls, terns and skimmers (*Laridae*) are species of the bays. These species are only marginally surveyed inland, except for the Least Tern (*Sterna antillarum*) which nests throughout Texas in small numbers.

DISCUSSION

The intent for the initiation of inland surveys was to compliment annual monitoring on the Gulf Coast to monitor population trends. After 17 years and considerable effort conducting ground surveys, TPWD (Yantis 1990) tested the variability of surveyors at the same colonies and determined there was a tremendous amount of variation in population estimates between observers at inland sites. This type of variation was typical for monitoring colonial waterbirds in very dense vegetation in wetlands (Portnoy 1977, Erwin 1980, 1985, 1990, Yantis 1990). It was decided in 1992 that conducting these inland surveys on an annual basis was not warranted when considering the natural variation which occurs between wet and dry cycles along with observer bias.

Even though there is a tremendous amount of variation among ground surveyors, these surveys did provide some useful information on the distribution of colonies and their relative sizes. Data for aerial flights 10 years later showed similarity in population estimates between aerial and ground surveys. Ground surveys of 1980s documented some of the largest nesting populations of Little Blue Herons in the United States (Ogden 1978). These populations either shifted their location or declined in northern counties before the flights of 2002-04. We gained a broader perspective on the magnitude of dispersed nesting on snags on major reservoirs where Great Blue Herons and Neotropic Cormorants occurred in numbers greater than elsewhere in Texas. The combined ground and air surveys over 31 years give a good characterization of the density and distribution of colonial waterbirds nesting in Texas. We recommend that aerial surveys be conducted in the future at least once per decade to continue to monitor the distribution and size of colonies of each species in eastern Texas where the bulk of nesting occurs.

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