SURVIVAL AND HABITAT USE OF FEMALE NORTHERN PINTAILS WINTERING ALONG THE CENTRAL COAST OF TEXAS

Final Report to:

Ducks Unlimited, Inc.

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February 2006

Northern pintails (*Anas acuta*; hereafter, pintails) are widely distributed in North America during breeding and non-breeding periods. In winter, largest concentrations are generally found in the Central Valley of California and the coastal prairies of Louisiana and Texas (Austin and Miller 1995, Bellrose 1980). The Texas Gulf Coast is a winter terminus for millions of waterfowl annually, and supports up to 78% of Central flyway pintails during the nonbreeding period (Bellrose 1980, Stutzenbaker and Weller 1989, U.S. Fish and Wildlife Service 2004). Wintering pintails arrive along the Gulf Coast of Texas in September and are most abundant during late November-January, with some individuals remaining into April (Bellrose 1980, Austin and Miller 1995).

Although the Texas Coast remains an important wintering area for many waterfowl species, wintering duck habitat has declined over the last several decades within this region, particularly habitats important to pintails (Moulton et al. 1997, Wilson and Esslinger 2002). The Texas Coastal Zone encompasses approximately 6% of the land area of the state; however, it supports one-third of the human population and economic wealth (Stutzenbaker and Weller 1989). Historical and continuing wetland losses due to anthropogenic disturbances have increased the need to conserve pintail habitat (Dahl and Johnson 1991). Moulton et al. (1997) estimated that over 100,000 hectares of non-farmed freshwater wetlands have been lost throughout the Coastal Plain of Texas in the last 50 years. Compounding the loss of natural wetlands, recent large-scale conversion of rice agriculture to cotton and soybeans in the Rice Prairie Region of Texas has resulted in considerable loss of wintering pintail habitat. Acreage planted in rice has declined by 60% over the last 2 decades, of which Texas lost 52,120 hectares (34%) between 1988 and 1998 (Esslinger and Wilson 2001), with further declines anticipated because of problems crippling the Texas Rice Industry (Alston et al. 2000). Currently, the Texas Rice Industry contributes nearly $1 billion annually to the state economy, with 50% coming from crop sales and the remainder from outdoor revenues, such as waterfowl hunting and bird watching (Cockrell 2005).

The effects of large-scale loss of wintering habitat on pintail populations are unknown. Because of pintails' greater reliance on stored reserves during nesting relative to most species, wintering habitat quality likely plays a role in subsequent recruitment. Raveling and Heitmeyer (1989) found that pintail production was directly correlated to the quality of wintering habitat the previous winter. Similarly, Heitmeyer and Fredrickson (1981) found a high correlation between winter habitat conditions and recruitment the following spring in mallards. Thus, the relationship between wintering habitat conditions and breeding population dynamics can be important, particularly for early nesting species (Krapu 1974, 1981, Hobson et al. 2005).

Influences of wintering habitat on overwinter survival have been reported for several species. Bergan and Smith (1993) found that female mallard survival in the Playa Lakes Region was greatest during wet years. Female American black ducks (*Anas rubripes*; Reinecke et al. 1982) and male canvasbacks (*Aythya valisineria*; Haramis et al. 1986) provide additional information indicating a positive relationship between winter habitat conditions and the survival rates of waterfowl.

