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SPECIAL BALD EAGLE AND OSPREY SECTION

TEXAS BALD EAGLES

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ABSTRACT.—Bald Eagles (*Haliaetus leucocephalus*) were studied in Texas from 1970 to 2009 by the Texas Parks and Wildlife Department. Active nests increased from 5 in 1970 to 156 in 2005 when the last aerial survey was conducted. A total of 547 nest sites in 313 territories in 76 counties were identified thru May 2009. Longevity of 261 nests tracked averaged 4.2 years with a standard deviation of 3.4. Six hundred and sixty-one food items were examined at nest sites. They were comprised of 33.7% birds, 30.7% reptiles and 30% fish. Hurricanes did not appear to have any impacts on nest production. Nest production varied from 1.2 to 1.45 young per active nest. One-hundred and thirty-eight eaglets were banded and color-marked. Fledging success was 97% after 6 weeks of age. Three band recoveries and sightings of 29 adults and 32 immatures were obtained. Twenty sightings occurred outside of Texas with 74% of these occurring from May to August. Texas born eagles were reported from South Carolina to Canada and Arizona. Bald Eagle populations are increasing 13% per year, but there are a number of threats which may limit populations in the future.

INTRODUCTION

The Bald Eagle is the national emblem of the U. S. It is a large, showy and charismatic bird. It has served as a symbol of freedom associated with democracy in the U. S. and in recent years with wilderness and environmental ethic (Buehler 2000). Populations declined greatly after World War II due primarily to eggshell thinning effects of p,p'-DDE, a biodegradation product of DDT (Grier 1982, Bowerman et al. 1995).

The longest running Texas Parks and Wildlife Department (TPWD) project of a nongame species started in 1970 with the initiation of research on the status of the Bald Eagle in Texas (Sweptson 1976). This paper summarizes the results of 4 decades of research by TPWD and provides basic life history information from relevant literature (Buehler 2000).

LIFE HISTORY

The Bald Eagle, a large bird of prey, opportunistically forages and eats a variety of mammalian, avian, and reptilian prey but generally prefers fish over other food types (Buehler 2000). The species typically breeds in forested areas adjacent to large bodies of water. It nests mostly in trees large enough to support their massive nest, and these sites are generally within 1.6 km (1 mile) of permanent water. In some cases, distance to water is not as

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10-week-old eaglet in a typical nest. Photo by TPWD staff.

critical as the quality of the foraging area. Quality of foraging areas is defined by diversity, abundance, and vulnerability of the prey base (Livingston et al. 1990), structure of aquatic habitat, such as the presence of shallow water (MacDonald and Austin-Smith 1989), and absence of human development and disturbance (McGarigal et al. 1991).

Nests are located farther from the shoreline in areas with considerable shoreline development or human activity (e.g., Florida, Chesapeake Bay, Minnesota, etc.) than in less developed areas, such as Alaska (Robards and Hodges 1977, Andrew and Mosher 1982, Fraser et al. 1985, Swenson et al. 1986, Anthony and Isaacs 1989, Wood et al. 1989). The minimum distance from a nest to human development in some populations is less than 91 m, (100 yards), but the average distance in most populations is >450 m (500 yards) and reflects habitat selection away from these developments (Andrew and Mosher 1982, Fraser 1985, Fraser et al. 1985, Anthony and Isaacs 1989, Wood et al. 1989, Livingston et al. 1990). Forested tracts with nests have relatively open canopies, some form of habitat discontinuity or edge, or high levels of foliage-height diversity that provide access to nest trees (Gerrard et al. 1975, McEwan and Hirth 1979, Anthony and Isaacs 1989, Wood et al. 1989).

The Bald Eagle has a complex pattern of migration that is dependent on age of the individual (immature or adult), location of breeding site (north vs. south, interior vs. coastal), severity of climate at breeding site (especially during winter but also possibly during summer), and year-round food availability. Most immature eagles migrate and may move nomadically, presumably because they are not tied to the defense of a nest site. Adult birds, in contrast, migrate when food becomes unavailable. Bald Eagles generally migrate alone but occasionally join other migrants on the wing, but not in kettles or flocks (Buehler 2000).

Bald Eagle migration is quite varied between geographic areas and appears to be influenced by availability of food and severity of climate. Young tend to migrate before adults (Buehler 2000). Migrants from non-breeding populations that frequent Texas, like those from Saskatchewan, winter in a broad region of the southwestern U. S., ranging from California to Texas (Gerrard et al. 1974, Gerrard et al. 1978, Griffin et al. 1980). Some adults from these northern populations might not migrate but instead move locally to seasonal food sources. Bald Eagles that summer around the Great Lakes and adjacent areas in Canada migrate south along major river systems from August to January (Buehler et al. 1991, McCollough et al. 1994).

Adults breeding south of latitudes below Denver, Colorado, usually do not migrate south for winter with some remaining year-round in the vicinity of the nest site but may be less closely associated with the nest than during breeding season (Broley 1947, Buehler et al. 1991, Curnutt 1992, Wood 1992). These southern Bald Eagles migrate north in spring or summer after nesting during winter and return southward from August to December (Broley 1947,

Bald Eagles on nest. Photo by Jess Thompson.

Buehler et al. 1991, Wood 1992). Some Chesapeake Bay area immatures (<10%) move south of the bay in December-February (Buehler et al. 1991).

Feeding

Bald Eagles hunt from perches or while soaring over suitable habitat. They attempt to take most prey on the wing. They use carrion of fish, birds, and mammals extensively wherever encountered at sites that provide disturbance-free access from the ground (Buehler 2000). In most regions, they seek out aquatic habitats for foraging and prefer fish (Wright 1953, Spencer 1976, Steenhof 1976, Stalmaster 1987, DeLong 1990). Bald Eagles are frequently observed near large concentrations of waterfowl in Texas during winter, and waterfowl is an important food item for breeding eagles (Mabie et al. 1995).