Currently, there is little published information on survival rates for pintails in coastal Texas. Hestbeck (1993*b*) found no geographic variation in annual survival rates of female pintails throughout North America based on banding data. However, other findings using conventional radio telemetry suggest there to be considerable variation in regional over-winter survival of pintails throughout North America. For instance, pintails in Louisiana and Arkansas (Cox et al. 1998), the San Joaquin Valley of California (Fleskes et al. 2002), and the Suisun Marsh of California (M. Casazza, United States Geological Survey, unpublished data) were found to have high harvest rates and low winter survival. In contrast, female pintails in the Sacramento Valley of California (Miller et al. 1995), Sinaloa, Mexico (Migoya and Baldassarre 1995), and the Playa Lakes Region (PLR) of Texas (Moon 2004) were found to have low harvest rates and high winter survival. The contrasting results suggest that harvest and survival rates vary geographically. Similar reports for geographic variation in survival rates have been reported for winter-banded canvasbacks (*Aythya valisineria;* Nichols and Haramis 1980, Reinecker 1985, Haramis et al. 1986, Hohman et al. 1993). Differing results for mallards reveal that survival rates generally do not differ among geographic areas (Burnham et al. 1984, Drilling et al. 2002). Therefore, an understanding of regional survival estimates and identification of factors influencing survival and harvest rates in an area holding the majority of pintails in the Central Flyway is critical for sound management strategies. Because of large-scale habitat changes on the Canadian Prairies, most attention on pintail recovery has been placed on evaluating issues pertaining to vital rates and habitat changes on breeding areas (Cox et al. 2000). However, because pintails rely on endogenous reserves for reproduction, and because there is indication of large geographical variation in survival rates, issues dealing with migration and wintering areas are also of concern. Undoubtedly, winter conditions will affect habitat use by pintails on the Texas Coast. A basic understanding of habitat use by pintails is fundamental to habitat management and refuge establishment for pintails wintering in this region. This basic understanding also is critical for effective delivery of land management and acquisition programs by federal, state, and private agencies.

The objectives of our study were to estimate rates of survival and harvest of adult and juvenile female pintails, and document diel (daytime and nighttime) use of habitats by female pintails.

STUDY AREA

Historically, the coastal prairie of Texas was a tall grass plant community interspersed with bands of woodlands along streams and bayous, and natural depressional wetlands that were wet during winter and through spring (Linduska 1964, Prochaska 1993). The Texas Gulf Coastal Zone, known physiographically as the Gulf Prairies and Marshes (Gould 1975), extends for nearly 600 km with approximately 2,300 km of shoreline along bays, lagoons, and estuaries (Brown et al. 1980). Coastal wetlands encompass about 192,000 hectares of the Texas Coast (Alexander et al. 1986), or 6% and 12% of the national and regional totals, respectively (Field et al. 1991). A 684-km long Intracoastal Waterway influences the Texas coastline and has modified salinities along its route (James et al. 1977, Tunnell and Judd 2002). The Texas Gulf Coastal Zone is further broken down into the upper, mid-, and lower coast regions, including all or parts of 17 counties.

This study was conducted throughout the Gulf Coast and Rice Prairie Regions of the Texas mid-coast (Fig. 2). Our research focused on the GCJV Texas Mid-Coast Initiative area, which includes 16 counties from Galveston Bay to Corpus Christi and encompasses a total land area of over 3.55 million hectares (Wilson and Esslinger 2002). The area contains varying wetland habitats (Stutzenbaker and Weller 1989), of which three major waterfowl habitats are available: agricultural lands dominated by rice and pasture, coastal marsh, and seagrasses with their associated estaurine wetlands (Wilson and Esslinger 2002).

The prairies in the Texas rice belt are found along the southeastern Gulf Coast of Texas, comprised of 4 major prairies as well as 6 smaller, adjacent prairies that encompass approximately 900,000 hectares in portions of 18 counties (Hobaugh et al. 1989). The major rice prairies of Texas are the Beaumont, Katy, Lissie, and Garwood prairies, and are referred to as the Gulf Coast Prairie vegetational region (Gould 1975). Our efforts will concentrate on the Katy, Lissie, and Garwood prairies that occur in the mid-coast region south and west of the Houston metroplex.

The climate of mid-coastal Texas is humid, with mild winters and an average growing season of 270 days per year (Mc Ewen and Crout 1974). Average annual rainfall in the rice prairies is 104 cm, ranging from 90-104 cm per year (Hobaugh et al. 1989), with other parts of the mid-coast receiving 60-80 cm annually (Norwine et al. 2005). Average annual evapotranspiration rates range from 45-50 cm (Norwine et al. 2005). Temperatures during fall and winter are typically mild, with the lowest readings occurring in December and January (NOAA 2004). Due to unpredictable weather events, such as tropical storms and hurricanes, precipitation patterns and resulting wetland conditions along the Texas coast are highly capricious (Grand 1992).

METHODS

Pintails were captured along the Texas mid-coast from 21 October-21 November 2002 and 10 November–30 November 2003 with baited rocket nets and swim-in bait traps. We delayed trapping effort until late October-November due to concerns of potentially tagging migrants en route to more southern areas (e.g., lower Texas coast, east coast of Mexico, and Yucatan Peninsula) (Bellrose 1980). Female pintails were fitted with conventional radiotransmitters (Texas A&M University–Kingsville University Institutional Animal Care and Use Committee approval #2001-11-4, United States Geological Survey banding permit #21314–K); our goal was to radio-tag equal numbers of adults [after hatch-year (AHY)] and immatures [hatch-year (HY)].

At capture, each female was aged (AHY or HY; Duncan 1985, Carney 1992) and sexed using cloacal and wing- and tail-feather characteristics (Hochbaum 1942; Carney 1992, 1993), weighed to the nearest 5 g using a Pesola scale, and the following morphometric variables were measured using digital calipers (0.01 mm): (1) central culmen length, (2) head length, (3) total tarsus length (Dzubin and Cooch 1992), (4) middle toe length. Flattened wing chord length (1 mm) was measured using a graduated ruler. Birds were allowed to sufficiently dry prior to weighing. To account for ingesta, upper digestive tract contents were scored (0-4) based on the amount of rice in the esophagus, similar to techniques used for pintails in Louisiana (Cox and Afton

1998). Area of capture, Gulf Coast (GC) or rice prairies (RP), was recorded.

Female pintails were fitted with a harness-type, 21-g VHF radiotransmitter (Dwyer 1972), each with a unique frequency (165-167.999 MHz) and an expected life of 200 days. Radiotransmitter harness loops were fitted and tightened, with feathers preened under harness loops according to procedures from Cox and Afton (1998) and Houston and Greenwood (1993). We did not attach transmitters to females that weighed < 600 g at capture. Any female that appeared to show signs of stress (e.g., excessive panting) during transmitter attachment was immediately returned to the holding pen and processed at a later time. Female pintails were banded with standard, U.S. Fish and Wildlife Service, size 6, aluminum leg bands.

All radiotransmitters had mercury-type mortality sensors, which caused the pulse rate to double (120 bpm) if transmitters were motionless for >8 h, and were coded to give an extra pulse every ten pulses to distinguish them from any other radiotransmitters on the same frequency. Transmitters had minimum ground-to-ground ranges of 7 km to truck-mounted 4-element null-peak antennas and minimum ground-to-air ranges of 60 km to fixed-wing aircraft at altitudes of 1300–1700 m. Each radiotransmitter carried a label on the ventral side offering a reward (pen-and-ink print) to hunters for contacting project personnel and providing information about the bird (date, time, and location bird was harvested; flock size, etc.).

Instrumented females were provided rice (*Oryza sativa*) and water *ad libitum* while being held and were released at their capture sites ≤24 h following capture. Flight status was recorded upon release (scored as poor, moderate, or good; Cox and Afton 1998). Captured male pintails were held with females to reduce the probability of breaking pair bonds as space for captured individuals permitted. Males and females not receiving transmitters were processed, banded, and released with instrumented females.

We monitored status (alive or dead) and location of female pintails at 5 day intervals. We attempted to divide sampling effort to monitor habitat use equally between diurnal and nocturnal periods, obtaining a diurnal and a nocturnal location every 5 days per marked individual. We used fixed-wing aircraft outfitted with 4-element null-peak telemetry antennas to search the entire study area. Intermittent flights were made along the upper and lower Texas coasts to search for missing individuals (no signal within the study area). Aerial locations were communicated to technicians in trucks equipped with 4-element, null-peak telemetry antennas for accurate estimation of locations using triangulation.

Electronic compasses (Azimuth ® 1000R, KVH Industries, Inc., Middletown, R.I.) were used to increase tracking efficiency while yielding accurate estimates of locations without sacrificing precision. We calibrated the antenna systems each week to known locations of beacon transmitters to within $\pm 0.5^{\circ}$ accuracy. Accuracy and precision of triangulations were assessed on-site using Location of a Signal (LOAS) software (Ecological Software Solutions 1999), Global Positioning System (GPS) receivers (Garmin Etrex Venture, Garmin International, Inc., Olathe, Kansas), and laptop computers. When error ellipses exceed 20 hectares, additional azimuths were acquired until the estimated error ellipse was reduced below the accepted threshold.