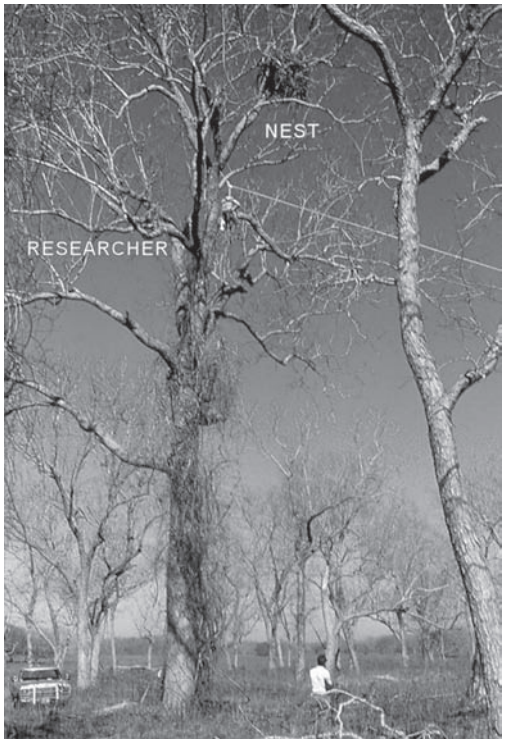
Breeding

Pair formation is thought to occur on the breeding grounds but may also occur on wintering grounds (Harmata 1984). Bald Eagles have spectacular courtship rituals, involving vocalizations and acrobatic flight displays. Perhaps the most noted courtship act is Cartwheel Display, in which the courting pair fly to great altitude, lock talons, and tumble/cartwheel back toward earth; the pair finally break-off the display at the last moment to avoid collision with the ground (Stalmaster 1987).

Pair bonds can last >1 year, but very little data exist because of the difficulty in marking adults. One female eagle hatched in Matagorda County, Texas, nested in Arizona and remained paired for several years (G. Beatty pers. comm.). Eagles very rarely have more than 2 adults in a territory. Three adults have been reported at nests in Alaska, Minnesota, Connecticut, California and Texas (Sherrod et al. 1976, Fraser et al. 1983, Hopkins et al. 1993, Garcelon et al. 1995, Ortego et al. 2006).

Nest building generally begins 1–3 months prior to egg laying. Eagles in southern latitudes start nest building earlier (Buehler 2000). Nest building and maintenance in Florida begin in late September to early October (Broley 1947); whereas, further north in Ohio, these activities usually begin in February (Herrick 1932).

Bald Eagles only raise 1 brood per season and replacement clutches are possible if eggs are taken or destroyed early during incubation, especially at southern latitudes (Buehler 2000). Timing of egg laying and length of the breeding season varies by latitude. Broley (1947) reported incubation began as early as October and as late as April in Florida. Eagles nesting in northern latitudes do not have 7 consecutive months of ice free conditions and thus have a shorter breeding season. Incubation typically lasts 35 d.



Researcher climbing nest tree. Photo by TPWD staff.

Nest trees generally are the largest trees available with accessible limbs capable of holding a nest (Herrick 1924, Andrew and Mosher 1982, Swenson et al. 1986). A large super-canopy nest tree provides good flight access to the nest and good visibility of the surrounding area (Buehler 2000). Both sexes contribute in nest construction. Sticks are collected from the ground or from nearby trees. Typical nest size ranges from 2 m (5–6 ft) in width to 1 m (2–4 ft) in height (Stalmaster 1987) but width of 3 m (9 ft) and height of 6 m (20 ft) are known (Broley 1947).

Territorial defense is common during the breeding season to ensure sufficient food resources to raise young without interference. Defense can involve perching in prominent areas, using threat vocalizations, and, at the extreme, chasing intruders out of the area (Stalmaster 1987).

Estimates of territory size vary widely based on nesting density, food supply, and method of measurement. Many territories are oriented along waterways and density appears driven by available shoreline. Average territory has been reported as 100 ha (250 acres) in Minnesota (Mahaffy and Frenzel 1987), and 400 ha (1000 acres) in Saskatchewan (Gerrard et al. 1992) with a minimum of 50 ha (120 acres) in Alaska (Hodges and Robards 1982).

Clutch size ranges from 1–3 eggs with 2 the most common. Eggs are laid 1 per day and egg laying is generally completed in 3 to 6 d (Stalmaster 1987). Incubation normally takes 35 d (Herrick 1932), and Bortolotti (1986) reported young eagles fledged at 8 to 14 weeks of age. Young eagles associate with adults for several weeks after fledging before dispersing (McCollough 1986, Hunt et al. 1992, McClelland et al. 1996, Wood et al. 1998).

Bald Eagles take 4 years to reach full adult plumage and are capable of breeding at 5 years of life (Buehler 2000). The species lives a relatively long time and has been recorded to survive 28 years in the wild (Schempf 1997) and 36 years in captivity (Newton 1979). They may follow a survival pattern similar to other raptors, with lower first-year survival rates, followed by an increasing survival rate to adulthood. Early estimates of eaglet mortality are largely speculative (Brown and Amadon 1968, Sherrod et al. 1976, Gerrard et al. 1978).

TEXAS PARKS AND WILDLIFE DEPARTMENT BEGINNING

Oberholser and Kincaid (1974) chronicled their dissatisfaction with conservation of raptors and eagles in Texas. Ranchers, hunters and fishermen were reported to continue to shoot, trap and poison Bald Eagles during the 1940s, despite passage of the federal Bald and Golden Eagle Protection Act during that decade. Sentiment in favor of protecting eagles increased during the 1950s, but heavy concentrations of DDT, dieldrin, heptachlor, and other stable, toxic compounds began accumulating in soil and water, especially coastal waters (Oberholser and Kincaid 1974). The 1960s were primarily noteworthy for soaring pollution (Oberholser and Kincaid 1974). Bald Eagles were laying cracking – or even shell-less—eggs by 1970.

Oberholser and Kincaid (1974) reported 6 miracles occurred in Texas in 1971. Six young Bald Eagles flew from 4 nests being monitored by the Texas Parks and Wildlife Department (TPWD) along the central Texas Coast. Oberholser and Kincaid (1974) also reported the only place in Texas where a bird watcher could be sure of seeing Bald Eagles was in the middle of Falcon Dam on the Texas-Tamaulipas boundary where a metal Bald Eagle adorns a monument.

This was the setting in which TPWD began to investigate the status of rare and endangered species

in Texas. Many Texans were unaware of the severity of chemical pollutants in the habitat and diet of fish and wildlife at that time.

TPWD received funding to initiate nongame work in Texas in 1969. Nongame specialists were hired and projects were initiated. This new "Nongame" program placed heavy emphasis on the research of key indicator species such as Bald Eagle, Osprey (*Pandion haliaetus*), Peregrine Falcon (*Falco peregrinus*), colonial waterbirds, and several species of mammals.