Radiotransmitters detected in mortality mode were investigated immediately. Hand-held antennas were used to locate mortalities on the ground following triangulation via truck telemetry. Females that were alive but were emitting a false mortality signal were flushed every 5 days for status and a location was recorded if the bird flushed. In areas inaccessible to vehicles, mortalities were estimated from fixed-wing aircraft using telemetry, a Garmin35 GPS (Garmin International, Inc., Olathe, Kansas), and a Compaq Pocket PC with Anywhere Map software.

Cause of mortality was investigated and determined if sufficient evidence based on location and characteristics of the carcass warranted a known fate. Hunter harvest reports were recorded throughout the waterfowl season as hunters relayed harvest information to researchers.

Hunting regulations for pintails were lessened to the last 39 days of the 2002-2003 and 2003-2004 waterfowl seasons with a daily bag limit of 1 bird (either sex). Regular pintail seasons (South Texas Zone) were from 12 December 2002 to 19 January 2003, and from 11 December 2003 to 18 January 2004. Youth only hunts (1 pintail included in daily bag) were conducted from 26–27 October 2002 and 18–19 October 2003. Regular duck seasons extended from 2 November–1 December and 7 December–19 January in 2002–2003, and 25–26 October and 8 November–18 January during 2003–2004.

Survival estimations were initiated 72 hours following release to allow for acclimation and potential radio effects (Gilmer et al. 1974, Migoya and Baldassarre 1995, Cox and Afton 1998). We used Program MARK (White and Burnham 1999) to estimate over-winter survival of female pintails. Using the nest survival function Program MARK, we modeled over-winter survival as a function of year, age, capture site, body condition index, and a time trend within year.

RESULTS

In 2002-03, weekly Palmer Drought Severity Indices indicated near normal (-1.9 to +1.9) to unusually moist (+2.0 to +2.9) conditions prior to trapping on 19 October 2002. Conditions became very wet through February (PDSI > 3.0) followed by a drying trend into April that brought the PDSI back to normal (http://www.cpc.ncep.noaa.gov). In 2003-04, PDSI for the Texas mid-coast remained relatively normal throughout winter.

Severe weather influenced our trapping success as well as habitat conditions during our study. Large rainfall events flooded bait sites, shorted-out rocket nets and caused them to fire unmanned (no waterfowl caught). In addition, a tornado on 17 November 2003 killed several pintails, northern shovelers (*Anas clypeata*), and blue-winged teal (*Anas discors*), tossing some birds into power lines on one of our bait sites south of Pierce in Wharton County. Tropical storm Fay made landfall 16 km east of Port ‘O Connor on 7 September 2002 and deposited over 33 cm of rainfall in parts of Brazoria County and much of the Garwood, Lissie, and Katy prairies. In addition, Hurricane Claudette, a category 1 hurricane, made landfall in the same general location near Port ‘O Connor on 15 July 2003, with a storm surge reported at 2–3 m above normal tide levels (http://www.srh.noaa.gov).

We captured and attached radiotransmitters to a total of 315 (141 adults, 174 immatures) female pintails using baited rocket nets and swim-in traps during late October to late November in 2002 and 2003. In 2002, we captured 157 female pintails (78 AHY and 79 HY) at Peach Point Wildlife Management Area in Brazoria County, and at the Myrtle-Foester-Whitmire unit of the Aransas National Wildlife Refuge (MFW-ANWR) in Calhoun County. In 2003, we captured 158 female pintails (62 AHY and 96 HY) at the MFW-ANWR and at the Wintermann Wildlife Management Area in Wharton County. Mean holding time for processing birds during the first year was 19.5 hours, and was 15.2 hours in 2003. State and federal lands were chosen because of the problems associated with baiting migratory game birds on private lands during the hunting season and the lack of cooperation from federal law enforcement officers on providing post-baiting inspection and approval to private landowners that had granted us permission to capture on their lands.

Survival.—We considered radio-marked females to be at risk for survival analysis 72 hours following release based on distributions of mortalities across time, and previous findings (Cox and Afton 1998). Over-winter survival ranged from 0.17 to 0.61 (Table 1). We detected a significant age effect both years as immature females were 1.3 times more likely to die than adults. During 2002-03, cumulative daily survival was estimated to be 46% for AHY and 32% for HY females (these birds were radioed primarily on MFW-ANWR). In 2003-04, there were significant age and capture site effects with birds captured in the Rice Prairie region 1.7 times more likely to die than those from MFW–ANWR. Over-winter survival was 60% for AHY females and 48% for HY females captured on MFW–ANWR, and 31% for AHY and 17% HY females captured in the Rice Prairies. A quadratic time trend explained most variation across the winter period each year, with survival increasing throughout mid-February then declining through departure. Body mass at capture had no influence on a female's ability to survive winter in either year.

Cause of Mortality.--Although cause-specific mortality was not one of our objectives of this study, we recorded the fates of all known mortalities during both years. Since radiotagged pintails were being tracked in several counties in the mid-coast for habitat use and survival estimates, our large sample precluded us from monitoring status any more frequent than twice every 5 days. The sampling interval combined with the lag time for the mortality sensor to activate (8 hours) increased time for the possibility of scavenging, resulting in many unknown fates.

Mortality dynamics were quite similar between the 2 years of our study. We recorded 122 mortalities across both years (65 in 2002-03 and 58 in 2003-04). Harvest related mortality accounted for 37% of pintail mortality in both 2002-03 and 2003-04. Of these, 6 (about 13% each year) were harvested during regular duck season, but prior to the opening of the restricted pintail season. Some of these were phoned in for the reward information and the hunters were unaware that the pintail season had not yet opened. About 50% of the harvest-related mortality was from legal hunter harvest each year, and 35% was suspected crippling loss. Only one of the birds that we radioed in our study was shot outside of the Texas mid-coast. This bird was shot 18 miles west of Raymondville in Willacy County in South Texas.

The majority of harvest occurred away from the coast and in the Rice Prairie region. In 2002, all birds were captured relatively close to the Gulf Coast, however, 54% of the harvest occurred when birds emigrated northwest to the Garwood or Lissie prairies. In 2003, about 45% of our sample was radioed in the Garwood/Lissie prairies and resulted in 90% of the harvest-related mortalities occurring in the Rice Prairies.

Other known causes of mortality included avian depredation (4%) and avian cholera (*Pasteurella multocida*, 2%). Mammalian depredations and unknown fates (58%) were combined because of our inability to separate true mammalian depredation from the diverse array of mammalian scavengers that left signs on carcasses.

Of the two pintails that succumbed to avian cholera, one was recovered on 27 November 2003 at MFW–ANWR during a short (3-5 day), relatively mild outbreak along the Texas mid-coast. Several carcasses of lesser snow and Ross' (*Chen rossii*) geese were observed at MFW–ANWR at the same time, along with observations of carcasses of blue-winged teal, shovelers, and snow geese in Wharton County. The other was recovered at MFW–ANWR on 19 April 2004.

We obtained 7,022 locations on radio-marked female pintails during the 2 years of study. Based on percentage of locations in each habitat, female pintails used habitats similarly between years. Fifty-two percent of locations were in rice habitats (18% in current rice, and 34% in fallow rice) each year. Pintails also were observed using vegetated, freshwater wetlands for 44% of the locations. Of these, 74% were on managed wetlands as apposed to natural depressional wetlands. All other habitats (flooded agriculture other than rice [e.g., sorghum, cotton, etc.], lacustrine habitats, and esturine habitats) were each used $\leq$ 4% of the time.

During the duck hunting season in 2002-03, pintails used refuge areas (areas where hunting was known not to occur) 35.6% of the time, whereas after the season was closed they reduced the use of refuge areas by 50% (Table 2). During 2003-04, pintails reduced the use of refuge areas from 53% during the duck hunting season to 17.4% following the hunting season. Diurnal use of refuge areas showed the greatest decline following the duck hunting season as pintails spent $\geq$ 85% of their diurnal of refuge areas. Nocturnal use of habitats also exhibited a decrease in refuge habitats as pintails spent $\geq$ 75% of their nocturnal time off refuges (Table 2).