NEST SURVEYS

Phase I

After large population declines in the first half of the 20th Century, little was known about the status of Bald Eagles in Texas. A questionnaire requesting information on status of Bald Eagles was mailed annually from 1970 through 1975 to a total of 15,968 federal and state field personnel, members of the Audubon Society, Texas Ornithological Society, falconers, flying organizations and related groups. This phase of the project resulted in 2,340 reports covering most of Texas. The largest Bald Eagle concentrations occurred in Bandera, Grayson, Marion, Newton, Randall and Waller counties with each having reports of at least 100 Bald Eagle sightings during the five years. The study suggested a strong relationship between eagle concentrations and the presence of a river or lake and a readily available supply of waterfowl and fish. Since few Bald Eagles nested in Texas at the time of the questionnaire, almost all reports were of non-nesting, wintering birds (Swepston 1976), but TPWD did receive reports of 5 nest sites.

Bald Eagles were reported in every month with 95% of observations occurring between October and March with peak months from December through February (Swepston 1976).

Wintering Bald Eagles tended to congregate around loafing and roosting sites. In the Texas Panhandle these sites were cottonwood trees (*Populus* spp.), canyon rims, cliffs, and large power lines near lakes and reservoirs. Trees near rivers, lakes, and bays were the predominant roost sites in the central and eastern portions of the state (Sweptson 1976).

In the Panhandle and Trans-Pecos Bald Eagles often shared their feeding and roosting sites with a large number of wintering Golden Eagles (*Aquila chrysaetos*). The largest reported concentration containing both species was 52 eagles feeding on fish at a playa lake in Hutchinson County on 10 February 1975 (Swepston 1976).

Phase II

As information was received on location of nests, TPWD began monitoring nests at least twice annually from the air or ground. The first visit was to determine if nests were still present and being used for nesting. The second visit was to determine how many eaglets survived to fledge.

After the completion of the questionnaire project, most reports of nests were received from cooperating landowners, interested citizens and conservation organizations incidental to normal work activities in association with these people. This inventory of known nesting sites grew to 23 territories and 13 active sites by 1982 (Fig. 1) with all located in the Coastal Prairie Ecoregion of southern Texas.

Phase III

Reports of potential nesting Bald Eagles inland from the coast in the vicinity of major river systems and reservoirs of East Texas were received during the early 1980s. As a result of this reported nesting activity, special funding was obtained from the U. S. Fish and Wildlife Service endangered species office in Albuquerque, NM, to conduct a much broader survey in 1983. Aerial surveys were expanded to include all areas with potential eagle nesting habitat in eastern Texas (Mabie 1983).

During the expanded search, 22 active nests were found with only 5 from areas further inland. Private airplanes were chartered by TPWD to conduct 117 h of low level (<91 m; 300 ft) searches for nests along rivers, major creeks and reservoirs throughout East Texas in March. With airplanes cruising near 185 km/h, (115 mph) observers searched about 16,000 km (10,000 miles) of Texas landscape. It was a search for the "needle in the haystack" in forested areas where pine (*Pinus* spp.) was the dominant tree. It was a little easier to locate nests in hardwood areas because most trees had no leaves in March. However, individual "large" nests in a forest often were difficult to locate and staff likely missed a "few" in this major effort. One of the more memorable new nests was near Lake Murvaul in Panola County that was found during a snow storm; a nest in a large hardwood at the edge of a pasture with an adult incubating as snow drifted across the landscape.

Phase IV

Nesting surveys reverted back to conducting aerial surveys twice each spring (February to April)

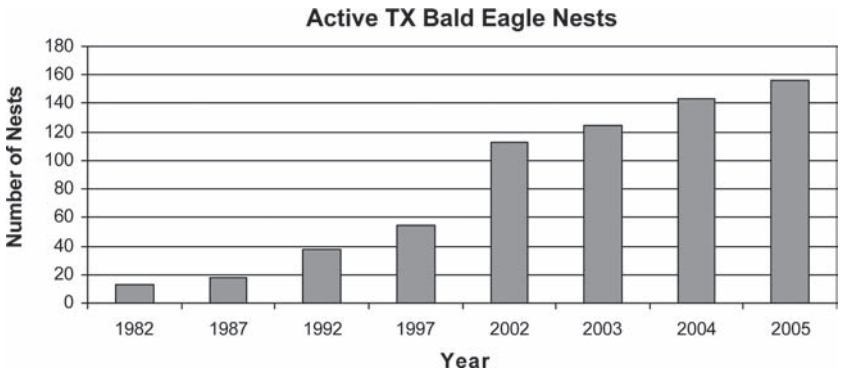


Figure 1. Number of active Bald Eagle nests in Texas from 1982 to 2005.

at known and suspected nesting sites after the major 1983 survey (Ortego et al. 2006). Information about more distant sites from where aircraft were typically flown relied on visits and reports submitted by TPWD staff or reliable observers. Biologists used about 40 airplane hours per breeding season to monitor known nests during the 1980s. This effort required about 80 airplane hours to complete the survey as nest inventories grew in size and space. Aerial surveys were discontinued in 2005 primarily for financial reasons. Nest surveys after 2005 were conducted opportunistically in conjunction with other work, and TPWD continued to log nest locations when reports were received from reliable sources. This combined effort resulted in a total of 547 nest sites within 313 nesting territories in 76 counties (Table 1) being recorded from 1971 through May 2009.

Summary

Nesting Bald Eagles in Texas have exceeded productivity goals (i.e., >0.9 young/occupied site, and >50% success rate/occupied nest) set by the Southeastern States Bald Eagle Recovery Team (US Fish and Wildlife Service 1989) since 1989. Texas nesting production ranged from 1.2 to 1.45 young per active nests from 1971–2005 (Saalfeld et al. 2009). This greatly exceeded the production of >0.74 per active nests suggested by Buehler et al. (1991) as the benchmark of an expanding population. The increased discovery and reporting of active nests reflected an expanding population as the number of active nests increased an average of 13% per year in Texas (Table 2) from 1971 through 2005 (Saalfeld et al. 2009).

MID-WINTER SURVEY

One aspect of monitoring Bald Eagles in Texas was to survey when they were most abundant (Swepston 1976) during the middle of winter. The nesting surveys conducted by TPWD gave a reasonable estimate of nesting population and production trends but did not address total number of Bald Eagles. The earlier questionnaire (1970s) indicated a large number of non-resident eagles wintered in the state.

The National Wildlife Federation initiated the Mid-Winter Bald Eagle survey as a cooperative project between multiple agencies, organizations and citizens across the geographic range of the Bald Eagles in the U. S. Texas started participating in 1984. A summary of the results of the survey can be found at the U. S. Geological Survey (USGS) website: http://srfs.wr.usgs.gov/research/indivproj.asp?SRFSProj_ID=2 10 MAY 2009.

Nationwide counts of eagles were coordinated by the National Wildlife Federation from 1979 until 1992, when the Raptor Research and Technical Assistance Center assumed responsibility for overseeing the count. The USGS established a partnership with the U. S. Army Corps of Engineers to maintain the long-term coordination of the survey, data analysis, and reporting in 2007 and the U. S. Army Corps of Engineers began coordinating the survey in 2008.

Initial objectives of the survey were to: 1) establish an index to the total wintering Bald Eagle population in the lower 48 states; 2) determine eagle distribution during a standardized survey period; and 3) identify previously unrecognized areas of important winter habitat. Millsap (1986) reported results of the mid-winter survey from 1979 through 1986.

Table 1. Documented Bald Eagle nest sites from 1970 to 2009 by county and river basin.

County	River basin	Nests	Breeding territories	County	River basin	Nests	Breeding territories
Angelina	Angelina	17	10	Lee	Brazos	3	3
Austin	San Bernard	1	1	Leon	Trinity	4	2
Bastrop	Colorado	7	4	Leon	Navasota	1	0
Bell	Lampasas	4	1	Liberty	Trinity	8	6
Bosque	Brazos	1	1	Limestone	Navasota	7	4
Bowie	Red	2	1	Llano	Llano	4	2
Brazoria	Brazos	20	8	Marion	Sabine	1	1
Brazoria	San Bernard	5	1	Marion	Red	1	1
Burleson	Brazos	1	1	Mason	Llano	1	1
Burleson	Brazos	3	3	Matagorda	Colorado	19	10
Calhoun	Guadalupe	4	3	McLennan	Brazos	1	1
Cass	Red	2	1	McLennan		1	1
Chambers	Trinity	3	3	Milam	Brazos	4	2
Cherokee	Angelina	1	1	Montgomery	San Jacinto	27	15
Colorado	Colorado	18	5	Morris	Red	2	1
Cooke	Trinity	1	1	Nacogdoches	Angelina	4	3
Dallam	None	1	1	Navarro	Trinity	2	2
Delta	Sulphur	1	1	Newton	Sabine	4	2
Donley	Red	1	1	Orange	Sabine	4	3
Edwards	Dry Frio	1	1	Panola	Sabine	3	2
Ellis	Trinity	1	1	Polk	Trinity	16	8
Falls	Brazos	3	2	Red River	Red	1	1
Fannin	Red	1	1	Refugio	San Antonio	6	3
Fayette	Colorado	7	4	Robertson	Navasota	8	5
Fort Bend	Brazos	28	7	Rusk	Sabine	4	3
Freestone	Trinity	4	3	Sabine	Sabine	37	26
Goliad	San Antonio	15	7	San Augustine	Angelina	23	13
Grimes	Navasota	4	2	San Jacinto	Trinity	7	6
Harris	Trinity	8	4	San Saba	San Saba	1	1
Harris	San Jacinto	4	4	Shelby	Sabine	25	13
Harris	Green's Bayou	1	1	Smith	Sabine	8	5
Harrison	Sabine	1	1	Tarrant	Trinity	1	1
Harrison	Big Cypress	2	2	Travis	Colorado	3	3
Henderson	Trinity	5	4	Trinity	Trinity	14	8
Henderson	Neches	4	4	Tyler	Neches	2	2
Henderson		1	1	Upshur	Sabine	1	1
Hopkins	Sulphur	2	1	Van Zandt	Sabine	2	2
Houston	Trinity	7	2	Victoria	Guadalupe	32	10
Hunt		2	2	Walker	San Jacinto	5	2
Jack	Trinity	1	1	Walker	Trinity	6	3
Jackson	Lavaca	19	9	Wharton	Colorado	9	6
Jasper	Angelina	5	5	Wharton	Navidad	2	2
Kaufman	Trinity	2	2	Wharton	San Bernard	1	1
Kimble	Llano	1	1	Wood	Sabine	8	4
Lavaca	Navidad	2	2				

Table 2. Bald Eagle population trends by Texas survey regions.

	Region	Number of territories	Active nests	Fledged young	Young per active nest*	% Active nest increase
1982	State-wide	23	13	16	1.2	
1987		26	18	21	1.2	38%
1992		46	38	38	1.0	111%
1997		62	54	55	1.0	42%
2002		144	113	152	1.4	109%
2003		154	125	149	1.5	11%
2004		171	143	184	1.6	14%
2005		176	156	204	1.4	11%
1982	W of I-35	0	0	0	0.0	
1987		0	0	0	0.0	
1992		0	0	0	0.0	
1997		0	0	0	0.0	
2002		3	2	2	1.0	
2003		4	2	1	1.0	
2004		4	3	5	1.7	50%
2005		4	3	5	1.7	
1982	Post Oak	0	0	0	0.0	
1987		2	1	2	2.0	
1992		5	5	6	1.2	400%
1997		4	4	5	1.3	−20%
2002		21	12	12	1.5	200%
2003		18	14	16	1.6	17%
2004		26	22	31	1.7	58%
2005		30	25	38	1.7	14%
1982	PINEYWOODS	0	0	0	0.0	
1987		6	1	2	2.0	
1992		15	10	8	0.8	900%
1997		28	23	27	1.2	130%
2002		70	52	68	1.4	126%
2003		75	58	61	1.6	12%
2004		79	64	68	1.5	10%
2005		87	68	85	1.4	6%
1982	SOUTH TEXAS	23	13	16	1.2	
1987		18	16	17	1.1	123%
1992		26	23	24	1.0	44%
1997		30	27	23	0.9	18%
2002		50	47	70	1.6	74%
2003		57	51	71	1.5	9%
2004		62	54	80	1.7	6%
2005		65	60	78	1.4	11%

*Average is only for active nests with known outcome.