Table 1. Estimates of winter survival of female northern pintails captured along the Central Gulf Coast of Texas during late Oct-early Nov 2002 and 2003 and monitored with radio-telemetry and compared to other published studies.

	Survival	
Location	Adult	Immature
Texas Coast (this study)		
2002-03	0.46	0.32
2003-04 – Coast	0.60	0.48
2003-04 – Rice Prairie	0.31	0.17
Playa Lakes, Texas (Moon 2004)	0.69-0.93	
Louisiana (Cox et al. 1998)	0.71	0.55
California (Miller 1995)	0.87	
California (Fleskes et al. 2002)	0.65	0.76
Mexico (Migoya and Baldassarre 1995)	0.91	

Table 2. Percentage of locations of radio-marked female northern pintails in refuge and hunted areas along the Texas Coast during winters 2002-03 and 2003-04.

	Hunting Season		No Hunting Season	
	Diurnal	Nocturnal	Diurnal	Nocturnal
2002-03				
Refuge	33.8	34.8	15.1	24.8
Hunted	66.2	65.2	84.9	75.2
2003-04				
Refuge	53.0	49.4	10.7	21.0
Hunted	47.0	50.6	89.3	79.0

DISCUSSION

Survival of female pintails along the Texas Coast appears to be lower than that reported for female pintails in other regions of North America and emphasizes the importance of understanding components of over-winter mortality for this species of conservation concern. In addition, our findings are lower than similar studies using harness-type transmitters to report over-winter survival and harvest rates of mallards and American black ducks (*Anas rubripes*) (Reinecke et al. 1987, Conroy et al. 1989, Bergan and Smith 1993, Dugger et al. 1994).

Other recent research on female pintail survival along the Texas Gulf Coast has provided corroboration to our findings of relatively low survival rates. A study addressing large-scale movements and survival using female pintails instrumented with PTTs was conducted during 2001 and 2002 (M. Miller, USGS, unpublished data). Of 20 female pintails marked with PTTs on the lower- and mid-coasts of Texas (10 at each location), only 5 were known to have survived long enough to initiate spring migration. Survival estimates of PTT-marked pintails in other locations that the study was implemented were considerably greater, and are consistent with estimates of survival derived from conventional radio-telemetry methods in those regions.

Survival of female pintails in the PLR of Texas during the same period as this study was considerably higher (69-92.5%; Moon 2004) than for pintails along the Texas Gulf Coast. Comparison between the 2 studies is unique in that radio-transmitters from the same source were used on all females and were fitted by the same individual for both studies, negating any differences in radio effects. Moon (2004) reported 34 total mortalities out of 327 tagged females, with relatively higher mortality (76%) experienced during the second year, presumably as a result of declines in habitat availability. Estimated harvest rates were quite low relative to other studies, including ours. Only 4 birds died of known harvest-related causes. One of the 4 birds emigrated from the PLR and was harvested near El Campo in Wharton County along the Texas Gulf Coast.

Regional variation in estimates of hunting mortality has been shown to exist for other research with pintails. Harvest-related mortality accounted for 36% of mortalities each year of our study and appears to be lower than that reported in California (83%; Fleskes et al. 2002) and Louisiana (65%; Cox et al. 1998). Both our study and Cox et al. (1998) occurred during periods of restricted pintail harvest (30 day season, 1 bird daily bag). In Mexico, hunting was the primary cause of mortality, however, over-winter survival was found to be high (91%) (Migoya and Baldassare 1995).

It appears that hunting-related mortality is variable within the Texas mid-coast region. A greater proportion of birds were harvested in the Rice Prairies compared to those areas along the Texas Coast. Several birds that emigrated from the coast into the Garwood or Lissie prairies died soon after arrival. Additionally, it appeared that harvest rates decreased along the coast from 2002-03 to 2003-04. Only 1 radio-marked bird was harvested along the coast during 2003-04, however, we observed a larger emigration of birds from coastal areas to the rice prairies that year. Hunting pressure was notably lower in coastal areas during 2003-04. Several areas that experienced intense hunting pressure in 2002-03 were not hunted in 2003-04. Estimates of duck hunter days in Texas (Harvest Information Program) decreased by 25.7% from the

2002-03 to the 200304 hunting seasons (Kruse 2004). The Texas Coast supports 55% of the state's active waterfowl hunters and accounts for 52% of the total annual harvest (Gulf Coast Prairies and Marshes; Texas Parks and Wildlife, unpublished data), thus, the reduced hunter activity may have played a large role in the higher estimated survival along the coast in 2003-04.