The USGS evaluated mid-winter count data from 1986 to 2005 to assess count trends. Their analysis was based on 178,896 observations of eagles during 8,674 surveys of 746 routes in 43 states. Throughout the survey area, counts increased an estimated 17% per year from 1986 to 2005. Sixty-three percent of routes showed increasing trends, and 37% showed decreasing trends during the 20-year period. Model-based estimates of counts in the Northeast increased approximately 6% per year; whereas, those in the Southwest decreased 1.2% annually. Seventy-six percent of survey routes north of 40° latitude had increasing count trends, but only 50% of routes south of 40 degrees latitude (southern Nebraska) showed increasing trends.

This variability in results from wintering population trends did not match results from nesting surveys, which indicated eagle populations across the nation were mostly increasing (Buehler 2000).

Texas mid-winter survey data showed a rapid rise in reported Bald Eagles from 1984 thru 1990, which was mostly related to increasing numbers of sites surveyed rather than an expanding population. From 1990 thru 2004, the number of eagles observed at each survey area was essentially unchanged, indicating the methodology used in Texas was not effective at monitoring eagle population trends. Bald Eagles have been increasing nationally and in Texas at rates >10% per year (Buehler 2000, Saalfeld et al. 2009).

DISPERSAL OF EAGLES

As TPWD monitored nesting of Bald Eagles and worked with landowners for their conservation, one common question arose from landowners was where did "My Eagles" go? Landowners in general reported adults and their young leaving in summer and adults returning in fall with occasional observations of young. In a few territories, landowners reported observing adults in the general vicinity throughout summer.

TPWD staff coordinated a research project from 1985 to 1991 with interested landowners to capture, band, and color tag eaglets in the nest and follow their movements as long as the tags (coded colored leg-bands and patagial markers) lasted (Mabie et al. 1994). Data were also collected on pre- and post-fledging survival, and nest site use of the area prior to migration (Mabie 1985). This was the most exciting and dangerous eagle research conducted by TPWD. Staff devised ways to climb trees to nests which were frequently 18 m (60 ft) above the ground. They placed eaglets in cloth bags, lowered them to the ground for measurements, blood sampling, and attachment of markers. The eaglets were then lifted back to the nest and the staff person rappelled to the ground.

Banding eaglets was extremely challenging as each nest tree offered different obstacles. They were tall, very limby, potentially rotten, and not always in accessible locations. The preferred method to climb trees was securing a rope over a large limb just below the nest and lifting staff via pulley connected to a vehicle (see photo on page 4). The first task was to get a rope over a strong limb near the nest. This was accomplished by shooting a projectile attached to a light line from a modified gun with .22 caliber blanks over the targeted limb. The light line was then used to pull up the main support line which had a pulley that had an additional rope which would be attached to the staff person and vehicle. The staff person with tree climbing gear was lifted by backing the vehicle. It was something similar to an improvised country elevator ride. The staff person then used tree climbing gear to climb further up the tree and into the nest.

Eaglets were banded with a #9 U. S. Fish & Wildlife Service pop rivet band, and a pop rivet color leg band on the opposite leg. Vinyl patagial markers with unique codes and colors for location per bird were attached to each wing. Ground checks were made the day after banding to determine if adults returned to feed the young and weekly ground checks were made to determine fledgling success (Mabie 1985). A total of 85 eagle nest trees, representing 26 nesting territories in 16 counties, were located by aerial surveys, visited on the ground, and climbed if conditions were safe for the birds and researchers. Over the life of the project, 138 eaglets, ages 6 to 11 weeks were banded and color-marked.

Letters and requests for information on observed or recovered marked eagles were sent to all U. S. state and Canadian province nongame/endangered species divisions following each banding season. Reports or sightings of wing-marked eagles were evaluated on the basis of correspondence or telephone conversations with the observer. Consecutive sightings of a single marked bird within one general area and in the same year were recorded as one sighting. Marked nesting birds observed in consecutive years at nest sites were recorded each year as one sighting.

Survival to fledging of color-marked eaglets was determined through fixed-wing aerial surveys

(Nesbitt 1988) and ground checks of all nest sites. Fledging success was determined when marked birds were observed in flight or away from the nest tree. Survival of color-marked eaglets to fledging was 97%. If eaglets survived to 6 weeks, there was a strong possibility they would fledge. Productivity during this project was 1.6 eaglets per nest, which was indicative of an expanding population (Buehler et al. 1991) and as high as any recorded value for productivity (Sprunt et al. 1973).

Three band recoveries were reported from 1985–1993. A juvenile female hatched in Brazoria County died 2 months after fledging in Red River County, a male banded in Matagorda County was hit by a car in LaFourche Parish, Louisiana, and another eagle was shot in Liberty County 3 years after banding in Colorado County.

Sightings of 29 adult and 32 immature color-marked eagles were verified from 1985–1993. Forty-one sightings were reported from within the state with 70% occurring from November to March. A marked eagle observed in Cameron County was the most southerly documentation of a Bald Eagle in Texas.

Twenty sightings were outside of Texas with 74% occurring from May to August. Observations of color-marked eagles indicated a gradual spring-summer northward migration begins in April. Marked birds moved across a broad region from the Rocky Mountains to the Mississippi River and north into Canada. Two sightings occurred on the Atlantic Coast (South Carolina, New York), 1 in Mexico (Sonora), and 1 in Arizona. In 1989, a nesting eagle with a yellow wing tag and black lettering was reported in Sonora, Mexico. The alpha-numeric code was not fully legible, but the first 2 numbers indicated the bird had been banded as an eaglet in Texas in 1985. The eagle sighted in Arizona has recently been confirmed as nesting there. We suspect that Bald Eagles fledged in Texas may enter breeding populations throughout the southern breeding range.

Recruitment into the Breeding Population

Of 138 Bald Eeagles color-marked as eaglets in Texas from 1985–91, 46 are known to have attained breeding age. Twenty percent (9 of 46 eagles) established nesting territories in Texas. These nine eagles occupied 7 nesting territories (Mabie et al. 1994). Two of the 9 birds were males (a 3-year-old and a 4-year-old) that mated with females at established nest sites. The females presumably lost their mates the previous year. One male was observed nesting for 3 consecutive years and the other male for 5 consecutive years. TPWD personnel recorded two instances in which both members of a breeding pair were color marked as eaglets in Texas. One pair nested for 2 consecutive years. Three other new nesting territories located in 1989 and 1990 contained 1 individual color-marked as an eaglet in Texas. All 7 nesting pairs successfully fledged young in consecutive years. We were unsuccessful in identifying the specific nest site from which these color-marked breeding bald eagles were fledged. Data on marked eaglets returning to natal breeding areas as breeding adults establishing nesting territories are lacking (Stalmaster 1987). Many eaglets have been banded and/or radio-tagged (Broley 1947, Gerrard et al. 1978, Buehler et al. 1991, Gerrard et al. 1992, Hunt et al. 1992), but there are few reports of eaglets returning as nesting adults (Swenson et al. 1986, Gerrard et al. 1992). Data indicated that bald eagles fledged in Texas exhibited strong fidelity to natal nesting areas for breeding (Mabie et al. 1994).

The USGS Bird Banding Lab (BBL) Bald Eagle band return data were queried for all recoveries in Texas thru 2008. Twenty-two Bald Eagles banded as nestlings outside of Texas were recovered in Texas. Sixty-eight percent of recoveries occurred during the first year, 9% the second year, 18% the third year and 1 eagle was recovered after 10 years. Roughly equal numbers were recovered from the Panhandle, near San Angelo, the Hill Country, Dallas, and northeast and southeast Texas (Danny Bystrak, pers. comm.).

To date, 8 eaglets of the 138 banded have been recovered (Table 3). In comparison, Bald Eagle nestlings banded in Texas (Table 3) had a higher survival rate than those banded outside Texas. To date, 8 eaglets of the 138 banded have been recovered. Two were recovered during the first year, 1 at 2 years, 2 at 6 years, 1 at 9 years, and 2 at 15 years. These Texas eagles also tended to wander. One was recovered in California after 3 months, 1 recovered in Colorado at 2 years, 1 recaptured in Arizona after 6 years, and 1 was recovered in New Mexico at 6 years (Table 3).

NESTS

With the exception of an increasing number of nests available for public viewing, most nests are located in semi-isolated areas with very low human traffic or near the top of the highest tree in the vicinity, often a cottonwood (*Populus deltoids*),

Table 3. Locations by county or state of banding and recovery sites for Bald Eagles banded in Texas.

Band location	Band date	Recovery date	Recovery location	
Columbus	4/1/1988	3/25/1997	Fayette	9 yrs
Calhoun	3/10/1987	3/17/2002	Matagorda	15 yrs
Sabine	3/29/1988	1/25/2003	McKinney	15 yrs
Matagorda	3/31/1988	5/7/1994	Arizona	6 yrs
Brazoria	4/2/1987	6/1/1987	Tyler	2 months
Grimes	5/3/1988	6/5/1994	Albuquerque	6 yrs
Goliad	3/5/1991	11/30/1993	Boulder	2 yrs
Colorado	4/2/1987	7/3/1987	California	3 months

pecan (*Carya illinoensis*) or sycamore (*Platanus occidentalis*) (Allen 2009).

Bald Eagles tend to nest in the largest tree available that provides an easy flight access, clear view of the surroundings, near permanent water, and within its breeding territory. Water sources in Texas were mostly rivers, creeks and reservoirs. Bald Eagles did not nest near tidal areas in Texas as elsewhere (Buehler 2000). Lack of trees large enough to support nests might be the limiting factor.

Bald Eagle nesting along coastal rivers tended to predominantly use pecan, water oak (*Quercus nigra*), live oak (*Quercus virginiana*), cottonwood and sycamore trees because these were likely the largest canopy trees available. When the eagles started nesting in East Texas, the dominant tree used for nesting was loblolly pine (*Pinus taeda*).

Some Bald Eagle nests last decades (Buehler 2000), but most nests in Texas are only used a few years. The use of 261 nests was tracked by TPWD personnel from first construction until they fell apart. Nest longevity averaged 4.2 years with a standard deviation of 3.4 years (Fig. 2). While the nest that lasted 20 years is very memorable, the normal scenario had nests in use from 1 to 4 years with nests falling apart for a number of reasons which included storms, tree mortality, limbs breaking, etc.

Hurricanes

One potential threat to nest longevity is hurricanes. Broley (1947) reported severe impacts by a hurricane in Florida on nesting eagles with 18 nests blown down by an October hurricane and 27 nests damaged. This was 4 to 6 weeks prior to normal nesting in the area. Although all nests, except 1, were either repaired or rebuilt, the Bald Eagles produced no young that breeding season. Broley (1947) attributed this to stress related to the hurricane.

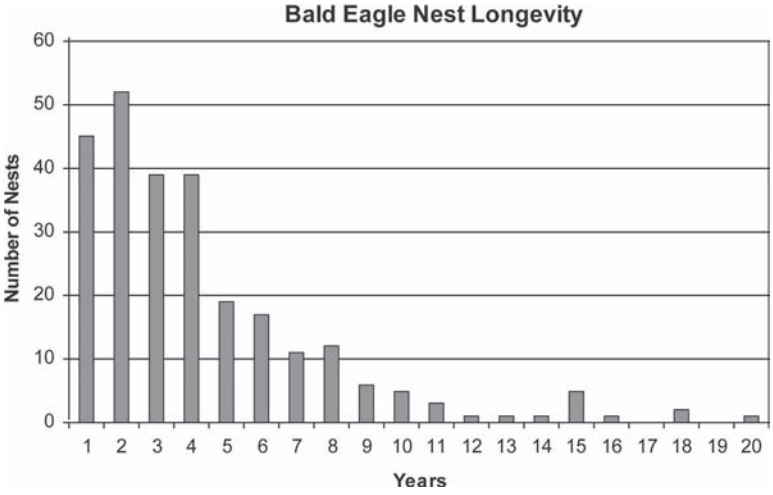


Figure 2. Longevity of 261 Bald Eagle nests in Texas.