Natural causes of mortality appear to be the primary cause of death along the Texas Coast and in the PLR (Bergan and Smith 1993 and Moon 2004). Unknown fates of pintails made up a significant proportion of the mortalities recorded in this study, much of which are assumed to be non-hunting related. Stutzenbaker (1988) commented on the diverse predator and scavenging community along the Texas coast that had a large impact on the mottled duck population. Research on the J. D. Murphree Wildlife Management Area along the upper Texas Coast revealed that waterfowl carcasses that were randomly placed on the WMA were usually scavenged within one day (D. Lobpries, Texas Parks and Wildlife, personal communication). Although we did not set out to examine cause-specific mortality, our research suggests that motion-activated mortality sensors are not optimal for quickly assessing mortality. We approached several carcasses of dead pintails that were still emitting an "alive" signal, indicating recent predator or scavenger presence (i.e., 8 hour motion sensor).

Moon (2004) found that pintails engaged in dry field feeding, presumably due to exhaustion of the wetland food resource (Sheeley and Smith 1989, Smith and Sheeley 1993). She speculated that birds were subjected to increased exposure to predation when required to feed in agricultural fields. We found no evidence of dry field feeding by pintails throughout the Texas mid-coast. Research in the PLR also indicated that birds in better condition at time of capture experienced higher over-winter survival (Moon 2004). Our results did not show a similar relationship between body condition and survival rates for pintails on the mid-coast.

Pintails arrived along the Texas Coast in early October and concentrated in large flocks (3,000-20,000 birds), primarily on palustrine wetlands, such as early-flooded rice fields, Texas Prairie Wetland Project (TPWP) sites, and freshwater impoundments used for goose roosts. Each year we observed a general pattern in movements of female pintails from areas near the coast to the Garwood and Lissie prairies which coincided with flooding of first- and second-crop rice fields and fallow rice fields for the regular waterfowl season. Stutzenbaker (1988) observed similar shifts in distribution by mottled ducks (*Anas fulvigula*) from Gulf Coast marshes to the Rice Prairies, especially for second-crop rice. Several radio-marked pintails that spent most of the winter along the coast imigrated to rice habitat in Garwood and Lissie prairies prior to departure in spring. Most pintails had departed the study area by 8 March in 2002 and 14 March 2003, similar to findings reported by Ballard (2001) for the lower Texas coast. We also recorded 3 female pintails that were radioed in the PLR and immigrated to the Garwood and Lissie prairies. No pintails radioed on the Texas Coast were known to have made movements to the PLR.

The importance of rice fields to waterfowl has been well documented. For example, Miller (1987) found that rice fields were important for pintails wintering in the Sacramento Valley of California, with flooded fields providing an additional invertebrate food source in late winter. Rice fields often produce more energy per unit area and are often able to support greater densities of waterfowl than available native wetlands (Fredrickson and Taylor 1982). Second-cropping of rice in Louisiana and Texas paired with standing rice left unharvested on levees (Lobpries 1990) increases rice availability, resulting in an increased food supply for pintails and other water birds (Esslinger and Wilson 2001). We found current and fallow rice habitats to be the most used habitats by pintails in our study. Many individuals that were radio-marked in areas >40 miles from the rice prairies, made movements to these habitats at some point during winter.

Much of the habitat within the Texas mid-coast is managed for waterfowl hunting. A large proportion of these areas are drained in late January as the duck season closes, resulting in a drastic change in available habitat over a short period. The quadratic fit to our time trend in our survival analysis indicates that female survival declines in late winter-early spring. This coincides with the potentially large reduction in available habitat to pintails in early February that may result in reduced resource availability or quality. Further, increased concentration of birds may increase susceptibility to disease or predation.

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