Hurricanes hitting the Texas Coast are almost an annual event. About half pass through areas of nesting Bald Eagles. Hurricane Claudette passed through Texas coastal counties during July 2003 as a Level I hurricane during the non-nesting season. This was 4 months before Bald Eagles were expected to begin laying eggs. Nesting data from 8 counties not impacted by the hurricane were compared to 7 counties that were. Noticeable hurricane impacts were mostly knocked-down nests and tall trees that potentially would serve as nests in the future. Seven nests in the 7 counties within the path of the hurricane were destroyed by the storm and all were rebuilt during the following fall when nesting commenced. The 8 adjoining non-impacted counties had 14 nesting attempts that fledged 22 eagles before the hurricane in 2003, and 16 nesting attempts and fledged 32 eagles after the hurricane in 2004. The 7 impacted counties had 19 nesting attempts before the hurricane that fledged 31 eagles in 2003, and 20 nesting attempts fledged 33 eagles after the hurricane in 2004. Short-term loss of nests was the only noted impact.

Hurricanes Ike (2008) and Rita (2005) likely destroyed a number of Bald Eagle nests in Texas, but as long as there were sufficient nest trees surviving in suitable areas for nesting that were relatively isolated and near rivers and lakes the eagles were expected to re-build in the same territories. We do not know if production dropped due to these hurricane related events.

FOOD ITEMS

The Bald Eagle is most associated with wetlands throughout its range (Buehler 2000, Allen 2009) and as human populations increase in Texas, demand for water and society's impacts on wetlands are likely to increase. Understanding food preferences and distribution and density of available foods are important for providing the needs of an increasing population of Bald Eagles.

David Mabie's TPWD team of eagle researchers collected food remains during February to May from 1985 to 1991 at nest sites (Mabie et al. 1995). Most of the 661 food items came from the nest bowl. Food debris around the nest tree was usually scarce or absent and was likely scavenged. Birds represented 33.7% of the remains and American Coots (*Fulica Americana*) accounted for 52.5% of bird remains. The American Coot was also the most abundant prey item in Florida (McEwan and Hirth 1980), Louisiana (Dugoni et al. 1986), and Arizona (Haywood and Ohmart 1986). Other waterfowl represented by 11 species comprised 38.6% of bird remains in Texas. Bald eagles were commonly observed feeding on crippled or diseased geese and ducks in rice fields and typically nested in nearby riparian forests.

Reptiles comprised of 30.7% of prey remains at nest sites, and softshell turtles (*Apolone* spp.) accounted for 89.7% of these. Some eagles seemed to specialize on capturing softshells with 1 nest containing as many as 20 of these turtle shells. This finding of large reptile use is unique to Texas. Studies across the range of the species typically indicated that reptiles comprised $<1\%$ of the diet. The bulk of foraging for softshell turtles occurred along the Brazos, Colorado and Trinity rivers.

Fish comprised 30% of prey remains with freshwater catfish (*Ictalurus* spp.) and carp (*Cyprinus carpio*) being the most common fish, 64.8% and 20.1%, respectively.

Mammals accounted for only 5.5% of prey remains with rabbits making up 63.9%. Eagles were observed scavenging at deer (*Odocoileus virginianus*) carcasses, but no deer remains were observed at nest sites.

These results indicated that food availability was not a limiting factor to the growth of the eagle nesting population during the time of the study. With major prey items mostly associated with wetlands, it was suggested that eventually the availability and quality of wetlands would be an important issue in the future of Bald Eagles (Mabie et al. 1995).

Since this study, Bald Eagles have been frequently observed scavenging on road killed deer and other large mammals particularly in areas of high nesting density. As nesting density increases, opportunistic availability of foods found in wetlands may become more limiting and eagles foraging in competition with vultures (Cathartidae) and Crested Caracara (*Caracara cheriway*) may be more common.

UNIQUE SITES

Bald Eagles nest in many interesting places. Most are in relatively secluded floodplains away from daily visits from the public. One very unique nest was located near Dalhart in the extreme northwestern panhandle far from any permanent water of any size. Other nests were located in full public view and received varying visitations from the public. Some were several hundred meters (yards) from public

roads are hardly noticed, while others were conspicuously located within 100 m (100 yards) of public roads received thousands of human visitors per year.

Panhandle Nest

Boal et al. (2006) observed a breeding Bald Eagle pair nesting in a short-grass prairie and agricultural community on the southern Great Plains of the Texas Panhandle in 2004 and 2005. The nesting eagles produced 1 fledgling in 2004 and 2 fledglings in 2005. Their assessment of land cover types within a 4-km (3-mile) radius of the nest indicated that grasslands accounted for most of the area (90%) followed by agricultural lands (8%). Black-tailed prairie dog *(Cynomys ludovicianus)* colonies occupied 2.5% of the area and a single human residence with associated structures (i.e., barns) occupied <1%. The nearest source of permanent surface water >2.4 ha (6 acres) in surface area was 51.5 km (32 miles) to the nest. An analysis of regurgitated castings collected near the nest revealed a mammalian-dominated, breeding-season diet with black-tailed prairie dogs occurring in 80.9% of castings. Other identified prey included cottontails *(Sylvilagus* spp., 15.9%); black-tailed jackrabbits *(Lepus califomicus,* 3.2%), pronghorn antelope *(Antllocapra americana,* 3.2%), and plains pocket gopher *(Geomys bursarius,* 1.6%). Bird remains were also present in 34.9% of castings. This is the first reported successful nesting of Bald Eagles in the Panhandle region of Texas since 1916; the nest is particularly unique because of its distance from any substantial body of water.

The tree supporting this nest fell after this study, and no trees large enough to support a nest occurred nearby. Clint Boal's team was able to get funding to erect a nest tower at the site during fall 2006, and the eagle pair accepted this man-made structure and successfully nested on it. This was the first nesting of Bald Eagles on a nesting platform in Texas. In addition, eagles in South Texas started using large, steel, transmission-line towers. One pair started nesting in 2007 along the Mission River and successfully fledged young in 2008 and 2009. Another pair nested and fledged 1 young on the same powerline 46.7 km (29 miles) further to the northeast along the Guadalupe River in 2009.

Llano River Eagle Nest

In the fall of 2004 travelers along Texas Highway 29 in Llano County noticed a large nest being constructed just off the highway. A Bald Eagle trio (3 adults) was constructing a nest only 120 m (130 yards) from the roadside. The area, 12.8 km (8 miles) east of Llano, soon became a major tourist attraction for Llano County. Bald Eagle sightings in Llano County had been somewhat common and wintering Bald Eagles have always been easy to spot on Lake Buchanan and up the Colorado River.

The nest is located on the bank of the Llano River in the Llano uplift of the Texas Hill Country. The Llano River is a shallow river with a constant flow year round. The clear running water provides ample food supply for the nesting pair. The banks are lined with large pecan, cottonwood and sycamore trees providing plenty of perching and nesting trees. Currently the nest is located in a pecan tree.

Visitors to the nest site from 2004 to 2007 saw a rare event, an eagle trio. Although rare, the third adult appeared to be an older female. It was so common to see the third adult that most visitors thought that it was common to have more than 2 adults at a nest site. The third adult was allowed on the nest while the eaglets were in the nest. At times the nest became very crowded with more than 1 adult along with 1 to 2 eaglets all in the nest at the same time. The third adult was also active with nest maintenance, feeding the eaglets with food brought in by the other eagles and chasing predators away from the area. She seemed to stay close to the nest looking over the eaglets, often perched in a nearby pecan tree. January 2007 was the last time the third adult was seen at the nest site, it is unclear as to why the adult left the nest and area.

The public soon took notice of this nesting trio and crowds of eagle watchers began flocking to the roadside to get a glimpse of the birds. By the time the first 2 eaglets were big enough to peer over the side of the nest, the public was peering back. By now news media from as far as San Antonio, Houston, Dallas and San Angelo had done stories about the nest site and the popularity had grown. As a result of the large crowds Texas Department of Transportation (TXDOT) had to erect "No Parking" signs 3 m (10 ft) from the pavement on both sides of the highway, but allowed parking from the no parking signs to the fence line. In order to slow highway traffic and protect pedestrians crossing a (70 mph, 113 km/hr) highway two large portable signs were put in place on each end of the area cautioning drivers to slow down. Only a few months earlier this stretch of highway was covered with wildflowers and grass, eventually the area was

paved and a 1.5 m fence was built replacing the old barbed wire fence in order to hold back the growing crowd wanting to see what the eagles were going to do next. Local law enforcement was called on constantly to keep traffic moving and to keep the highway clear. In March 2007 a tragic accident happen involving a tractor trailer rig that veered off of the highway into the parking/observation area. Several people were injured and one person was killed.

Since the nest was so close to the highway and a good chance of seeing bald eagles, many photographers were able to capture detailed photos of the adult bald eagles and the eaglets over the years. Most photographers would show up to the site before sunrise to setup their cameras in the better spots and stay most of the morning. A number of photographers were selling their photo's on the internet and at the nest site. Some photographers went as far as to set up tents with generator, computer and printer so that a visitor could get an up to the minute photo of what they saw when they where at the site. Other vendors sold cold drinks and a chance to look at the nest through a telescope. TXDOT eventually stopped vendors from operating in the area due to the massive crowds that were on the shoulder of the highway.

Even though this is a highly visible and visited nest site, the adult nesting pair continues to raise eaglets. Two eaglets fledged in 2004, 2 in 2005, 1 in 2006, 1 in 2007, 2 in 2008, and 2 in 2009. Public visitation peaks from hatching in December to fledging in March, and during that time, the eagles and eaglets put on quite the show. The morning hours provide the most activity with feeding, nest building and changing of the guards. The nesting pair has been apparently unaffected by the close proximity of the crowd of spectators.

The Llano nest site has allowed people of all ages to experience this national symbol of freedom providing a direct connection with one of nature's wonders. Every fall people want to see if the nesting pair will return to the nest and then how many eggs will hatch. The roadside fills with anticipation as an eaglet takes that first flight, an awe inspiring moment.

POTENTIAL THREATS

Even though Bald Eagle populations are increasing at the rate of 13% per year, there are still few nesting eagles for a state the size of Texas and many threats still exist.

Lead shot contained in prey and eaten by Bald Eagles have been linked to their mortality and lower productivity (Pattee et al. 1981, Pattee and Hennes 1983, Nelson et al. 1989). The U. S. Fish & Wildlife Service has subsequently required steel shot to be used for hunting ducks and geese. However, lead shot is still used to harvest other wildlife, and we have observed increased use of carrion by Bald Eagles.

A number of diseases have the potential to impact Bald Eagles. The most serious to date has not been known to kill any eagles in Texas. Avian vacuolar myelinopathy (AVM) has been associated with the death of over 100 Bald Eagles and thousands of American Coots in South Carolina and Arkansas (Wilde et al. 2005) since 1994. The agent of AVM is an uncharacterized neurotoxin produced by a novel cyanobacterial epiphyte that coats the leaves of hydrilla (*Hydrilla verticillata*). American Coots eat the affected hydrilla and in turn are eaten by Bald Eagles. Though hydrilla is present in most Texas reservoirs, the triggering mechanism which causes the toxicity has not been known to occur in Texas.

The ultimate threat to Bald Eagles is people. Human populations are expanding in Texas. People are attracted to water and consume huge volumes of fresh water (Texas Parks and Wildlife Department 2002). Buehler et al. (1991) found Bald Eagle use of potential foraging habitat was inversely proportional to the density of buildings on the northern Chesapeake Bay. We have also observed that most Bald Eagles try to nest away from high-people-use areas. A few pairs have adapted to human presence and are nesting in relative close proximity to houses.

While additional suitable nesting habitat has been created with development of inland reservoirs and maturation of forested lands surrounding a few of these reservoirs, disease, habitat loss, disturbance, and human tolerance are still major concerns for nesting populations (Saalfeld et al. 2009). Demand for water for human use increases annually, and at some point will limit food resources available to an expanding Bald Eagle population.

Saalfeld et al. (2009) pointed out that two major habitat requirements necessary for nesting by Bald Eagles are suitable nest trees near foraging areas (i.e., large bodies of water and/or permanent flowing creeks and rivers; Murphy 1965, Livingston et al. 1990, Garrett et al. 1993) and freedom from human disturbance (Murphy 1965, Andrew and Mosher 1982, Garrett et al. 1993, Thompson and McGarigal 2002). However, because of increased

Adult pair looking forward to the future. Photo by Jess Thompson.

recreation and development pressure, these habitat characteristics are becoming increasingly rare not only in Texas, but throughout the lower 48 states (McGarigal et al. 1991).

The future is bright for Bald Eagles nesting in Texas. There are many kilometers (miles) of river riparian areas and lake shorelines that are suitable for nesting and are yet to be occupied. When you see a Bald Eagle, enjoy it for its beauty, its representation of wildness in nature and give it some space. It will thrive and we will all be better off for it.

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